Situation of Interim Storage of Spent Nuclear Fuel and Highly Active Waste in Germany – 14249

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ABSTRACT

According to the German atomic law § 6 storage of spent nuclear fuel (SNF) and highl active waste (HAW) has to be licensed following by the competent authority in this field, which is the Federal Office of Radiation Protection.

Dry Interim storage started in the storage sites in Ahaus, Jülich and Gorleben. Onsite of the nuclear power plant sites the interim storage started in 2002 with the facility next to the NPP Lingen. Since this time each NPP erected its own storage facility. All of these facilities use dry storage in metallic casks. The actual storage licenses for spent nuclear fuel (SNF) and the vitrified high level waste (HAW) are limited to 40 years. As no opening of the cask is intended during the storage period the condition of the inventory and the cask before loading has to be known in detail. This requires for instance detailed knowledge of the history of the SNF loaded as well as supervision of the manufacturing process of the cask.

According to the safety philosophy in Germany the number of active systems at the storage facility is minimized. For instance cooling is ensured by natural convection. The only active system is the monitoring system for the closure system which is continuously monitored and documented. Since beginning of the interim storage in Germany no leakage was detected. There have been several alarms of the monitoring system but all of them indicated a non-systematic malfunction of the pressure switch, which is a proof for working of the permanent self-monitoring and was used to improve the manufacturing process of certain components.

After expiring of the storage license an extension or a new license can only be granted if the at this time relevant requirements are met. This will require detailed knowledge about the happenings and accidents during the previous storage period. All experience of the periodic safety assessment (PSÜ) and accompanying experiments conducted till now and during the licensed storage time will be needed. Special attention has to be paid to the ageing of components which have a direct safety function like the metallic seals and the bolts in the closure system. Major aspect is of course the protection against radiation and radioactive release.

INTRODUCTION

According to the German atomic law § 6 storage of nuclear material has to be licensed following by the competent authority in this field, which is the Federal Office of Radiation Protection (BfS). The legal basis for all licenses in this field is the atomic energy act latest version (15.11.2012). The competent authority is the Federal Office of Radiation Protection (§ 23) which is responsible for the licensing procedure. Because the Federal Office of Radiation Protection cannot cover all relevant fields with its own experts, assignment of external experts (§ 20) is necessary to check if the requirements for the license are given. After the applicant was able to show that all requirements are met, the license has to be granted. The supervision of the storage lies in the responsibility of the competent authority of the federal state in which the storage facility is located (§ 24). This authority can allow minor changes of the storage licence, In case of

substantial changes the Federal Office of Radiation Protection has to be consulted and is responsible for the licensing procedure.

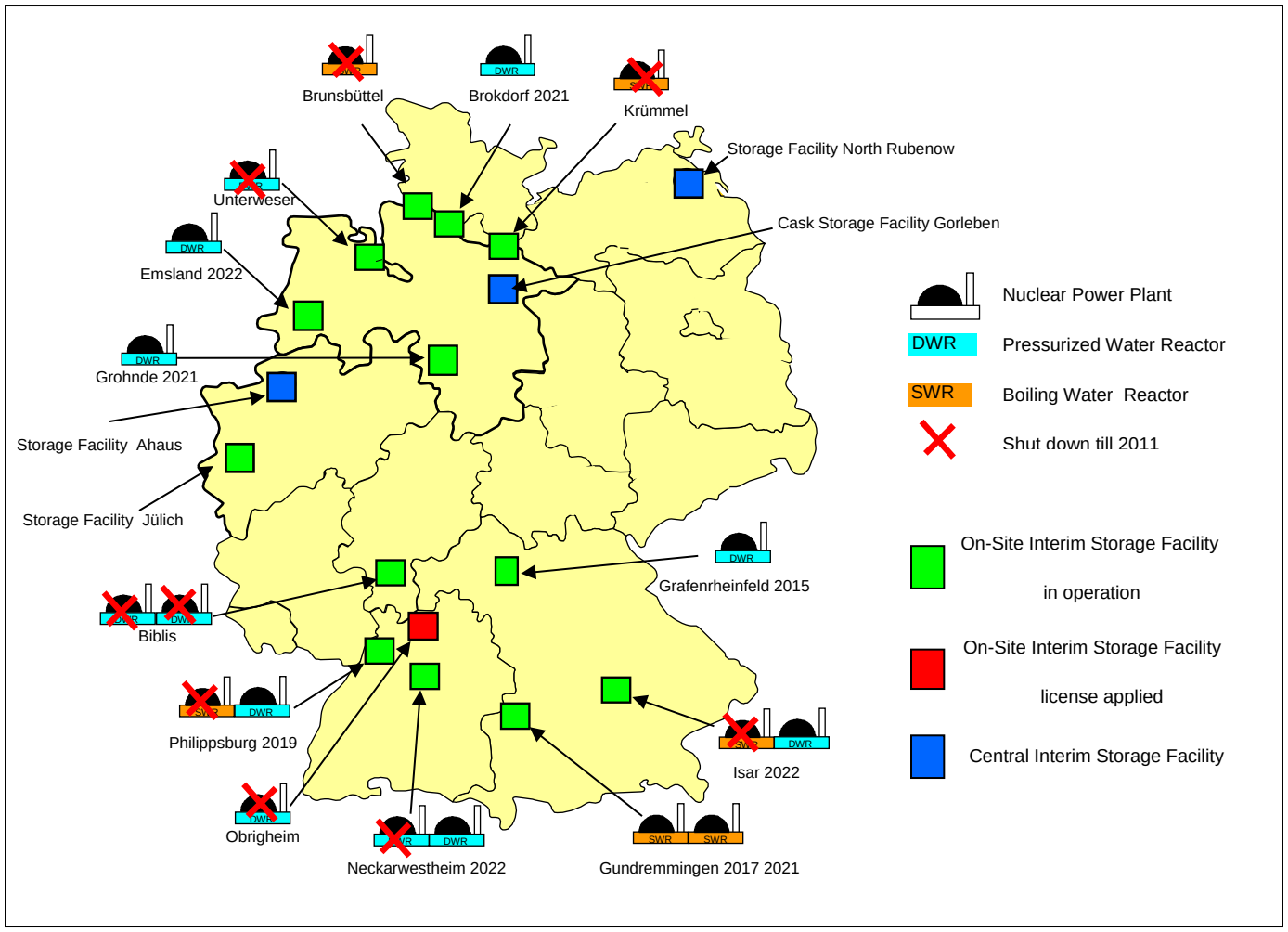

Fig. 1. NPP and storage sites in Germany

In Germany Interim storage of SNF and HAW in its actual form started in 2002 in the interim storage facility next to the NPP Lingen. Since 2005 delivering SNF for reprocessing is forbidden and direct disposal is the only allowed way of waste treatment in Germany. Because of this in the following years each NPP had to erect its own storage facility in addition to the three central storage facilities. Anyhow there is still waste from the former reprocessing in France and Great Britain to be taken back to Germany. It was planed to store this reprocessing waste in Ahaus and Gorleben. The storage facility in Lubmin was intended as storage site for the shutdown of the NPP Greifswald.

In all of these facilities dry storage in metallic casks inside concrete buildings is used. A remarkable requirement for the storage license is the need for a valid package design approval during the whole storage period of 40 years. This enables the possibility to transport the cask at any time to a nuclear facility away from the storage facility.

All safety functions like subcriticality, safe enclosure, radiation shielding and decay heat dissipation are guaranteed by the cask. The storage building serves mainly as weather protection and additional radiation shielding. In Germany two cask concepts are licensed and in use: the CASTOR® design of the manufacturer GNS and TN design of the manufacturer TNI. The CASTOR® design is based on a spheroidal graphite cast iron body with neutron moderator rods within. TNI uses a forged steal body surrounded by moderator compartments at the outside. Both designs use as required in ”Guidelines for dry cask storage of spent fuel and heat-generating waste” a double lid system with metallic gaskets which is constantly monitored.

As the last NPP in Germany is going to be out of commission in 2022 the number of casks to store can be calculated. In the year 2011 326 different casks were in the storage sites at the NPPs. It is expected to have about 1046 different casks with SNF in the different storage sites after all SNF from the NPPs has been loaded into casks.
The HAW from reprocessing in France is stored in Gorleben in 117 casks and five casks with HAW from the experimental reprocessing facility in Karlsruhe is stored in Rubenow. Research reactor fuel e.g. from the pebble bed reactors is stored in Jülich and Ahaus.

location	number of casks	cask type
Ahaus	305	CASTOR THTR/AVR
	18	CASTOR MTR2
	2	CASTOR V/19
	1	CASTOR V/19SN06
	3	CASTOR V/52
Gorleben	1	CASTOR IIa
	1	TS28V
	3	CASTOR V/19
	1	CASTOR Ic
	74	CASTOR HAW20/28CG
	12	TN85
	21	CASTOR HAW28M
Rubenow	61	CASTOR 440/84
	1	CASTOR 440/84mvK
	3	CASTOR KRB-MOX
	3	CASTOR KNK
	1	CASTOR KNK
	5	CASTOR HAW 20/28CG
Jülich	152	CASTOR THTR/AVR

Fig. 2. Casks in Central storage facilities 2012 (SNF and HAW)

NPP location	casks 12/2012	cask type	casks expected 2022	t (HM) expected 2022
Biblis	51	CASTOR V/19	102	1.024
Brokdorf	16	CASTOR V/19	78	776
Brunsbüttel	9	CASTOR V/52	22	169
Grafenrheinfeld	20	CASTOR V/19	62	561
Grohnde	18	CASTOR V/19	79	762
Gundremmingen	41	CASTOR V/52	191	1663
Isar	25	CASTOR V/19 CASTOR V/52	122	1148
Krümmel	19	CASTOR V/52	41	371
Lingen	32	CASTOR V/19	87	884
Neckarwestheim	41	CASTOR V/19	113	1039
Philippsburg	36	CASTOR V/19 CASTOR V/52	101	993
Unterweser	8	CASTOR V/19	38	386
Σ	326		1046	9776

Fig. 3 Casks in Interim storage facilities [1]

The actual storage licenses for spent nuclear fuel (SNF) and the vitrified high level waste (HAW) are limited to 40 years. As no opening of the cask is intended during the storage period the condition of the inventory and the cask before loading has to be known in detail. This requires for instance detailed knowledge of the history of the SNF loaded as well as supervision of the manufacturing process of all the cask components. Furthermore the loading and drying procedure of the cask is strictly regulated. This is necessary to ensure that no temperatures occur which might affect the behaviour of cask components during storage time.

Type of storage facilities

According to the safety philosophy in Germany the number of active systems at the storage facility is minimized. For instance cooling is ensured by natural convection. There are two different storage site designs the WTI concept and the STEAG concept with a two or one span hall. In case of the WTI design the building is expected to collapse in case of an aircraft crash, the STEAG design allows only damage of the building. Due to limitations in space the NPP Neckarwestheim decided to use two tunnels for storage instead of an extra building.

Supervision during storage

The only relevant active system is the monitoring system for the closure system which is continuously monitored and documented. At the beginning of storage an overpressure is adjusted between primary and the secondary lid. During storage the system continuously compares the pressure between the lids with the atmospheric pressure. Any change in pressure relation causes alarm. Sealing is realized by metallic gaskets in both lids. To gather further knowledge about the long term behaviour of these gaskets experiments are running at the Federal Institute of Material Testing (BAM) under different conditions. Since beginning of the interim storage in Germany no leakage or gasket failure was detected. There have been several alarms of the monitoring system but all of them indicated a malfunction of the pressure switch, which is a proof for working of the permanent self-monitoring. All of these incidents have been checked for any systematic failure, but till now none was detected. Anyhow there have been and there are still several minor changes in the construction in order to improve the system. At the moment the focus is on the connection between the switch and the cable.

Repair

In case of a leakage the cask is transported into the maintenance station of the storage facility. All facilities have a special equipment to check if there is contamination in the space between the two lids. If none is found it is possible to remove the secondary lid and change the gasket. This is not possible if contamination is detected and a leakage has occured at the primary lid which can’t be removed without release of radioactive material. In this case the cask has to be transported to the neighbouring power plant. If this is not operating anymore it has to be transported to a nuclear facility which is equipped with a hot cell and able to repair the primary lid barrier. Alternatively a licensed possibility is the welding of an additional lid on top of the secondary lid and the installation of the monitoring device in the additional lid. The welding at this position requires highly qualified and continuously trained manpower which has to be ensured by the storage facility operator. Storage of such a repaired cask is licensed. As the cask cannot be transported with the additional lid it has to be removed before transport of the cask.

End of the storage period

After the storage period of 40 years provision is made for transporting the casks to a repository. It has not yet been decided if repackaging will be required. After expiring of the storage license an extension or a new license will only be granted if the at this time relevant requirements are met. This will require detailed knowledge about the happenings and accidents during the previous storage period. All experience of the periodic safety assessment (PSÜ) and accompanying experiments conducted till now and during the licensed storage time will be needed. In Germany the storage sites Gorleben and Lingen took part in a test run of the PSÜ and delivered reports. The outcome of these reports was used for improvement of the PSÜ procedure, which will be used on all other sites during 2014.

REFERENCES

1) S. GEUPEL, K. HUMMELSHEIM and W. MESTER, Entsorgung abgebrannter Brennelemente aus den Kernkraftwerken in der Bundesrepublik Deutschland, p. 17, (2013)