RSK Statement

Increase of the thermal reactor power of the Grafenrheinfeld nuclear power plant (KKG)

18.09.2003

1 Advisory request

With letter referenced RS I 3 – 14200/7.12 of 20.12.2002 [1], the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) informed the Reactor Safety Commission (RSK) that the Bavarian State Ministry for Regional Development and Environmental Affairs (BStMLU) submitted the draft of a licence [3] for increasing the thermal reactor power of the Grafenrheinfeld nuclear power plant (KKG) to 3,950 MW. For the preparation of a statement of the federal supervisor, the BMU requested the RSK to make a corresponding statement for the safety assessment of the thermal power increase on the following issues:

- Evaluation of operating experiences or evaluation of preliminary tests,
- impact of the power increase on design and construction of safety-relevant plant components with regard to the available safety margins,
- impact of the power increase on the plant behaviour during specified normal operation,
- impact of the power increase on the plant behaviour during transients and design-basis accidents as well as radiological consequences in case of accidents, particularly under consideration of the most unfavourable incident, and
- impact of the power increase on the plant behaviour during beyond-design-basis accidents.

In addition to the initial advisory request, a statement was requested on the following topics:

- Neutron fluence at the reactor pressure vessel (RPV) and at the reactor pressure vessel internals,
- strength behaviour of systems and components during operational transients and accidents, and
- water chemistry.

2 Assessment criteria

In the application for the licensing of a power increase according to Section 7 of the Atomic Energy Act (AtG) it shall be demonstrated that the necessary precautions against possible damage due to the construction and operation of a plant with a power increase to 3,950 MW_{th} have been taken in accordance with the state of the art in science and technology. It shall be examined to which extent the applicable rules and regulations are complied with under consideration of new findings according to the state of the art in science and technology.

The assessment criteria have mainly been derived from

- the Atomic Energy Act,
- the BMI safety criteria of the Federal Ministry of the Interior (BMI),
- the incident guidelines,
- the incident calculation bases,
- the RSK guidelines,
- the RSK recommendations, and
- the KTA standards.

For the assessment, experiences from the expert opinions on comparable plants and operating experiences after power increase are taken into account.

3 Proceeding

To answer the questions posed in the advisory request of the BMU, the Committees on PLANT AND SYSTEMS ENGINEERING and REACTOR OPERATION heard the operator, the authorised inspection agency and GRS on the power increase of the KKG nuclear power plant applied for in their joint meeting on 15.04.2003. The Committee on PLANT AND SYSTEMS ENGINEERING continued the respective discussions at its 18th meeting on 23.05.2003 with a hearing of GRS, compiled the results of the discussions at its 19th meeting on 02.07.2003 and at its 20th meeting on 04.09.2003 for the RSK and concluded its consultations at its 20th meeting on 04.09.2003.

At its 36th meeting on 25.06.2003, the Committee on PRESSURE-RETAINING COMPONENTS AND MATERIALS discussed the thermal power increase of the KKG nuclear power plant and compiled the result of its consultations at its 37th and 38th meeting on 16.07.2003 and 03.09.2003 for the RSK.

At its 152nd meeting on 09.07.2003 and its 153rd meeting on 11.09.2003, the Committee on REACTOR OPERATION discussed partial aspects of the power increase and compiled the results of its consultations for the RSK.

At its 157th meeting on 11.09.2003, the Committee on ELECTRIC INSTALLATIONS discussed the modifications of electric and I&C components planned within the framework of the power increase and compiled the results for the RSK.

4 Results of the safety assessment of the thermal power increase of the Grafenrheinfeld nuclear power plant (KKG)

The answers of the RSK to the questions of the BMU posed in letter RS I 3 – 14200/7.12 of 20.12.2002 [1] are given on the basis of the documents and reports of GRS [16,17,23,24,25,27,28], the authorised inspection agency [14,15,20,22,26,30] and operator or manufacturer, respectively [4-13,18,19,21,29] as well as on their consultations as follows:

- Evaluation of operating experiences or evaluation of preliminary tests

At the plants Philippsburg 2 (KKP-2) and Isar 2 (KKI-2), comparable thermal power increases have already been implemented. Neither the routine evaluation of reportable events nor the evaluation of events below the reporting threshold from the annual report of the plant operator by GRS [16] revealed any anomalies to be attributed to the thermal power increase. This applies to four other German nuclear power plants with pressurised water reactor (Grohnde (KWG), Neckarwestheim 2 (GKN-2), Emsland (KKE) and Unterweser (KKU)) where, compared with KKG, the power increases were slightly smaller.

At the KKG plant, a preliminary test was conducted as measurement run [14] with a power increase to about 3,950 MW_{th}. During the whole run there was no disturbance related to safety-relevant systems and equipment. There was no impact on the safe operation of the plant.

Further, there are no other safety-relevant indications from operating experiences or preliminary tests known to RSK which argue against the thermal power increase to the extent applied for by KKG.

- Impact of the power increase on design and construction of safety-relevant plant components with regard to the available safety margins as well as on plant behaviour during specified normal operation

The reports submitted by GRS [16, 17] and the authorised inspection agency [14, 20] address the necessary scope of design characteristics to be considered in the view of the RSK. According to these reports, there are no indications that the design values will not be complied with after the power increase applied for. The effects of a cavitation of the feedwater pumps which might occur during specified normal operation will be examined, according to the competent *Länder* authority BStMLU, within the framework of the in-service inspections. From the point of view of RSK, this does not entail any safety-relevant aspects. Despite a reduced value of the departure from nucleate boiling (DNB) resulting from the power increase, the KKG plant can be operated with the necessary safety margin against film boiling.

No objections were raised by the authorised inspection agency [14] and GRS [17] against the admissibility of the statistical methods used in the application documents for the assessment of the mechanical design of the fuel rods for specified normal operation. The RSK supports the application of this method, since it provides quantitative data on uncertainties of relevant parameters. The RSK is of the opinion that in case of changing from a conservative-deterministic approach to statistical methods for calculations on the fuel rod design, the compliance with the respective design criteria should be ensured with a comparable safety and reliability. The deterministic approach of core design for specified normal operation includes the requirement that no fuel rod damages are to be expected, which is ensured by corresponding conservativities. As the failure rate calculated with statistical methods is always greater than zero, the above-mentioned design goal shall be defined specifically for each method. The RSK is of the opinion that an analysis goal equivalent to the deterministic approach is achieved if it is demonstrated that no more than one defective fuel rod in the core is to be expected within one cycle. Here, the statistical validity shall be 95 %.

Whether this is demonstrated specifically for the cycle or within the framework of the licensing procedure for the power increase has no safety significance.

On the basis of the expert opinion [14], the values for control, limitations and reactor protection to be adjusted due to the power increase were discussed. It was concluded from the discussions that there are no objections against the modification of the limit values with regard to I&C. From the scope of modification applied for, no functional or equipment-related changes of the safety I&C will result.

Regarding the safety-relevant electrotechnical components, the result of the discussions was that the power increase will not lead to changes of these components.

- Impact of the power increase on the plant behaviour during design-basis accidents as well as radiological consequences in case of incidents, particularly under consideration of the most unfavourable incident

  - Completeness of the design-basis accidents under consideration

GRS examined the completeness of the design-basis accidents considered in the application documents and the expert opinion of TÜV Süddeutschland and arrives at the conclusion that all relevant accident groups have been dealt with [17]. The events “turbine trip with bypass failure” and “inadvertent closure of main steam isolation valves” not considered according to [17] shall be regarded, after re-examination of the documents by the RSK Committee on REACTOR OPERATION at its 152nd meeting on 09.07.2003, as dealt with.

According to the results of GRS [17], the scenarios examined regarding the leak accidents to be considered are complete except for the bypass sequences

- leakages in the main steam system outside the containment with leakages at steam generator tubes (SG tubes),

- failure of a SG safety valve to close with leakages at SG tubes,

- leak in volume control system outside the containment, and

- leak in a line carrying primary coolant.

The change of the activity concentration in the coolant associated with the power increase is assessed to be minor by GRS. However, GRS recommends a statement on this issue to be prepared by the TÜV.

In the view of the RSK, the mentioned bypass sequences are included in the event spectrum to be considered and thus should also be considered for the accident analyses.

- Uncertainties of the calculation methods and model assumptions applied, compliance with the analysis criteria

For the analyses on the control of design-basis accidents, both the applicant and the inspection agency applied the calculation methods in accordance with the applicable nuclear rules and regulations and also applied in other licensing or supervision procedures.

The RSK is of the opinion that the application documents and expert opinions should generally include a comprehensible presentation of the reliability of the applied calculation methods obtained by a quantitative approach, also including a reference to the documentation of the validation and verification steps performed.

The RSK is of the opinion that, in view of the increasing reduction of safety margins and the details given by GRS [25, 26] and the details given by GRS at the 363rd meeting of the RSK on 04./05.06.2003, a generic discussion should be held regarding the conservativity of the methods applied in the accident analyses. This is an issue already taken up by the RSK independent of the current licensing situation of the KKG nuclear power plant.

Regarding the generic issue “boron dilution during reflux-condenser mode with small leak”, the RSK states that the quantity of accumulating deborated coolant is mainly limited by the plant geometry (e. g. pipe bends, outlet chambers of the steam generators) and is considered in the analyses correspondingly conservative. The current state of knowledge shall be taken into account in the analyses.

Regarding the generic issue “influence of the insulating material on core cooling after a LOCA”, the RSK is of the opinion that new findings on it should be considered in the analyses.

- Impact of the power increase on the plant behaviour in case of beyond-design-basis accidents

The RSK states that the scenarios postulated today for plant-internal beyond-design-basis events have completely been considered.

- Uncertainties of the calculation methods and model assumptions applied for anticipated transients without scram (ATWS), compliance with the accident analysis criteria

The ATWS analyses submitted were performed with point kinetics models, also using reactivity coefficients (Doppler, coolant temperature, coolant density and spectral coefficient). A traceable analysis that, in particular, the spectral coefficient has been determined with sufficient reliability and conservativity has not been submitted to the RSK. The RSK recommends to perform the analyses and submit the corresponding results.

For the reactor core on which the application documents are based, ATWS analyses without taking account of switching off the main coolant pumps and with conservative bounding nuclear characteristics according to the applicable frame of acceptable core loadings have not been submitted. According to the explanations of the *Land* licensing authority, the respective analysis on the control of ATWS events is performed within the framework of the cycle-specific analyses. In addition, the results of Framatome ANP (FANP) and TÜV Süddeutschland were presented on the 18th meeting of the Committee on PLANT AND SYSTEMS ENGINEERING on 23.05.2003 [26] [27]. On the basis of these results it was demonstrated that the core loading planned for the 21st cycle fulfils the requirements of the RSK recommendation on ATWS events [31].

The RSK recommends to adjust the ATWS specific requirements in the core boundary conditions of the KKG to the changed requirement situation according to [31] (particularly with regard to the conservative "void" curve).

- Reliability and effectiveness of preventive emergency measures

The measures for power increase applied for lead to a reduction of the grace times (difference between required and available time) for manual actions in case of emergency measures for secondary and primary depressurisation. On this issue, GRS assessed the feasibility and reliability of the emergency measures based on the requirements of the emergency manual and the plant-dynamics analyses examined by the TÜV.

For the thermal hydraulics and time budget analyses on the events "loss of all feedwater" and "station blackout (SBO)" performed by FANP, the TÜV generally confirmed that the effectiveness will further be given without any restrictions and that the grace times will remain to be sufficient. However, there were indications to unfavourable factors, such as temporal reduction of accident sequences, the criterion "SG valves open" sometimes reached before termination of the preparation of secondary depressurisation and the

criterion for the preparation of primary depressurisation sometimes reached before effectiveness of the secondary depressurisation. Until now it has not been possible to check the ergonomic conditions on site.

From their analyses, among others based on simulator experiments in France and in the USA, GRS obtained the following results:

- Under the condition that in case of loss of all feedwater and immediate switch-off of the main coolant pumps (MCP) personnel is immediately available, the grace time for secondary depressurisation is reduced from 13 to 9 minutes and the grace time for primary depressurisation from 27 to 21 minutes.

- For SBO, the grace time for secondary depressurisation is reduced from 29 to 21 minutes and the grace time for primary depressurisation from 26 to 19 minutes.

The influence of the favourable boundary conditions "necessary measures can immediately be taken after reaching the emergency criterion" and "MCP switch-off immediately after reaching the emergency criterion", on which the FANP analyses are based, on the results has been assessed by GRS. According to this assessment, additional time of up to ten minutes may be required for the return of the personnel to the control room and the termination of precedent actions. In case of a delayed MCP switch-off performed according to the emergency manual (NHB), the time sequence is reduced by four minutes; moreover, the provisions of the instruction manual only permit minimum staffing with two electricians.

GRS is of the opinion that in case of loss of all feedwater the time available for the early initiation of secondary depressurisation may not be sufficient and that the probability for the double loss of secondary depressurisation/primary depressurisation further increases by a factor of 2 to 4. The grace times are further reduced by the consideration of the boundary conditions of the emergency manual.

The plant operator added that the time-related data (5 minute blocks) on secondary and primary depressurisation given in the emergency manual were examined more closely. In the assessment performed within the framework of the licensing procedure for the power increase, the operator arrived at the result that there was sufficient time for secondary depressurisation and a possible overlap of secondary and primary depressurisation in a 5 minute block was due to the circumstance that the blow-off control valve for secondary depressurisation was open whereas the criterion for the preparation of primary depressurisation was already reached.
In summary, GRS arrives at the following results:

- For "loss of feedwater", the time available in case of "no immediate switch-off of the main coolant pumps" and "necessary personnel not immediately available" is not sufficient to perform the emergency measure secondary depressurisation before reaching the criteria for the preparation of primary depressurisation.

- The time available for the emergency measure primary depressurisation is considerably reduced. However, it is sufficient to perform the measure.

- The probability that in case of demand neither secondary depressurisation nor primary depressurisation are available increases compared to the situation before power increase.

- The reliability of the emergency measures secondary and primary depressurisation is to be assessed less favourable than at other plants with comparable measures already before the power increase due to, among other things, the lower water inventory at the secondary side of the steam generators.

The RSK recommends to optimise the emergency procedures for the loss of feedwater by decoupling secondary depressurisation/primary depressurisation regarding time and/or personnel and to adjust the emergency manual correspondingly.

- Neutron fluence at reactor pressure vessel und reactor pressure vessel internals

According to the inspection agency TÜV Süddeutschland, the power increase leads to an increase of the average maximum neutron flux density (energy > 1 MeV) at the inner surface of the RPV for the equilibrium cycle under consideration. This increase was due to the increase of the neutron source strength and the lower shielding resulting from the slight reduction of the water densities in the RPV due to the increased coolant inlet temperature.

Under the condition of the equilibrium cycle under consideration and under consideration of the previous operating cycles, the extrapolated maximum lifetime fluence of $3.1 \cdot 10^{18}\,cm^{-2}$ at the inner surface of the RPV was about 5 % higher after power increase compared to the reactor capacity before power increase. The margin against the design value of $5 \cdot 10^{18}$ cm^{-2} remained to be sufficient due to the core loadings associated with the increased reactor capacity.

Regarding the safety-relevant structural components of the RPV internals made of austenitic materials, the results of the calculations on the maximum lifetime fluence to be expected after the power increase were exceeding the values precalculated so far by about 5 % as a maximum. The increase of the fluences was thus within the range of the change calculated for the RPV due to the small differences of the neutron fluence in the fast energy range.

The change of the material properties caused by neutron irradiation in the area of the RPV was reported to reduce the material toughness at neutron fluences of more than 10^{20} cm^{-2}, as they were determined for the core barrel. The changes of the neutron fluences at the RPV internals resulting from the power increase would reduce the toughness properties of the material only insignificantly. Due to the high initial toughness of the austenitic materials installed here, especially considering the loads given for the core internals, this change is not regarded as significant.

GRS reported on interim results of its task to review the expert opinion of the TÜV Süddeutschland (consultation documents [14] and [15]). In summary, GRS arrives at the result that the above statements are plausible.

The RSK states that retroactive effects on the material behaviour (e. g. toughness) are negligible due to the mentioned increase of the neutron fluence.

It remains to be stated that the expert opinion does not include any statement on the impact of the neutron fluence on the radiation-induced stress corrosion cracking of the materials of the RPV internals. Thus, the assessment of the RSK is based on values from literature according to which the probability for the occurrence of a radiation-induced stress corrosion cracking is not increased with the changes of the neutron fluences (+5 %) presented.

Due to the power increase, an increase of the potential for intergranular stress corrosion cracking is not to be postulated for the components of the pressure-retaining boundary made of austenite or Inconel.

The RSK is of the opinion that no safety-relevant effects on materials will occur due to the increase of the neutron fluence and the temperature.

Cladding corrosion has not been considered in the expert opinion. This shall be done, in accordance with the application documents, specifically for each cycle. The RSK recommends that the respective analysis shall also be submitted for the reference core. .

- Strength behaviour of systems and components during operational transients and accidents

Reports were made to the RSK on two fields where changes occur: pressure-retaining boundary and water/steam cycle.

The stress analysis on the relevant load cases by the inspection agency TÜV Süddeutschland revealed, according to their report, that the increase of loads for the primary circuit resulting from the power increase is small and covered by the present design data (pressure and temperature). The strength design of the reactor coolant and pressurising system fulfilled the requirements also in case of increased reactor capacity.
For the water/steam cycle, the load case “turbine trip” was considered in the design for the main steam system in the turbine hall with a load of 105% according to KTA 3211.2 [33]; the circumferential loads were determined by means of operational data.

The examination of the inspection agency TÜV Süddeutschland of the systems affected by the power increase showed that these fulfil the requirements regarding safe operation. The process parameters and valve positions after power increase shall be measured and verified in comparison with the values expected. For special components of the water/steam cycle special tests shall be performed. The dynamic plant behaviour during design-basis accidents was examined, among other things, by analyses of the inspection agency. According to the agency, the requirements will further be complied with. The margins against the

respective acceptance limits had only changed slightly by the power increase and remained to be sufficiently large. For operational transients with disturbances of the secondary-side heat removal where the measures of reactor protection and the limitation systems are initiated by the limit value “main steam pressure high”, more favourable sequences were obtained due to the main steam pressure increased with the power increase. Upon inquiry of the Committee about the significance of the mentioned design data (pressure and temperature) in the analyses it was explained that the verification calculations are performed with operational data. Regarding ATWS, the inspection agency confirmed that the statements of the plant operator that for the allowable stresses a margin of the maximum pressure reached against the 1.3-fold design pressure was defined.

GRS reported on the interim results of its task to review the expert opinion of the TÜV Süddeutschland (consultation documents [14] und [15]). In summary, GRS arrives at the result that the above statements are plausible.

The RSK states that the analyses on the strength behaviour presented represent delta analyses on the initial analyses. A delta analysis corresponds to the state of the art in science and technology if the initial analyses also correspond to the state of the art in science and technology. It shall be demonstrated that the current analysis meets the requirements of the applicable rules and regulations.

On ATWS, the RSK states that the assessment with the 1.3-fold design pressure (cf. explanations under agenda item TOP 11 in the minutes of the 328th RSK meeting on 03.02.2000) on the basis of the section of ASME III quoted in the RSK guideline is not comprehensible. The RSK states that based on the design and analysis according to ASME and KTA and the postulation that the design pressure in case of ATWS is not exceeded, the 1.2-fold of the design pressure shall be taken as a basis for the assessment. The fulfilment of the boundary conditions mentioned with regard to the design of the components must be confirmed.

The RSK states that the available documents and reports do not clearly show the status regarding the analyses on the safety-relevant parts of the water/steam cycle in the turbine hall. The RSK recommends to perform the analyses and submit the corresponding results.

- Water chemistry

According to the explanations of the inspection agency TÜV Süddeutschland, the power increase will lead to a proportionally increased radiolysis gas accumulation in the pressuriser. It was concluded from the examination of the exhaust gas system on the basis of the system documents by the inspection agency that there were sufficient design reserves in the system. The reduction of the stay time in the delay columns due to the flow rate increase was also without any safety concerns. The inspection agency regards it as necessary to increase the monitoring of the water chemistry in the primary coolant within the framework of plant start-up.

The RSK states that regarding the oxygen concentration during the measurement run performed in the cooling circuit, no measurable changes occurred compared to previous operation so that no changes are to be expected with regard to the respective corrosion behaviour of the materials.

5 Conclusion

Provided that the restrictions described above are taken into consideration and the required analyses will be performed, the RSK has no objections against the thermal power increase of the Grafenrheinfeld nuclear power plant from a safety point of view.

CONSULTATION DOCUMENTS

[1] Schreiben des BMU Az.: RS I 3 – 14 200/7.12 vom 20.12.2002
Thermische Leistungserhöhung in deutschen Kernkraftwerken
Kernkraftwerk Grafenrheinfeld (KKG) – Erhöhung der thermischen Reaktorleistung auf 3.950 MW
(11. Änderungsgenehmigung)

[2] Schreiben von Herrn Donderer vom 03.03.2003
Betr.: Beratungen zur Leistungserhöhung KKG in RB/AST
Fragen an den Gutachter

[3] Genehmigung nach § 7 Atomgesetz (AtG) zur Erhöhung der thermischen Reaktorleistung des Kernkraftwerks Grafenrheinfeld (KKG) –
11.Änderungsgenehmigung –
Bayerisches Staatsministerium für Landesentwicklung und Umweltfragen,
Akz.: 93-88.11.07–2000/178-35 vom 03.12.2002

[4] KKG – Genehmigungsantrag nach § 7 AtG zur Erhöhung der thermischen Reaktorleistung für das Kernkraftwerk Grafenrheinfeld
Bayernwerk Kernenergie, Az.: TS-Roe/He vom 16.05.2000

[5] Kernkraftwerk Grafenrheinfeld – Genehmigungsverfahren zur Erhöhung der thermischen Reaktorleistung
E.ON Kernkraft, Az.: TG-Rö/Ost vom 16.04.2002

[6] Kernkraftwerk Grafenrheinfeld
hier: Gutachtensbedingungen zur Leistungserhöhung auf 3950 MW_{th}
A.-Nr. 5304 vom 19.11.2002
E.ON Kernkraft, Az.: TTA-Dr. So/Hat vom 21.11.2002

[7] Kernkraftwerk Grafenrheinfeld – Änderungsgenehmigung nach § 7 Abs. 1 AtG zur Erhöhung der thermischen Reaktorleistung
hier: Nachweis der Deckungsvorsorge
E.ON Kernkraft, Az.: TG-Rö/Ost vom 24.07.2002

[8] Entsorgungsvorsorgenachweis
KKG-Leistungserhöhung
E.ON Kernkraft, Az.: TTA-Dr. So vom 27.03.2002

[9] Kernkraftwerk Grafenrheinfeld – Änderungsgenehmigung nach § 7 Abs. 2 Nr. 1 AtG
zur Erhöhung der thermischen Reaktorleistung
hier: Verantwortliche und beauftragte Personen
E.ON Kernkraft, Az.: TG-Rö/Ost vom 24.07.2002

[10] KKG – Änderungsgenehmigung zur Erhöhung der thermischen Reaktorleistung
hier: Kenntnisvermittlung von sonst tätigen Personen
Az.: TG-Rö/Cor vom 25.06.2002

[11] Kernkraftwerk Grafenrheinfeld
Änderungsgenehmigung zur Erhöhung der thermischen Reaktorleistung
hier: Begutachtungsunterlagen
Framatome-ANP-Arbeitsbericht NGES 4/2002/de/0136
E.ON Kernkraft, Az.: EKK-TTA-Dr. So/Tü vom 10.09.2002

[12] Kernkraftwerk Grafenrheinfeld – Änderungsgenehmigung zur Erhöhung der
thermischen Reaktorleistung
hier: Bundesimmissionsschutzgesetz
E.ON Kernkraft, Az.: TG-Rö/Cor vom 14.05.2002

[13] KKG – Erhöhung der thermischen Reaktorleistung
IBS-Programm
E.ON Kernkraft, Az.: dz-gr vom 25.06.2002

[14] Kernkraftwerk Grafenrheinfeld
Gutachten zur Erhöhung der thermischen Reaktorleistung für das
atomrechtliche Genehmigungsverfahren nach § 7 AtG
TÜV Süddeutschland, November 2002

[15] Kernkraftwerk Grafenrheinfeld (KKG)
Auftrag vom 24.05.2000, Az.: 93-8811.07-2000/178-2
Begutachtung der Leistungserhöhung auf 3950 MW_{th}
Gutachterliche Stellungnahme zur Radiologie
TÜV Süddeutschland, Az.: BB-ETB-MUC/he/pr Rainer Hero A.-Nr.: 4115
vom 29.08.2002

[16] Geplante Erhöhung der Reaktorleistung des Kernkraftwerks Grafenrheinfeld (KKG)
Stellungnahme der GRS, Teil 1, 15.04.2003, Folienkopien

[17] Geplante Erhöhung der Reaktorleistung des Kernkraftwerks Grafenrheinfeld (KKG)
Teil 2
Bewertung der Kernauslegung und des dynamischen Anlagenverhaltens bei Transienten und Störfällen
W. Pointner, U. Jendrich, S. Langenbuch, H.-G. Sonnenburg
Tischvorlage für die gemeinsame Sitzung der RSK-Ausschüsse Anlagen- und Systemtechnik und Reaktorbetrieb, Bonn, 15. April 2003

[18] Thermische Leistung [MW] deutscher Druckwasserreaktoren
E.ON Kernkraft, Folienkopie

[19] Leistungserhöhung um 5% von 3765 MW auf 3950 MW
E.ON Kernkraft, Kernkraftwerk Grafenrheinfeld, Folienkopien

[20] Kernkraftwerk Grafenrheinfeld, Genehmigungsverfahren nach § 7 AtG
Erhöhung der thermischen Reaktorleistung auf 3950 MW_{th}
Durchführung und Ergebnisse der Begutachtung
TÜV Süddeutschland, Folienkopien

[21] Konservative Analysen und Best Estimate Programm
Leistungserhöhung Kernkraftwerk Grafenrheinfeld aus 3950 MW
Framatome ANP, Folienkopien

[22] TÜV Süddeutschland
Kernkraftwerk Grafenrheinfeld (KKG)
Leistungserhöhung auf 4000 MW
Hier: Ergänzende Erläuterungen zu den ATWS-Nachweisen
Von BB-ETH03-MUC, Jörg-Thomas Bornemann

[23] Bericht über die zusätzlichen ATWS- Berechnungen für KKG ohne Abschaltung der Hauptkühlmittelpumpen
S. Langenbuch, GRS, Folienkopien

[24] Kernkraftwerk Grafenrheinfeld: Verringerung der Karenzzeiten für Handmaßnahmen zur sekundär- und primärseitigen Druckentlastung
Wolfgang Preischl, GRS, Folienkopien

[25] Bestimmung der Aussagesicherheit von thermohydraulischen Rechenergebnissen
H. Glaeser, GRS, Folienkopien

[26] Kernkraftwerk Grafenrheinfeld (KKG)
Leistungserhöhung auf 4000 MW
Hier: Ergänzende Erläuterungen zu den ATWS-Nachweisen
TÜV Süddeutschland, BB-ETH03-MUC, Jörg-Thomas Bornemann

[27] Bericht über die zusätzlichen ATWS- Berechnungen für KKG ohne Abschaltung der Hauptkühlmittelpumpen
S. Langenbuch, GRS, Folienkopien

[28] Kernkraftwerk Grafenrheinfeld: Verringerung der Karenzzeiten für Handmaßnahmen zur sekundär- und primärseitigen Druckentlastung
Wolfgang Preischl, GRS, Folienkopien

[29] Notfallmaßnahmen SDE und PDE
E.ON Kernkraft, Kernkraftwerk Grafenrheinfeld
Folienkopien 23.05.2003 TTA-Dr. So/Len

[30] Kernkraftwerk Grafenrheinfeld (KKG), Genehmigungsverfahren nach § 7 AtG
Erhöhung der thermischen Reaktorleistung auf 3950 MW_{th}
Beratung der RSK-Auschüsse AST und RB
Beantwortung der Fragen von Herrn Donderer (Physikerbüro Bremen)
TÜV Süddeutschland, Bau und Betrieb

[31] Reaktor-Sicherheitskommission, Stellungnahme
ATWS-Ereignisse
Anlage 2 zum Ergebnisprotokoll der 340. RSK-Sitzung am 03.05.2001, 07.06.2001

[32] Erhöhung der thermischen Reaktorleistung auf 3.950 MW im Kernkraftwerk Grafenrheinfeld, E.ON Kernkraft, Kopien von Folien, TTA-Dr.So/Len, 25.06.2003

[33] RSK-Beratungen zur KKG-Leistungserhöhung, Druckführende Komponenten und Werkstoffe, TÜV Süddeutschland Bau und Betrieb, Kopien von Folien, ETH03/Bor

[34] Erhöhung der thermischen Leistung des KKG, GRS, Kopien von Folien, Dr. Jendrich