Proceedings of the 19th International Symposium on the Packaging and Transportation of Radioactive Materials
PATRAM 2019
August 4-9, 2019, New Orleans, LA, USA

SUCCESSFUL LICENSING OF THE NEW DN30 PACKAGE FOR THE TRANSPORT OF UF_6 AND FIRST IMPRESSIONS FROM ITS USE

Yara van Wijk **Maik Hennebach**
DAHER NUCLEAR TECHNOLOGIES GmbH, Hanau, Germany

ABSTRACT

The DN30 package was developed by DAHER NUCLEAR TECHNOLOGIES GmbH (DAHER NT) for the transport of enriched commercial grade and reprocessed uranium hexafluoride (UF_6) up to an enrichment of 5 wt.%. It consists of a standard 30B cylinder and the DN30 Protective Structural Packaging (PSP). The design and several aspects of the licensing process were already presented at previous PATRAM symposia.

Licensing took overall a time period of around ten years. Several drop test campaigns and fire tests with 1:1 scale prototypes took place at the German BAM test facility. Several, sometimes unexpected, optimizations of the design of the packaging were required to achieve in the end very positive results.

The complete PDSR comprising extensive FEM simulations of the tests was submitted to the French competent authority at the end of 2016. After several rounds of questions/answers and revisions of the PDSR, the final meeting with the permanent expert group to get a "go" took place at the end of 2018. The DN30 package was then licensed in France as a type AF, IF and B(U)F package in December 2018. Subsequently, validations in all relevant countries dealing with the transport of enriched UF_6 were applied for.

Mid of 2018 the application for the NRC certificate of approval as a type AF package with the goal of having the certificate available mid of 2019 was filed.

For the serial manufacturing process, experience gained from manufacturing the prototypes used for testing is taken into account. Two series-prototypes have also been manufactured to ensure proper serial manufacturing of the DN30 PSPs. Hence, the technical aspects of the prototype manufacturing of this new package can be shared during the PATRAM symposium.

The paper will give an overview first about the ten-year successful licensing process in France, second about the considerably shorter licensing process in the USA, and will then concentrate on manufacturing of the new DN30 PSPs and their functional testing.

INTRODUCTION

Enriched UF_6 has been transported worldwide for decades in 30B cylinders using an additional PSP for mechanical and thermal protection under routine, normal and accident conditions of transport (respectively RCT, NCT and ACT/HAC). There are several PSP designs in use today; however, several years ago it became apparent that a new state-of-technique design was required to answer the evolving requirements of the Regulations. DAHER NT has developed this new PSP design called the DN30 and has been presenting it at the last three PATRAM symposia during its design phase in papers [1], [2], [3], [4] and [5].

The DN30 was approved in December 2018 in France as type IF, AF and B(U)F package for enriched commercial grade and enriched reprocessed uranium up to an enrichment of 5 wt.%, and since then the manufacturing process has started. The NRC Type AF approval for commercial grade is expected to be issued before PATRAM.

The following presentation contains a description of the licensing processes both in France and in the USA, as well as information concerning the manufacturing process of the DN30 PSPs and the functional tests that were carried out.

OVERVIEW OF THE DESIGN OF THE DN30 PACKAGE

The DN30 package consists of the 30B cylinder (according to the standards [6] and [7]) and of the DN30 PSP. The DN30 PSP accommodates the 30B cylinder and provides its mechanical protection during NCT and ACT/HAC and thermal protection during ACT/HAC.

The DN30 PSP consists of two halves made of stainless-steel shells, one top and one bottom, which are connected by a closure system consisting of six individual robust closure devices, three at each side of the PSP. A gasket is fitted on the step-joint part between both halves to prevent water inleakage. The DN30 PSP also includes two robust seal holders for high security seals. The lifting interfaces permit the safe handling of the DN30 package and its parts: lifting lugs for the top half, lifting lugs at the feet, as well as forklift pockets (see Figure 1). The tie-down interfaces permit the safe stowing of the DN30 package and are compatible with the existing PSP designs: they allow the transport of 4 DN30 packages on a 20 ft flatrack (industry standard).

Besides the energy-absorbing closed-cell foam preventing impairment of the safety of the 30B cylinder during NCT and ACT/HAC, the DN30 PSP includes a thermal insulation system which ensures that the temperature of the 30B cylinder and its content remains below the acceptable limit and therefore keeps the latter from building up pressure in case of a fire under ACT/HAC. This thermal insulation system consists of an insulation layer between the inner shell and the foam, an intumescent layer covering the inner shells which expands at a certain temperature, as well as thermal plugs at the outer shells which melt after reaching a certain temperature and therefore allow escape of the hot gases produced by the pyrolysis of the foam.

The DN30 package includes several advanced and innovative safety features to ensure that containment provided by the 30B cylinder is preserved under NCT and ACT/HAC. The valve protecting device guarantees that there is no contact between the valve and any part of the DN30 package other than its initial point of attachment. The same applies to the plug protecting device, which also permits both the hex head and the socket head plug design to be installed in the 30B cylinder. Two rotation preventing devices ensure that the 30B cylinder does not rotate

on its axis inside the DN30 PSP at any time and therefore do not render the other safety features previously mentioned inoperable (see Figure 2).

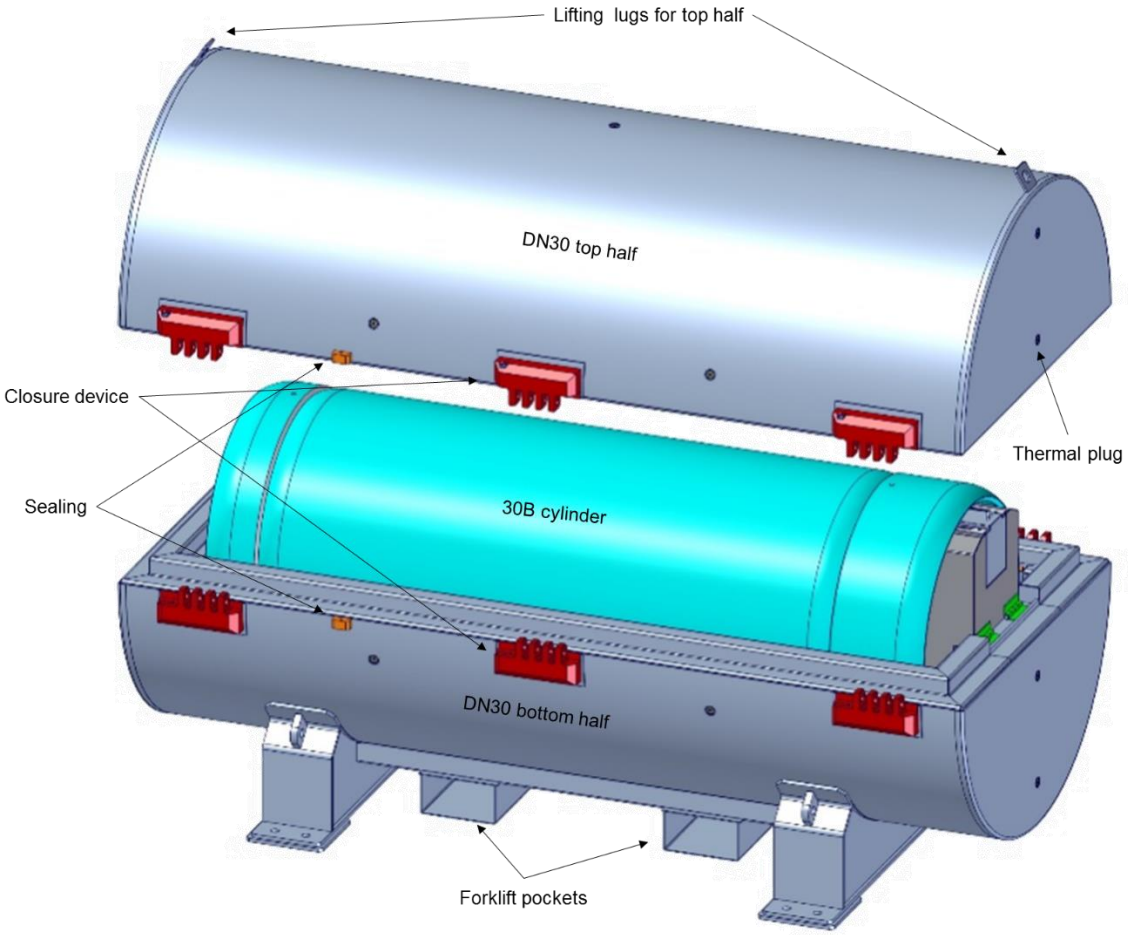

Figure 1. DN30 package overview

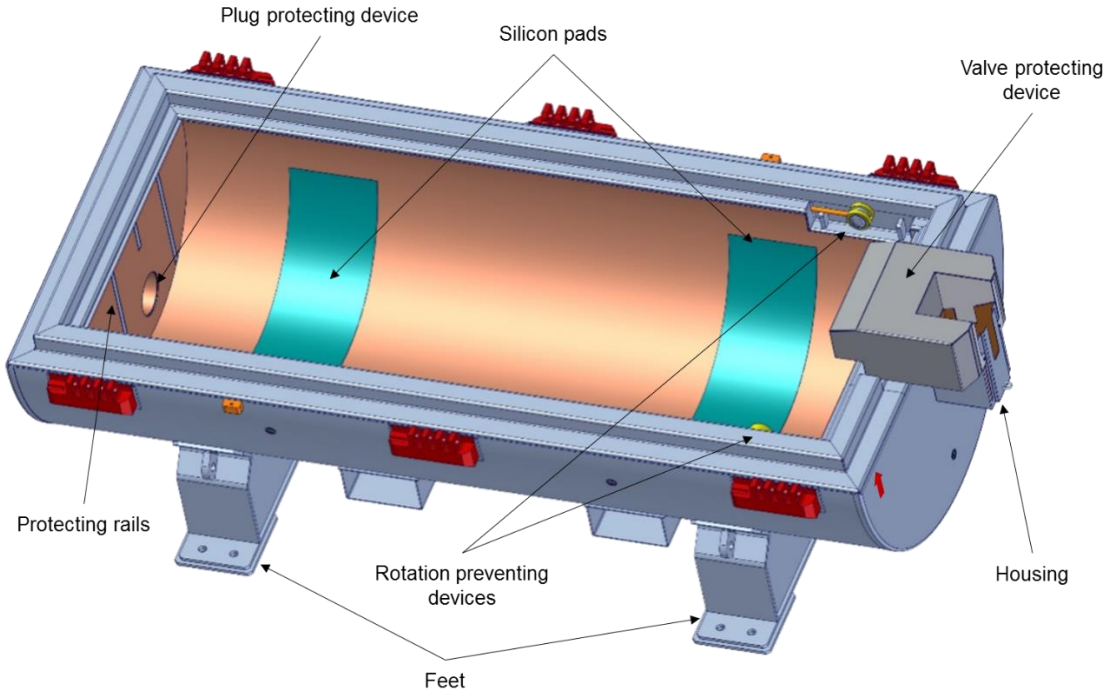

Figure 2. DN30 bottom half overview

LICENSING PROCESS IN FRANCE AS TYPE IF, AF AND B(U)F PACKAGE

Designing of this new package started in 2008. From this point onwards, the design process was performed with frequent and close communication with the French nuclear safety authority (ASN) and its technical expert (IRSN). The conceptional safety report was submitted in 2011, as well as the drop test program. This led to three drop test campaigns with five drop test sequences each:

- 2012-2013: deformations of the 30B cylinder too high → change of shock-absorbing foam
- 2013-2014: too conservative surrogate material for UF_6 → change of surrogate for UF_6
- 2015-2016: successful drop test campaign!

After the drop test campaigns, the prototype for the fire test was selected. To achieve conservative test results, the prototype for the fire test was pre-damaged by two consecutive drop test sequences and the 30B cylinder filled with UF_6 surrogate material during the drop test was replaced with an empty cylinder. Three fire tests were carried out:

- March 2016: valve temperature 345 °C → addition of the intumescent layer
- September 2016: valve temperature 221 °C → addition of the insulation layer
- November 2017: successful fire test!

After eight years of designing, testing and then redesigning the DN30 PSP, the complete PDSR of the DN30 package was submitted to the ASN in December 2016. Over the following two years, several rounds of questions and discussions ensued, leading to a revision of the PDSR.

An official meeting was held by the French Expert Group of Transports (GPT) in November 2018 to wrap up the safety case and advise the ASN on issuing the certificates of package approval. Following this meeting, the final version of the PDSR was sent to the ASN. This resulted in December 2018 in the three French certificates of approval: type IF for enriched commercial grade and reprocessed uranium for full cylinders, type AF for enriched commercial grade, full cylinders and heels, and type B(U)F for enriched reprocessed uranium, full cylinders and heels.

Validations for these certificates were applied for in several countries: Belgium, Brazil (already available), Canada, Germany, the Netherlands (already available), Russia, South Korea, Sweden (already available) and the United Kingdom.

LICENSING PROCESS IN THE USA AS TYPE AF

To be able to carry out domestic transportation in the USA, a Nuclear Regulatory Commission (NRC) certificate of compliance is required.

Before the NRC certificate was applied for, the Quality Assurance Program of DAHER NT was approved according to 10 CFR 71 in 2015. In August 2018 the type AF certificate with a new safety analysis report (SAR) based on the European PDSR was applied for: this SAR had been adapted for a type AF package only, with all IAEA references replaced by 10 CFR 71 and 49 CFR 173 references in the main SAR and keeping all appendices the same as used for the French approval.

The NRC sent their Requests for Additional Information (RAI) in March 2019. The answers provided by DAHER NT were accepted in July 2019 and the revised SAR submitted to the NRC. The NRC certificate of compliance for a type AF for enriched commercial grade uranium is expected to be issued in the last week of July, less than one year after the application was submitted and by having only one round of RAIs.

At that point, a DOT validation of the French type AF license for US export/import will also be applied for.

MANUFACTURING OF THE DN30 PSP

For manufacturing of the serial DN30 PSPs, DAHER NT selected the same manufacturer and suppliers that had also participated in making the prototypes used during the testing phase, so it was not a "start from scratch"-type situation.

As the first step, the manufacturer made all manufacturing drawings for stainless-steel parts based on the licensed drawings and the CAD model. Likewise, the supplier DUNA-Corradini S.p.A. of the shock-absorbing foam parts CORAFOAM® also made their drawings based on the licensed ones.

Once the part drawings were accepted and released, welding drawings along with welding instructions, the welders' certificates and information regarding the welding robot were prepared, which then also had to be checked and released by DAHER NT.

Besides the steel and the foam parts, all other materials were ordered from their respective suppliers: thermal protections, silicone pads and their glue, nameplate with text according to ADR, screws and washers.

A detailed manufacturing and test sequence plan (MTSP) with all related instructions and protocols (for the visual, dimensional, penetration, leak and overloading tests) to fill in during manufacturing and used for documentation was established based on the MTSP approved by the French authority.

This was also done with the parts list including all parts from all suppliers and their respective drawing numbers, dimensions, weight (according to the CAD model) and material certification according to EN 10204.

To ensure proper serial manufacturing, two series-prototypes were made before the start of the series DN30 PSPs manufacturing.

Apart from the parts-assembly check, the first prototype allowed the set up for programming the welding robot for long welds on both halves, the determination of the original length for both halves so that the appropriate length is obtained after welding, the confirmation of the handling of the DN30 PSP with a dummy cylinder, etc.

Once this first prototype was fabricated, acceptance inspections were done. This included the functional check of all devices, the visual inspection, the leak test (making sure each half of the DN30 PSP is leak tight, see Figure 3), a dye penetrant test of the most important welds (see Figure 4), and the dimensional checks.

Figure 3. Leak test of the DN30 bottom half

Figure 4. Dye penetrant test of the welds of the closure devices of the DN30 top half

Then the intumescent layer as well as the silicone pads were glued to the inner shells. Loading of a dummy cylinder and closing of the prototype was also checked (see Figure 5).

Figure 5. Loading of a dummy cylinder inside the DN30

Following the manufacturing of the first prototype and taking into account the lessons learned with it, the second prototype was manufactured the exact way the serial DN30 PSPs will be manufactured and checked. All the materials were ordered according to the revised drawings, and assembly started after receiving them. The second prototype will be ready before PATRAM.

Since there will be no discrepancies between this second prototype and the series units, serial manufacturing will start immediately after the second prototype is completed. The first serial DN30 PSPs will be delivered to the customer in August 2019.

FUNCTIONAL TESTS BEFORE FIRST USE

As mentioned before, functional tests were carried out on the first prototype (and will of course also take place with the second prototype and the series DN30 PSPs).

Initially this included the operation of all moveable safety features:

- turning the handle of the anti-rotation devices to put the pins in their open or locking positions (see Figure 6)

Figure 6. Operation of the DN30 anti-rotation devices (left: open position, right: locking position)

- turning the valve protecting device and moving its housing in the open or closed positions (see Figure 7)

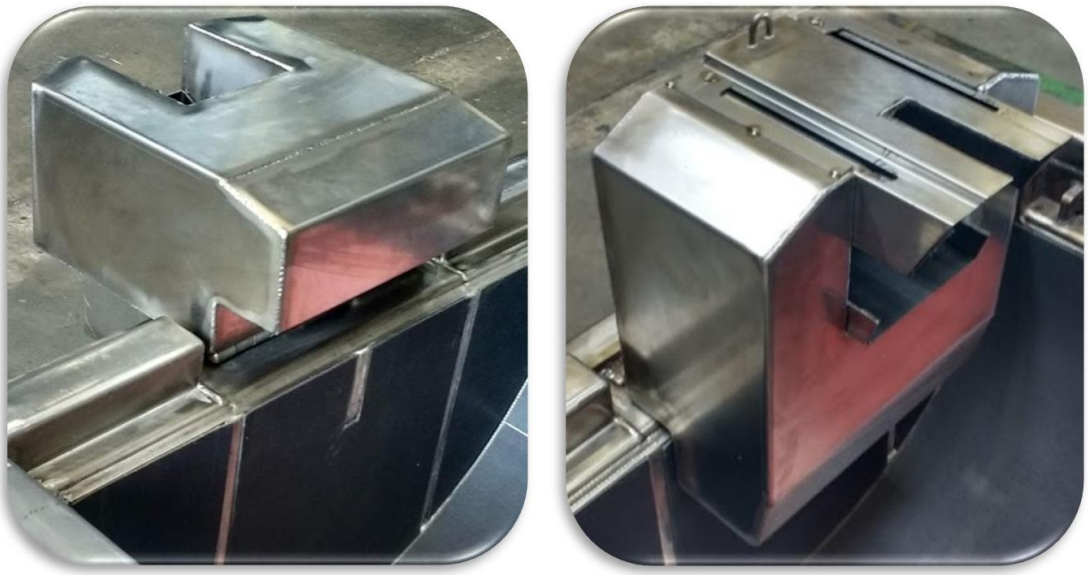

Figure 7. Operation of the DN30 valve protecting device and its housing (left: open position, right: closed position)

- assembling the two halves together (see Figure 8)

Figure 8. Lowering of the DN30 top half onto the DN30 bottom half

- closing the DN30 by inserting all pins inside their respective closure devices and locking the pins with the screws (see Figure 9)

Figure 9. Operation of a DN30 closure device (left: not closed position, right: closed position)

Once all of this was correctly executed, a dummy cylinder was loaded into the DN30 PSP prototype and these operations were repeated but this time with the cylinder to check the functionality of the DN30 PSP (see Figure 10).

Figure 10. Closing of the DN30 after it had been loaded with a dummy cylinder

Furthermore, the prototype was lifted just like a serial DN30 would be: with slings attached to shackles at the lifting lugs at the feet and with a forklift inside the forklift pockets (see Figure 11).

Figure 11. Lifting of the DN30 by means of a forklift

All of this was carried out successfully.

CONCLUSION

The new DN30 PSP, with advanced and innovative safety features, is a long-term solution for the transport of UF_6. It has been licensed in France as a type IF, AF and B(U)F package for enriched commercial grade and enriched reprocessed uranium up to an enrichment of 5 wt.%, and already validated in several countries. It is also soon to be licensed in the USA by the NRC as a type AF package for enriched commercial grade uranium.

Two series-prototypes were manufactured to ensure proper serial manufacturing (documentation, fabrication, inspection), followed by successful functional tests. Serial manufacturing starts in August, meaning you can soon buy your own DN30 PSP!

REFERENCES

[1] The DN30 overpack – a new solution for 30B cylinders; W. Bergmann, F. Hilbert, F. Noyon; PATRAM 2010

[2] Drop testing of the DN30 protective structural packaging for the transport of uranium-hexafluoride; W. Bergmann, T. Breuer; PATRAM 2013

[3] Advanced safety features of the DN30 package for the transport of UF_6; A. Favre, F. Hilbert; PATRAM 2016

[4] Thermal test of the DN30 package for the transport of UF_6; A. Favre, F. Hilbert; PATRAM 2016

[5] Prototype testing of a protective structural packaging for 30B cylinder; K. Müller, A. Favre, F. Hilbert, T. Quercetti, T. Neumeyer, B. Weingart; PATRAM 2016

[6] ISO 7195, Nuclear Energy – Packaging of uranium hexafluoride (UF_6) for transport

[7] ANSI N14.1 Uranium Hexafluoride – Packaging for Transport