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Operational Best Practices and Sustainability of the UX-30 package

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ABSTRACT

The UX-30 package is an essential package to support international transport flows of enriched UF_6 between enrichment facilities and fuel manufacturers. It is approved by the Nuclear Regulatory Commission as a type B package and it can transport UF_6 from natural and reprocessed uranium enriched up to 5% with a 30B or a 30C cylinder. It is also licensed in 10 countries around the world. Today, a fleet of more than two thousand (2,000) UX-30 overpacks is operated and transported by multiple worldwide users. Over the last two years, several similar issues related to the disengagement of ball lock pins which assure the closure of the two half shells of the UX-30 package have impacted the shipments highlighting the need to share information between users and to implement best inspection and maintenance practices.

In addition, an evaluation of the sustainability of the UX-30 package has been conducted jointly between Columbiana Hi- Tech (CHT) and AREVA TN based on the following points:

- Licensing and regulatory status

- Operating of the package

- Manufacturing and maintenance of the package

This paper will describe operational best practices and the positive results of the joint effort between CHT and AREVA licensing experts for the continued use of a well-designed and efficient package.

INTRODUCTION

The UX-30 package is an essential package to support international transport flows of enriched UF_6 between enrichment facilities and fuel manufacturers, it is now the most widely used UF_6 package in the world.

Figure 1: UX-30

The UX-30 package consists of an overpack containing a 30B cylinder. The overpack ensures mechanical and thermal protection, whereas containment is provided by the 30B cylinder.

Figure 2: 30B cylinder inside the UX-30 overpack

The licence holder of the UX-30 package is Columbiana Hi-Tech; the UX-30 is licensed by the US Nuclear Regulatory Commission and the US Department of Transport as a type B package until 2016; it can transport UF_6 from natural and reprocessed uranium enriched up to 5% with a 30B cylinder.

Most of the countries in which the package is licensed have issued the validation the UX-30 certificate on the same basis.

However starting in 2010 several similar issues related to the disengagement of the ball lock pins which assure the closure of the two half shells of the UX-30 package resulted in a 4-month cancellation of transport in France.

Moreover, the most essential questions raised by the French and UK Competent Authorities which led to limited validation in both countries related to UF_6 content and to the 30B cylinder. These questions also pushed other Competent Authorities to limit the duration of their own validation while waiting for FCA and UKCA final statements.

CHT and AREVA TN have been working jointly to address these issues simultaneously.

LICENSING AND REGULATORY STATUS

The modification of the regulations as well as the additional requests from the Competent Authority in each country concerned by UF_6 transport represents a risk for sustainability of all UF_6 packages. Indeed, numerous questions raised by the FCA deal with the 30B cylinder independent of the overpack. The 30B cylinder conforms to ANSI N14.1 standards to ensure the containment of the content.

AREVA TN faced similar questions when licensing the COG-OP-30B package (AREVA is the licence holder of COG-OP-30B which can also transport UF_6 from natural and reprocessed uranium enriched up to 5% with a 30B cylinder), and was thus in an excellent position to provide CHT with assistance in answering the concerns of the Authorities for the UX-30 package. The primary questions are detailed below:

First, the FCA did not agree with the justification of the absence of brittle fracture in the 30B cylinder as they do not recognize the application of the NUREG 7.11 standard which stipulates that fracture toughness of materials for thin-wall shells as an acceptable criterion. This subject is still an open question and will need further discussions between Authorities to converge on a common position on the application of this standard.

Secondly, the FCA required a justification of the chemical composition of UF_6 heel cylinders to justify type A classification, which necessitated a characterization test of the UF_6 from natural and reprocessed uranium. The objective was to guarantee the classification of the heel cylinders. After intensive work with the AREVA facilities in Pierrelatte, France, a report detailing the UF_6 composition was provided to the FCA.

This work consisted of:

- washing 3 heel cylinders containing UF_6 from natural uranium

- characterization of the content of the washing water, which revealed a list of isotope types

- ageing the isotope spectrum between two washings taking into account the natural uranium decay

- evaluation of the total activity of the aged isotope spectrum and comparison with the type A criterion (activity less than 1 A2)

- extrapolation of the characterization results for reprocessed uranium

The FCA accepted the conclusion for natural uranium, but required supplementary tests and analyses of the washing water for the reprocessed uranium heels.

As result AREVA succeeded in developing a methodology to calculate activity of heel cylinders for both natural and reprocessed uranium. Because there was no need in France to transport heel cylinders of UF_6 from reprocessed uranium, AREVA did not provide any additional tests and therefore the content was not validated. This methodology is available for UX-30 cylinder owners who may need to transport reprocessed uranium.

Thirdly, the French Competent Authorities asked that the revision of the safety criticality studies take into account the presence of solid residues in the form of UO_2F_2, hydrated when the 30B cylinder is filled with UF_6.

AREVA TN provided the FCA with a complementary criticality study justifying that the package remains sub-critical taking into account hydrated UO_2F_2.

In France, at the present time, the UX-30 package has been validated until July 2014. The validation is restricted to the transport of a 30B cylinder filled with UF_6 from natural uranium enriched up to 5% and to a type A package.

CHT and AREVA TN are currently working jointly to facilitate the renewal of the validation in 2014 and other new countries such as China.

OPERATION OF THE PACKAGE

Closing system: 2-inch ball lock pins

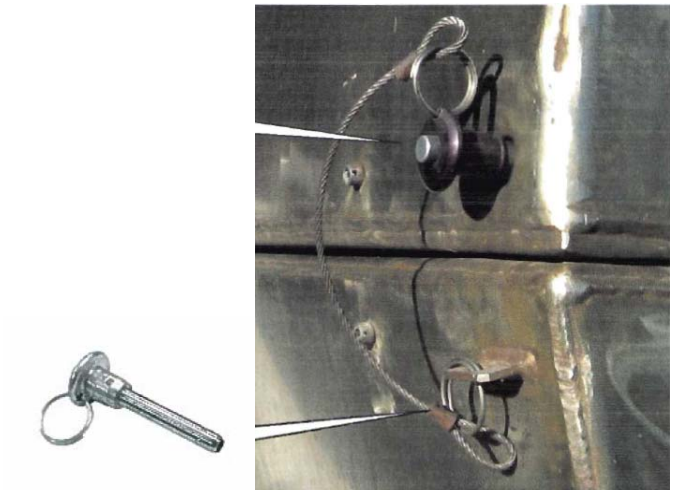

Figure 3: 2-inch ball lock pin

In France, several incidents in transport occurred between 2010 and 2012 concerning the disengagement of the 2-inch ball lock pins which ensure the closure of the two half shells of the UX-30 package. During the early months of 2011, AREVA TN stopped all transport of UX-30 in France to determine the root cause and how to avoid such events.

AREVA found some damages on the pins coming from bad material: in fact the material used for the locking pin was not the one recommended by CHT. But the problem was that the material recommended by CHT was written in the proprietary version of the SAR which was not known by users.

An other identified main reason for these events was linked.to human factors: a lack of pre-departure control in compliance with CHT's standards and safety consciousness in the field.

The FCA accepted the resumption of UX-30 transport based on the fulfilment of the following conditions:

- Change of all 2-inch ball lock pins of the AREVA UX-30 fleet (AVIBANK BLC7BC20SL6C8 as described in the proprietary safety analysis report, see reference <3>)
- Inspection of the 2-inch ball lock pins in compliance with the CHT-01 procedure, see reference <2>

However, these actions were not sufficient enough. In February 2012, another ball lock pin was found to be malfunctioning in the port of Baltimore.

This latter event in February 2012 led AREVA TN and the AREVA Pierrelatte facilities to jointly carry out a deeper root-cause analysis of the failure modes and shared with the FCA for implementation of resulting actions, described as follows:

In order to avoid further dysfunctioning of the ball lock pins, multiple barriers of inspection must be set up:

- Before assembling the two half-shells the compliance of the ball lock pins must be verified.
- After locking the ball lock pins an inspection of the locking must be done with a double verification to be sure of proper locking.
- On the transport means before shipment a visual inspection must be done and registered with a digital image as proof of the proper engagement of the ball lock pins and the correct position of the plug.

In addition, accessibility of the package is recommended for the assembling of the two half-shells and for the inspection: assembling of the two half-shells on a defined plane surface, free access completely around the package to facilitate operations and inspections.

The frequency of human errors must decrease through a specific training course for inspectors, including an explanation of the importance of safety rule (safety functions of components) to ensure thorough inspections.

The analysis exposed that it was necessary to implement preventive maintenance linked with a systematic surveillance of the parameters for the proper engagement and locking of the ball lock pins. The following criteria are thus concerned by the surveillance:

- alignment of the two half-shells
  - diameter of the upper shell hole
  - diameter of the lower shell pins
  - easy insertion of the ball lock pins
- locking system
  - diameter of the lower shell pin holes
  - no chamfering and no matting at the angle of contact
  - dimensions of the ball lock pins

The above criteria were defined based on the detailed drawing of the locking system provided by CHT and based on the functional criteria of the Safety Analysis Report.

AREVA TN and AREVA facilities succeeded in implementing this surveillance in around 4 months to resume transport with FCA approval. The good condition and the inspection of the overpack prior to shipment in compliance with the certificate are the best guarantees of the sustainability of the UX-30 package.

MANUFACTURING AND MAINTENANCE OF THE PACKAGE

Only CHT is authorized to manufacture the UX-30 package, thus ensuring that only one stakeholder is involved in the manufacturing and the compliance of the Safety Analysis Report. In this way, communication is facilitated when faced with Competent Authority requirements regarding the manufacturing.

Unlike the manufacturing, the maintenance is not centralized and is performed independently by each owner. All UX-30 owners must comply with safety requirements of the maintenance program.

Considering that proper maintenance of the overpack is essential, CHT and AREVA TN are developing a user-friendly maintenance guide based on CHT best practices and AREVA TN quality processes. This guide of recommendations, called "Operations and Maintenance Guide," will be shared with and distributed to all owners.

CONCLUSION

Enriched UF_6 is transported through multiple countries requiring licensed packages in each. Questions related to the criticality of the 30B cylinder inside the overpacks have made the licensing renewal more complex resulting in shorter validation periods. The certification of the UX-30 package, the essential element for the transport of enriched UF_6, has obviously been impacted by these questions. In addition, the fact that different stakeholders manage validations in different countries creates even more complexity. To ensure consistency and efficiency of responses to the Authority's questions and to guarantee the continuity of the license, a centralization of the licensing activities would certainly facilitate the renewal process.

Conformity of the UX-30 package prior to shipment in accordance with the certificate is essential to avoid any issues in transport and, more importantly, any transport stoppages, thus ensuring its sustainability. Obviously, the maintenance program developed by each of the owners must comply with certificate requirements.

CHT and AREVA TN propose to work with owners and users to:

- share feedback on operations and maintenance
- develop and share a user-friendly maintenance guide based on CHT best practices and AREVA LBU quality processes
- support licensing activities:
    - to address questions from worldwide Authorities ensuring consistency of responses
    - to evaluate design implications based on new regulatory requirements

REFERENCE

<1> IAEA TS-R-1 Edition 2009 - Regulations for the safe transport of radioactive material

<2> CHT-01 – Manufacturers recommended procedure regarding Acceptance, Maintenance, and Operation of a UX-30 component known as Two Inch Locking pins

<3> Safety analysis report for model UX-30 package – revision 2 – March 2011

<4> ANSI N14.1 Edition 2001 “Uranium Hexafluoride – Packaging for Transport”

<5> ISO 7195 Edition 2005 “Packaging of uranium hexafluoride (UF_6) for transport”