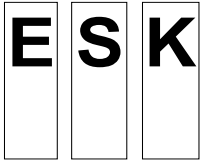


Note:
This is a translation of the ESK statement entitled
“Stilllegung und Abbau des Kernkraftwerks Isar 1 (KKI 1)”
In case of discrepancies between the English translation and the German original, the original shall prevail.



STATEMENT

Decommissioning and dismantling of the Isar 1 nuclear power plant (KKI 1)

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1 Background and advisory request

On 4 May 2012, the then E.ON Kernkraft GmbH – now PreussenElektra GmbH – submitted an application to the then Bavarian State Ministry for the Environment and Public Health pursuant to § 7(3) of the Atomic Energy Act (AtG) for the decommissioning and dismantling of the Isar 1 nuclear power plant (KKI 1) [1]. The documents for public participation ([2]-[4]) were published in the period from 14 March 2014 to 14 May 2014. The hearing took place on 22 July 2014.

In a letter dated 14 June 2016 [5], the Bavarian State Ministry of the Environment and Consumer Protection (StMUV) submitted to the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) the draft “Erste Genehmigung nach § 7 Abs. 3 Atomgesetz (AtG) zur Stilllegung und zum Abbau des Kernkraftwerks Isar 1 in Essenbach, Landkreis Landshut (1. SAG)” (*first licence pursuant to § 7(3) of the Atomic Energy Act (AtG) for the decommissioning and the dismantling of the Isar 1 nuclear power plant in Essenbach, district of Landshut*) of 14 June 2016 [6], the expert opinion of TÜV SÜD Industrie Service GmbH of June 2016 [7], the statement of the Bavarian Environment Agency of 13 November 2015 [8] and the “Zusammenfassende Darstellung und Bewertung der Umweltauswirkungen (§ 14a AtVfV)” (*summarising presentation and assessment of the environmental impacts according to § 14a of the Nuclear Licensing Procedure Ordinance (AtVfV)*) of 14 June 2016 [9].

The licensing and supervisory authority intends to permit practices and measures and to make requirements in the draft licensing notice [6] relating to the following:

- decommissioning,
- residual operation,
- adjustments of operation and use of systems, components and rooms as well as of the operating documents,
- the limits for permissible discharges of radioactive substances,
- the changes in use of room areas for the operation of installations for the processing of radioactive residues within the controlled area and for transports and buffer storage spaces,
- the final shutdown, taking-out-of-service and disassembly of building structures, systems and components that are no longer required, including the technical measures required for this purpose, and
- the installation and introduction of systems and components required for dismantling as well as the subsequent dismantling of these systems and components.

In a letter dated 15 June 2016 [10], the BMUB asked the joint ad hoc Working Group on Decommissioning Licensing (STILLEGUNGSGENEHMIGUNG – AG STG) of the Nuclear Waste Management Commission (ESK), the Reactor Safety Commission (RSK) and the Commission on Radiological Protection (SSK) for an initial technical assessment of the draft licence [6]. In a letter dated 30 June 2016 [11], the BMUB's request for advice was answered by the chairman of the AG STG. Based on this, the AG STG held the view that the project applied for was not sufficiently defined or at least not sufficiently presented in five aspects (overall view of decommissioning, dismantling and waste management concept, general operating procedures that are part of the safety specifications, event analysis, non-interaction with other plants) to be able to confirm

compliance with the assessment criteria. In addition, the review of the submitted documents had revealed five indications that should be reviewed by the licensing authority and, if necessary, also be taken into account in the licensing procedure.

The issues addressed in the AG STG's response were taken into account in the further internal BMUB discussion and finally incorporated into a list of aspects in need of information and clarification. These were sent by the BMUB to the licensing authority and discussed at a meeting with the authority on 27 July 2016. Following this meeting, the licensing authority commented on the individual aspects requiring information and clarification and submitted further documents ([12]-[23]). Since the information was not sufficient to confirm compliance with the requirements of the assessment criteria, the BMUB requested the ESK on 2 September 2016 to provide advice [24] on the following items:

- Overall view of decommissioning:
The overall concept of decommissioning and dismantling remains incomplete, in particular with regard to the framework conditions of the planned centre for the processing of residues and waste (*Zentrum für die Bearbeitung von Reststoffen und Abfällen – ZEBRA*), their consideration in the safety analyses, and with regard to the effects of the use of ZEBRA for the treatment of waste from KKI 2 on the overall duration of the dismantling process.
- Dismantling and waste management concept:
It is not comprehensible how the dismantling concept presents the dismantling steps and dismantling measures of installations and building structures, including their mutual dependencies and the planned time sequence. The waste management concept is not presented in a comprehensible way in the licensing procedure. Overall, it cannot be concluded whether the level of detail of the dismantling concept and the waste management concept is sufficient to form a viable basis for the dismantling planning and the waste management planning in the supervisory procedure. This applies, for example, to the radiological characterisation.
- General operating procedures that are part of the safety specification:
It remains incomprehensible how the necessary regulations for the classification of systems, for modification procedures and for the safety classification of work in the decommissioning and dismantling process are defined in the licensing procedure. Likewise, it remains incomprehensible whether the procedures with regard to planning, permission, implementation, monitoring, verification and documentation of the individual dismantling steps is adequately specified within the work permit procedure, especially with regard to the aspects of radiation protection and fire protection.

With advisory request [24], the BMUB has asked the Nuclear Waste Management Commission for a more detailed technical examination of the above-mentioned items on the basis of the ESK Guidelines for the Decommissioning of Nuclear Facilities against the background of the overall regulatory framework:

- § 7(3) AtG stipulates that the decommissioning of the facility and the safe enclosure of the permanently decommissioned facility or the dismantling of the facility or parts thereof shall require a licence. The application for decommissioning and dismantling of a facility shall be eligible for approval if the

licensing requirements of § 7(2) AtG, which apply *mutatis mutandis* to the construction of a nuclear power plant according to § 7(3) AtG, are fulfilled. This also includes the precautions against damage as they are necessary in the light of the state of the art in science and technology (§ 7(2) no. 3 AtG).

- § 19b(1) sentence 1 AtVfV stipulates that in the licensing procedure, the documents to be enclosed with the first application for a licence pursuant to § 7(3) AtG Act shall also include specifications on all measures planned for the decommissioning, safe enclosure or dismantling of the facility or parts thereof. According to the wording of § 19b(1) sentence 1 AtVfV, it is not required that all dismantling steps be described in the documents submitted with the first licence application in a manner that is suitable for licensing. It merely requires that specifications on all measures planned for the decommissioning [...] or dismantling of the facility or parts thereof be included in the application documents “which make it possible, in particular, to judge whether the measures applied for do not impair or prevent further measures, and whether an appropriate order of the dismantling measures is provided.”

Since the advisory request also affects the competences of the SSK, the BMUB requested the participation of the SSK members dealing with the licensing procedure in the AG STG and, insofar as the competences of the RSK are affected, to involve these in the consultations. The BMUB requested the preparation of an ESK statement by 31 October 2016.

2 Consultations

After the entry into force of the Thirteenth Act Amending the Atomic Energy Act, the Federation and the *Länder* had agreed to take measures to ensure that the upcoming licensing procedures for decommissioning and dismantling of the facilities could be carried out without delays. Against this background, the ESK had decided to inform itself at an early stage about the decommissioning concepts of the nuclear power plants in the post-operational phase so that it could immediately start preparing a statement on selected aspects of the licensing procedure for a first decommissioning and dismantling licence if the BMUB issued a corresponding advisory request. For this reason, the Committee on DECOMMISSIONING had already visited KKI 1 within the framework of its 33rd meeting on 25 September 2014 to learn about its decommissioning concept. In preparation for the consultations, the ESK had developed a guidance [25] which was to be used to present and explain the conceptual aspects during the information visits.

After submission of the draft licence [6], the BMUB first asked the AG STG by letter dated 15 June 2016 [10] for an initial technical assessment. Based on the evaluation of the content of the written reply from the chairperson of the AG STG [11], a subsequent discussion with the authority and comments by the AG STG, the BMUB developed the present advisory request by the ESK [24] (see Chapter 1).

The ESK took note of the advisory request [24] at its 56th meeting and asked the ESK Committee on DECOMMISSIONING to discuss the issues with the involvement of the SSK members of the AG STG and to prepare a draft statement. From the ESK's point of view, the competences of the RSK are not affected. At its 44th meeting on 22 September 2016, the Committee on DECOMMISSIONING heard the competent licensing and supervisory authority (StMUV) [26] as well as the licence holder [27] on the three items mentioned in the

advisory request. After this meeting, the licence holder provided further documents ([28]-[32]), which were taken into account in the assessment. With the participation of the SSK members of the AG STG, the Committee on DECOMMISSIONING prepared a draft statement. The ESK adopted the present statement at its 57th meeting on 27 October 2016.

3 Assessment basis

In addition to the requirements under nuclear and radiation protection law, the assessment is mainly based on the following documents for the three items stated in the advisory request [24]:

- the ESK Guidelines for the Decommissioning of Nuclear Facilities of 16 March 2015 [33],
- the compilation of essential aspects of decommissioning of 18 June 2015 [34], which contains all essential items – including radiation protection aspects - that came to the attention of the ESK during the information visits and presentations of the licence holder, as well as
- the Guide to the decommissioning, the safe enclosure and the dismantling of facilities or parts thereof as defined in § 7 of the Atomic Energy Act of 19 July 2016 [35].

During the decommissioning of a facility, the precautions against damage as they are necessary in the light of the state of the art of science and technology shall be taken. This includes compliance with the main safety functions

- safe enclosure of the radioactive materials and
- avoidance of unnecessary radiation exposure, limitation and control of the radiation exposure of the operating personnel and the population.

As long as the facility is not yet free from nuclear fuel, compliance with the following safety functions is to be ensured additionally:

- maintenance of subcriticality and
- residual-heat removal [33].

4 Statement on the items of the advisory request

4.1 Overall view of decommissioning

Background

According to the expert opinion on safety [3], the licence holder intends to apply the strategy of immediate dismantling for KKI 1, assuming that not all spent fuel will have been removed from the facility by the time the dismantling work begins.

Dismantling is to take place in two phases, each of which is to be applied for separately pursuant to § 7(3) AtG. It is planned to carry out the work in the two phases in parallel once both nuclear licences have been granted.

It is planned to divide Phase 1 into three periods (Section 1 A to Section 1 C).

- Section 1 A: There are still spent fuel assemblies and individual defective rods in the fuel pool. Fuel pool cooling is required for reliable cooling of the spent fuel.
- Section 1 B: There are still some defective rods. These are located in the fuel pool. Sufficient shielding of the defective rods in the fuel pool is ensured.

According to the expert opinion on safety [7], the defective rods (special fuel rods) from the power operation of KKI 1 have in the meantime been transferred to KKI 2. However, since it cannot be ruled out that defects in fuel assemblies might occur during the loading of the fuel assembly storage casks, Section 1 B continues to be considered.

- Section 1 C: Fuel-free, i.e. there is no more nuclear fuel in KKI 1

In Phase 2, the plant is free of fuel.

Dismantling in Phase 1 mainly includes

- the dismantling of radioactively contaminated plant components in the controlled area,
- the dismantling and packaging of the reactor pressure vessel top head,
- the dismantling and packaging of the containment cover,
- the dismantling, disassembly and packaging of movable and fixed reactor pressure vessel internals,
- the dismantling of plant components outside the controlled area that are subject to nuclear licensing,
- the dismantling of contaminated concrete structures and their disposal,
- the clearance measurement of parts of the building structures,
- the clearance measurement of parts of the site areas.

Dismantling in Phase 2 mainly includes

- the dismantling of the reactor pressure vessel without reactor pressure vessel top head,
- the continuation of the clearing and the further dismantling of the containment and dismantling of the biological shield,
- the dismantling of other radioactively contaminated plant components that are subject to nuclear licensing and are not to be further used for the dismantling of KKI 2,
- the removal of remaining plant components in the buildings that are subject to nuclear licensing and that are not to be further used for the dismantling of KKI 2,
- the further dismantling of plant components outside the controlled area that are subject to nuclear licensing,
- the decontamination of contaminated concrete structures,
- the clearance measurement of parts of the building structures,
- the clearance measurement of parts of the site areas.

After completion of the dismantling of KKI 2 follows:

- the residual clearing of KKI 1 (dismantling of residual operating systems, dismantling of ZEBRA),
- the decontamination of building structures,
- the clearance measurement of building structures,
- the clearance measurement of site areas.

A centre for the processing of residual materials and waste (*Zentrum für die Bearbeitung von Reststoffen und Abfällen* - ZEBRA) is planned for the radioactive residues and waste produced during the remaining operation and dismantling of KKI 1. ZEBRA is to be set up in the turbine building and in other rooms of the controlled area of KKI 1 and will also be used for residual material treatment and waste conditioning of dismantled radioactively contaminated plant components and radioactive waste during the dismantling of KKI 2.

The anticipated time frame and course of the project are described in the expert opinion on safety [3]. The summary of 10 October 2016 [32] specifies that the release of KKI 1 from the Atomic Energy Act is planned for approximately 2040. Furthermore, the summary of 10 October 2016 [32] contains an overview of the overall schedule for the dismantling of KKI 1, which shows the chronological order of the main activities in the dismantling of KKI 1 and the main dependencies. This also shows that the "decontamination of the building and release of the turbine building/decontamination building" can basically only take place when the dismantling of ZEBRA and thus also its use by KKI 2 will have been completed.

According to the summary of 10 October 2016 [32], ZEBRA is to be cleared last and then released, which would also provide a sensible sequence of dismantling measures for KKI 1. According to this plan, the complete release of KKI 1 from nuclear regulatory supervision is only possible after completion of all dismantling work in KKI 2.

In the summary of 10 October 2016 [32], it is further stated that with regard to the event analyses, various scenarios with direct reference to ZEBRA have been considered:

- crash of a container with filter dust,
- crash of a 20' container onto the floor slab of an outdoor buffer storage area,
- crash of a 20' container onto a 20' container in ZEBRA,
- fire of mixed waste in the solid waste storage area and in the decontamination building ZC,
- fire of a filter mobile, and
- aircraft crash onto buffer areas of KKI 1.

In the presentation at the 44th meeting of the ESK Committee on DECOMMISSIONING [26], the licensing and supervisory authority refers to the fact that the specification of the procedural steps in the licence ensures that the main safety functions are fulfilled in all dismantling activities and that, with regard to the sequence of dismantling, a more detailed presentation of the overall concept of decommissioning and dismantling in the licensing procedure beyond the basic division into Phases 1 A, B, C and 2 is not necessary.

Assessment criteria

For an assessment of the decommissioning concept, it must be possible to have a complete overview of the overall concept of decommissioning and dismantling. For this purpose, all measures related to dismantling must be taken into account, even if they are not part of the decommissioning licence applied for ([33] and [34]). The overall view must show for all phases that the measures applied for in a specific phase do not impede or prevent further measures and that a sensible sequence of dismantling measures is envisaged.

Assessment

Initial state at the beginning of decommissioning

From the ESK's point of view, the initial state of the facility when the first decommissioning and dismantling licence is used is not sufficiently described neither on the basis of the documents available to date nor by the summary of 10 October 2016 [32] and has to date not been defined in the licensing procedure. The preparatory measures for decommissioning, such as the change of utilisation in the turbine building, are carried out in the supervisory procedure as a modification of the facility within the scope of the operating licence.

The change of utilisation in the turbine building, which is already being implemented, also includes dismantling measures that are mentioned as measures (in the sense of creating areas for logistics) to prepare for the dismantling of the plant. Thus, in terms of the overall view of decommissioning, it is not clear what the initial state of the facility will be when the decommissioning licence is claimed. The procedure lacks a clear separation of dismantling within the meaning of the first decommissioning and dismantling licence from the prior preparation of dismantling within the scope of the operating licence.

Recommendation 1:

As a result of the adaptations already made to the facility in the supervisory procedure during low-power and shutdown operation, mainly in the turbine building, the ESK recommends that the initial state at the time of the use of the first decommissioning and dismantling licence be clearly described in advance.

Overall scheduling

The overall view includes an overall schedule for dismantling, which shows the expected time sequence of the main dismantling steps and dismantling measures with their mutual dependencies [33]. With the supplementary explanations in the summary of 10 October 2016 [32], information is now available on the time sequence of the main activities in the dismantling of KKI 1 and on the main interdependencies.

End of decommissioning

The overall view also includes a time schedule showing the total duration of decommissioning [34]. In the summary of 10 October 2016 [32], the schedule for the dismantling of KKI 1 from the expert opinion on safety was presented, supplemented by the expected end of the overall project in 2040. In the view of the ESK, the overall schedule is plausible.

ZEBRA

Within the framework of the overall view, all measures associated with the dismantling must be taken into account, including the planned expansion into a centre for the processing of residual materials and waste (ZEBRA). The construction and operation of ZEBRA are associated with both changes in the facility and changes in the distribution of activity in the facility.

ZEBRA is composed of existing installations and building structures from power operation, which are to be operated according to the operating licence that continues to be valid, and of new installations and building structures to be constructed and operated according to the decommissioning licence. The information provided so far does not indicate to what extent the planned expansion and operation of ZEBRA may impede or prevent the previously applied-for or further dismantling measures.

Recommendation 2:

The ESK recommends checking whether the measures planned in connection with the planned expansion and operation of ZEBRA ensure compliance with the main safety functions at all times and will not make decommissioning more difficult.

The explanations in the summary of 10 October 2016 [32] show that various scenarios with direct reference to ZEBRA were considered in the event analyses. The event analyses carried out for the existing and newly constructed facilities and buffer areas of ZEBRA are plausible. In particular, an aircraft crash onto the buffer areas at the facility site was considered. However, no specification values for ZEBRA are mentioned in the present application documents that constitute the framework for the use of ZEBRA in the supervisory procedure.

Recommendation 3:

The ESK recommends that basic specification values for the use of the turbine building and the buffer areas outside buildings (maximum activities, dose rates, etc.) should be established before the use of the turbine building and ZEBRA under the first decommissioning and dismantling licence.

4.2 Radiological characterisation, dismantling and waste management concept

4.2.1 Radiological characterisation

Background

The documents [3] and [20] submitted by the licence holder, which were considered insufficient by the ESK, were supplemented by reports on contamination [29] and activation [30] as well as by the summary of 10 October 2016 [32].

Thus, the document Radiological Characterisation [20], which describes the future methodology for sampling prior to the start of concrete dismantling work, was supplemented by additional reports on the estimation of existing contamination [29] and activation [30], which form the basis for the activity data contained in the expert opinion on safety [3]. The summary of 10 October 2016 [32] additionally includes exemplary illustrations that prove that systematically collected data on local dose rates, contamination and leaks that have occurred exist.

The calculated estimation of the activation [30] is based on exemplary cobalt contents in materials of the RPV and its internals, using simplified modelling of the irradiation regime, since no more detailed plant-specific information was available at the time of the estimation. These data are to be validated and optimised at a later point in time during work in progress.

Data on contamination within systems are estimated in terms of magnitude from the activity discharge of system decontamination in KKI 1. Data on contamination outside systems are mainly derived from wipe test samples and (in the case of higher-contaminated areas) from dose rate measurements. A supplementary passage in the summary of 10 October 2016 [32] contains statements on nuclide inventories of alpha emitters and

concludes that their share in the contamination is so low that there is no reason to expect any adverse effects on degradation. Leakages that had radiological relevance were documented in accordance with Section 2.3 of the summary [32] and are to be applied to the radiological assessment for the disassembly and dismantling work. Likewise, Section 2.3 of the summary [32] makes it clear that information on the room-specific local dose rate in the plant is available. Section 5.2 of the summary [32] contains assumptions on the decontaminability of systems.

Assessment criteria

Radiological characterisation serves to create the basis for the waste management and dismantling concept [33]. Sufficient knowledge of the activity inventory and the activity distribution is required to provide reliable specifications on dismantling strategies, dismantling steps, accident analyses, material flows and quantity estimates. The "Guide to the decommissioning, the safe enclosure and the dismantling of facilities or parts thereof as defined in § 7 of the Atomic Energy Act" [35] requires, with regard to the content of the application documents according to Section 7(3) of the Atomic Energy Act, an estimation and evaluation of the radioactive inventory and, if applicable, of hazardous substances as well as evidence in this respect. In addition, the radiological characterisation also serves as a planning tool for determining an optimised dismantling plan with regard to the main safety function of radiation protection.

Assessment

The summary of 10 October 2016 [32], which includes documents [29] and [30], shows that information on local dose rates and leakages is available and can be used as a basis for specifications on the dismantling of the plant. Furthermore, the summary of 10 October 2016 [32] shows that the relevance of alpha emitters cannot be regarded as significant at the present time with regard to the procedure for dismantling the plant. According to Section 5.2 of the same document, assumptions on the decontaminability of systems have been incorporated into the mass estimates for radioactive waste. The way in which the "decontamination capability of individual rooms" was assessed is not explained in detail.

However, the information provided on the radiological characterisation is only of a general nature. For the ESK, it is therefore not comprehensible in detail whether the available information on radiological characterisation is sufficient as a basis for the waste management and dismantling concept. The derivation of statements on the amount of radioactive waste produced (especially with regard to non-metallic residues or waste) and its nuclide composition is not presented in a comprehensible way. The statements on the total activity due to contamination in the plant are only sufficient for estimating the quantity if supplementary information on the fixed/penetrated contamination is also taken into account for building structures. The estimated total mass for radioactive waste is a low value taking into account the mass estimates for other nuclear power plants. The document Radiological Characterisation [20] describes the future procedure for further characterisation steps but does not provide an overview of the current radiological status of the plant. With regard to the applicability of document [20] for determining the future procedure for sampling, the ESK's

DECOMMISSIONING Committee already identified points of criticism at its 38th meeting on 15/16 April 2015 that are still valid in terms of content.

With regard to the radiological characterisation for optimising radiation protection during the dismantling of building structures and components of the KKI 1 plant, the procedure described in the application documents of carrying out these samplings "on a subsystem basis" prior to the dismantling activities and describing them in results reports [20] is also the method of choice in the view of the ESK.

In summary, and in accordance with the requirements of the ESK Guidelines [33], the ESK believes that further steps are necessary to increase the informative value of the radiological characterisation and to specify the quantity structure for the accumulation of radioactive waste. In this context, the ESK has distinguished between measures that, in its view, still have to be carried out within the framework of decommissioning planning and studies that can be carried out at a later date:

Recommendation 4:

The ESK recommends the following staggered approach to updating the radiological characterisation.

In the ESK's view, the following measures are necessary before a licence can be granted:

- In a first step, the estimation of the amount of radioactive rubble has to be shown in a methodically comprehensible way, taking into account the operating history. If the operating history is not sufficient for such an estimate, it must be demonstrated with regard to contaminated building structures, for example by a (small) number of metrological investigations at suspected sites, that there is no major penetration of contamination in the building structure that could result in deviating procedures for dismantling the plant. Further investigations of the penetration behaviour, which have no influence on the implementation of the overall project, can be carried out at a later date during dismantling, as envisaged in the application documents. With regard to the biological shield, it must be explained and justified (e.g. based on activation calculations) how it was included in the quantitative analysis of radioactive waste. These data should then be included in a summarising graphic that includes the mass contributions of all different waste streams (see Recommendation 6).*
- The radionuclide C-14 is to be considered as another relevant radionuclide in the radiological characterisation of radioactive residues and plant components. From the point of view of the ESK, a corresponding fundamental determination is necessary. The examination of whether the respective activity inventories are to be determined by activation calculations, by special nuclide analyses or by correlation factors can be decided in the supervisory procedure on a case-by-case basis, depending on the type of residues to be characterised and the intended waste management target. For radioactive waste, the requirements from the process qualification by the BfS must be observed.*

At a later stage, in addition to the radiological characterisation measures already included in the application documents, the following further measures will be required:

- *The radiological characterisation is to be updated and systematically documented taking into account detailed information on all radionuclides relevant for the description of radioactive residues and plant components on the basis of activation calculations (consideration of real material compositions of activated components) or sampling ("waste characterisation plan"). The sampling necessary for this can, as intended, take place after the licence has been granted in order to be able to take into account the mandatory regulations and the non-mandatory guidance instruments then applicable. The ESK recommends that systematic investigations of possible activation within the containment should be carried out that go beyond the components RPV, RPV internals and biological shield.*

4.2.2 Dismantling concept

Background

The applicant states in the summary of 10 October 2016 [32] that the principles, boundary conditions, influencing factors and characteristics for the dismantling, the dismantling techniques and the logistics are described in the documents

- expert opinion on safety [3],
- logistics of dismantling and change of utilisation of room areas (R-06) [31],
- dismantling concept (R-17) [19],
- maintenance and dismantling regulations (R-19-03) [18] as well as in
- documents from power operation that continue to apply.

Figure 3.2 from the summary of 10 October 2016 [32] visualises the planned dismantling sequence for the dismantling of KKI 1. The figure shows the time-critical path and a dismantling sequence resulting from logistical boundary conditions.

Sections 4.1 "Principles of dismantling" and 4.4 "Dismantling sequence and milestone description" from the summary of 10 October 2016 [32] list planning principles for dismantling activities with reference to the logistics concept [31] on a superordinate scale. Likewise, an order "from the outside to the inside, from the top to the bottom (with the exception of large components such as RPV or RPV internals)" is given as a rough dismantling direction. The sequence of system disconnection is described from a systems-engineering point of view. This is followed by a list of disassembly principles "large components first, creation of transport routes and logistics areas" with regard to logistical aspects and, given in key words, by the aspects of radiation protection, occupational safety and fire protection.

Assessment criteria

According to ESK Guide [33], the dismantling concept must describe the dismantling steps and dismantling measures of installations and buildings, including their mutual dependencies and the expected time sequence.

Assessment

The planned general dismantling sequence shown in Figure 3.2 of the summary of 10 October 2016 [32] is plausible.

The room-by-room dismantling of still existing machines, valves, piping, cable routes, etc. in the reactor building and the turbine building is to be carried out partially or completely within the framework of the dismantling of plant components. As long as the dismantled or disassembled components are not removed from the plant rooms, the previous installation area of the components is to serve as a storage area in each case. A dismantling sequence results at the beginning of dismantling from the subsequent use of room areas for the processing of radioactive residues, the treatment of radioactive waste, or as logistics areas for buffer storage. In the further course of room-by-room dismantling, the procedure is logistically optimised to ensure a continuous mass flow.

From the ESK's point of view, it is thus essentially comprehensible how the dismantling steps and dismantling measures of installations and building structures are to be carried out in the dismantling concept, including their interdependencies and the expected chronological sequence.

The decision criteria for the concrete selection of the dismantling sequence listed in the summary of 10 October 2016 [32] and in the logistics concept [31] are comprehensible to the ESK, without the concrete component or room-by-room implementation for the dismantling of the KKI 1 plant being evident from this. However, since a too strict component-by-component definition of the dismantling sequence can have disadvantages in the further dismantling project (e.g. changes in the radioactive inventory in systems or room areas during dismantling due to decontamination processes, etc., thus changing the basis for decisions on the definition of the dismantling sequence), the ESK believes that it is advisable to define the details in a step-by-step manner. The ESK considers it necessary to check the implementation of the principles for the selection of the dismantling sequence, which are correctly listed in the application documents, by the supervisory authority. In the view of the ESK, such a review of the prerequisites must be completed in advance of concrete decommissioning and dismantling projects (see Section 4.3, Recommendation 8). It should be noted that, according to the ESK Guidelines [33], all requirements or measures necessary to fulfil the main safety functions have safety significance. For example, considerations of radiation protection, fire protection and occupational safety as well as waste-management-related reasons may also result in dismantling sequences that are justified in terms of safety.

Recommendation 5:

In order to meet the requirements of the ESK Guidelines for the Decommissioning of Nuclear Facilities [33], the dismantling steps and dismantling measures of installations and buildings, including their mutual dependencies and the expected time sequence, have to be updated and reviewed by the supervisory authority within the framework of dismantling planning in accordance with the principles listed in the application documents. The respective current status can then serve as a basis for the individual decommissioning and dismantling projects. In the view of the ESK, a corresponding regulation should be anchored in the licensing procedure.

4.2.3 Waste management concept

Background

In the summary of 10 October 2016 [32], the licence holder states that the principles of waste management are set out in the residue/waste concept [28] and in the safety analysis report. The summary of 10 October 2016 [32] does not specify or detail the information contained in the documents submitted. Thus, with regard to the description and classification of the radioactive residues, a distinction is only made between building masses, residues (for release, for reuse in the nuclear sector) and radioactive waste, and the radioactive residues are quantified in these categories. According to the information provided by the applicant, the qualitative assessment of i.a. the contamination level and the decontaminability is used to determine which disposal path is to be provided for the residual materials. For this purpose, Figure 5-1 in the summary of 10 October 2016 [32] shows an excerpt of the corresponding database.

With regard to waste management and the associated transport logistics, the documents submitted contain basic statements on the possible treatment paths in the form of flow charts. Statements on the mass flows via the individual disposal paths are not included in the documents.

Regarding the clearance and removal of material, the licence holder states that this is done on the basis of the radiation protection regulations and a work instruction (AAW 35/36-ENT-024), which is part of the radiation protection regulations. The result of an examination of the extent to which the already existing regulations meet the requirements of decommissioning cannot be inferred from the documents.

The description of ZEBRA shows the internal storage capacities for the buffering and provision of material for transport. The radioactive waste is intended for interim storage at the Mitterteich storage facility. According to the applicant, sufficient storage capacities are available there for the accumulating radioactive waste until the federal Konrad repository becomes available.

Assessment criteria

In accordance with the ESK Guidelines [33], the waste management concept must describe and classify the radioactive residues, describe the waste management for radioactive waste and the clearance procedure for radioactive materials, and explain the concept for the clearance or removal of land areas and buildings. In addition, the material flows including the necessary transport and storage logistics as well as their interdependencies have to be described.

Assessment

A more detailed classification of the radioactive residues in the sense of the ESK Guidelines [33] is not possible with the documents available, and the masses indicated as well as the allocation to the various disposal paths are not comprehensible or cannot be verified by the ESK.

Whether the regulations for the clearance and removal of material already in place during operation meet the requirements from decommissioning cannot be assessed conclusively. In the opinion of the ESK, the continuation of "established operational regulations" for clearance from the plant's power operation is not a priori sufficient for all dismantling requirements and must be validated accordingly at a later date.

The ESK is of the opinion that the requirements for a waste management concept are qualitatively fulfilled in the documents submitted with the basic presentation of the procedures and processes. In order to meet the additional requirements of the ESK Guidelines [33], at least a presentation based on Figure 5-3 from the summary of 10 October 2016 [32] is required in which the envisaged masses for the individual disposal paths are specified.

Recommendation 6:

In order to meet the requirements of the ESK Guidelines for the Decommissioning of Nuclear Facilities [33] for a waste management concept, the estimated total mass of radioactive waste from the different waste streams has to be presented in a summary figure within the licensing procedure.

4.3 Basic operating procedures that are part of the safety specification

Background

According to the draft of the licence notification [6], the operating procedures and regulations, consisting i.a. of the operating manual, the management manual, the waste management concept and the regulations on documentation from low-power and shutdown operation, are to continue to apply for residual operation. If necessary, changes due to shutdown and dismantling have to be made.

In the summary of 10 October 2016 [32], reference is made to the fact that in the operating manual (BHB), Part 2, Chapter 1.1, Section "Procedural regulations for handling modifications to the plant and its mode of operation" [23], the procedure for the classification of modifications and the involvement of the technical departments and, if necessary, the authority and the authorised expert are specified. These regulations result from power operation and also apply to dismantling.

Before the licence is used, all relevant regulations and parameters of the draft licence are incorporated into the safety specification. The entire operating manual is adapted to the requirements of residual operation after use of the licence. In Part 1 (Regulations), which also applies to KKI 2, the regulations applying to KKI 1 or to KKI 2 are to be identified as before [6].

The maintenance and dismantling regulations [21] define the procedures for elimination of disturbances and for preparing and carrying out maintenance and modification work at the Isar nuclear power plant (KKI 1 and KKI 2). Furthermore, issues of the residual operation of KKI 1 regarding the procedures for decommissioning and dismantling are regulated in these regulations.

According to the draft of the licence notification [6], parts of the plant that are no longer required for event control and for residual operation of the plant may be shut down and dismantled in accordance with the regulations of the operating manual. These parts would no longer have any safety or operational significance for the residual operation of the plant and for compliance with the main safety functions [6].

Assessment criteria

As long as fuel assemblies are still present in the fuel pool, the systems for heat removal from the fuel pool and the systems for criticality-safe storage of the fuel assemblies are safety-relevant. Furthermore, with regard to the enclosure of radioactive materials and the avoidance of unnecessary radiation exposures, installations with activity-containing media, facilities for the conditioning of radioactive material and installations to protect operating personnel, to protect against inadvertent releases and to reduce direct radiation in the environment of the facility have safety significance. This also includes systems for fire protection as well as necessary systems for energy supply and for instrumentation and control [33].

Classification, reclassification and adaptations of safety-relevant installations to the changed conditions of dismantling require the performance of safety assessments and approvals by the supervisory authority. Here, potential releases of existing radioactive material during disassembly of individual facility components or systems and the potential concentration of radioactive material in containers or in the form of packages in individual room areas are to be considered with a view to the confinement of radioactive material and the avoidance of unnecessary radiation exposure. [33].

For the decommissioning of a nuclear facility, the operating procedures are to be included in a decommissioning manual. Structure and contents of the decommissioning manual should be based on nuclear safety standard KTA 1201 [9] and are derived from the operating manual for power operation or production, which is to be adapted to the changed requirements. In particular, regulations relating to personnel and organisation are to be laid down that determine the competencies and responsibilities and reflect the transition from power operation or production to decommissioning operation. Furthermore, regulations are to be specified for the decommissioning operation, for the elimination of malfunctions as well as for the control of accidents and, if required, beyond-design-basis events. Requirements for the collection, sorting, storage and conditioning of wastes and residues as well as for the clearance or removal of the materials produced are to be laid down in a residue and waste regulatory regime [33].

Throughout the entire duration of decommissioning, the operating procedures, including operating and personnel organisation, are to be reviewed event-specifically and at regular intervals with a view to changing requirements and adapted to the respective requirements and the respective current state of the facility. To this end, an appropriate amendment procedure is to be defined [33].

For the planning, approval, performance, monitoring and documentation of the activities related to decommissioning, an appropriate work permit procedure (e.g. step-by-step dismantling procedure) is to be defined [33].

The work permit procedure must ensure for all decommissioning activities that

- the safety and availability requirements for all installations necessary during the work will be reviewed and adapted where necessary,
- the safety requirements from radiation protection, occupational health and safety and fire protection as well as physical protection where necessary – including administrative measures – are taken into account and that for subprojects with special importance, the sequence of work steps will be specified in detail,
- the requirements relating to the safe handling and recording of the residues from dismantling are taken into account, and
- all measures relevant for safety and dismantling are described [33].

The "Guide to the decommissioning, the safe enclosure and the dismantling of facilities or parts thereof as defined in § 7 of the Atomic Energy Act" [35] also calls for appropriate licensing procedures for practical work in the decommissioning of nuclear installations.

Assessment

Categorisation and safety-related classification

The categorisation of the systems and equipment appears to be based exclusively on system technology. Based on the available documents, it is not comprehensible how the requirement of the ESK Guidelines [33] that systems with activity-carrying media, facilities for the conditioning of radioactive materials and installations for the protection of operating personnel, for protection against accidental releases and for the reduction of direct radiation into the plant environment are also of importance from a safety or radiation protection point of view was taken into account. This also applies to systems for fire protection as well as to necessary systems for energy supply and for instrumentation and control.

The "Rules of Procedure for the Handling of Modifications to the Plant and its Operation" [23] refers to the power operation of the plant. From the available documents, e.g. [23], it is not clear to the ESK how the review of the safety assessments for classification, reclassification and for adaptations of important safety-related or radiation-protection-related equipment to the changing conditions of dismantling is performed and how the approvals of the supervisory authority are given.

A classification of the systems and equipment adapted to the requirements of dismantling that ensures the involvement of the supervisory authority in advance of the dismantling of all radiologically relevant systems (also below the collective dose criterion according to the IWRS II Guideline) is an important building block for the dismantling procedure.

Recommendation 7:

The ESK recommends adapting or supplementing the existing classification system in such a way that it also includes all systems and equipment with safety or radiation protection significance in accordance with the ESK Guidelines for the Decommissioning of Nuclear Facilities [33].

Disconnection and disassembly projects

The document "Concept of dismantling" [19] only lists principles and very general information. What information is communicated to the supervisory authority and whether compliance with the requirements can be verified on this basis cannot be assessed on the basis of the document.

In the expert opinion on safety [7], a specification of the documents to be submitted for disconnection and disassembly projects is required (expert opinion condition 3). Although ancillary provisions 6.2 and 6.3 of the draft licence also require the submission of "essential information", this is not sufficiently specified. For example, in connection with disassembly projects, no information on fire protection is submitted to the authority and only "fundamental statements on radiation protection" are made. Information on the planned separation processes should also only be provided if they are not mentioned in the safety analysis report [19]. From the point of view of the ESK, the suitability for use and the absence of safety-related retroactive effects as well as compliance with the main safety functions (in particular radiation protection, but also, for example, the accumulation of secondary waste) must be demonstrated in each case under the concrete boundary conditions of the respective measure, i.e. in principle also in the case of already proven procedures, and must be reviewed by the supervisory authority.

Recommendation 8:

The ESK recommends that the content of the "essential information" be defined and evaluated in the licensing procedure. For this purpose, it may be expedient to draw up an evaluation matrix for the classification of the dismantling packages that contains suitable criteria for the classification (e.g. radiation protection, fire protection, occupational safety, physical protection, safety-relevant components and components with increased requirements). On this basis, suitable specifications can then also be made with regard to the procedure for testing and releasing the dismantling packages, including any necessary accompanying control during implementation.

Work permit procedure and optimisation with regard to occupational radiation protection

In the decommissioning process, the work permit procedure is of particular importance as an organisational instrument for ensuring radiation protection, fire protection, and occupational safety. All relevant activities in the facility to be decommissioned should therefore be subjected to such a procedure in order to take into account the requirements of radiation protection and safety-related protection goals, among others. The work permit procedure is laid down in the Maintenance and Dismantling Ordinance. Here, the procedure for determining the radiation protection measures before and during the performance of the maintenance and dismantling activities is also specified. The involvement of radiation protection for the determination of corresponding radiation protection-related protection and monitoring measures takes place during the planning of the decommissioning, sampling and disassembly steps. In the case of IWRS II activities, radiation protection is already included in advance in the planning of activities with a view to optimising the process.

From the ESK's point of view, however, it is not comprehensible how the necessary optimisation and review by the supervisory authority is carried out, e.g. with regard to operational radiation protection. For example,

according to Subsidiary Provision 3.1, "Before carrying out work in the controlled area that is subject to the special radiation protection procedure according to the IWRS II guideline, [...] the supervisory authority must be notified in good time in advance of the scope of this work and the radiation protection measures planned for it. ..." The evaluation of the personal doses applied in previous dismantling procedures shows, however, that only a small part of the total dose occurs in the special tasks that are handled according to the special radiation protection procedure.

However, according to the explanations in the summary [32], the competent supervisory authority is informed about all assessments with regard to radiation protection. This is done irrespective of whether the assessment results in a special procedure or in a routine procedure according to the IWRS II guideline.

Recommendation 9:

The ESK recommends making the stipulation provided in the summary of PreussenElektra GmbH of 10 October 2016 [32] with regard to informing the supervisory authority in the licensing procedure binding. In order to meet the optimisation requirement regarding radiation protection, compliance with the complete IWRS II guideline should be verified.

5 Summary

Overall view of the decommissioning

The overall concept of decommissioning and dismantling was examined with regard to the overview of the completeness of the measures related to dismantling. This applies in particular to the boundary conditions of the planned ZEBRA facility, their consideration in the safety analyses, and the effects of ZEBRA use for the treatment of waste from KKI 2 on the overall duration of the dismantling process.

The hearing at the 44th meeting of the ESK's DECOMMISSIONING Committee on 22 September 2016 and the additional documents submitted made it possible to clarify some open questions. A recommendation (Recommendation 1) results with regard to a sufficient description of the initial state of the plant at the beginning of decommissioning.

Recommendations were also made for ZEBRA with regard to the absence of retroactive effects of planned measures on compliance with the main safety functions during its construction and operation (Recommendation 2) and for the determination of specification values in the licensing procedure (Recommendation 3).

Radiological characterisation, dismantling concept and waste management concept

From the ESK's point of view, further steps are necessary to increase the informative value of the radiological characterisation and to specify the quantity structure for the accumulation of radioactive waste. In this context,

the ESK has distinguished between measures that, in its view, must be carried out before a licence is granted and investigations that can be carried out at a later date (Recommendation 4).

Dismantling concept

From the ESK's point of view, it is basically comprehensible how the dismantling steps and dismantling measures of installations and buildings are to be carried out in the dismantling concept, including their mutual interdependencies and the expected time sequence.

The decision criteria for the concrete selection of the dismantling sequence listed in the summary of 10 October 2016 [32] and in the logistics concept [31] are comprehensible to the ESK, without the concrete implementation of the dismantling of the KKI 1 plant in terms of components or space being evident from this. From the ESK's point of view, it is expedient to define the details in a step-by-step manner. The ESK considers it necessary to review the implementation of the principles for the selection of the dismantling sequence correctly listed in the application documents (Recommendation 5).

Waste management concept

The ESK is of the opinion that the requirements for a waste management concept are qualitatively fulfilled in the submitted documents with the basic description of the procedures and processes. However, a more detailed classification of the radioactive residues in the sense of the ESK Guidelines [33] is not possible with the documents presented, and the masses indicated and the allocation to the various disposal paths are not comprehensible to the ESK. Therefore, at least a representation based on Figure 5-3 from the summary of 10 October 2016 [32] is required in which the envisaged masses for the individual waste management paths are indicated (Recommendation 6).

Basic operating procedures that are part of the safety specification

Categorisation and safety-related classification

From the available documents, it is not clear to the ESK how the review of the safety assessments for classification, reclassification and for adaptations of important safety-related or radiation-protection-related systems and equipment to the changing conditions of the dismantling takes place and how the approvals of the supervisory authority are given (Recommendation 7).

Disconnection and disassembly projects

The document "Concept of dismantling" [19] only lists principles and very general information. What information is communicated to the supervisory authority and whether compliance with the requirements can be verified on this basis cannot be assessed on the basis of the document (Recommendation 8).

Work permit procedure and optimisation with regard to occupational radiation protection

From the ESK's point of view, it is not comprehensible how the optimisation requirement of radiation protection is met and how the review by the supervisory authority is carried out, e.g. with regard to operational radiation protection (Recommendation 9).

In summary, the ESK finds that for the topics reviewed in this Statement, the requirements of the underlying assessment criteria are only partially fulfilled or not fulfilled at all. The ESK has formulated nine recommendations as a way of fulfilling the requirements:

Recommendation 1:

As a result of the adaptations already made to the facility in the supervisory procedure during low-power and shutdown operation, mainly in the turbine building, the ESK recommends that the initial state at the time of the use of the first decommissioning and dismantling licence be clearly described in advance.

Recommendation 2:

The ESK recommends checking whether the measures planned in connection with the planned expansion and operation of ZEBRA ensure compliance with the main safety functions at all times and will not make decommissioning more difficult.

Recommendation 3:

The ESK recommends that basic specification values for the use of the turbine building and the buffer areas outside buildings (maximum activities, dose rates, etc.) should be established before the use of the turbine building and ZEBRA under the first decommissioning and dismantling licence.

Recommendation 4:

The ESK recommends the following staggered approach to updating the radiological characterisation.

In the ESK's view, the following measures are necessary before a licence can be granted:

- In a first step, the estimation of the amount of radioactive rubble has to be shown in a methodically comprehensible way, taking into account the operating history. If the operating history is not sufficient for such an estimate, it must be demonstrated with regard to contaminated building structures, for example by a (small) number of metrological investigations at suspected sites, that there is no major penetration of contamination in the building structure that could result in deviating procedures for dismantling the plant. Further investigations of the penetration behaviour, which have no influence on the implementation of the overall project, can be carried out at a later date during dismantling, as envisaged in the application documents. With regard to the biological shield, it must be explained and justified (e.g. based on activation calculations) how it was included in the quantitative analysis of radioactive waste. These data should then be included in a summarising graphic that includes the mass contributions of all different waste streams (see Recommendation 6).*
- The radionuclide C-14 is to be considered as another relevant radionuclide in the radiological characterisation of radioactive residues and plant components. From the point of view of the ESK, a*

corresponding fundamental determination is necessary. The examination of whether the respective activity inventories are to be determined by activation calculations, by special nuclide analyses or by correlation factors can be decided in the supervisory procedure on a case-by-case basis, depending on the type of residues to be characterised and the intended waste management target. For radioactive waste, the requirements from the process qualification by the BfS must be observed.

At a later stage, in addition to the radiological characterisation measures already included in the application documents, the following further measures will be required:

- *The radiological characterisation is to be updated and systematically documented taking into account detailed information on all radionuclides relevant for the description of radioactive residues and plant components on the basis of activation calculations (consideration of real material compositions of activated components) or sampling ("waste characterisation plan"). The sampling necessary for this can, as intended, take place after the licence has been granted in order to be able to take into account the mandatory regulations and the non-mandatory guidance instruments then applicable. The ESK recommends that systematic investigations of possible activation within the containment should be carried out that go beyond the components RPV, RPV internals and biological shield.*

Recommendation 5:

In order to meet the requirements of the ESK Guidelines for the Decommissioning of Nuclear Facilities [33], the dismantling steps and dismantling measures of installations and buildings, including their mutual dependencies and the expected time sequence, have to be updated and reviewed by the supervisory authority within the framework of dismantling planning in accordance with the principles listed in the application documents. The respective current status can then serve as a basis for the individual decommissioning and dismantling projects. In the view of the ESK, a corresponding regulation should be anchored in the licensing procedure.

Recommendation 6:

In order to meet the requirements of the ESK Guidelines for the Decommissioning of Nuclear Facilities [33] for a waste management concept, the estimated total mass of radioactive waste from the different waste streams has to be presented in a summary figure within the licensing procedure.

Recommendation 7:

The ESK recommends adapting or supplementing the existing classification system in such a way that it also includes all systems and equipment with safety or radiation protection significance in accordance with the ESK Guidelines for the Decommissioning of Nuclear Facilities [33].

Recommendation 8:

The ESK recommends that the content of the "essential information" be defined and evaluated in the licensing procedure. For this purpose, it may be expedient to draw up an evaluation matrix for the classification of the dismantling packages that contains suitable criteria for the classification (e.g. radiation protection, fire protection, occupational safety, physical protection, safety-relevant components and components with increased requirements). On this basis, suitable specifications can then also be made with regard to the

procedure for testing and releasing the dismantling packages, including any necessary accompanying control during implementation.

Recommendation 9:

The ESK recommends making the stipulation provided in the summary of PreussenElektra GmbH of 10 October 2016 [32] with regard to informing the supervisory authority in the licensing procedure binding. In order to meet the optimisation requirement regarding radiation protection, compliance with the complete IWRs II guideline should be verified.

The ESK asks the BMUB to keep it informed about the handling of its recommendations, in particular because they concern situations in which the requirements of the ESK Guidelines for the Decommissioning of Nuclear Facilities have not yet been fully met in this case.

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