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5 YEARS OPERATION OF THE NCS 45 PACKAGE FOR IRRADIATED FUEL RODS

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ABSTRACT

The development of the type B(U)F-96 package NCS 45 for the transport of irradiated fuel rods was presented at PATRAM 2004 [1]. The comprehensive drop test program and the drop test results were presented at PATRAM 2007 [2]. The package design was approved in the country of origin Germany end of 2008, some seven years after the application for package approval.

The presentation at hand will show the "highlights" of the first 5 years of operation.

The first step after approval was its validation in other countries. In some countries the validation process is a relatively fast and administrative process whereas in other countries extensive reviews are carried out. The presentation will give a short summary of procedures and questions asked.

The next step was the introduction of the packaging into the operations handbooks of the respective nuclear installations. In general, a site specific handling instruction comprising a detailed step by step plan must be written by DAHER-NCS, checked by the nuclear site and – at least in Germany – double checked by the supervising expert organization of the nuclear site. The presentation will show schematically the evolution of the licensed package handling procedure into the site specific handling procedures.

Finally, the presentation will give a summary of the transports carried out so far, and the first periodical checks after 3 years of operation. Lessons learned during this initial operation period conclude the presentation.

THE DESIGN OF THE NCS 45 PACKAGE

The package NCS 45 is primarily designed for the transport of irradiated fuel rods for Post Irradiation Examinations (PIE) between Nuclear Power Plants (NNPs) and Hot Cells. The main design principles are

- **Safety:**
  The package NCS 45 was designed and tested according to the IAEA 96-Regulations and is licensed as type B(U)F-96 package.
- **Quality:**
  QA measures during design, manufacturing and operation comply with the high requirements of the German Competent Authority. Independent witnessing by an expert assigned by the Authority is mandatory in Germany.

- **Easy to use:**
  The packaging NCS 45 was designed for loading and unloading under water and in dry conditions attached to a Hot Cell. The orientation of the packaging during loading/unloading can be vertical or horizontal. Tools which come with the package allow handling in all relevant nuclear facilities.
- **Easy to transport:**
  The NCS 45 is transported in a tailor-made 22' IP-2 container for easy tie-down to transport means and transfer between transport means and facilities. The gross weight of the transport unit consisting of package, container and truck is well below 40 Mg.

Fig. 1 shows the main design features. The packaging body is a sandwich design of stainless steel sheet encasing a thick layer of lead. On both sides the packaging body is closed by bolted plugs which accommodate on one end the rotary plug mechanism and on the other end the push plug mechanism. These plugs are only removed for maintenance purposes and allow easy access in case of necessary repairs. For loading and unloading small lids need to be operated which can be handled manually.

The packaging is equipped with two trunnions on each end which are designed and licensed for vertical handling (two trunnions) and horizontal handling (four trunnions) in nuclear facilities. Shock absorbers are attached to each end of the packaging during transport to ensure the ability to withstand accident conditions of transport.

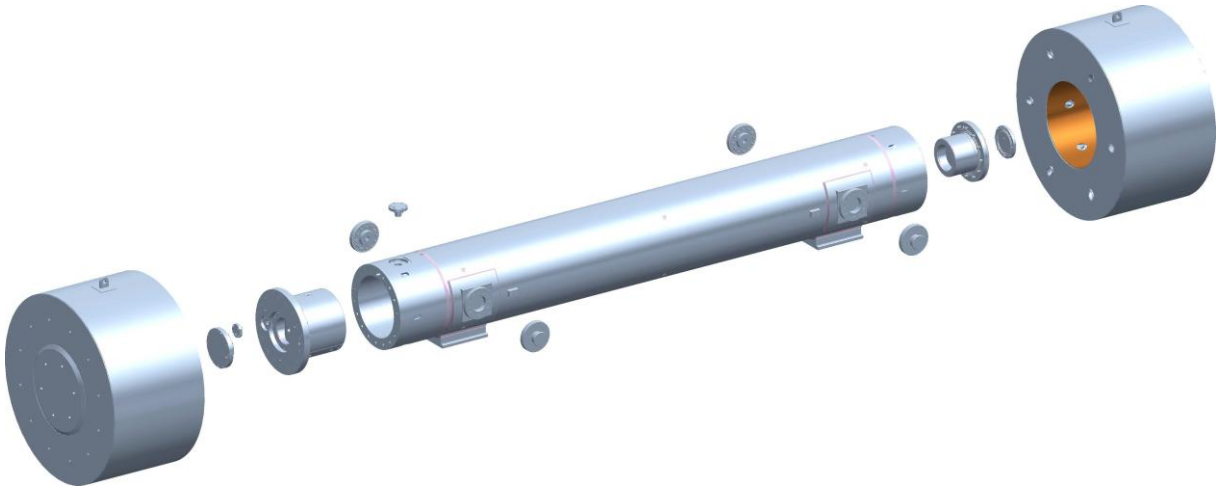

Figure 1. The NCS 45 packaging design

LICENSING OF THE NCS 45 PACKAGE

The country of origin for the certificate of package approval is Germany. The first license was issued by the German Competent Authority end of 2008. Currently, Rev. 2 of the certificate is valid which will expire August 2015.

The content description of Rev. 0 of the certificate comprised mainly UOX fuel in a rather general specification. It allowed enrichment up to 7 wt.% U-235, burn-up values up to 120 GWd/MgU and cooling times as short as 120 days. With Rev. 1 only a geometrical variation of fuel with 7 wt.% enrichment in U-235 was added to enable the transport of rather old fuel of the German Otto Hahn research vessel from Germany to France. Rev. 2 extended the content description to MOX fuel with the same burn-up and cooling time values as for UOX

fuel. The encapsulation technology to encapsulate fuel rods under water patented by DAHER-NCS [3] was also included in Rev. 2 of the approval.

Rev. 0/1 of the certificate was validated in Denmark, France, Spain, Sweden, Switzerland, UK and USA. The respective validations of Rev. 2 are currently ongoing. Whilst the validations in Denmark, Spain, Sweden, Switzerland and UK went rather smoothly, the validation processes in France and the USA took a lot of effort to come to a successful completion.

Although the Competent Authority in France had been informed from an early stage about all relevant issues of the licensing procedure in Germany and contributed to the drop test program, during the validation procedure many requests for additional information were raised. These requests for additional information were not only restricted to the criticality safety proof but also to all other safety aspects of the type B(U) package design for fissile material. The validation procedure could be completed after more than one year; however, only a partial validation covering about 50% of the content description of the original certificate could be achieved. It should be mentioned here that France and Germany are both ADR Member States and RAM transport is hence regulated by the same dangerous goods code.

Validation of the NCS 45 certificate of package approval in the USA required considerable effort because all European and International standards used for materials, manufacturing and safety analysis had to be translated to US standards. Furthermore, some concepts used for the specification of the content in the German certificate were at that time not considered to be adequate by the US Competent Authority. E. g., the source term based formula specified in the German certificate for the proof that the dose rate limits are met had to be replaced by a definite specification of no. of fuel rods, burn-up and cooling time. As result, the content description in the US validation is to a large extent different to the one given in the German original certificate.

SITE SPECIFIC PROCEDURES AND COLD TESTS

In order to be able to use the NCS 45 package in nuclear facilities following steps were necessary

- Development of site specific handling procedures
- Adaptation of handling tools to comply with site specific requirements
- Acceptance of the safety case by the site authority
- Cold test
- Acceptance of the cold test by the site authority

Development of site specific handling procedures

The handling procedure referenced in the German certificate of package approval specifies a framework of handling steps required to ensure that the package complies with the requirements of the certificate. In the site specific handling procedures this framework is completed with the handling steps and provisions required to ensure safe handling and operation inside the nuclear facility. Tab. 1 shows schematically the evolution of the package specific step by step plan into a site specific step by step plan.

An important part of the site specific handling procedure is the definition of responsibilities and interfaces between the different parties present during handling. The document is as well used to document the execution of the individual steps by each of the responsible functional units named for the respective step and to record items for possible improvements.

Table 1. Evolution of the package specific to site specific handling instructions (example)

Step by step handling instruction			
Package specific		**Site specific**	
Step no.	**Description**	**Step no.**	**Description**
X	Drying of the cavity of the packaging according to procedure no. 4711	Y	Connect vacuum pump type 123 to connection A of the packaging and connect the air outlet to the site ventilation system
		Y + 1	Start the pump and set up a vacuum of not less than ZZ hPa
		Y + 2	Check the dryness of the cavity according to checklist procedure no. 4711
		Y + 3	Disconnect the vacuum pump type 123 and check the interfaces for contamination

Adaptation of handling tools to comply with site specific requirements

The NCS 45 packaging comes with a comprehensive set of handling tools which interface with the nuclear facility

- Handling tools for horizontal lifting
- Tie-bar with telescopic tabs for handling in the fuel assembly pool
- Gripper for handling of the baskets
- Support plates and earthquake fixations
- Transport and tilting frames

The interface between the lifting tools and the facility is rather simple – the crane hook – so that rarely adaptations are necessary. Adaptations of the gripper are necessary if non-standard baskets are to be used. The safety of the support plates and the earthquake fixations must be checked against the design earthquake spectra of the facility and, if necessary, adapted. And finally, transport and tilting frames must be fitted to internal transport means and handling positions of the facility.

Acceptance of the safety case by the site authority

In Germany, all nuclear sites are regulated by the ministry of environment of the respective federal state where the site is located. Independent expert organizations (e. g. TUEV) are assigned by the ministry to give expert advice concerning the operation of the facilities. The safety case consisting of the handling procedures, safety proof of the tools, loading plan and related documents must be submitted to the expert organization responsible for the respective site and must be released by this expert organization before the cold test can be carried out.

Cold test

In general, a cold test is required in all nuclear facilities before the NCS 45 can be handled and loaded with fuel. The cold test is supposed to prove that the site specific handling procedure covers all necessary steps and that all responsibilities and interfaces are specified. For that, the complete step by step plan is processed except of loading of fuel into the packaging. The documentation of inconsistencies and/or possibilities for improvement is used to amend the handling procedure accordingly.

Acceptance of cold test by the site authority

The last step of the qualification of the NCS 45 for the use in a nuclear facility is the acceptance of the handling procedure and the cold test by the expert organization responsible for the respective site and the regulator.

OVERVIEW ABOUT 5 YEARS OF OPERATION

NCS 45 packaging series no. 1 was commissioned in 08/2009, series no. 2 in 08/2011. Fig. 2 shows the number of fuel transports and cold tests in the years 2009-2013.

In the first three years of operation, only one fuel transport from Germany to France was carried out, but cold test in 6 different nuclear facilities. In 2012 and 2013 fuel transports increased considerably and cold tests were carried out in 5 further nuclear facilities.

In 2012 the first periodical recertification of the NCS 45 series no. 1 was carried out successfully. The recertification consisted of visual inspections, dye penetration tests of welding seams, dimensional checks of bolts and threads and leakage tests. There were no deviations from the requirements of the certificate of package approval.

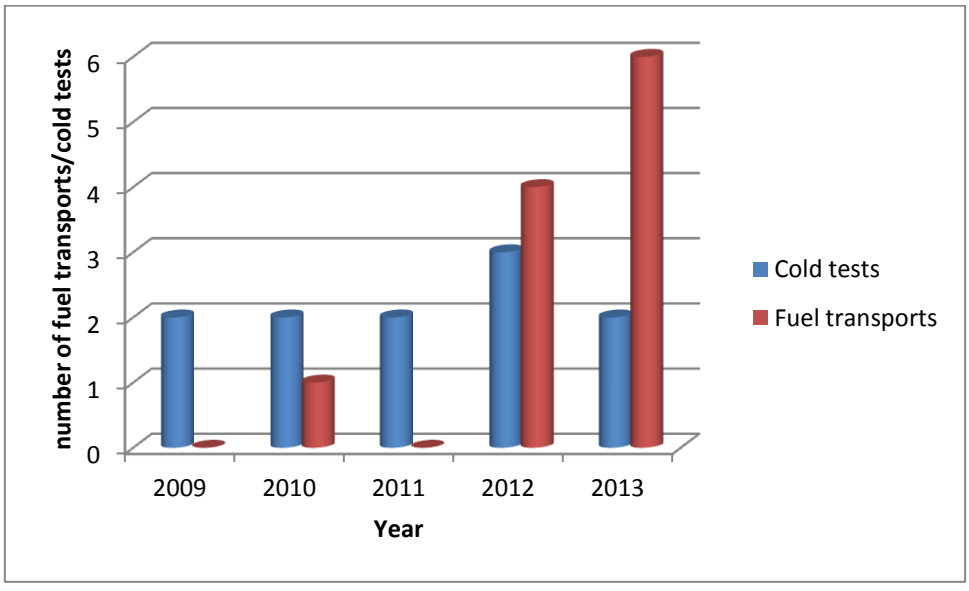

Figure 2: Number of fuel transports and cold tests with the NCS 45 in the years 2009-2013

LESSONS LEARNED

In the 5 year of operation the NCS 45 packaging proved to be a safe and reliable transport packaging for the transport of irradiated fuel rods. The design goals as specified at the beginning of this presentation were met in full. However, some important lessons were learned.

Validation of a new type B(U)F-96 certificate of package approval

With a type B(U)F design complying with latest Regulations and approved by the German Competent Authority we expected a smooth and less troublesome validation process in ADR countries. From past experience we certainly expected requests for additional information (RAI) concerning criticality safety proof. It was however unexpected that after we answered several RAIs only a partial validation could be reached. It became apparent that the interpretation of identical Regulations seems to be drifting apart and a common European certification process is many years away.

The RAIs from countries outside the ADR were as expected and also the work involved for translating European and international standards to the domestic standards of the validating country had been anticipated. Unexpected however was that most parts of the original certificate were discarded and new requirements introduced. After decades of discussions about harmonization among the authorities this is somehow hardly understandable for an applicant.

Site specific handling procedures and cold tests

The evolution of the package specific to the site specific handling instruction is shown in Tab. 2. The number of handling steps relevant to ensure that the condition of the package complies with the requirements of the certificate of package approval is roughly 60 for loading with fuel and 50 for unloading the fuel.

For nuclear site 1, the number of handling steps in the step by step procedure is tripled, for nuclear site 2 it is doubled. The number of organization units involved is in the nuclear sites much higher than requested by the handling instruction specified in the certificate of package approval.

There are big differences in the requirements of the nuclear sites concerning the level of detail of the site specific handling instruction. Tab. 2 shows that for almost identical handling procedures the number of steps can vary by more than 50%. A general site specific handling instruction is hence rather difficult to be realized.

Table 2. Evolution of the package specific to site specific handling instructions

	Handling instruction specific for		
	Package	NPP 1	NPP 2
No of steps for loading of fuel	58	176	101
No of steps for unloading of fuel	50	165	93
Organization units involved	1	5	3

CONCLUSION

The first 5 years of operation of the NCS 45 package were challenging, interesting and finally successful.

The first and unexpected challenge was the validation of the certificate of package approval in some ADR countries. According to our understanding B(U) properties – like shielding – of the package design need not to be reviewed and validated by any other ADR country if the country of origin is as well an ADR country. Only the "fissile" part of the design safety proof requires multilateral approval. According to our experience this concept is well recognized in many countries, but not everywhere.

The process to introduce the NCS 45 package into nuclear facilities was time consuming and required considerable resources. In most cases the challenge was to find a suitable time window for these activities in the nuclear facility.

Since two years the volume of transport is increasing steadily. The operation of the packaging is safe and efficient. The recent first recertification proved the excellent design and quality of the packaging.

REFERENCES

[1] W. Bergmann, F. Hilbert, The NCS 45 Cask Family: an Updated Design Replaces an Old Design – Lessons Learned during Design, Testing and Licensing, PATRAM 2004

[2] F. Hilbert, C. Kuschke, Th. Goedecke, T. Neumeyer, Drop Testing of the NCS 45, PATRAM 2007

[3] S. Stanke, F. Hilbert, Encapsulation of Fuel Rods for Transport, PATRAM 2010