INSTITUTE OF RADIATION PROTECTION

GUIDE YVL 7.1

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In the event of any differences in interpretation of this guide, the Finnish version shall take precedence over this translation

DOSE AND RELEASE LIMITS FOR NUCLEAR POWER PLANTS

1 GENERAL

General provisions on radiation protection applicable to nuclear power plants are set forth in the Act on Radiation Protection (174/57, 1/65), Statute on Radiation Protection (328/75, 393/58, 545/68) and the Resolution (594/68) of the Ministry of Health and Social Welfare. They define the dose limits for persons living under the influence of a radiation source as well as stipulate certain concentration limits - derived from the dose limits - that shall not be exceeded when releasing radioactive materials into the environment. However, when a nuclear power plant or related activity involving great amounts of radioactive material is concerned, the authorities will, under Resolution 594/68, separately determine the quantities of radionuclides that may be discharged from the plant into air and water. This guide provides the basis for these special regulations relating to the nuclear power plants.

According to the basic principles of radiation protection adopted by the ICRP, all unnecessary exposure to radiation should be avoided; in other words, the doses that result from certain activity must be justifiable from the benefit, which could not be achieved by any other means. Such an approach shall be applied to the licensing review of nuclear power plants as well. Also, is must be assured that the doses are kept as low as reasonably achievable, taking into account social and economic considerations.

This guide is an application of the Inter-Nordic recommendations

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"Basic Principles for the Limitation of Releases of Radioactive Substances from Nuclear Power Stations" (1976) to the Finnish conditions.

In conformity with principles expressed in the recommendation, the releases from nuclear power plants are restricted to such extent that the doses received by individuals living within the spehere of influence of the plant amount only to a fraction of the dose limits set forth in Resolution 594/68 of the Ministry of Health and Social Welfare. Also, this guide provides limits aiming at a stringent limitation of the average population dose in the future, foreseeing a situation when large numbers of nuclear power plants of this type are in operation all over the world.

The numerical limits relating to the design of nuclear power plants given in the guide represent the position taken by the radiation protection authorities on what level of protection is considered achievable with reasonable effort.

Calculation of doses is dealt with in Guide YVL 7.2.

2 SCOPE

This guide provides limits for releases of radioactive materials from light-water-cooled nuclear power plants under normal operating and accident conditions as well as dose limits for the population living in the environment.

3 DEFINITIONS

Dose The term "dose", as used in this tect, means dose equivalent. The dose equivalent H is the product of D x Q x N at the given point of tissue, where D is the absorbed dose, Q the quality factor and N the product of other modifying factors of the

radiation field. The absorbed dose is the quotient of de/dm where de is the average energy absorbed in a volume element of the exposed tissue and dm is the mass of the volume element. The unit of the dose equivalent is rem. The unit of the absorbed dose is:

(Gray (Gy) (1 Gy = 3/kg)

Dose Commitment

Dose commitment means the infinite time integral of the average dose rate in a given population (calculated per caput) due to a specified action or decision. If the dose rate is integrated over a limited period of time, the term incomplete dose commitment is used.

Collective Dose

If the number of individuals who receive doses between H and H + dH is N(H)dH, the collective dose is

$$HN(H)\,dH$$

where the integration is carried over the population monitored. When the entire world population is considered, the term "global collective dose" is used.

Critical Group

A group of individuals representing the population being monitored who receive the highest exposure from a given source of radiation and who are to a great extent homogeneous with respect to factors that affect the magnitude of the dose.

Plant

"Plant" refers to all units on the site.

Normal Operation

The following operating conditions are classified as normal operation

- normal power operation, start-up and shutdown
- normal hot standby condition and cold shutdown

including refuelling
- routine inspection, testing and maintenance
- orderly changeover to station service power upon loss of off-site power

Abnormal Operation

Anticipated transients occuring at moderate frequency caused by malfunctions which require no safety system actuation except for a reactor trip.

Operating Conditions

Conditions that arise during normal and abnormal operation of the plant.

Accident Conditions

Conditions resulting from failures which require safety system actuation in addition to a reactor trip or which lead to exceptionally high releases of radioactive materials inside the plant or off the site boundary, for example in connection with the handling of fuel or radioactive waste.

Concervative Expectation Valve of Dose

$$D_a = \sum_i \lambda_i \cdot D_i,$$

where λ_i is the probability for the accident of type i (within one year) and D_i is the dose resulting from type i accident.

4 DOSE AND RELEASE LIMITS

The limits are divided into design limits and operative limits.

4.1
Design Limits

Design limits are given as dose limits separately for operating conditions and accident conditions.

Only those radionuclides, discharge and exposure pathways that significantly contribute to the dose are considered.

Guide Dose Limit

Whole body	10 mrem
Thyroid	30 mrem
Other individual organ	30 mrem

The limit is concerned with the average dose comitment received by the critical group resulting from plant operation during any one year.

The plant shall be so designed that this dose limit, averaged over a period of one year, will probably not be exceeded routine releases notwithstanding.

Collective Guide Dose Limit

Whole body	1 manrem/MW
Thyroid	1 manrem/MW

This limit is given as a global collective dose per installed power reactor. This limit is applied to the collective dose commitment over 500 year resulting from activites relating to operation in any one year, considering the whole fuel cycle.

The radiation doses received by the plant personnel are not taken into account when applying the collective dose limit (see Guide YVL 7.9).

The plant shall be so designed that this dose limit, averaged over a period of one year, will probably not be exceeded routine releases notwithstanding. This requirement is parallel with the guide dose limit for individuals and, in practice, the limit which results in smaller releases of radioactive materials is binding.

If only the nuclear power plant itself is considered in the calculation of the collective dose, the collective dose limit is reduced to half of its value.

Design Basis Accident Dose Limit

Whole body	25 rem
Child's thyroid	150 rem

This limit provides the ultimate basis for the design of plant safety systems and is applied to the dose commitment received by a hypothetical unprotected individual standing on the site boundary as a result of a design basis accident.

The design basis accident shall be defined so that its consequences are, as a minumum, as severe as those caused by the breaking of the largest pipe in the reactor primary coolant system.

Collective Accident Dose Limit

Whole body	0.1 manrem/MW
Thyroid	0.1 manrem/MW

This limit is concerned with the conservative expectation value of the global collective dose per installed power reactor. The limit is applied to the collective dose commitment resulting from activities regarded as accident conditions, condidering the whole fuel cycle.

The radiation doses received by the plant personnel will not be considered when applying the collective accident dose limit.

The plant shall be so designed that this dose limit, averaged over any one year, will probably not be exceeded.

If only the nuclear power plant itself is considered in the calculation of the collective accident dose limit, the limit is reduced to half of its value.

4.2 Operative Limits

As a rule, operative limits are expressed in terms of release limits derived from dose limits. They are not based on direct dose monitoring bacause of the difficulties in measuring low doses with a sufficient degree of accuracy. If, however, the monitoring results measured in the environment indicate that the doses in the critical group are substantially higher than what is expected from the releases, release limits shall be made stricter.

Guide Release Limit

This limit must be determined considering all the radionuclides or groups of radionuclides to be released from the plant and given such a value that the individual and collective guide dose limits are not exceeded. This limit is applied to releases taking place during a period of one year but a shorter period may be used, too. The release rate corresponding to the guide release limit is referred to as "the guide release rate".

The plant should be operated so that the guide release limit is not exceeded. To accomplish this, action must be taken when the limits set forth below are exceeded.

Release Rate Requiring Corrective Action

2 x guide release rate (averaged over three months)

If the release rate exceeds this value, the operator of the plant is obliged to make a note of it in the daily report submitted to the Institute of Radiation Protection as well as to take action to identify the cause of excessive releases in order to stop them.

If the release rate temporarily exceeds 10 x the guide release rate, a note of it must be made in the daily report and corrective action taken immediately.

The cause of excessive releases and the action taken shall be delineated in the normal release reports to be submitted to the Institute of Radiation Protection. Reporting requirements are set forth in Guide YVL 7.8.

Release Rate Requiring Authority Action

5 x guide release limit (averaged over 24 hr)

If the release rate exceeds this value, the operator of the plant is obliged to notify the Institute of Radiation Protection by means of a special report as required by Guide YVL 1.5 as well as to take action to identify the cause of excessive releases in order to stop them.

If it is obvious in a case like this that the continued operation of the plant would result in exceeding 5 x the guide release limit (total annual release), the authorities will issue instructions on plant operation which may require power reduction or interruption of operation.

Release Limit for Planned Intermittent Releases

5 x guide release rate (averaged over 24 hr)

Such a release is subject to prior approval by the Institute of Radiation Protection.

The quantities of released radioactive materials, release rates as well as the time of beginning and termination of the release shall be given in the normal release reports submitted to the Institute of Radiation Protection.

Dose Limit Requiring Unconditional Shutdown

Whole body	500 mrem
Thyroid	1500 mrem
Other individual organ	1500 mrem

The plant or plant unit involved shall be unconditionally shut down, if dose measurements or environmental monitoring results indicate that the dose commitment to the critical group resulting from activities relating to operation during one year would exceed this limit.

5 RECOMMENDATIONS, LITTERATURE

Basic Principles for the Limitation of Releases of Radioactive Substances from Nuclear Power Stations, Chapter 19 on The Applicability of Current International Radiation Protection Recommendations in the Nordic Countries, 1976.