Note:
This is a translation of the RSK statement entitled “Einschätzung der Abdeckung extremer Wetterbedingungen durch die bestehende Auslegung”.
In case of discrepancies between the English translation and the German original, the original shall prevail.

RSK statement
(462nd meeting of the Reactor Safety Commission (RSK) on 06.11.2013)

Assessment of the coverage of extreme weather conditions by the existing design

1 Background

The reason for dealing with this topic is a request of the RSK and the recommendation in the "EU stress test" conducted by the ENSREG to consider assessing the robustness of German nuclear power plants with respect to extreme weather conditions beyond the existing design (see [1] or [2]).

2 Consultations

The Committee on PLANT AND SYSTEMS ENGINEERING (AST) heard a report from GRS on extreme weather conditions with effects on river water temperatures and water levels at its 66th meeting on 22.07.2010 and a report on this topic from the operator [3] at its 74th meeting on 13.10.2011. At the 82nd meeting of the Committee held on 09.08.2012, the Chairman presented a concept for the consultations on the topic "extreme weather conditions" to the Committee and asked some Committee members to further develop this concept with regard to weather-related impacts on the plants, in particular with regard to the completeness of the listed impacts and proposals for classification of impacts with respect to their coverage by the existing plant design. At its 83rd meeting on 04.10.2012, a document prepared on this issue was presented to the Committee. The Committee revised this document at its 84th, 85th, 86th and 87th meeting on 08.11.2012, on 20.12.2012, on 15.01.2013 and on 14.02.2013. Upon request of the Committee on PLANT AND SYSTEMS ENGINEERING (AST), the Committee on ELECTRIC INSTALLATIONS (EE) consulted on the the impacts caused by “lightning” and “solar storms” as an additional topic at its 226th meeting held on 13.03.2013. At its 88th meeting on 20.03.2013, the Committee discussed these additional issues. At its 457th meeting held on 11.04.2013, the RSK dealt with the report of the Committee and recommended, following international developments (ENSREG, RHWG/WENRA), that analyses should be conducted to demonstrate robustness against design basis weather conditions with a return frequency of 10^{-4}/a. As far as impacts in this frequency range cannot be determined with sufficient reliability, effective management of events and a high level of robustness should be demonstrated deterministically using engineering judgement. Based on the comments of the RSK, the Committee revised the statement at its 90th meeting on 13.06.2013 and adopted it at its 91st meeting on 10.07.2013. The RSK adopted the statement at its 462nd meeting held on 06.11.2013.

3 Assessment of the coverage of extreme weather conditions by the existing design

At its 457th meeting held on 11.04.2013, the RSK recommended that analyses should be conducted to demonstrate robustness against design basis weather conditions with a return frequency of 10^{-4}/a in line with international developments (ENSREG, RHWG/WENRA). As far as impacts in this frequency range cannot be determined with sufficient reliability, effective management of events and a high level of robustness should be demonstrated deterministically using engineering judgement. In addition, it was suggested with a view to robustness that impacts beyond these impacts should be taken into account by engineering estimates for the determination of safety margins. The extreme weather conditions addressed in this RSK statement refer to the impacts to be examined in this context.

The assessments made in the following on the coverage of extreme weather conditions by the existing plant design refer to potential influences on the safety and emergency system with regard to the maintenance of vital safety functions. Effects on operational installations or on safety functions that are not necessary for coping with extreme weather conditions will not be considered in the following. All assessments are based on the assumption that the relevant impact parameters have not been determined quantitatively and therefore the resulting impacts on the plant have exclusively been determined by engineering estimates.

In a first step, the RSK collected and structured all weather conditions listed in national [5] and international standards and regulations [6], [7] and [8]. Based on a compilation of potentially coupled effects of extreme weather conditions it was also assessed to what extent their superposition or causalities may be relevant. In a second step, these conditions were assessed with regard to their coverage by the existing design. The results of these assessments are presented in the following two tables. In Table A, those weather conditions are listed for which the RSK deems it necessary to conduct additional analyses for assessing their coverage. Table B lists the weather conditions for which the RSK considers coverage to be given generically by the existing plant design.

Not subject of this statement are weather-related extreme flooding events that have already been addressed in the context of the RSK-SÜ [11] (flooding scenarios at sites near rivers or tidal waters). Also not dealt with in this statement are impacts caused by lightning, which is the subject of current RSK consultations. However, weather-related flooding potentials due to local ice movement or local heavy rain not explicitly addressed in [11] are included in the following tables. Weather-related impacts that are covered by the recommendation of the RSK regarding an alternate heat sink will be dealt with in the following by reference to the related RSK statement [12].

A	Additional analyses required	
Low temperatures		
A1	Freezing rain / ice storm / snow storm (direct effects on the plant)	For plants with emergency cooling system cooled via cells, clarification is needed as to whether these coolers can freeze. Here, not only freezing of water in the water tray is to be considered, but also, e.g., freezing of the installations through which the cooling water is distributed for trickling down. The grids and slats in the building openings for ventilation or supply air for the emergency diesel generators could freeze or be covered up by wind-blown snow. In this context, not particularly low temperatures but other unfavourable boundary conditions (such as rain or high humidity at temperatures just below freezing) are of significance. It should be shown for both cases that this is either not to be postulated or that there are sufficiently effective and robust precautions in place for prevention (e.g. heating), removal (e.g. by administrative regulations) or for the management of the related effects.
A2	Ice floes (on the receiving water)	According to nuclear safety standard KTA 2207, ice movement on sites on rivers and on lakes is to be taken into account when defining the design basis flood, but without further specification of the procedure. It should be shown that the formation of ice barriers at the site is either not to be postulated or that there are sufficiently effective and robust precautions in place for prevention, removal or for the management of the related effects.
A3	Air temperature extremely low, also for longer periods of time	Operating experience shows that, e.g., pipes may freeze (frozen drain pipe in GKN-1 on 14.01.82; damage to spray water extinguishing system in KKR (Rheinsberg) on 12.02.96). Appropriate measures are to be provided by which the vital safety functions will also be maintained under these conditions.
A4	Ambient or receiving water temperature extremely low for prolonged periods of time and receiving water level extremely low for prolonged periods of time	The combination of these conditions may be relevant. It should be examined whether under such conditions not only the primary heat sink but also the alternate heat sink may be affected at the same time (according to [12]).
A5	Formation of slush ice/floating ice	At some sites, sudden drops in temperature led to the formation of slush ice/floating ice which may affect the intake of cooling water. It should be examined whether under such conditions not only the primary heat sink but also the alternate heat sink may be affected at the same time (according to [12]).

Long-lasting drought		
A6	Receiving water level extremely low for prolonged periods of time	It should be shown that in case of a prolonged drought, a loss of water supply via the receiving water is either not to be postulated or that under such conditions the alternate heat sink cannot be affected in addition to the primary heat sink at the same time.
A7	External fire	It should be examined whether external fires, particularly during strong winds, can result in effects on installations of the plant which may lead to a loss of vital safety functions.
Precipitation		
A8	Prolonged periods of heavy rain, possibly in combination with strong winds	The power plant sites are all flat and open to the surrounding area so that the water can principally flow off during heavy rain. It should be checked whether in the case of an extreme heavy rain event, sufficient drainage for all plants is ensured, also taking into account the potential for clogging of drainage paths. Studies on the ingress of rainwater into the building are dealt with as part of Information Notice 3/2012. As an additional aspect, the possibility of rainwater ingress during heavy rain combined with extreme storm, e.g. via vents or through the intake ports, and the potential consequences thereof for the supply air for the emergency diesel generators should be examined. Note: The aspect of the possibly increased pollution load in the intake structure, which may also be caused by long periods of rain, or the entry of biological foreign matter has already been addressed in the RSK statement on the loss of the primary heat sink (“Ausfall der Primären Wärmesenke” [12]. With the availability of an alternate heat sink according to [12], such impacts are covered.
Wind		
A9	Strong wind, tornado (negative pressures)	For statements on the formation of negative pressures or resulting pressure gradients, the degree of potential negative pressures should be determined and a possible relevance be assessed.
A10	Sand/dust storms (from dried agricultural land)	It should be examined to what extent sand/dust storms are to be postulated due to site-specific conditions of agricultural use and the soil conditions and whether in this case, adequate precautions are in place to maintain the operability of emergency diesel generators. Here, the possibilities of the entry of other airborne material (such as leaves) should also be taken into account.

B	No need for further analyses	
B1	Solar storms	Geomagnetically induced currents (GICs) of a solar storm may induce considerable electrical interference voltages and currents in the overhead line system. During high grid utilisation it cannot be ruled out that this may lead to extensive and prolonged grid disturbances up to grid failures. The same applies to failures of heavily loaded transformers (close to rated power) in the auxiliary power supply of the nuclear power plants, such as generator transformers, which cannot be ruled out either. The installed surge protection devices serve to prevent voltage transients due to grid disturbances. If necessary, loss of offsite power will be initiated, an event whose management is provided by the plant design.
B2	Prolonged periods of icing / snow drifts on-site or off-site	Refuelling of the diesel generators in case of loss of offsite power during prolonged periods of icing or snow drifts on the plant sites is ensured for a period of at least three days. With the pre-planning to ensure emergency power supply required according to RSK SÜ [11], the case of a prolonged loss of offsite power (duration up to a week) in combination with a prolonged period of icing/snow drifts on the the access roads is also covered.
B3	Hail, snow load	The mechanical impacts of hail and snow load are covered by the design of the emergency systems against aircraft crashes, blast waves and against design basis earthquakes.
B4	Receiving water temperature extremely high for prolonged periods of time	Since the residual heat removal systems are designed for a LOCA at full load, but this combination is not to be postulated, the design margins of these systems are also sufficient for very high temperatures. For events not associated with a loss of coolant, such as the loss of offsite power, larger margins for diesel generator cooling are available due to the partial load of the diesel generators. In addition, there is the possibility of performing manual actions to ensure diesel generator cooling independently of the receiving waters.
B5	Humidity extremely high for prolonged periods of time and air temperature extremely high for prolonged periods of time	The combination of these conditions may be relevant for cooling of the outside air since this is always associated with a dehumidification process, and higher humidity combined with higher air temperatures may be an operational problem with regard to the cooler capacity (summer design values for ventilation systems usually +32°C/ 40 % rel. humidity). Although the design of the ventilation may, under certain conditions, not cover the most unfavourable ambient conditions, accident management will not be challenged since the required room air cooling is effected by water-cooled air recirculation coolers that are independent of the outside air conditions.

B6	Strong wind, tornado (positive pressures, wind and tornado-generated missiles)	Due to the EU stress test [4], studies are available for representative plants according to which - the effects induced by positive pressure from strong winds or tornadoes related to a maximum positive pressure of 0.2 bar according to USAEC REG. Guide 1.76 are covered by the design against blast waves (see [3]), and - the effects by tornado-generated missiles and other debris loads from the vent stack not designed against tornadoes are covered by the design against aircraft crashes or sufficient building wall thicknesses.
B 7	Extremely salty air	Operating experience does not indicate any problems for safety systems. Safety-relevant switchyards are located within buildings and are therefore not affected by salty air outside. In the long term, only corrosion-assisted effects are conceivable, which are adequately covered by the monitoring measures.

4 Next steps

In light of the recommendations of ENSREG stress test peer review, it was to be examined by the operators by way of an engineering assessment as part of the robustness assessments according to [11, 13] whether necessary vital safety functions could be impaired in an impermissible manner by the impacts due to extreme weather conditions listed in Table A. As far as a reliable quantification of these impacts is not possible, the robustness of the provisions in place should be assessed qualitatively based on the existing design margins and available countermeasures, possibly by means of analyses using extreme physical parameters.

Literature/documents

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Stress Test Peer Review Board
v12i – 2012 04 25

[2] Peer Review Country Report
Germany
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[3] VGB PowerTech
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VGB PowerTech
Effects of extreme weather conditions on the safety of nuclear power plants
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[4] EU Stresstest, National Report of Germany
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Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations
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RSK statement: “Plant-specific safety review (RSK-SÜ) of German research reactors in the light of the events in Fukushima-I (Japan)”, 16.05.2011

[12] RSK-Stellungnahme (446. Sitzung am 05.04.2012): „Ausfall der Primären Wärmesenke“ (veröffentlicht im Bundesanzeiger: BAnz AT 03.08.2012 B5)
RSK statement (446th meeting on 05.04.2012): “Loss of the primary ultimate heat sink” (published in the Federal Gazette: BAnz AT 03.08.2012 B5)

[13] RSK-Empfehlung (450. Sitzung am 26./27.09.2012): „Empfehlungen der RSK zur Robustheit der deutschen Kernkraftwerke“
RSK recommendation (450th meeting on 26./27.09.2012): “Recommendations of the RSK on the robustness of the German nuclear power plants”