RSK RECOMMENDATION

Control of loss-of-coolant accidents at PWRs under consideration of dead volumes in the containment – scientific/technical aspects

10.11.2005 (388th meeting)

1 Advisory request

With letter RS I 3 17018/1 of 23.03.2005 [1-48], the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) informed the RSK that on 24.06.2004 there was a meeting of representatives of the FANP GmbH with representatives of operators of German nuclear power plants. At this meeting, the issue of sump levels required in case of a loss-of-coolant accident was discussed. During the discussion it was pointed out that for certain loss-of-coolant accidents it was to be assumed that the reactor cavity was filling with water and this water was no longer available for sump operation. In this connection, it was also of importance which formula was to be used to calculate a water level that is above the sump suction nozzle. The BMU requested, among others, the RSK Committee on PLANT AND SYSTEMS ENGINEERING (AST) to discuss the question whether a sufficient water level above the sump suction nozzle and, altogether, the control of the loss-of-coolant accident with a small and medium leak under consideration of the dead volume of the reactor cavity was ensured for the German PWRs according to the state of the art in science and technology.

2 Course of discussions and background

At its 33rd meeting on 25.05.2005, the committee heard reports of the plant operators [49] and GRS [50]. The operators informed the committee about the safety analyses on the control of loss-of-coolant accidents under consideration of the dead volume in the reactor cavity and drew the conclusion that the pipe-in-pipe system constructed for limitation of the leak rate was generally effective, although absolute leak tightness was not given by the construction. A minor leak flow rate in the reactor cavity would also have to be considered for leakage at the RPV nozzle; likewise, filling of the reactor cavity had to be assumed in the long term. For all cases, sufficient level above the sump suction level was given.

In its report, GRS dealt with the available data of the other pressurised water reactors Biblis A and B (KWB-A and KWB-B), Neckar 1 (GKN-1), Neckar 2 (GKN-2), Unterweser (KKU), Grafenrheinfeld (KKG), Grohnde (KWG), Brokdorf (KBR), Isar 2 (KKI-2) and Emsland (KKE) on the consideration of the dead volume in the reactor cavity during LOCAs. The evaluation was based on respective documents of the plant operators, the authorities of the *Länder* and expert organisations which were submitted to the BMU by the authorities of the *Länder* in 2005.

In the course of its discussions, the committee stated that there are several issues that still need to be clarified, which are, among other things:

- the boundary conditions of the analyses at the different plants (e. g. consideration of the single-failure concept, the method regarding filling of the reactor coolant system (RCS), RCS temperatures taken as a basis after filling of the RCS, number of injecting accumulators, water masses injected, determination of water flow into the reactor cavity, sump temperature),
- availability of plant-specific analyses,
- influence of manual actions for faster pressure reduction to the minimum sump level,
- gap width at the pipe-in-pipe system,
- quantification of water retention in the containment,
- horizontal position of the sump ceiling to avoid potential air cushions,
- measurement of the sump geometry and sump volume, and
- opening behaviour of the overflow valve in the support shield.

For further clarification of the open questions, the RSK Committee on PLANT AND SYSTEMS ENGINEERING (AST) heard at its 34th meeting on 30.06.2005 reports of the experts on the control of loss-of-coolant accidents at German PWRs under consideration of the dead volume in the reactor cavity. *

For the plants Biblis-A (KWB-A), Unterweser (KKU) and Brokdorf (KBR), the TÜV NORD SysTec reported about FANP results and own analyses on existing and required sump levels for the postulated leakage "leak at RPV nozzle" in dependence of the leak size. The analysis of the expert was performed by means of a check list. As assessment criterion for vortex-free suction, covering of the lower edge of the sump ceiling with margins was referred to. Further, the water paths in the containment were checked. Altogether, the analyses of TÜV NORD SysTec showed that for all three plants, there were margins when using conservative assumptions, i. e. the lower edge of the sump ceiling was covered and thus control of the LOCA in case of leak location at the RPV nozzle given. The check of the water paths at KBR showed that there is no defined water path from the operational rooms into the RPV sump which, however, did not call the control of the event into question. Moreover, the FANP experiments had confirmed the physical model according to which no air-sucking hollow vortex was generated at a filling level above the lower edge of the sump ceiling.

The TÜV NORD EnSys Hannover continued the presentations and explained the safety analyses on the control of LOCAs under consideration of the dead volume in the reactor cavity for the Grohnde nuclear power plant (KWG) and Emsland (KKE). First, the analyses of the plant operators and the respective boundary conditions (among others repair case and single failure, injection from four hot-leg accumulators in case of small leaks, consideration of injection by the extra borating system) were presented. The result was that the sump level at both plants was above the upper edge of the sump ceiling. Further, there was a clear distance to the required net positive suction head (NPSH) under the boundary conditions to be applied according to the RSK guideline. The TÜV NORD had also performed own investigations to verify the safety analyses of the operator. Here, less favourable boundary conditions were chosen in some cases (no injection from the hot-leg accumulators). Further, among others, measurement of the sump geometries and check of the opening pressures for the overflow was initiated. A representative of the TÜV NORD EnSys Hannover

* In this connection, the secretariat submitted a list of questions [51] to the technical experts in advance which was compiled following the 33rd meeting of the committee on 25.05.2005 by the members of the committee.

participated in the experiments on hollow vortex formation; scaling and applicability was checked. Altogether, the analyses and tests showed that the loss-of-coolant accident under consideration of the dead volume in the reactor cavity was controlled at the plants KWG and KKE.

Regarding the plants Philippsburg (KKP-2), Neckarwestheim 1 (3-loop plant) and 2 (GKN-1 and -2), the TÜV Süd ET BW reported [54] about the boundary conditions for the analyses, about the investigations performed and about the balancing of available and required water inventories on the basis of the incident analyses and mass balances. For KKP-2, a sump level above the lower edge of the sump ceiling was reached in all analyses. Further, the NPSH value was always sufficient. For GKN-1, the analyses performed only showed one case where the sump level was only just above the lower edge of the sump ceiling. The NPSH value was always sufficient. Until availability of plant-specific experimental analyses, the cavitation-free sump suction at GKN-1 was ensured by a shift instruction. This prescribed that in case of failed injection from a pair of water storage tanks a repair time according to (2 out of 4) failures was applicable. Within the frame of the discussion, a representative of the plant operator explained that the low covering of the sump ceiling at GKN-1 was obtained on the basis of a first estimation. In the meanwhile, further analyses were available with more favourable results.

For GKN-2, a level above the lower edge of the sump ceiling was reached in all analyses. Further, the NPSH value was always sufficient. According to the technical expert TÜV Süd ET BW, it was agreed between the TÜV and the supervisory authority of Baden-Württemberg not to consider manual actions in the analyses within the framework of this investigation. The analysis under consideration of manual actions was performed within the framework of a report still to be submitted.

For the plants Biblis B (KWB-B), Grafenrheinfeld (KKG) and Isar 2 (KKI-2), the TÜV Süd IS reported [55] about the proceeding regarding the safety analyses on the control of LOCAs under consideration of the dead volume in the reactor cavity and addressed postulated leak sizes and leak locations. It explained the balancing of the water volume and derivation of the sump level from volume level characteristic of the containment sump. As criterion for the required covering of the sump suction nozzle to prevent air suction, the following was specified:

- Covering with water > level necessary for vortex-free suction according to ANSI formula, or
- covering with water > level above the lower edge of the sump ceiling.

Regarding the available water volumes, the repair case or, where applicable, preventive maintenance and single failure were assumed as failure for balancing of the water volumes. Manual actions with favourable effects, such as connecting refuelling water storage tanks not used, were not considered. For small leaks with low pressure drop (≤ 20 cm²), injection from the accumulators was not considered (manual shut-off according to instruction manual). According to the technical expert, injection with the extra borating system was considered as far it is provided in the design via an automatic measure of the reactor protection system.

For KWB-B, the sump level for leaks smaller than 20 cm^2 was below the lower edge of the sump ceiling, but 1 cm above the level required according to the ANSI formula. For leaks with a size between 20 and 40 cm^2, the sump level was above the level required according to the ANSI formula. For leaks with 100 cm^2, the

sump level was below the level determined according to the ANSI formula, but 34 cm above the lower edge of the sump ceiling (4 cm above the upper edge of the sump ceiling).

For KKG, the TÜV Süd IS explained that no opening of the overflow valves was considered due to the opening pressure difference of 500 mbar. For KKG, the sump level for leaks smaller than 20 cm^2 was below the lower edge of the sump ceiling, but 5 cm above the level according to the ANSI formula. For leaks with a size between 20 and 40 cm^2, the sump level was above the level determined according to the ANSI formula. For leaks with a size of 100 cm^2, the sump level was below the level determined according to the ANSI formula, but 32 cm above the lower edge of the sump ceiling. Issues still to be clarified for KKG would be, among others,

- verification of the distribution pattern of the volume level characteristic of the containment sump and the dimensions of the reactor cavity by walk down,
- final analysis of the RPV leak under consideration of unfavourable manual actions, and
- filling of the reactor cavity under consideration of evaporation.

According to the technical expert, a conservative analysis for KKI-2 results for all relevant leak sizes of 20 cm^2 to 100 $cm^{2,}$ in a sump level below that required according to the ANSI formula but which is 46 cm above the lower edge of the sump ceiling. Issues still to be clarified for KKI-2 concerned, among others, the verification of the distribution pattern of the volume level characteristic of the containment sump and the dimensions of the reactor cavity by walk down.

According to the TÜV Süd IS, for all three plants KWB-B, KKG and KKI-2, the issues

- opening pressure of the overflow valves,
- applicability of tests on suction behaviour of the ECC and RHR pumps under consideration of air cushions and surface waves, and
- in-depth analyses on water loss in the containment

were still to be clarified.

The discussion following the presentation of the experts can be summarised as follows:

- The statements of the technical experts on the steam mass released into the containment according to the knowledge of the technical experts showed a considerable range. The representative of the TÜV Nord SysTec remarked that for the rupture of the surge line, a maximum release of 89 t steam into the containment and the operational rooms was determined by MELCOR calculations. The leak postulated here was larger than that considered for the release into the reactor cavity. Thus, a value of 50 t for the retention in the containment and the operational rooms was plausible. The representative of the TÜV Nord EnSys Hannover added that he had determined the steam mass flow from the leak and obtained a value of clearly below 50 t for small leaks. From his point of view, the value of 50 t for the retention in the containment was covering the respective releases in connection with the dead

volume in the reactor cavity. The TÜV Süd IS explained that, at a total mass flow (steam and water) of about 160 t from a leak (covering release for leaks between 20 to 100 cm^2), its calculations led to a value of 65 t for retention in the containment.

- On the basis of current knowledge, the criterion "sump level above the lower edge of the sump ceiling" is generally regarded as suitable by the experts for the exclusion of air-sucking hollow vortices, subject to some individual aspects still to be clarified (air cushions, surface waves). The members of the committee explained that hollow vortices preferably occur under undisturbed conditions. Turbulences and waves would disturb the formation of air-sucking vortices. Further, there would be small flow rates for the RHR pumps with small leak sizes. According to the ANSI formula, a lower level above the sump suction nozzle was required than a level corresponding to the lower edge of the sump ceiling.

At its 35th meeting on 15.09.2005, the committee drafted a recommendation on the basis of document [56] which was passed at its 36th meeting on 27.10.2005. The RSK discussed the draft at its 388th meeting on 10.11.2005 and passed this recommendation.

3 Requirements on safety analyses on the control of loss-of-coolant accidents at PWRs under consideration of dead volumes in the containment

From the RSK point of view, the analysis of the necessary sump level after LOCA for German PWRs requires

- balancing of the water and steam mass flow rates for determination of the sump inventory, and
- determination of the required minimum sump level for safe operation of the RHR pumps in the sump.

3.1 Balancing of the sump level

According to the RSK, the following aspects shall be considered for balancing of the sump level:

1. Water and steam masses from the leak.
2. Water masses retained/stored outside the containment sump.
3. Sump level characteristic (filling level as function of the sump water level).

If balancing of the sump level is performed in the course of a LOCA explicitly time-dependent, i. e. under consideration of transient curves of temperatures, steam volumes, leak flow rates etc., thermohydraulic computer codes validated with it shall be applied.

Simplified analyses without detailed thermohydraulic methods can be used, provided that it is ensured that covering results are achieved in the periods of time considered by corresponding conservative parametrisation.

In the following, the different analysis requirements are listed.

3.1.1 Water masses from a leak

The water masses flowing out of a leak at a certain point in time depends on the mass injected (first, from accumulators and refuelling water storage tanks, and further on also from the containment sump), the coolant inventory present in the reactor coolant system at the beginning of the accident and the coolant mass present at the respective point in time.

Regarding the water inventories injected by the different systems, the following assumptions shall apply:

- The single failure concept including the requirements regarding overlap with maintenance processes shall be applied. As far as there are licences for preventive maintenance during operation, the assumptions on overlapping contained in it shall be considered.

- The nominal level in the accumulators (operational fluctuations are irrelevant compared to the balanced masses) and the operational minimum level in the refuelling water storage tanks shall be taken as a basis.

- The injections actuated by the reactor protection system or automatically, as provided, can be taken into consideration.

In case of transient thermohydraulic analyses, the inventory remaining in the reactor coolant system is determined, in particular, under consideration of the time-dependent temperature distribution in the reactor coolant system, the time-dependent formation of steam cushions as well as the pressure in the reactor coolant system developing in dependence of the RHR pump characteristic and the leak size.

For the performance of the analyses, the following boundary conditions shall be assumed:

- The nominal filling level in the reactor coolant system shall be the initial condition.

If balancing is performed by means of simplified bass balances, the following boundary conditions shall apply:

- A single-phase RCS condition and at least the maximum pressuriser level to be reached according to the event-based instruction manual shall be assumed.

- For the period of time considered, the temperature in the reactor coolant system shall be conservative regarding the masses remaining in the reactor coolant system.

- The mass injected by the available accumulator shall be defined by assuming an adiabatic outflow.

In addition to the LOCA analysis under consideration of the design boundary condition for the respective plant, the influence of manual actions according to the event-based instruction manual, including reference to the protection-goal oriented instruction manual, shall also be assessed with regard to the sump level.

3.1.2 Retention or storage of water masses

Regarding the retention or storage of water masses outside the sump, the following boundary conditions shall apply:

- The plant-specific level to be demonstrated shall be based on the most unfavourable combination of leak location and leak size to be postulated. This may be determined within the framework of parameter analyses.

- For leaks at the RPV nozzle, a flow distribution in the pipe-in-pipe system, if existing, may be considered in case of transient analyses if verified models are available for it. The respective flow cross-sections available and the pressure loss coefficients to be applied shall be conservative according to plant-specific knowledge with regard to the flow rate into the reactor cavity.

- By means of the input masses of steam and drop entrainment into large plant compartments (direct discharge into the sump of the large plant compartments) or into the operating rooms/small plant compartments (discharge into the operational sumps, from there, if applicable, into the plant sump), the water masses not flowing into the sump shall be determined under consideration of the dead volumes in the mentioned compartment areas and possibilities of discharge into the plant sump.

- The proceeding regarding the determination of other water masses not available in the sump (atmospheric humidity, condensate film on surfaces) shall be justified.

For leak locations, e. g. extraction or injection line behind the first RCS isolation valve, which in case of the LOCA considered are either shut off by the reactor protection system or automatically by construction, shut-off failure shall be postulated in accordance with the single-failure concept. Here, a single failure does no longer have to be postulated for the consideration under 3.1.1 (see above, availability of emergency cooling trains).

3.1.3 Sump level characteristic

For the determination of the sump level characteristic, the volume of annular gap with ventilation channels within the support shield shall be considered in the sump volume. As far as the sealing behaviour of the flaps in the support shield has not been verified, both the case of tight flaps until opening of the flaps under overpressure with additionally occurring retention of water in the annular gap and the case of untight flaps with filling level balancing between gap and sump shall be considered.

3.2 Determination of the required sump level

From the RSK point of view, the following shall be referred to as criteria to demonstrate an adequate sump level:

a) No air suction by hollow vortex formation

This criterion is fulfilled,

- if the sump level exceeds the value resulting from the applicable test results for the vortex-free suction,
  or,
- if applicable test results are not available from the so-called ANSI formula [50].

b) No occurrence of cavitation

This criterion is fulfilled, if the NPSH margin is > 0 under design-basis conditions (no containment overpressure, saturation temperature of the sump water, pressure loss via the sump strainers negligible).

In case of non-negligible pressure losses via the sump strainers due to depositions on the sump strainers, the requirements of the RSK recommendation "Requirements for the demonstration of effective emergency core cooling during loss-of-coolant accidents involving the release of insulation material and other substances" (Annex 2 on the minutes of the 374th RSK meeting on 22.07.2004) shall be met.

If, in the individual case, a temporarily cavitation or hollow vortex formation cannot be excluded, this shall be assessed regarding the reliability under consideration of further test results (e. g. pump-specific tests with cavitation during operation).

Regarding the analyses on exclusion of air suction due to hollow vortex formation, the temperature of the sump water shall be conservative for the period of time considered regarding the water masses required in the sump. An increased pump flow rate due to single-pump operation (one pump during RHR operation, one pump during sump operation) shall be considered at the appropriate time.

4 Recommendations

Within an overall view of the results available so far, the RSK recommends for a final assessment that the plant operator and expert organisations demonstrate that the requirements presented in Chapter 3 are covered by plant-specific analyses and assessments. The RSK recommends that the experts give their report on the analyses and assessments performed on the basis of this recommendation in about three months.

In addition, the RSK recommends reviewing and, if required, amending the instruction manuals of the different plants with regard to the regulations and presentations on ensuring the fulfilment of the requirements for maintenance of the required minimum level in the sump.

Documents for discussion

[1] BMU-Schreiben RS I 3 – 17018/1 vom 23.03.2005
Stellungnahme der RSK zur Beherrschung des Kühlmittelverluststörfalls bei DWR unter Berücksichtigung des Totvolumens der Reaktorgrube
Beratungsauftrag

[2] FANP-Besprechungsbericht NGPS1/2004/de/0431 „Bewertung der SSP-Grenzwerte und deren Abweichungen vom Nachweisstand vom 14.07.2004

[3] BMU-Schreiben RS I 3 14222/30.2 vom 14.01.2005
Kernkraftwerk Philippsburg 2, Nachweis- und Auslegungsmangel

[4] Schreiben des Ministeriums für Umwelt und Verkehr Baden-Württemberg 7-4651.22-20.7 vom 14.01.2005
Nachweis- und Auslegungsmangel bei KKP-2

[5] Vermerk Abteilung 7 UVM, Az.: 7-4651.22-20.7 vom 14.01.2005
Nachweis- und Auslegungsmangel bei KKP-2

[6] Ministerium für Umwelt und Verkehr Baden-Württemberg, Pressestelle, Pressemitteilung, 14.01.2005
Mögliche Nachweislücke im Kernkraftwerk Philippsburg

[7] Schreiben des Niedersächsischen Umweltministeriums 44-40311/7(52.1) vom 15.01.2005
Kernkraftwerke Unterweser (KKU), Grohnde (KWG) und Emsland (KKE);
Vorsorgliche Übertragbarkeitsprüfungen auf Grund der Information über eine Lücke in der Nachweisführung für einen Kühlmittelverluststörfall mit der Lecklage innerhalb des biologischen Schildes im Kernkraftwerk Philippsburg (KKP) 2

[8] Schreiben E.ON Kernkraft GmbH vom 15.01.2005
Ergänzung unseres Schreibens
Vorsorgliche Übertragbarkeitsprüfungen auf Grund der Information über eine Lücke in der Nachweisführung für einen Kühlmittelverluststörfall mit der Lecklage innerhalb des biologischen Schildes im Kernkraftwerk Philippsburg (KKP) 2

[9] Schreiben E.ON Kernkraft GmbH vom 15.01.2005
Vorsorgliche Übertragbarkeitsprüfungen aufgrund der Information über eine Lücke in der Nachweisführung für einen Kühlmittelverluststörfall mit der Lecklage innerhalb des biologischen Schildes im Kernkraftwerk Philippsburg (KKP) 2 (Anlage 2a)

[10] Schreiben E.ON Kernkraft GmbH vom 15.01.2005
Vorsorgliche Übertragbarkeitsprüfungen aufgrund der Information über eine Lücke in der Nachweisführung für einen Kühlmittelverluststörfall mit der Lecklage innerhalb des biologischen Schildes im Kernkraftwerk Philippsburg (KKP) 2 (Anlage 2b)

[11] KWG, Schichtanweisung Nr. 76 vom 15.01.2005
Vorsorgliche Abweichung von der allgemeinen Verfahrensweise bei Reparaturen

[12] Schreiben Kernkraftwerke Lippe-Ems, Kernkraftwerk Emsland,
KKE AM 0862.1 1410 050115 vom 15.01.2005
Kernkraftwerk Emsland (KKE)- Aufsichtsverfahren
Vorsorgliche Übertragbarkeitsprüfung aufgrund einer Lücke in der Nachweisführung für einen Kühlmittelverluststörfall mit der Lecklage innerhalb des biologischen Schildes im Kernkraftwerk Philippsburg (KKP) 2

[13] Schreiben des Bayerisches Staatsministeriums für Umwelt, Gesundheit und Verbraucherschutz vom 15.01.2005
Vollzug des § 19 Atomgesetz (AtG) bei den bayerischen Kernkraftwerken; Nachweis- und Auslegungsmangel im Kernkraftwerk Philippsburg 2; Anfrage des BMU vom 14.01.2005

[14] Schreiben des Ministeriums für Soziales, Gesundheit und Verbraucherschutz des Landes Schleswig-Holstein vom 15.01.2005
Kernkraftwerk Brokdorf (KBR)
Nachweis- und Auslegungsmangel im Kernkraftwerk Philippsburg 2

[15] Schreiben des Hessischen Ministeriums für Umwelt, ländlichen Raum und Verbraucherschutz IV3-991.2.1/2.3.11 vom 15.01.2005
Kernkraftwerk Biblis, Bericht zum Nachweis- und Auslegungsmangel bei KKP-2

[16] Schreiben RWE Power, Kernkraftwerk Biblis Dr. Ha-ra vom 15.01.2005
Kraftwerk Biblis, Blöcke A und B, Information des KKW Philippsburg 2 Sumpffüllstände

[17] RWE Power, Kraftwerk Biblis Block A
Schichtanweisung (SA) Nr.03/04 vom 15.01.2005
Vorgehen bei der Feststellung von Störungen und Befunden mit Melderelevanz

[18] Schreiben des TÜV Nord KWB2005/0060 vom 15.01.2005
Kraftwerk Biblis A
Aufsichtsverfahren nach § 19 AtG
Kernkraftwerk Philippsburg 2, Nachweis- und Auslegungsmangel
Erste Überprüfung zur Übertragbarkeit auf Block A

[19] Schreiben des TÜV Süd vom 15.01.2005
Kernkraftwerk Biblis, Block B (KWB-B)
Aufsichtsverfahren nach § 19 AtG

[20] Kernkraftwerk Obrigheim GmbH
Fax vom 21.01.2005

[21] Schreiben des Kernkraftwerks Obrigheim GmbH Sen/Ric vom 21.01.2005
Möglicher Nachweis- und Auslegungsmangel bei KKP-2
Aufsichtliches Gespräch am 17. Jan. 2005 im UVM Baden-Württemberg

[22] Anhang zum Schreiben Sen/Ric vom 21. Jan. 2005
Nachweis der ausreichenden Bemessung der Flutwasservorräte bei Kühlmittelverluststörfällen (KMV) mit spezieller Lecklage innerhalb des Biologischen Schildes

[23] BMU-Schreiben AG RS I 3 14222/30.3 vom 22.02.2005
Kernkraftwerk Philippsburg 2, Nachweis der Störfallbeherrschung
Folgerungen für andere Kernkraftwerke

[24] Schreiben des Niedersächsischen Umweltministeriums 44-40311/4/5.2 vom 10.03.2005
Kernkraftwerk Philippsburg 2 – Nachweis der Störfallbeherrschung hinsichtlich der gesicherten Sumpfansaugung; Folgerungen für die niedersächsischen Kernkraftwerke Unterweser (KKU), Grohnde (KWG) und Emsland (KKE)

[25] Schreiben von E.ON Kernkraft vom 09.03.2005
Kernkraftwerk Unterweser (KKU)

[26] Schreiben von E.ON Kernkraft vom 09.03.2005
Gemeinschaftskernkraftwerk Grohnde (KWG)

[27] Schreiben Kernkraftwerke Lippe-Ems, Kernkraftwerk Emsland
KKE AM 0862.1 0064 050309 vom 09.03.2005
Kernkraftwerk Emsland (KKE) – Aufsichtsverfahren

[28] Schreiben des Ministeriums für Soziales, Gesundheit und Verbraucherschutz des Landes Schleswig - Holstein VIII – 614 416.502.110 vom 11.03.2005
Kernkraftwerk Philippsburg 2, Nachweis der Störfallbeherrschung
Folgerungen für andere Kernkraftwerke

[29] Schreiben des Bayerischen Staatsministeriums für Umwelt, Gesundheit und Verbraucherschutz 95-U8811.00-2005/3-16 vom 11.03.2005
Vollzug des § 19 Atomgesetz (AtG) bei den bayerischen Kernkraftwerken; Kernkraftwerk Philippsburg 2, Nachweis der Störfallbeherrschung; Folgerungen für andere Kernkraftwerke

[30] Schreiben des Hessischen Ministeriums für Umwelt, ländlichen Raum und Verbraucherschutz IV3b-99.1.2.1/2.4.10.2 vom 15.03.2005 an RWE Power
Kernkraftwerk Biblis, Blöcke A und B
Nachweis der Störfallbeherrschung für das Kernkraftwerk Philippsburg 2 und die Folgerungen für andere Kernkraftwerke

[31] Schreiben des TÜV Süd 0515 vom 04.02.2005
Kernkraftwerk Biblis,, Block A und Block B
Aufsichtsverfahren nach § 19 AtG

[32] TÜV Süd
Kernkraftwerk Biblis, Blöcke A und B
Aufsichtsverfahren nach § 19 AtG
Ergebnisbericht zur Besprechung am 25.01.2005

[33] Schreiben des Hessischen Ministeriums für Umwelt, ländlichen Raum und Verbraucherschutz IV3b-99.1.2.1/2.4.10.2 vom 15.03.2005 an das BMU
Kernkraftwerk Biblis, Blöcke A und B
Nachweis der Störfallbeherrschung für das Kernkraftwerk Philippsburg 2 und die Folgerungen für andere Kernkraftwerke

[34] Entwurf- Schreiben des Hessischen Ministeriums für Umwelt, ländlichen Raum und Verbraucherschutz IV3b-99.1.2.1/2.4.10.2 vom 25.02.2005 an RWE Power
Kernkraftwerk Biblis, Blöcke A und B
Nachweis der Störfallbeherrschung für das Kernkraftwerk Philippsburg 2 und die Folgerungen für andere Kernkraftwerke

[35] Schreiben RWE Power Dr. Haag-jj vom 10.03.2005
Kraftwerk Biblis, Block A und B
Nachweis der Störfallbeherrschung für das Kernkraftwerk Philippsburg 2 und die Folgerungen für andere Kernkraftwerke

[36] Schreiben des Ministeriums für Umwelt und Verkehr Baden-Württemberg 73-4651.22-20.7 vom 16.03.2005
Schreiben des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit vom 22. Februar 2005, Az.; AG RS I 3 14222/30.3

[37] Schreiben der EnBW Kernkraftwerk GmbH
Kernkraftwerk Neckarwestheim – GKN GKND2184706 vom 11.03.2005
GKN-I
Schreiben des BMU vom 22.02.2005

[38] Schreiben der EnBW Kernkraftwerk GmbH
Kernkraftwerk Neckarwestheim – GKN GKND2184705 vom 10.03.2005
GKN-I
Schreiben des BMU vom 22.02.2005

[39] Schreiben der Kernkraftwerk Obrigheim GmbH vom 10.03.2005
Schreiben des BMU vom 22.02.2005

[40] TÜV Süd Energie und Systeme 09.03.2005
Stellungnahme GKN I

GKN-I – Möglicher Nachweis- und Auslegungsmangel bei KKP-2
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[49] VGB Power Tech

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33. Ausschusssitzung AST, Gustav-Stresemann-Institut Bonn, 25.05.2005, Folienkopien

[51] AST-Information 34/3 vom 14.06.2005
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Entwurf/Fragenliste

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[53] Beherrschung des Kühlmittelverlust-Störfalls bei DWR unter Berücksichtigung des Totvolumens in der Reaktorgrube
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