Use of Free Spaces in the Cooling Pond of the Stade Nuclear Power Plant

Statement by the Commission on Reactor Safety
February 1st, 2001

1 Request for Discussion

With letter AG RS I 4 – 14001/1 of 13th December 2000 the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) had requested the Commission on Reactor Safety (RSK) to make a statement on the question if safety-related detriments could result from the use of free spaces in the cooling pond of the Stade nuclear power plant (KKS). BMU asked to represent and substantiate these detriments assuming the free spaces to be used for a period of one to two years.

2 Facts

Already on its 2nd meeting on 16th December 1999 the RSK-committee on Plant and System Engineering had dealt with the question if and how to use the free spaces in the cooling ponds of German nuclear power plants. The issue was discussed on the basis of a plant-independent investigation of this problem by GRS.

At that time the RSK-committee on Plant and System Engineering had come to the conclusion that in case of incidents long-term heat removal without discharging of the core as designed was planned and possible. Furthermore it stated that the thermal output additionally arising as a result of filling the free spaces was low compared to the designed cooling capacity, since the additionally emplaced fuel elements would only show strongly reduced residual heat. The committee therefore mainly considered the use of free spaces of the cooling pond an availability risk for the operation of the plant.

Independently of this the RSK-committee on Plant and System Engineering was of the opinion that one should continue to keep the cooling pond spaces free for a full discharge even without necessary safety-related requirement. This would extend alternatives regarding a removal of leaks that cannot be blocked.

Following a detailed discussion the RSK-committee on Plant and System Engineering endorsed the main conclusions of the GRS report.

It stated in particular that if the free spaces in the cooling pond were used

- The redundancy level during pond cooling had to be controlled plant-specifically,
- Restrictions in the availability of the plant and at in service inspection could occur due to a discharge not being possible, and

- Delays could occur in the clarification of causes of incidents, which are of safety-related importance for other plants, due to a discharge not being possible.

From the point of view of the RSK-committee on Plant and System Engineering , regarding long-term safety of residual heat removal no conclusive reasons resulted from the information then available against using the free spaces in the cooling pond. It supported the opinion that for the aforementioned reasons the use of free spaces should not be considered normal but an exception.

During its 328th meeting on 3rd February 2000 the RSK discussed the results gained by the RSK-committee on Plant and System Engineering and recommended – according to the state of knowledge at that time – that the previous practice be kept of keeping the storage spaces free for a full discharge even without necessary safety-related requirement.

3 Discussion during the 8th Meeting of the RSK-committee on Plant and System Engineering on 11th January 2001

During the 8th meeting of the RSK-committee on Plant and System Engineering on 11th January 2001 the operator of the Stade nuclear power plant reported that due to the continuing ban on nuclear transports it was not possible any more to dispose of the spent fuel elements until refuelling and that sufficient storage capacity in the cooling pond was no more available. The operator therefore wants to use part of the storage spaces that have to be kept free for discharge temporarily until transports will be resumed again.

The operator and the expert TÜV Nord with participation of GRS informed the committee on the results of their investigations regarding the consequences of the use of free spaces in the cooling pond applied for.

3.1 Report by the Operator

The operator explained that the core of the Stade nuclear power plant had 157 spaces of which 145 were used for fuel elements and 12 for steel elements. The cooling pond has a total capacity of 321 fuel element spaces.
Currently there are 164 spent fuel elements and 1 basket with 37 spent fuel elements in the cooling pond. 145 free spaces are required for a full discharge of the core. Currently there are 321 – 310 = 11 free spaces for refuelling in the cooling pond.

The operator intends to reload 44 new fuel elements after the revision 2001 within the scope of the annual cycle. Consequently there will then be 208 fuel elements and 1 basket in the cooling pond so that only 112 free spaces will be available. It will not be possible then to discharge 33 fuel elements of the core.

- Cooling pond

According to statements made by the operators the cooling pond was designed to be filled completely with spent fuel elements. The cooling pond has its own twin-cooling system. The emergency cooling and residual heat removal system was constructed

separately from this. As long as the core remains in the reactor pressure vessel, cooling of the core and simultaneously cooling of the cooling pond is required at a cold subcritical reactor. Residual heat is removed from the reactor pressure vessel by the emergency cooling and residual heat removal system and from the cooling pond by the cooling pond cooling system.

As regards heat removal the operator explained that the thermal output to be removed from the cooling pond was mainly determined by the fuel elements of the 28th cycle remaining in the pond. Despite the fact that there are more fuel elements stored in the cooling pond, the thermal output to be removed following the loading of the reactor pressure vessel for the 29th cycle differs only marginally from the thermal output at preceding refuelling processes. The cooling system capacity covers this operational state with sufficient reserves.

From the point of view of the operator no safety-related differences result from using the free spaces in the cooling pond.

- In-service inspections, repairs

Regarding in-service inspections and repairs the operator stated that the next reactor pressure vessel inspection, which requires complete discharging of the core, was only due during the inspection in 2003. Inspections of reactor pressure vessel internals required during the revision in 2002 could already be carried out in 2001.

Operational incidences during plant operation or findings from other plants could lead to a state where the plant had to be shut down. Should necessary measures require a complete discharge of the core and should this not be possible the plant remains in the state “cold subcritical and unpressurised”. According to statements made by the operators there is no safety-related requirement to unload the reactor pressure vessel. The operator considers a restriction of availability associated with this to be his risk.

- Control of LOCA incidents when using free spaces in the cooling pond

In the KKS plant the emergency cooling and residual heat removal system is independent of the cooling pond cooling system. To remove residual heat from the reactor pressure vessel 4 x 100% residual heat removal pumps are available. In long-term operation one emergency cooling and residual heat removal train is switched on residual heat removal. The second emergency cooling and residual heat removal train balances leakage. In case one train fails residual heat is removed via the steam generators or in intermitting operation with the remaining emergency cooling and residual heat removal train which then takes over alternatively residual heat removal and leakage balance. This plant state is as planned by design and according to statements made by the operators guarantees residual heat removal also for the long-term. Cooling pond cooling remains unaffected by this. There is no necessity to discharge the core.

Regarding failures at closed and filled primary coolant circuit the operator reported that the residual heat removal system had been designed such – taking into account the single-failure concept – that in case of one train failing due to a single failure residual heat may be removed from the core via the remaining train. Also in this case

there is no safety-related requirement of discharging the core. Besides the possibility of removing residual heat via the emergency cooling and residual heat removal trains, the secondary side is available as heat sink at filled primary coolant circuit. Measures regarding this procedure are listed in the operating manual.

- Reliability of the systems in long-term operation

The operator explained that the active components of the service water system and the fuel-cooling pond cooling system were in permanent operation, which was the reason why a low failure rate had to be assumed. With regard to the emergency cooling and residual heat removal system experiences from the previous revisions on the 28 years of operation of the KKS plant were available.

From the point of view of the operator spare aggregates which can be exchanged within 24 hours are available to a sufficient extent for the active components of the residual heat removal chain and the cooling pond cooling system. Alternatively there is the possibility to carry out necessary repair work during the same period.

In the opinion of the operator the provisions of the Safety-Related Conditions of the operating manual cover the storage of relevant, workable components during outage times when using free spaces in the cooling pond. During the long-term phase discharge is not necessary. Following a LOCA incident repair work and checking the auxiliary installations required for discharging would anyway last several weeks according to statements made by the operator.

- Measures of the 4^{th} safety level when using free spaces

According to statements made by the operator no consequences result either for measures of the 4^{th} Safety level when using free spaces, since in the KKS plant there is no system interrelation between the systems for heat removal from the cooling pond and the residual heat removal system.

The operator answered a question by BMU, explaining that it was intended to use free spaces of the cooling pond until it would be possible to transport fuel elements. Answering another question by BMU, the operator explained that the inspections stipulated in the operating manual could be carried out earlier in agreement with the supervisory authority and that this would not lead to detriments in the inspection of pipelines. Until 2003 no inspection had been planned for which it would be necessary to discharge the reactor pressure vessel.

The competent authority of the federal state Lower-Saxonia (NMU) pointed out that at the KKS plant a large part of the fuel elements could also be discharged if free spaces were used and that only part of the fuel elements remained in the reactor pressure vessel. An inspection possibly required would be made more difficult but would not be prevented.

GRS added that the case of an urgently required discharge had never occurred in Germany.

The operator, answering the question by the RSK-committee on Plant and System Engineering, confirmed again that the use of free spaces in the cooling pond would

not result in additional safety-related requirements. NMU added that no demand for free spaces was included in the nuclear regulations but that this was regulated in the Principles on Precautionary Measures to Dispose of Radioactive Waste (printing 11/1632 of 19th March 1980 of Federal Parliament). With the exception of the Stade nuclear power plant the operating licences of the German nuclear reactors include the demand for free spaces in the cooling pond. The safety-related reasons for this provision cannot be comprehended any more in the meantime from the point of view of the operators.

3.2 Report by the Expert

TÜV Nord explained that the assessing scale of its examinations was the state-of-the-art of science and technology. Taking into account the requirements of the GRS study of 3rd December 1999 and the charging situation during the 29th cycle of the KKS plant, TÜV Nord examined

- The plant states “power operation” and “cold subcritical”,
- The keeping of the protection goals
  – control of radioactivity
  – cooling of fuel elements
  – enclosure of radioactive materials
  – limitation of radiation exposure and
- The keeping of safety levels 1 – 4 requirements.

TÜV Nord came to the conclusion that there were no new aspects regarding reactivity control regarding safety-related requirements because of the use of free spaces in the cooling pond. A source term increase with consequences for the limitation of radiation exposure does not occur.

It is ensured further without restriction that the fuel elements are cooled, even when the free spaces are used as it is planned.

To sum up TÜV Nord stated that no consequences were to be expected for the fulfilling of the safety-related requirements of the four safety levels as designed as a result of using the free spaces. Sufficient long-term availability of the safety-related components is kept further because of the precautions taken. Operational restrictions in availability are limited to very few exceptional situations.

Answering the question by the RSK-committee on Plant and System Engineering TÜV Nord added that the use of free spaces would not result in new safety-related requirements. No restrictions in availability had to be expected for the 29th cycle in question from the point of view of TÜV Nord since the respective inspections at the reactor pressure vessel internal parts would be carried out earlier.

4. Safety-related Assessment

The RSK-committee on Plant and System Engineering took the results of its second meeting on 16th December 1999 as a basis for its discussion and on this basis dealt with the concrete situation of the Stade nuclear power plant.

From the point of view of the RSK-committee on Plant and System Engineering the following aspects have to be considered for a safety-related assessment of the planned use of free spaces:

- What consequences result from the planned increase in using free spaces for the cooling pond and its auxiliary installations, and are these covered by design?
- Do detrimental consequences result for the plant in normal operation or in case of incidents if the core cannot be discharged completely?

The design of the plant and the requirements of the nuclear regulations are taken as scales for the assessment of the determined consequences.

- **Consequences for the cooling pond**

According to the explanations given by the operator and the expert the cooling pond has been designed for full use with 321 spent fuel elements.

The planned increase in use from 176 positions to 209 positions in future does, thus, not require further considerations regarding the aspects of sub-criticality, activity inventory, activity retention and radiation exposure in operation and in case of incidents.

Regarding heat removal it has to be stated that in the cooling pond released heat mainly originates from the fuel elements that have been discharged last. The fuel elements emplaced additionally over the free spaces only make a small contribution, since these elements have already decayed to a large extent.

According to statements made by the operator less fuel elements are planned to be exchanged in the forthcoming refuelling than were last year. Thereby the thermal output in the cooling pond will be lower in the cycle to come than in the last cycle, despite having used more spaces.

Regarding the consequences for the cooling pond the committee comes to the conclusion that no safety-related disadvantages for the cooling pond can be recognised as a result of the planned use of free spaces.

Regarding the dischargeability of the core which is no more complete one has to distinguish between the following plant states:

- **Consequences for the plant at operational states without coolant leakage**

Normally, the necessity of a complete discharge of the core only exists for the carrying out of in-service inspections such as e. g. the US-American inspection of the reactor pressure vessel. Since those are processes that can be planned the time of discharge can be determined by corresponding time scheduling (carrying inspections out earlier).

In addition to this, exceptions are possible where a discharge of the core could become necessary due to e. g. inspections or repair measures as a result of special occurrences.

In most cases these measures can be carried out without complete discharge. Should this fail, the plant would have to remain shut down until the used free spaces in the cooling pond are available again as a result of spent fuel elements having been transported.
From that results an availability risk for the operator. For the plant no safety-related disadvantages result from that.

- **Consequences for the plant at operational states with coolant leakage that cannot be blocked**

As designed, leakage incidents in the area of the pressure boundary that cannot be blocked are controlled by the emergency cooling systems. No direct feedback on these systems result from the use of additional free spaces of the cooling pond at the KKS plant.

The question arises, however, if doing without complete dischargeability of the core is linked with safety-related disadvantages regarding long-term residual heat removal.

To be able to discharge the core, the containment has to be entered at the KKS plant, as at all German pressurised water reactor plants. The time when the containment can be entered depends strongly on the extent of an activity release into the containment resulting from the leakage and can thus not be predicted. In favourable cases this may be possible after some days, in unfavourable cases after some months.

Furthermore the reactor building crane, whose electrical and instrumentation and control installations are not designed incident-proof, is required for opening the reactor pressure vessel. They may not be able to work due to elevated temperature and humidity.

There is the same problem with the fuel handling machine.

Regarding residual heat removal it must be assumed that a short-term discharge of the core after LOCA incidents is not possible.

Operators and experts have confirmed that when designing the plant a dischargeability of the core after LOCA incidents had not be assumed.

Operational experience shows that the systems and components for residual heat removal used here work sufficiently reliably. Additionally there are sufficient possibilities of repair measures, since the active components are in the accessible area outside the containment.

The RSK-committee on Plant and System Engineering thus comes to the conclusion that no safety-related requirements on the dischargeability of the core result from the control of LOCA incidents as designed at the KKS.

In summary, the RSK-committee on Plant and System Engineering established that due to the partial use of free spaces

- The consequences for the cooling pond were low and covered by design
- The consequences for the plant regarding possible restrictions of in-service inspections and inspections only led to an availability risk for the operator
- Incident control as designed was not affected in case of LOCA incidents.

In the opinion of the RSK no considerable safety-related disadvantages for the plant were identified in the analysis of the intended use of additional 33 free spaces in the cooling pond of the Stade nuclear power plant for the 29th cycle. The RSK therefore does not raise any safety-related objections against the use of this option which is limited regarding time and extent. The RSK refers to its statement at the 328th RSK meeting on 3rd February 2000 in which it recommends that the previous practice basically be kept of keeping free spaces in the cooling pond for a full discharge of the core.

Documents used for discussion

[1] Studie über die Hintergründe der Forderung nach Freihaltepositionen im Brennelementlager deutscher Kernkraftwerke und deren sicherheitstechnische Bedeutung. Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH Köln, den 03.12.1999
(Study on the backgrounds of the requirement of free spaces in the fuel element storage facility of German nuclear power plants and their safety-related importance. Company for Plant and Reactor safety Köln, 3rd December 1999).

[2] Erhöhung der Lagerkapazität von Brennelement-Lagerbecken in deutschen Kernkraftwerken. Stellungnahme, 320. RSK-Sitzung am 16.09.1998
(Increase in storage capacity of cooling ponds in German nuclear power plants. Statement, 320th RSK meeting on 16th September 1998)

[3] 2. Sitzung des RSK-Ausschusses Anlagen- und Systemtechnik, Bonn, 16.12.1999. TOP B4: Freihaltepositionen im Brennelementlager deutscher Kernkraftwerke. GRS, Folienkopien
(2nd meeting of the RSK Plant and System Engineering committee, Bonn, 16th December 1999. Item B4: Free spaces in the cooling ponds of German nuclear power plants. GRS, copies of foils)

[4] Beratungsauftrag für die Reaktorsicherheitskommission. Nutzung von Freihaltepositionen zum jederzeitigen Entladen des Reaktorkerns im Kernkraftwerk Stade. BMU-AG RS I 4 – 14001/1 vom 13.12.2000
(Request for discussion for the Reactor Safety Commission. Use of free spaces for a discharge of the core at the Stade nuclear power plant at any time. BMU – AG RS I 4 – 14001/1 of 13th December 2000)

[5] Auszug aus dem Ergebnisprotokoll der 328. RSK-Sitzung am 03.02.2000, TOP 10
(Excerpt from the minutes of the 328th RSK meeting on 3rd February 2000, item 10)

[6] Belegung von Freihaltepositionen im Brennelementbecken des Kernkraftwerks Stade. E.ON Kernkraft, Kernkraftwerk Stade, Folienkopien
(Use of free spaces in the cooling pond of the Stade nuclear power plant. E.ON Kernkraft, Stade nuclear power plant, copies of foils)

[7] Gutachterliche Stellungnahme zur Sicherheit des Kernkraftwerkes Stade. Belegung von Freihaltepositionen für eine Kernausladung ins Brennelementlagerbecken im BE-Zyklus mit dem 28. Folgekern ab März 2001. Gemeinsame sicherheitstechnische Bewertung des TÜV Nord e.V. und der Gesellschaft für Anlagen- und Reaktorsicherheit. Folienkopien, Tischvorlage
(Expert statement on the safety of the Stade nuclear power plant. Use of free spaces for a discharge of the core into the cooling pond in the fuel element cycle with the 28th follower core from March 2001 on. Joint safety-related assessment by TÜV Nord e. V. and the Company for Plant and Reactor Safety. Copies of foils)

[8] E.ON Kernkraft. 8. Sitzung des RSK-Ausschusses “Anlagen- und Systemtechnik”. Belegung von Freihaltepositionen im Brennelementlagerbecken des Kernkraftwerk Stade, Folienkopien
E.ON Kernkraft. 8th meeting of the RSK “Plant and SYSTEM ENGineering” committee. Use of free spaces in the cooling pond of the Stade nuclear power plant, copies of foils)

[9] Gutachterliche Stellungnahme über die Sicherheit des Kernkraftwerkes Stade. Belegung von Freihaltepositionen für eine Kernausladung ins Brennelementlagerbecken im BE-Zyklus mit dem 28. Folgekern ab März 2001. Gemeinsame sicherheitstechnische Bewertung des TÜV Nord e.V. und der Gesellschaft für Anlagen- und Reaktorsicherheit. Hamburg/Köln im Januar 2001, Nr. 23-01-001
(Expert statement on the safety of the Stade nuclear power plant. Use of free spaces for a discharge of the core into the cooling pond in the fuel element cycle with the 28th follower core from March 2001 on. Joint safety-related assessment by TÜV Nord e. V. and the Company for Plant and Reactor Safety. Hamburg/Cologne January 2001, No. 23-01-001)