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Contents

Guideline for Radiation Protection of Personnel during the Execution of Maintenance Work in Nuclear Power Plants with Light Water Reactors

Part 1: The Precautionary Protective Measures to be taken during the Planning of the Plant

of 10 July 1978

Richtlinie für den Strahlenschutz des Personals bei der Durchführung von Instandhaltungsarbeiten in Kernkraftwerken mit Leichtwasserreaktor

Teil 1: Die während der Planung der Anlage zu treffende Vorsorge

vom 10. Juli 1978

**Bundesamt für Strahlenschutz
Salzgitter**

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GUIDELINE FOR RADIATION PROTECTION OF PERSONNEL DURING THE EXECUTION OF MAINTENANCE WORK IN NUCLEAR POWER PLANTS WITH LIGHT WATER REACTORS
PART 1: THE PRECAUTIONARY PROTECTIVE MEASURES TO BE TAKEN DURING THE PLANNING OF THE PLANT
of 10 July 1978

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1. Introduction

1.1 Preface

The licensing and supervisory authorities of the States, responsible for the execution of the Atomic Energy Act and the legal regulations issued on the basis of this law, and the Federal Minister of the Interior agreed in the States Committee for Atomic Nuclear Energy (Radiological Protection) on May 9, 1978 to apply the Guideline uniformly.

1.2 Purpose

The purpose of the Guideline is to specify on the basis of the terms defined for this Guideline (section 2) and the applicable legal regulations (section 3) the requirements in the planning of nuclear power stations with light water reactors relating to safety measures to be taken for the protection of personnel against radiation exposure during maintenance work to be expected after commissioning (section 4) and the content and proof of such measures to be presented within the context of the licensing procedures (section 5).

1.3 Scope of Application

This Guideline applies for the precautionary safety measures to be taken in relation to protection against radiation exposure of personnel who have to carry out maintenance work after commissioning of the plant within the context of specified normal operation. The Guideline does not apply for the safety measures to be taken in relation to the protection against radiation of personnel who have to carry out work for the decommissioning of the plant, its safe enclosure or its dismantling.

2. Definitions of terms

The following definitions of terms apply for the purposes of this Guideline:

Plant

Nuclear power plant as an installation specified for the fission of fuel according to Section 7, para. (1) of the Atomic Energy Act. A plant is composed of systems with components and their construction elements, including the buildings and rooms intended to hold them.

Plant room

Room intended to hold systems of the plant or their components and construction elements.

Plant status

The plant in one of the following phases:

- design
- erection
- commissioning
- operation
- decommissioning
- safe enclosure of dismantling

Construction element

Part of a component (see "Plant").

Time required for a maintenance task

Man-hours of Workers engaged in the performance of a particular maintenance task.

Operating room

Plant room in which systems and components of a plant are operated.

Specified normal operation

- 1) Operating processes for which the plant, assuming the able function of all systems (fault free condition), is intended and suited (normal operation);
- 2) Operating processes which occur in the event of plant component or system malfunction (fault condition), insofar as safety related reasons do not oppose continued operation (abnormal operation);
- 3) Maintenance procedures (inspection, servicing,

repair). (cf. "Sicherheitskriterien für Kernkraftwerke"¹⁾)

Permanent devices

Technical devices (shields, spacing) which ensure at parts of the plant, where this is not in conflict with operational requirements that the Body doses received by a person, taking into account the time it is expected he will stay in the area of the point protected by the relevant permanent device cannot exceed 1/5 of the values given in Annex X, column 2, StrlSchV²⁾ per year. (cf. Sec. 54 StrlSchV)

Plant personnel

Persons employed by the holder of an operating license for a plant and who belong to the persons occupationally exposed to radiation.

Transient personnel

Persons, who on request of the holder of the operating license of a plant are charged by their employer with service in the plant and who belong to the persons occupationally exposed to radiation. (cf. Sec. 20a StrlSchV)

Frequency of a maintenance task

Frequency with which the maintenance task concerned is to be carried out annually. (The frequency of maintenance tasks to be repeated at intervals of more than one year is less than one.)

Individual dose due to the Performance of a maintenance task

Whole and partial body doses accumulated by an individual during the Performance of the maintenance task concerned. (see Section 63, StrlSchV)

Inspection

Measures to determine and assess the actual condition. (DIN 31051 Sheet 1: Maintenance (Terms), December 1974 edition)

Maintenance

All measures to maintain and restore the design condition and to determine and assess the actual condition. (DIN 31051 Sheet 1: Maintenance (Terms), December 1974 edition) Maintenance includes inspection, servicing and repair.

Repair

Measures to restore the design condition. (DIN 31051 Sheet 1: Maintenance (Terms), December 1974 edition)

Actual condition

The (actual) condition existing at a given time. (DIN 31051 Sheet 1: Maintenance (Terms), December 1974 edition)

Collective dose due to the Performance of a particular maintenance task

Product of the average whole body dose equivalent to all the individuals engaged in the Performance of a particular maintenance task and the number of the individuals engaged in manrem. The numerical value of the collective dose in manrem due to the performance of a particular maintenance task can be obtained by summation of the numerical values of the whole body doses in rem, which are accumulated by the individuals during the Performance of the maintenance task concerned.

Communications system of a plant

The alarm systems, staff locator installations and telecommunications connections within the plant and from the plant to the outside world. (cf. KTA 3901)

Component

Part of the system (see "Plant")

Planning of a plant

The sum of all activities required for the preparation and co-ordination of the design, erection, commissioning and operation of the plant.

Layout drawings

Layout drawings are graphical representations of the design of systems and the local arrangement of systems and components, (e.g. flow diagrams, installation plans, piping plans). The particularization of layout drawings will change in accordance with the Progress of construction.

Design condition

The condition fixed (required) for the particular case. (DIN 31051 Sheet 1 :Maintenance (Terms), December 1 974 edition)

Operational lifetime

Design value for the duration of the use of a component or element expressed in the operation period during which the permitted tolerances of the design values of the component or element relevant for safety engineering aspects are adhered to under given operating conditions.

Servicing

Measures aimed at the preservation of the design condition. (DIN 31051 Sheet 1: Maintenance (Terms), December 1974 edition)

Recurrent inspection and servicing tasks

Recurrent inspection and servicing tasks are such tasks to be carried out as a rule at certain intervals on the basis of legal regulations or other requirements.

3. Legal principles

3.1 Whoever constructs, operates or otherwise holds a plant or who substantially changes the plant or its operation requires a license for this in accordance with Sec. 7 of the Atomic Energy Act³⁾ (AtG) and is responsible for radiological protection in accordance with Sec. 29, para. (1) of the Radiation Protection Ordinance⁴⁾ (StrlSchV).

3.2 In accordance with the protective regulation of Sec.31, para (1) StrlSchV, the duties of those responsible for radiological protection - with respect to the state of science and technology and the protection of the individual and the general public against radiation damage to life, health and property - include the duty to ensure by means of suitable protective measures, in particular by

- the provision of
 - suitable rooms,
 - protective devices,
 - apparatus and protective equipment for persons,
- appropriate regulation of the course of operations, and by
- the provision of sufficient, suitable personnel, that
 - 1) the radiological protection principles of Sec. 28 StrlSchV are adhered to,
 - 2) the protective regulations listed in Sec. 31, para.(1), sentence 1, no.2 StrlSchV are adhered to,
 - 3) the propagation of radioactive substances is kept as low as possible in order to restrict the risk of

³⁾ Act on the Peaceful Utilization of Atomic Energy and the Protection against its Hazards (Atomic Energy Act) of October 31, 1976 (BGBl.I p.3053), last modified by the Act on the Simplification and Acceleration of Legal Proceedings of December 3, 1976 (BGBl.I p.3281)

⁴⁾ Ordinance on the Protection against Damage and Injuries Caused by Ionizing Radiation (Radiation Protection Ordinance) of October 13, 1976 (BGBl.I p.2905; 1977 p.184), last modified by the 2nd Ordinance on the Modification of the Executive Ordinance of the Act on Units in Metrology of December 12, 1977 (BGBl.I p.2537).

¹⁾ Nuclear Power Plant Safety Criteria, Bundesanzeiger 1977 No. 206

²⁾ StrlSchV: Radiation Protection Ordinance

- 4) absorption into the human body to a minimum, and the necessary measures are taken to prevent an unintended criticality of nuclear fuel.

3.3 In accordance with Sec. 7, para. (2) AtG, as a condition for the issue of a license for the erection of a plant as per Sec. 7 AtG, the person responsible for radiological protection must provide evidence that

- the persons responsible for the erection of the plant possess the necessary specialist knowledge for this (Sec.7, para.(2) subpara.1 AtG) and
- the precautionary protective measures against damage necessary in accordance with the state of science and technology are taken in the construction and operation of the plant (Sec.7, para.(2), subpara.3 AtG).

4. Requirements relating to the planning of the plant

4.1 General requirements

4.1.1 The precautionary measures to be taken in accordance with Sec.7, para.(2) subpara.3 AtG against damage due to the erection and operation of the plant must extend to precautionary protective measures against damage to persons caused by ionizing rays, i.e. to measures for the protection of personnel against radiation after commissioning of the plant. They thus include measures for the protection against radiation of personnel who are required to carry out the maintenance tasks to be expected after commissioning of the plant.

4.1.2 The expert knowledge required in accordance with Sec.7, para.(2), subpara.1 AtG of the persons responsible for the erection of the plant must extend to the precautionary measures to be taken during the design and erection of the plant, in accordance with the precautionary protective measures required under Sec. 7, para.(2) subpara.3, in order to create the technical conditions for the adherence to the protection specifications of the Radiation Protection Ordinance after commissioning of the plant.

4.1.3 To furnish proof that the obligation, according to Sec.28, para.(1)StrlSchV to keep the radiation exposure also below the limits fixed in the Radiation Protection Ordinance as low as practicable, was met for the personnel designated in 4.1.1, it must be verified that

- a) the radiation exposure of each individual commissioned with maintenance tasks and occupationally exposed to radiation (individual dose) and
- b) the number of individuals commissioned with the Performance of maintenance tasks and occupationally exposed to radiation can be kept as low as practicable.

This verification may be demonstrated by the proof that the individual doses as well as the collective doses can be kept as low as practicable and will be comparable to empirical values. For this proof it shall be taken into account that the annual exposure of external persons to radiation can include radiation exposure resulting from jobs in other plants and installations.

4.1.4 The "persons" described in Sec.28, para.(1) StrlSchV refer to all persons occupationally exposed to radiation commissioned with maintenance work at a plant, regardless of whether these are plant personnel or transient personnel.

4.1.5 The protection of persons exposed to radiation against ionizing rays must be ensured in accordance with Sec.54 StrlSchV by permanent devices at all places where normal operations permit.

4.1.6 In plant rooms which have to be entered more

frequently than twice a year for the purposes of servicing or inspection, measures must be taken to ensure that the concentration of activity in the room atmosphere can be kept so low that it is not necessary to wear a respirator (see also 4.2.2.3).

4.1.7 The access and departure routes from points which have to be visited frequently for the purposes of servicing or inspection must run through areas in which

- a) the lowest possible individual dose is received during access or departure, and
- b) it is not necessary to wear a respirator.

During the planning stage it must be ensured that at points from which personnel have to carry out maintenance tasks,

- a) the local dose is so low that with consideration being given to the frequency of the maintenance task and the annual time required for the performance of the maintenance tasks, the contribution caused by such tasks to the total annual collective dose for plant and transient personnel takes into account the requirements of Sec. 28, para.(1) StrlSchV, not forgetting all other contributions, or
- b) sufficient space and adequate load bearing capacity of the relevant floor slabs respectively work platforms are provided for movable shields, so that without obstructing the tasks the local dose rate can be reduced to values which allow the requirement stated under 4.1.8 a) to be met.

4.2 Special requirements

4.2.1 Layout and design of rooms The buildings and rooms of the plant as well as their accesses, connections, personnel and material locks should be laid out and designed in such a way that

- a) the material and personnel flow necessary for the execution of the work passes through the necessary radiation protection controls (control of entrance and work permit, contamination check, etc.) without being unnecessarily hindered and does not lead to unnecessary exposure of personnel to radiation on its further route within the plant.
- b) when up to three times as many transient personnel as plant personnel exposed to radiation are employed in exclusion and restricted access areas in these areas, especially in the hygiene tract and in the locks, no bottlenecks occur which render radiation protection more difficult or which increase the exposure to radiation of the personnel.
- c) first aid measures can be carried out in a special room in the restricted access area.
- d) access to points from which personnel have to carry out maintenance tasks is not unnecessarily impeded.
- e) adequate assembly room is available at points from which personnel have to carry out maintenance tasks, and where necessary additional room is available for additional shields.
- f) in the plant rooms outside the traffic area there is sufficient storage space for the intermediate storage of radiating or contaminated objects - if necessary behind shields and barriers - during maintenance tasks.
- g) the load-bearing capacity of floor slabs or working platforms is sufficient at points where additional shields are to be provided for the performance of maintenance tasks (see also 4.1.8 b).
- h) in rooms in which maintenance tasks can only be carried out in full protective clothing and an access, escape and rescue routes (including ladders, shafts and assembly apertures on these routes) there is sufficient room available to use these routes in full protective clothing and to be able to carry out the necessary tasks at the appropriate work points in full protective clothing.
- i) heavy components which cannot be dismantled at the point of installation and which give off a considerable amount of radiation, or are located in areas with a

high radiation dose or are severely contaminated and which are to be removed from the plant rooms can be removed in such a way with the aid of lifting gear that in such cases too, the principles of radiation protection in accordance with Sec. 28. para.(1) StrlSchV as regards the exposure to radiation of personnel occupationally exposed to radiation (especially in respect of the influence of the amount of time required for the work on the radiation exposure) can be adhered to.

- j) strongly radioactive or contaminated components which are to be removed from plant rooms can be placed in intermediate storage outside the plant rooms and if necessary can also be dismantled.
- k) rooms or groups of rooms in which air contaminations or surface contaminations or local dose rates can occur and to which access can only be permitted after completion of special precautionary radiological protection measures can be adequately isolated.

4.2.2 Layout and design of systems

4.2.2.1 The reactor cooling system shall be designed in such a way to reduce the radiation and contamination levels that

- a) contamination due to activated corrosion products is kept as low as possible by means of suitable selection of substances used in the primary circuit or which come into contact with the coolant, in accordance with the state of science and technology.
- b) the sedimentation of radioactive sludge in piping and containers is largely avoided and where this cannot be prevented, it can be reduced by suitable measures (e.g. flushing).
- c) leaks are largely avoided or are monitored (high quality requirements with regard to valves, seals and gate valves. Use of devices to restrict the possible propagation of leaks (e.g. bellows, suction devices, collecting tanks, etc.); monitoring of contamination by means of measuring instruments).
- d) the capacity of the filtering systems in the cleaning circuit is sufficient in order to be able to keep concentrations of activity in the System as low as possible with regard to maximum values during startup and shutdown corresponding to the state of science and technology.

4.2.2.2 The System for the collection and treatment of radioactive waste water should be designed in such a way that

- a) in the case of plant components for which leaks would represent a contamination hazard, leaks are avoided as far as possible or can be monitored to the extent necessary by suitable means.
- b) drainage connections are present in all rooms in which radioactive waste water constantly occurs with the exception of rooms which are designed as collecting tanks on a safety engineering grounds.
- c) the waste water can be sorted according to its origin and be cleaned with suitable measures, whereby any reduction of the concentration of activity by dilution must be avoided as far as possible.
- d) an undesirable sedimentation of radioactive sludge in piping and containers is largely avoided and where this cannot be prevented, necessary countermeasures (e.g. flushing) can be carried out.
- e) the capacity of the storage and discharge systems also takes into account the amount of radioactive waste water to be expected during maintenance work.
- f) storage tanks for radioactive waste water are provided with venting or gas exhaust systems where necessary.
- g) transfer of the radioactive solids separated from the waste water is possible at the plant location in a condition suitable for transport or storage.

4.2.2.3 The ventilation system of the plant rooms including their filters (the ventilation and air filtration systems) shall be designed in such a way that as far as possible the concentration of activity of radioactive substances in the

atmosphere of those rooms which are entered regularly and in which activation and contamination of the atmosphere are to be expected can be reduced by suitable air conditioning means or equivalent processes to values which do not require the wearing of respirators.

4.2.2.4 The communications system of the plant shall be designed in such a way that it enables personnel to be contacted at each point at which maintenance tasks are to be carried out. The telephone systems (private branch exchange and if necessary supplementary radiotelephone systems) shall be designed in such a way that the necessary communication with the supervisory centre is possible during maintenance tasks. The obstacles to communication to be expected due to shields, high noise levels and the wearing of protective clothing must be taken into account (see also KTA 3901).

4.2.2.5 The fixed systems for the monitoring of the local dose rate and the concentration of activity of radioactive substances in the room atmosphere (fixed sampling and measuring points) shall be designed in such a way that

- a) at characteristic points in non-isolated areas of the restricted access area a rise in the local dose rate and/or in the concentration of activity of radioactive substances in the room atmosphere to values which require additional radiological protection measures can be detected in good time and with sufficient certainty (see also KTA 1501).
- b) in exclusion areas the local dose rate and/or the concentration of activity can be determined from outside with sufficient certainty in order to be able to specify the special radiological protection measures which must be completed before access can be allowed.

4.2.2.6 The systems for monitoring the concentration of activity in liquids (sampling and measuring points) shall be designed in such a way that the concentration of activity in the reactor cooling circuit, in cleaning circuits and in all other systems containing radioactive substances in liquid media can be safely determined without contamination hazard for personnel in such a way that it can be detected in good time when limits are exceeded and corrective action is necessary.

4.2.3 Layout and design of the components and their construction elements

4.2.3.1 All components and their construction elements must be designed and arranged in such a way that while maintaining the requirements of radiological protection they can be

- a) tested for operational reliability to the extent necessary,
- b) serviced, inspected and repaired in accordance with the orders and conditions of the competent authorities, the applicable safety regulations, the operating instructions of the operator or the operating guides of the manufacturers, and
- c) replaced if their operational lifetime is shorter than that of the plant and repair is inexpedient or impossible.

4.2.3.2 The components and their construction elements required for operation and subject to servicing and inspection shall be designed, manufactured and arranged in such a way that

- a) the maintenance work can preferably be carried out at points at which the local dose rate can be kept low and at which no atmospheric or surface contamination calling for special radiological protection measures is to be expected.
- b) in cases where maintenance work is unavoidable at points at which high local dose rates and/or contamination can occur, the frequency of the repair work and the amount of time required for the performance of maintenance tasks can be kept as low as possible.

4.2.3.2.1 In order to keep the local dose rate as low as possible at points from which maintenance tasks are to be carried out, the following measures should be taken as far as is possible and expedient:

- a) monitoring, regulating and control elements as well as auxiliary aggregates such as drives, oil pumps etc. which do not give off radiation shall be separated from components with a high radiation level and be arranged in special operating or servicing rooms, or
- b) components or groups of components with a high radiation level shall be spatially separated from one another and where necessary be shielded separately or arranged such that they can be shielded, and sufficient free space and load-bearing capacity shall be provided for additional shields, or
- c) remotely controlled tools and optical and acoustic remote observation equipment shall be provided.

4.2.3.2.2 Components and their construction elements, for which certain maintenance tasks cannot be avoided at points where a high local radiation dose is to be expected, shall be designed in such a way that the frequency of the maintenance tasks in question is as low as possible.

4.2.3.2.3 In order to keep the time required for maintenance tasks at points at which high local radiation doses cannot be avoided as low as possible, the following measures shall be taken as far as possible:

- a) obstacles due to lack of space an access routes and for assembly shall be avoided,
- b) components and construction elements which have to be replaced frequently must be arranged and designed in such a way that they can be replaced easily,
- c) special tools shall be employed for operations which have to be repeated frequently,
- d) thermal insulation consisting of easy to assemble parts with rapid action fastenings shall be used.

4.2.3.3 In order to achieve an optimal arrangement for the components and their construction elements to fulfill the radiological protection requirements as best possible, it is recommended that a check be made as to whether the construction of models in addition to design drawings can make unclear or vague conditions clearer.

4.2.3.4 In cases in which components and their construction elements can no longer be directly localized visually after complete installation it is recommended that a check be carried out as to whether certain photographs taken before and during installation might not facilitate the maintenance tasks to be expected.

4.2.3.5 In cases in which the dismantling of components might prove difficult in view of space conditions, it is recommended that consideration be given to recording the installation and if necessary the first dismantling on video tape.

4.2.4 Marking

4.2.4.1 In order to mark their function safely, all ducts and components in exclusion areas and other restricted access areas must be marked in accordance with the uniform plant marking system on which the planning is based. The marking must be clearly legible and permanent.

4.2.4.2 The load-bearing capacity of floors and working platforms shall be indicated by signs on the spot on which the max. permissible additional area load and line load must be stated.

5. Evidence of the precautionary protective measures

Within the context of the licensing procedure for a plant the applicant must provide evidence that precautionary

protective measures against exposure to radiation of personnel during maintenance work to be carried out after commissioning have already been carried out during the design of the plant and in the course of its erection according to the Progress of construction, in accordance with the radiological protection principles of Sec.28 para.(1) StrlSchV. As evidence of the precautionary protective measures taken to protect personnel against radiation during maintenance tasks, the following documents shall be submitted to the competent issuing authority along with the license applications. The degree of detail in the technical documents shall correspond to the Phase for which a partial license is applied for in each case. When the application for an operating license is made, the competent license-issuing authority must have the detailed final versions of all the documents listed.

5.1 Transfer of duties

List of the radiological protection officers appointed in writing by the person responsible for radiological protection, for the management and supervision of the activity for which the license is applied for in accordance with Sec. 29 para.(2)StrlSchV, with details of the sphere of competence of each radiological protection officer from which it can also be seen who is authorized to manage or supervise activities which are necessary for the precautionary measures to be taken for the protection of personnel against radiation during the maintenance tasks to be carried out after the commissioning of the plant. (cf. 3.3)

5.2 Precautionary measures for the clear designation and marking of components

5.2.1 Information on the code system which is used for the clear marking of the systems, components and construction elements. (cf.4.2.4)

5.2.2 Description of the internal control system by means of which the marking of the systems, components and construction elements in accordance with the code system applied is ensured. (cf.4.2.4)

5.3 Precautionary protective measures for radiation hygiene and first aid

5.3.1 Description of the hygiene tract with layout drawing and details of the number of personnel for which the tract is designed. (cf. 4.2.1 b)

5.3.2 Description of the location and equipment of the special room for first aid measures located in the restricted access area. (cf.4.2.1 c)

5.3.3 Description of the ventilation system (ventilation and air filtration systems) for exclusion and other restricted access areas with layout drawings. (cf. 4.2.2.3)

5.3.4 Description of the systems for collection and treatment of radioactive liquid waste with layout drawings and details of the capacity of storage tanks and the individual treatment stages (e.g. throughput, decontamination factor). (cf. 4.2.2.2.)

5.3.5 Description of the processes and systems provided for the transfer of the radioactive substances occurring with the liquid wastes in a condition suitable for transport or storage with details of capacities. (cf.4.2.2.2 g)

5.3.6 Description of the communication systems in the various plant rooms with layout drawings. (cf.4.2.2.4)

5.3.7 Description of the fixed systems for monitoring the
a) local dose rate in the various plant rooms, (cf.4.2.2.5)
b) concentration of activity of radioactive substances in the room air, (cf.4.2.2.5)
c) concentration of activity of radioactive substances in liquids, (cf.4.2.2.6)
with layout drawings and tables, stating the measuring or sampling points, the points of indication and the

evaluation of the indication (reading, recording, fault indicator, alarm when a threshold value is exceeded).

5.4 Precautionary protective measures relating to the restriction of the concentration of activity of radioactive substances in the reactor cooling system.

5.4.1 Description of the measures taken to keep the activity in the reactor cooling system low and for monitoring this activity. (cf. 4.2.2.1)

5.4.2 Description of the reactor cooling system and the cleaning system as well as the measures to reduce sedimentation of radioactive sludge with layout drawings and details of performance data for the cleaning system. (cf. 4.2.2.1)

5.5 Precautionary protective measures for the safe intermediate storage of dismantled radioactive parts

5.5.1 Layout plan of places in the restricted access area to be protected, at which dismantled radioactive parts can be stored temporarily with all the protective measures required until they are reinstalled. (cf. 4.2.1 f)

5.5.2 Layout plan of places to be protected (outside the plant building) at which large components of the reactor cooling system with a high degree of radiation or contamination which are to be finally removed can if necessary be placed in intermediate storage and be dismantled, with all the protective measures required. (cf. 4.2.1 j)

5.6 Precautionary protective measures for the control of exposure to radiation in the restricted access area

5.6.1 Layout plan of the boundaries of the exclusion areas and other restricted access areas with details of the points at which

- a) recurrent inspection and servicing work, and
- b) where necessary repair work are to be carried out, with consideration being given to
 - the local dose rate
 - duration and frequency of the work, and
 - the number of persons to be commissioned with the execution of the work

for which detailed plans of the protective measures are required before execution in order to be able to keep the collective dose as low as possible. (cf. 4.1.6; 4.1.7; 4.1.8; 4.2.1 a; d, e, h, k; 4.2.3)

5.6.2 Layout plans of floor slabs and working platforms in restricted access areas (exclusion areas shall be included as parts of the restricted access areas) with the free space provided for movable shields being entered and details of the maximum permissible area loads and line loads at these points. (cf. 4.1.8 b; 4.2.1 e, g; 4.2.2)

5.7 Precautionary protective measures for the removal of large components from the reactor cooling system

5.7.1 Details of the measures provided for the case in which operation cannot be continued with the built-in large components of the reactor cooling system (in particular reactor pressure vessel, steam generator, pressure resistor, pumps) due to irreparable damage. (cf. 4.2.3.1 c)

5.7.2 Description of the precautionary protective measures provided for the rapid removal of certain major components of the reactor cooling system (lifting gear, fastening aids, provisions of the necessary transport space, proposed method of removal). (cf. 4.2.1 g, h, i; 4.2.3.4; 4.2.3.5)

5.8 Precautionary protective measures for the control of exposure conditions during maintenance work on certain components.

5.8.1 List of components for which

- a) recurrent inspection and servicing work,
- b) repair work

are to be carried out at points for which a detailed plan of the protective measures is necessary before execution of the work in order to keep the collective dose sufficiently low, bearing in mind

- the local dose rate
- duration and frequency of the work, and
- the number of persons to be commissioned with the execution of the work. (cf. 4.1.3 to 4.1.8)

5.8.2 List of the type, extent and frequency of the recurrent inspection and servicing work on the components listed under 5.8.1 a). (cf. 4.1.8; 4.2.3)

5.8.3 Estimate of the annual collective doses to be expected from the recurrent inspection and servicing work listed under 5.8.2 including that stated in Annex 1 a, using the form attached as Annex 1 b. (cf. 4.1.3 to 4.1.8; 4.2.3.2)

5.8.4 Estimate of the collective doses to be expected from the repair work listed under Annex 2 a, using the form attached as Annex 2 b. (cf. 4.1.3 to 4.1.8; 4.2.3.2)

5.9 Precautionary protective measures to ensure protection against radiation when carrying out maintenance work after commissioning of the plant.

5.9.1 Radiological protection directive in accordance with Sec. 34 StrlSchV, for plant and transient personnel employed in the plant, which also shows:

- the organization of the radiological protection stating the internal spheres of competence and responsibilities which fall under the management and Supervision of radiological protection officers;
- directives to be followed by plant personnel and transient personnel in order to be able to plan the radiological protection appropriately before commencement of work connected with exposure to radiation and to be able to ensure this protection during the execution of the work;
- directives for the recording and evaluation of data and procedures essential for radiological protection, (instructions, physical radiological protection checks and medical supervision of personnel; issue, registration, keeping and checking of radiation passports; air and surface contamination at places of work; decontamination of personnel and work and traffic areas; discharge of radioactive substances with air and water; monitoring of the environs; accumulation of solid and liquid radioactive waste; testing the operability and servicing of radiological measuring equipment and other equipment and devices essential for radiological protection; examination of sealed radioactive substances; extraction, production, acquisition; delivery and other whereabouts of radioactive substances; operations essential for radiological protection such as commencement, type, extent and duration of work connected with exposure to radiation and the level of the body doses accumulated by the persons participating during this work);
- directives for making reports to the internal supervision and notifying the competent supervisory authority, (events relevant to safety, exceeding of limits for local dose rates, body doses or activities of radioactive substances passed to the body; exceptional exposures to radiation; leaks of sealed radioactive substances; extraction, production, acquisition, delivery and other whereabouts of radioactive substances; stock of radioactive substances; loss of radioactive substances).

5.9.2 List of equipment available for movable shields, stating the storage point. (cf. 4.1.8.b; 4.2.1 e, f, g; 4.2.3.2.1 b)

5.9.3 List of remotely operated tools, remote observation equipment and special tools available for maintenance work to be specified, stating the storage point. (cf.

4.2.3.2.3 d; 4.2.3.2.1 c)

5.9.4 List of models available for planning maintenance work, stating the storage point. (cf. 4.2.3.3)

5.9.5 List of components and elements of systems for which in addition to design drawings there are photographs or video recordings (e.g. of installation) available for the planning of maintenance work, stating the storage point. (cf. 4.2.3.4; 4.2.3.5)

5.9.6 Layout drawings for entering local dose rates for points in the exclusion areas and other restricted access areas at which maintenance work is to be carried out and at which the radiological protection of the personnel commissioned with the execution of the work requires detailed planning. (cf. 5.8.1. to 5.8.4)

5.9.7 Layout drawings for entering surface contamination in exclusion areas and other restricted access areas. (cf. 4.1.6; 4.1.7b; 4.2.1 h, k; 4.2.3.2)

Annex 1a

List of recurrent inspection and servicing work for which detailed planning must be carried out in relation to the estimated annual collective dose of the personnel required for execution of the work.

| | PWR | BWR |
|---|-----|-----|
| 1. Reactor core | | |
| – change of fuel elements with incidental work | + | + |
| – inspection of core fittings with incidental work | + | + |
| 2. Primary system + reactor pressure vessel | | |
| – steam generator (SG) inspections per SG, (ultrasonic and eddy current tests with incidental work) | + | |
| – reactor pressure vessel inspections (ultrasonic and eddy current tests, TV recordings, with incidental work) | + | + |
| – main coolant pump-inspection + servicing (ultrasonic tests, inspection of bearings and seals, with incidental work) | + | - |
| – safety valve – inspection + servicing | + | + |
| – examination of circ. seams in piping in water circuit | + | - |
| – inspection + servicing of pipe in steam circuit | - | + |
| – inspection + servicing of pipe suspension | + | + |
| – inspection + servicing of circ. pumps | - | + |
| – inspection + servicing of turbine | - | + |
| 3. Auxiliary circuits and facilities | | |
| – change of building air filter | + | + |
| – inspection + servicing of collecting tanks for r.a. waste water, (tests for leaks, operability of agitator etc.) | + | + |
| – inspection + servicing of waste gas treatment plant (containers) | + | + |
| – inspection + servicing of concentrate store + concentrate treatment (containers) | + | + |

Annex 1b

Typical inspection and servicing work

System/component

- Designation
- Mark (code)
- Quant.
- Location (Room No.)

Type of inspection or servicing work

Frequency (a^{-1}) anticipated value

Man-hours required anticipated no.

- No. of personnel
- No. of hours

Equivalent radiation dose rate (mrem/a) anticipated value

- Weighted mean value over total work time
- At least favorable work point

Annual collective dose (manrem)

- Empirical value
- Anticipated value

Annex 2a

List of repair work for which detailed planning should be carried out

as a precautionary measure with regard to the estimated anticipated collective of the personnel required for the execution of the work.

| | PWR | BWR |
|---|-----|-----|
| 1. Reactor core | | |
| – exchange of control rod drive | - | + |
| 2. Primary system + reactor pressure vessel | | |
| – Exchange of pressurizer heating rods | + | - |
| – Exchange of pressurizer safety valve | + | - |
| – Exchange of seal on a main coolant pump (MCP) | + | - |
| – Exchange of inlet nozzle on an MCP | + | - |
| – Exchange of rotor runner of an MCP | + | - |
| – Repair of bearing damage to an MCP | + | - |
| – Installation and dismantling of the remote control device for closing steam generator pipes | + | - |
| – Exchange of a high pressure feed pump | + | - |
| – Exchange of a circulating pump | - | + |
| – Exchange of a feed water distributor ring | - | + |
| 3. Auxiliary circuits and facilities | | |
| – Exchange of an activated carbon charge | + | + |

Annex 2b

Typical repair work

System/component

- Designation
- Mark (code)
- Quant.
- Location (room No.)

Type of repair work

Manhours required anticipated no.

- No. of personnel
- No. of hours

Equivalent radiation dose rate (mrem/a) anticipated value

- Weighted mean value over total work time
- At least favourable work point

Annual collective dose (manrem)

- Empirical value
- Anticipated value