FEED BACK ON THE USE OF THE MX6 MOX FUEL TRANSPORT CASK: REDUCTION OF THE DOSE UPTAKE DURING OPERATIONS

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ABSTRACT

In the framework of the quality, safety and environment policy of AREVA, TN International has implemented a global management system according to ISO 9001, OHSAS 18001 and ISO 14001 requirements with certification obtained from third part organization (1).
The design of the MX6 cask is an example of the implementation of this system in order to guarantee safety and the health of everyone involved and the protection of the environment.
The MX6 design has allowed ALARA dose rates for the workers during all the phases of use of the cask, to be significantly reduced compared to previous design.

The MX6 cask was developed by TN International for the transport of either BWR or PWR fresh MOX fuel assemblies. Replacing the previous SIEMENS type III and SIEMENS BWR packaging, the MX6 has been firstly used in the German Nuclear Power Plants.

Complying with the TS-R-1 (IAEA 1996) regulations, the MX6 cask is based on innovative solutions implemented at each step of the design and the manufacturing.

Its design includes an efficient neutron shielding for high Plutonium content and an easy use content restraining system. The large payload of the MX6 cask, 6 PWR MOX fuel assemblies or 16 BWR MOX fuel assemblies, minimizes the doses uptake during its unloading at the NPP.

Moreover, new sequences of loading and unloading operations were proposed for testing and implementation in each Nuclear Facility. Concurrently, total dose uptakes by the operators were assessed in order to prove the efficiency of the packaging and the proposed sequences.

In this paper, the main contributors to the transports to Germany with the MX6 cask will present their involvement and feedback for the reduction of the dose uptakes by the operators during the loading and unloading operations.

Presently in use at GUNDREMMINGEN and ISAR Nuclear Power Plants (NPPs), the MX6 cask use will be extended to other German and Swiss NPPs from 2006 onwards.

(1) AFAQ-AFNOR Certification for ISO 9001, OHSAS 18001 and ISO 14001, and CEFRI (Comité français de certification des Entreprises pour la formation et le suivi du personnel travaillant sous Rayonnements Ionisants) certification in the health physics field according to its E specification

INTRODUCTION

For the first time between mid-March 2005 and mid-April 2006, fresh MOX fuel assemblies were delivered at the German GUNDREMMINGEN Nuclear Power Plant using the MX6 cask. The MOX fuel assemblies were manufactured in Belgium and were delivered by TN International to the GUNDREMMINGEN NPP at a rate of one transport of 16 BWR fuel assemblies per week. Since, 7 transport operations have been performed to GUNDREMMINGEN NPP. One campaign of 4 transports to ISAR NPP for the delivery of 24 PWR fresh MOX fuel assemblies was also performed in May 2005 at a rate of one transport of 6 fuel assemblies per week.

In this paper, TN International will present its involvement and feedback for the reduction of the dose uptakes by the operators during the loading and unloading operations.

GENERALITIES AND BACKGROUND

The MX6 packaging has been developed by TN International to replace the BWR SIEMENS packaging and SIEMENS III packaging for the transport of either BWR or PWR fresh MOX assemblies.

This project was launched in early 2000 for the European market, focusing firstly on MOX PWR 16x16 and 18x18 fuel assemblies and MOX BWR 10x10 fuel assemblies. The design allows transporting a greater number of fuel assemblies with increased Pu characteristics.

Packaging characteristics [Ref.1 and 2]

The MX6 packaging is designed for the loading and unloading of fuel assemblies under dry conditions.

The MX6 cask loaded either with 6 PWR MOX fuel assemblies or with 16 BWR MOX fuel assemblies has a total gross weight of less than 20 t, a total length of 5980 mm, a body diameter of 1340 mm and a shock absorber diameter of 2130 mm (fig.1).

The shielding has been optimised in order to minimise the total dose absorbed by the operators.

The fuel assemblies are transported in a horizontal position. The content restraining system and the basket were designed by TN International specifically to maintain the integrity of the MOX fresh fuels.

The maximum characteristics of the 16x16 or 18x18 fuel assemblies to be transported are as follows: Pu total = 15%, Pu fissile = 6.5% to 8%, with a maximum power per fuel assembly of 1100 W

The maximum characteristics of the 10x10 fuel assemblies to be transported are as follows: Pu total = 15%, Pu fissile. = 8%, with a maximum power per fuel assembly of 415 W.

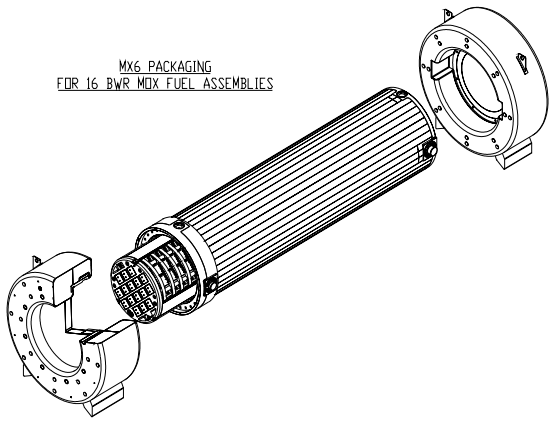

Fig. 1 The MX6 Package with its BWR basket

Safety requirements

The package complies with the TS-R-1 requirements as a Type B(U)F package and the corresponding international modal regulations ADR, RID and IMDG-Code.

It has been fully approved in France since December 2002 and in Germany since October 2003. It is also under validation in Switzerland.

Transport means

A new high-security system adapted to the MX6 package capabilities has been developed in co-operation between TN International and NCS. This new high security system, called SIFA2/2, complies with international road transport requirements and the German security regulations (fig.2).

Fig. 2: High security system for transporting the MX6

Handling

The trunnions of the MX6 packaging are designed in accordance with the German KTA standard 3905.

COLD TESTS [ref. 3]

General items

Due to its innovative design the MX6 cask has a much larger payload compared with previous packagings:

- 16 BWR MOX assemblies in one single packaging per transport instead of 8 BWR MOX assemblies in one packaging and 2 packagings per transport,
- 6 PWR MOX assemblies in one single packaging instead of 2 PWR MOX assemblies in one packaging and 2 packagings per transport,

New handling operations have been implemented in FBFC-I workshop and in the German NPPs.

In order to reduce the duration of the direct contact with the fuel assemblies during their loading or unloading, a longer preparation than performed on the previous packaging was done on the MX6 packaging. Furthermore, a specific shielding plate was adapted on the top of the packaging.

Considering the larger payload of the MX6 cask, the shielding of the packaging and the new handling operations, the duration of the direct contact during unloading of each fuel assembly was expected to be reduced significantly.

So, before the first transport in each plant, cold tests were successfully performed in 2003 at GUNDREMMINGEN NPP and in 2004 at ISAR NPP for qualification of the whole system with the participation of all parties involved: NPP, carrier, fuel supplier and local Authorities. These tests were conducted by the NPP’s operators in Belgium and in the NPP with dummy fuel assemblies.

Before performing transports in 2006, cold tests at GRAFENRHEINFELD NPP in 2004, at BEZNAU NPP (Switzerland) and at EMSLAND NPP in 2005 were also conducted by the NPP’s operators with full range of services offered by TN International.

Improvements in the plants were decided one year before the cold tests and conducted by the plants themselves; within this period.

TN International as well as all parties was involved in this preparation phase. First of all, the handling manual was issued for approval by both national and local Authorities (BfS and BAM for the transport licensing, AREVA NP in Belgium as well as TüV in Germany). Then, operating protocols were issued for the tests at the MOX manufacturing facility and in the NPP’s. Six months were necessary to approve all handling manuals (general and in plant manual) before proceeding with the test themselves.

Through these protocols, assessment of the dose uptakes by the operators during the operations was performed. This assessment was based on expected duration of each step of the loading/unloading operations.

The MX6 package was finally prepared and transported to every plant. Then, the whole system was tested by each plant with the attendance of all parties involved: NPP, carrier, fuel supplier, local Authorities as well as TN International, which provided its assistance in the cold test operation and in the routine transport operation.

The main feedbacks of the tests are:

- loading at the MOX manufacturing facility and unloading in the NPP’s are in accordance with operator’s safety requirements,
- The assessed duration of each step was overestimated. So, as the expected dose uptake by the operators during the current operations.
- the fuel assembly integrity is guaranteed during loading and unloading operations,
- heavy equipment and tools are qualified in the plants

Specific conditions for the return of the empty MX6 cask were also agreed between all the parties involved with respect to the health physics sections: values and location of the measurement of the non contamination control are so reported in a protocol issued before each return of the empty packaging. So, the packaging is fully controlled externally and internally, top plate, faces and bottom part of the lodgements are controlled. Therefore, the packaging returns to the manufacturing plant within allowed conditions of non contamination agreed by the plant.

Dose assessment

The assessment of the dose rate was based, for the BWR content, on the most pessimistic value of Pu isotopic vector. The main results are:

- dose rate at the contact of the lid: 215 µSv/h
- dose rate at the contact of the packaging: 580 µSv/h

We can compare these values with the value of dose rate at the contact of the basket, which is the case for the unloading of the previous packaging. This value is 820 µSv/h

So, without taking into account the shielding at the top of the packaging and the decrease of the duration of the operation, we may assess that the dose uptake by the operator will be significantly lower during an MX6 cask unloading than with the previous packaging.

FUEL ASSEMBLIES DELIVERIES WITH THE MX6 [ref.4]

The first transports of 10x10 fresh MOX fuel assemblies in the MX6 cask transport system from Belgium to GUNDREMMINGEN NPP were performed from mid-march 2004 to mid-April 2004 at a rate of one transport per week. Two additional campaigns of respectively 4 and 3 transports were performed to GUNDREMMINGEN NPP in 2004 and 2005. In May 2005, the first transports of PWR fresh MOX fuel assemblies in the MX6 cask transport system to ISAR were performed with the same rate.

The main differences with the previous containers are the size and the payload. For the BWR configuration, 16 fuel assemblies are loaded in one packaging instead of two packaging previously. For the PWR configuration, 6 fuel assemblies are loaded in one packaging instead of three packaging previously: the time period for preparation is longer, but the 16 fuel assemblies are loaded or unloaded during a shorter time period.

Therefore, thanks to the resin and an optimized time schedule for loading or unloading, the total dose is minimised.

Loading operations at the MOX manufacturing facility :

The main loading operations at DESSEL are described hereafter:

- The empty container arrives in a conventional truck at the plant, then is unloaded from the truck.
- Shock absorbers are removed, the flanges of the frame are unlocked and the packaging is transported on its tilting bench
- The fork lift truck tilts the packaging and introduces it in a pit
- The radiological shield is therefore installed, the lid is removed as well as the control orifice plug
- The clamping system is removed, the axial radiological shield is installed and the fuel assemblies are introduced and clamped one by one while removing each corresponding shield plug. The axial radiological shield is removed and the lid screwed with the appropriate torque.
- The leaktightness is controlled and the pressure inside the cavity checked
- The handling operations are then performed in the reverse order than previously
- The transport frame is unloaded from the security vehicle. The packaging is locked on the frame, the shock absorber replaced and sealed, the accelerometers switched on.
- The MX6 cask with the transport frame is installed and secured in the security caisson, the roof is replaced and external contamination control are recorded before departure.

Unloading operations in the NPP’s

The main unloading operations in the NPP are described in the sketch hereafter:

At the arrival of the security vehicle at the nuclear power plant, the control of the external non contamination of the vehicle is recorded, then the roof removed and the transport frame unlocked. The MX6 cask and the frame, connected with the horizontal lifting beam, are removed from the vehicle.

- The accelerometers are controlled, the seals removed, the flanges of the frame removed. The shock absorbers are removed and stored. Then, the external contamination is controlled and the results recorded, the MX6 cask is transferred on its airlock bogie before entering the power plant. The transport frame is replaced and locked in the security caisson, so that the security vehicle is ready for departure.

- The packaging is tilted and lifted in a preparation box, situated at the pool level. The scaffolding are put up, the accelerometers controlled, the internal pressure controlled and the packaging is put at the atmospherical pressure.

- The seals are taken off, the lid unscrewed and removed in a storage rack.

- The clamping systems are unlocked and removed.

- The refuelling manipulator, protected by a sock for avoiding contamination, transfers the fuel one by one in the cooling system. The fuel supplier controls each fuels with a camera.

- The internal contamination is controlled and recorded, the clamping systems locked, the lid replaced with the appropriate torque and the handling operations are then performed in the reverse order than previously.

- Then the external contamination is controlled and the results recorded, the MX6 cask is loaded on its storage frame with its shock absorbers and transported back to the MOX manufacturing facility on a conventional truck.

FEEDBACK OF THESE TRANSPORTS

General items

- All operations were undertaken in accordance with the operation manuals and the cold test.

- The protocol for the return of the empty packaging was correctly applied to the parties with the checking of all faces of the lodgement.

- All operations were conducted in accordance with operator’s security requirements.

- GUNDREMMINGEN NPP and the MOX manufacturing facility operators conclude that the operations of loading and unloading were quicker than with the previous SIEMENS casks as only one cask is needed instead of two for 16 fuel assemblies.

- The transports were performed according to the fuel integrity requirements; the transport frame and the new clamping system have proven their efficiency.

- During all the process of the test and during the current operation, TN International offered a large range of services from the documents issuance and the preparation of the test to the assistance during loading and unloading operations. The co-operation between all parties involved was necessary to reach this success.

Dose issue

The main success of the MX6 cask operations is the significant decrease of the dose uptake by the operators: The loading of the fuel lasts less than one day and the unloading with the associated fuel integrity control less than 4 hours. This was performed thanks to the new sequence of operations, which contributes significantly to the large decrease of the dose. Using the easiness of the clamping system contributes also to this decrease.

During the operations in GUNDREMMINGEN and ISAR NPP's, the dose uptake by the operator were measured, starting with the MX6 SIFA 2/2 unloading and ending with the empty MX6 cask loading on its conventional frame. The main results are the following:

- BWR results: The total dose for the unloading of the 16 MOX fuel assemblies from the MX6 cask is less than 550 µSv, compared to 1 900 µSv assessed; moreover, this value, comparable with the value measured in the ambient condition of the plant is more than three times lower than the value measured during the campaign performed in 2003 with the previous container with the same isotopic composition of Pu.

- PWR results: The total dose for the unloading of the 6 MOX fuel assemblies from the MX6 cask is less than 230 µSv; compared to 1 500 and 2 000 µSv value with the previous container, with comparable Pu isotopic vector for both deliveries.

CONCLUSION

15 MX6 cask transportations of fuel assemblies from Belgium to GUNDREMMINGEN NPP or ISAR NPP were successfully performed, according to the power plant representatives and the fuel supplier as well.

The MX6 cask is a fully TS-R-1 packaging, developed for several types of fuels with high performance and designed for a high payload. Its new design as well as its sequence for unloading operations contributes to optimize significantly the level of the dose uptake during the operations. A more than 3 times decrease of the total dose uptake during the unloading operation as compared to the previous casks is easily achieved.

The MX6 package is the right answer to NPP and nuclear facility requirements, thanks to the lessons learned with previous packagings and the radioprotection programs implemented by TN International at each steps from design to transport operations. This new design and its new sequence of operations have both contributed to a large decrease of the doses uptaken by operators.

The use of the MX6 cask will be extended soon to other German and Swiss NPP's.

After FBFC in Belgium, MELOX, in France, will load the MX6 cask for deliveries to NPP's.

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