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Criteria for the alert of the emergency services by the operators of nuclear plants

Recommendation of the German Commission on Reactor Safety and the Commission on Radiological Protection

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The German original of this English translation was published in 1994 by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety under the title:

Kriterien für die Alarmierung der Katastrophenschutzbehörde durch die Betreiber kerntechnischer Einrichtungen

in the Bundesanzeiger No. 96 of 20 May, 1995.

In the event of any doubts about the meaning, the German original as published shall prevail.

Contents

1 Scope

This recommendation applies to nuclear power plants with light-water reactors. It stipulates criteria for the operator/licensee for the alert of the emergency services in accordance with the stipulated alert stages of the "Outline Recommendations for the Emergency Services in the Vicinity of Nuclear Facilities" [GMBl 1989, page 71]. Other reporting obligations are not subject to this recommendation.

2 Stages of alert

The outline recommendations define the alert stages "emergency pre-alert" and "emergency alert" as follows:

– Emergency pre-alert is raised if an incident occurs in a nuclear facility which has had so far, according to known or comparable triggering criteria, no or only a small effect on the environment, however due to the condition of the plant, it cannot be ruled out that effects may occur which correspond with the criteria of an emergency alert.

– Emergency alert is raised if an accident occurs in a nuclear plant which includes or threatens the release of radioactive substances into the environment.

The raising of the alert stages is the responsibility of the head or the deputy of the emergency services and takes place in accordance with the planned recommendations of the licensee. The alert report of the licensee includes a recommendation for the classification of the alert (pre-alert or alert). The alert of the emergency services by the licensee must be carried out at the latest if one of the following criteria occurs. The criteria are classified according to alert stages.

3 Emergency pre-alert

3.1 General criterion

The emergency services must be alerted with the classification proposal "Emergency pre-alert" if incidents occur in which the release of radioactive substances has been established or is foreseeable which can cause an effective dose in the surroundings of the plant of more than 5 mSv or a thyroid dose of more than 50 mSv. The assessment of the doses must be carried out in accordance with the assumptions stated in the appendix.

3.2 Plant criteria

The emergency services must be alerted with the classification proposal "Emergency pre-alert" if a fault occurs in such a way that one or several of the protection aims subcriticality, core cooling and integrity of the containment cannot be ensured with the means designed. This is always the case if one of the alert criteria stated in table 2 "PWR plant criteria for emergency pre-alerts" or in table 4 "BWR plant criteria for emergency pre-alerts" is fulfilled. An alert must be raised as soon as the criterion is reached or if it is foreseeable that it cannot be prevented from being reached.

Remarks:

a. In principle, there remains the possibility to maintain the safety objectives with the aid of plant accident management measures.

b. The values, stated in tables 2 and 4 of the alert criteria apply to the plants KKP-2 (PWR) and KKI-1 (BWR) and must, if the criteria of other plants are fixed, be aligned to the prevailing conditions.

c. If different plant designs seem to make it necessary, specific individual criteria must be fixed for BWR plants.

3.3 Emission criterion

The emergency services must be alerted with the classification proposal “Emergency pre-alert“ if a release of airborne radioactive substances into the environment of over 1/10 of the release reference values for the effective dose or over 1/5 of the release reference values for the thyroid dose has been established. An alert must also be raised if a release is foreseeable due to the activity measurement data in the plant.

3.4 Immission criterion

The emergency services must be alerted with the classification proposal “Emergency pre-alert“ if, due to an incident-related release, a local gamma dose rate of 0.2 mSv/h is measured at the boundary or in the surroundings of the power plant and if this local dose rate is likely to last for several hours.

4 Emergency alert

4.1 General criterion

The emergency services must be alerted with the classification proposal “Emergency alert“ if incidents occur in which the release of radioactive substances has been established or is foreseeable in the surroundings of the plant which can cause an effective dose of over 50 mSv or a thyroid dose of over 250 mSv in the surroundings of the plant. The assessment of the doses must be carried out in accordance with the assumptions stated in the appendix.

4.2 Plant criteria

The emergency services must be alerted with the classification proposal “Emergency alert“ if an incident occurs in such a way that the safety objectives subcriticality, core cooling and integrity of the containment cannot be fought with plant internal emergency measures. This is always the case if one of the alert criteria as stated in table 3 “PWR plant criteria for emergency alerts“ or table 5 “BWR plant criteria for emergency alerts“ is fulfilled. An alert must be raised as soon as the criterion is reached or if it is foreseeable that it cannot be prevented from being reached.

Remark:

The figures of the alert criteria stated in tables 3 and 5 apply to the plants KKP-2 (PWR) and KKI-l (BWR) and must, if the criteria are fixed for other plants, be aligned to the prevailing conditions.

4.3 Emission criteria

The emergency services must be alerted with the classification proposal “Emergency Alert“ if a release of airborne radioactive substances into the surroundings of the plant has occured in such a way, that a transgression of the release reference values compiled in the appendix has been established or is to be expected on the grounds of activity measurements in the plant.

4.4 Imission criteria

The emergency services must be alerted with the classification proposal “Emergency alert“ if, due to an incident-related release, a local gamma-dose rate of 0.2 mSv/h is measured at the boundary or in the surroundings of the power plant and if this local dose rate is likely to last for several hours.

Appendix

Release reference values

In table 1 release reference values are compiled which could lead during a permanent stay outdoors of seven days (adults) at the most unfavourable point of exposure to a radiation exposure of 50 mSv effective dose or a thyroid dose of 250 mSv due to cloud radiation, ground radiation and inhalation. These release reference values are stated for various stack heights and four nuclide groups. The selection of nuclide groups is orientated on the stack instrumentation typical for nuclear power stations which covers continuously or quasi continuously inert gases, iodine and aerosol. Due to its radiological importance, caesium is mentioned separately. If only I-131 is measured the release reference value for iodine given in table 1 must be reduced by the factor 10. When taking the release of several nuclide groups into consideration the formula must be used as stated below.

Tab. 1: Reference values for an activity release corresponding to an effective dose of 50 mSv or a thyroid dose of 250 mSv without taking into consideration the ingestion pathway.

Nuclide group	Type of dose	Release reference values M_i [Bq]		
		50-80 m	81-130 m	131-180 m
Inert gases	effective dose	8,0E+16	1,5E+17	3,5E+17
Iodine		1,4E+15	3,7E+15	7,0E+15
Caesium		2,6E+14	5,1E+15	6,5E+14
Other nuclides		8,5E+14	1,4E+15	1,6E+15
Inert gases	thyroid dose	3,5E+17	7,5E+17	1,5E+18
Iodine		5,0E÷14	1,6E+15	4,3E+15
Caesium		1,3E+15	2,4E+15	3,0E+15
Other nuclides		1,0E+15	2,5E+15	4,6E+15

All nuclide groups stated in table 1 must be measured. The measurement must be carried out in accordance with the “Guideline for the monitoring of emissions and immissions of nuclear plants“. If, when raising the alert, measured values are not available for all of these nuclide groups they must be estimated conservatively based on other measured values available and be taken into account.

An alert based on “emission criteria“ is therefore needed if the sum of the radioactive shares of those four nuclide groups – for the effective dose or the thyroid dose – is higher than 1:

$$\sum_{i=1}^{4} \frac{A_i}{M_i} = 1$$

A1: Released activity of the *i* nuclide group
M1 : Release reference value of the *i* nuclide group in accordance with table 1.

The calculation of the release reference values in accordance with the table is based on the following additional assumptions:

– The source strength has been assumed with the nuclide vector which takes into consideration the releases at core melt down temperatures.

– It is assumed that the release takes place 30 minutes after the reactor is shut down.

– In agreement with the incident calculation bases, the calculation of the effective dose was based on an exposure time of seven days to external radiation (unprotected stay) and an integration time of 50 years for inhaled radionuclides. The same applies to the calculation of the thyroid dose.

– For the exposure pathways ground radiation and inhalation the respective 95 percent values have been calculated based on statistical assessments of realistic weather conditions at a selected location.

– Cloud radiation must be determined through the covering curves of all diffusion categories A to F.

A recommendation to the population to avoid the consumption of freshly harvested food can be necessary even if the effective dose or thyroid dose remains below the lower dose level for the measure “stay indoors“. If necessary, such a recommendation will be made by the regional authority responsible for radiological protection precautions. The ingestion pathway can therefore not be the foundation of a classification proposal of the licensee of a nuclear plant within the framework of an alert of the emergency services and was therefore not taken into consideration in the appendix.

Current release reference values during a concrete accident situation can be calculated by using the “General Criteria“ in accordance with section 3.1 or 4.1 by using acknowledged calculation procedures.

Table 2: Plant criteria for the emergency pre-alert in pressurized water reactor plants.

Safety objective	Criteria	Details	Limit value samples for KKP-2
1. Subcriticality	After excitation of RESA, the neutron flux continues to remain within power range	The reactor is not completely shut down and heat transfer from the RDB not guaranteed long-term. Timing: Boron System ineffective too long	ϕ > 5 % of full-load value 15 min after RESA excitation
2. Core cooling	Coolant temperature too high	RDB level too low Timing: There is no design controlled transient or no secondary heat sink: no DE feed or no secondary heat sink: steam release not possible	BE head temperature > 360 °C for Δt > 5 min or in 4 DE h < range and no emergency feed or in 1 DE p(DE) > 116 bar for Δt > 3 min
3. Integrity of the containment	Pressure inside containment too high or containment isolation on demand not possible	Containment integrity threatened	p(SB) > 0.5-times the design pressure for Δt = 10 min and increasing or RS signal “containment isolation“ present but no isolation. Example RS signal: p(SB) 1.03 bar

Abbreviations:
BE Fuel element
PWR Pressurized water reactor
h Height, levet
p Pressure
RESA Reactor **scram**
SB Containment
t Time
ϕ Neutron flux density
DE Steam generator
FD Main-steam
KK Suppression Pool
RDB Reactor pressure vessel
RS Reactor protection system
BWR Boiling water reactor
T Temperature

Table 3: Plant criteria for the emergency alert in pressurized water reactor plants.

Safety objective	Criteria	Details	Limit value samples for KKP-2
2. Core cooling	BE temperature too high	RDB level falls below the upper level of the active core head. Timing: There is no design controlled transient with short-term short-fall	BE head temperature > 800 °C t for Δt > 5 min
	or RDB pressure too high and increasing	or no secondary and an insufficient primary heat sink	or p(RDB) > 200 bar for Δt > 5 min
3. Integrity of the containment	Containment venting imminent	Warning before attaining a pressure of 7 bar, at which Venting is activated	p(SB) > 6 bar for Δt > 5 min
	or containment isolation on demand not possible and one "core cooling" pre-alert criterion is present		or containment isolation not forthcoming and BE head temperature > 360 °C for Δt > 5 min

Table 4: Plant criteria for the emergency pre-alert in boiling water reactor plants.

Safety objective	Criteria	Details	Limit value samples for KKI-1*
1. Subcriticality	After excitation of RESA, the neutron flux continues to remain within power range	The reactor is not completely shut down and heat transfer from the RDB not guaranteed long-term. Timing: Boron System ineffective too long	Φ > 5 % of full-load value 30 min after RESA excitation
2. Core cooling	RDB level too high and penetration isolation in the FD system, feed system TJ and ancillary steam-line RA 06 not activated	Rupture of a steam-line outside the SB imminent	h(RDB) > 16.0 m
	or RDB level too low	or Timing: the programme "Rupture Recognition Residual-Heat Removal Systems" ineffective too long	h(RDB) < 10.0 m for Δt > 25 min
	or RDB pressure too high	or Limit to design pressure has failed	or p(RDB) > 88 bar
	or KK level too low and feed into RDB is only possible from the KK	or Danger of falling short of the feed level required for the residual-heat removal pumps	or h(KK) < 13.79 m
	or KK level too low and KK is the heat-sink	or Water cover of the perforated-tube jets of the safety valves (12.21 m) is threatened and thus the function of the heat-sink	or h(KK) < 13.79 m
	or KK water temperature too high	or Due to the crude conden-sation, the KK is threatened and thus also the heat-sink	or Temperature(KK) > 76 °C
3. Integrity of the containment	Pressure inside containment too high	Containment integrity threatened	p(SB) > 0.5-times the design pressure for Δt = 10 min and increasing
	or containment isolation on demand not possible		or RS signal "containment isolation" present but no isolation. Example RS signal: p(SB) ≥ 1.25 bar

* If and when necessary, the applicability of these criteria is to be plant-specifically stipulated in order to apply to different plant designs

Table 5: Plant criteria for the emergency alert in boiling water reactor plants.

Safety objective	Criteria	Details	Limit value samples for KKI-1
2. Core cooling	RDB level too low	RDB level falls below the upper level of the active core head without sufficient possibilities of water feed. Timing: There is no design controlled transient with short-term short-fall	h(RDB) < 8.80 m for Δt > 5 min Tendency:decreasing
	or RDB pressure too high and increasing	or Imminent danger that RDB cover seal starts to leak at approx. 120 bar and that, at constant high RDB pressure, feed is either impossible or only possible with a limited flow rate via the control rod rinsing water. If the release ratio is higher than the feed, core cooling is not guaranteed.	or p(RDB)> 110 bar
3. Integrity of the containment	Containment venting imminent	Warning before attaining a pressure of 4.4 bar, at which Venting is activated	p(SB) > 4 bar
	or containment isolation on demand not possible and one “core cooling“ pre-alert criterion is present		or containment isolation not forthcoming and h(RDB) < 10.0 m for Δt > 25 min