MARITIME BACK END TRANSPORT
FIRST SHIPMENT OF OPAL USED FUEL FROM AUSTRALIA TO FRANCE
OVERVIEW OF A SUCCESSFUL OPERATION

P. Jacot
Orano TN
1 rue de Hérons, 78180, Montigny le Bretonneux, France

M. Healy, J. Lackenby, T. Donlevy
Australian Nuclear Science and Technology Organisation (ANSTO)
Locked Bag 2001, Kirrawee DC, NSW 2234, Australia

ABSTRACT

The transport of nuclear material from one side of the world to the opposite presents challenges and requires a high level of professionalism and expertise from the consignor and the consignee. This paper provides an overview of the various challenges that were overcome for the preparation and execution of a used fuel transport from ANSTO (Australia) to the Orano La Hague Reprocessing Plant (France) in 2018. Important lessons learned are presented for the benefit of organizations involved in similar undertakings. Project areas discussed in this paper include:

- International agreements and regulatory approvals
- Loading of transportation casks
- Road transportation in Australia
- Selection of a maritime shipping company
- Operations and controls at the Australian port
- Continuous communication throughout the maritime transportation
- Operations and controls at the French port
- Road transportation in France

Background

ANSTO is the location of Australia's nuclear science expertise and the 20 MW OPAL research reactor. Commissioned in 2006, OPAL produces medical and industrial radioisotopes, doping silicon for the manufacture of semiconductor devices, and neutron beams for scientific research. .

Orano is a world leader in the fields of radioactive material packaging, transportation, and used fuel reprocessing. In 2016 ANSTO entered into a contract with Orano for the provision of transportation and reprocessing services for OPAL used fuel. The contract between ANSTO and Orano is expected to be periodically renewed such that ANSTO and Orano will work together to manage used fuel throughout the life of OPAL. The 2018 shipment from ANSTO to France was the first ever shipment of used fuel from OPAL – a significant milestone.

Following reprocessing at La Hague, residual Intermediate Level Waste (ILW) will eventually be returned to Australia. The vitrified ILW waste form is compact, highly stable and suitable for ultimate disposal. For every 10 years of OPAL's operation, only 2.5 m3 of ILW will be generated.

Fuel Assemblies Shipped

OPAL fuel assemblies contain low enriched uranium silicide (U3Si2) dispersed in aluminum. Some of the transported fuel was manufactured by INVAP (Argentina), but most was manufactured by Orano. In 2018 a total of 236 used fuel assemblies were transported to France.

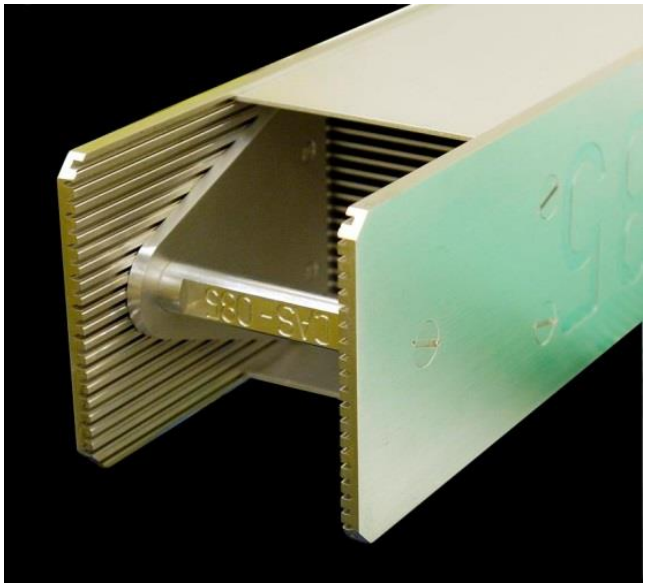

Figure 1 OPAL fuel assembly

Transport Casks

Four Orano TN-MTR casks were used for the transportation of the 236 used fuel assemblies. The TN-MTR cask has been used internationally since 1999 for the transport of used research reactor fuel assemblies. The casks are transported in 20' shipping containers. A fifth 20' shipping container, containing tools and accessories, was transported with the casks.

Three of the four TN-MTR casks used were owned by Orano. The fourth was procured by ANSTO from Orano. It was manufactured in France in 2016 and 2017. Orano also supplied all cask operating tools and a specially designed lifting beam. Factory acceptance testing was completed in September 2017 with ANSTO personnel in attendance. The empty Orano and ANSTO casks were shipped from France by sea and arrived at ANSTO in early 2018.

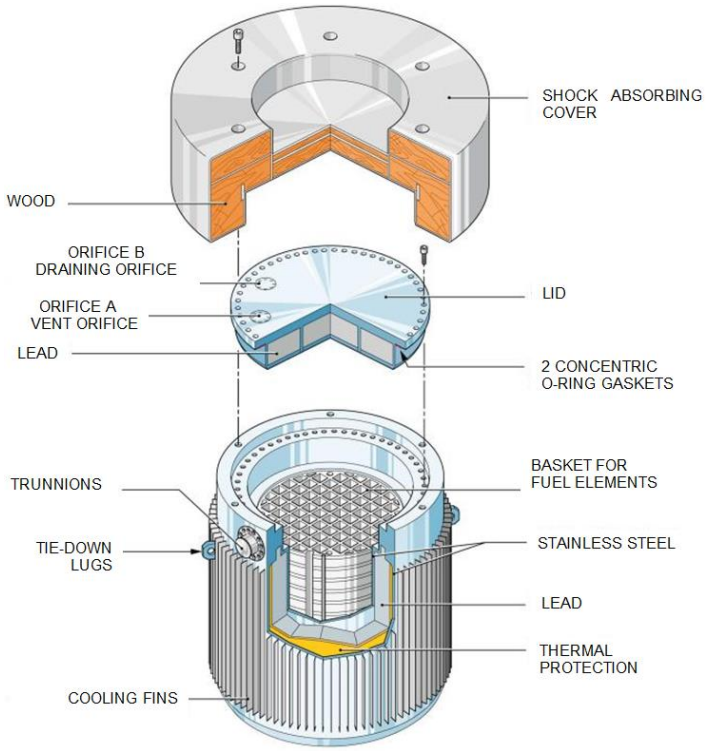

Figure 2 TN-MTR used fuel transportation cask

International Agreements

According to French law, the introduction of used fuel into French territory for reprocessing must be framed by an agreement between the French and Australian governments. This Inter-governmental Agreement (IGA) entered into force prior to the transportation and was consistent with the nuclear cooperation agreement between the two countries.

The IGA outlines the responsibilities and obligations of both countries, including the schedule for the receipt and reprocessing of OPAL used fuel in France, and the return shipment of the residual ILW to Australia. The IGA also references an agreement between ANSTO and Orano for the transfer of title of the fissile material extracted during reprocessing. This recovered material may be used to generate electricity in nuclear power plants.

Regulatory Approvals

An extensive series of regulatory approvals had to be obtained prior to transportation. ANSTO and Orano exchanged a significant amount of data and worked closely in the 2 years leading up to the transportation to ensure that all necessary Australian and French approvals were obtained in accordance with the project schedule.

The following approvals were granted to ANSTO:

- Competent authority (ARPANSA) validation of the TN-MTR cask design, and certification for the ANSTO-owned TN-MTR cask
- Approval for cask loading operations
- Approval to transport under Australian environment protection laws

- Safety, security and safeguard approvals for transportation
- Requisite international approvals to transport
- Australian government export permit

The following approvals were granted to Orano:

- French Nuclear Safety Authority (ASN) approval to transport OPAL fuel in TN-MTR casks (extension to existing Safety Analysis Report)
- ASN authorization for road and maritime transport
- ASN approval to reprocess U3Si2 fuel
- ASN approval to reprocess OPAL fuel assemblies

Cask LoadingOperations at ANSTO

The campaign to load 236 used fuel assemblies into four TN-MTR transportation casks was completed by mid-July 2018. Recognizing that the loading of TN-MTR casks is complex and time consuming, care was taken to ensure that the campaign was well resourced. Two "used fuel operations teams" were formed for the campaign. Each team was led by an OPAL Shift Manager, having the knowledge and authority to make important decisions and resolve unforeseen operational issues. Each team included four operators, having a mixture of practical skills to cover all loading operations, and a radiological protection expert. The teams were supported by an Orano specialist.

In the twelve months leading up to the commencement of the campaign the two teams attended multiple training sessions covering cask movements in and out of the reactor hall, cask components, the loading process (including cask interfacing with OPAL systems such as compressed air, active ventilation, active liquid waste, etc.), and campaign specific radiation protection requirements. Some team members travelled to the CEA Saclay Osiris reactor (near Paris) and to the HFR reactor in the Netherlands to witness cask loading operations.

Training concluded with mock operations in the OPAL reactor hall using a TN-MTR cask. The mock operations included the submersion of the cask in the reactor service pool (where used fuel assemblies are stored), and the use of dummy fuel assemblies so that operators could practice the underwater transfer of fuel assemblies from the fuel storage rack into the cask. The mock operations were facilitated by an Orano specialist. The early training of the teams proved valuable because it allowed team members to be involved in the refinement of the cask loading instructions, and the design of new equipment and tooling required for the work.

Fatigue management was an important consideration for the two teams. To ensure that the teams were well rested during the campaign the operations were conducted using six-day weeks, with each team working three consecutive day shifts, and then having a four day rest.

The loading of each cask involved the following key steps:

- Transfer of cask in shipping container into the OPAL reactor building ??
- Lifting of cask from shipping container into the reactor hall
- Placement of cask adjacent to the service pool and preparation for submersion
- Submersion of cask and placement on support platform at the bottom of the pool
- Underwater transfer of used fuel assemblies from fuel storage rack into cask
- Lowering of shielded lid onto cask (underwater)

- Lifting of cask from the pool and poolside preparation for transportation (draining, drying, decontamination and leak testing)
- Transfer of cask out of reactor hall and back into shipping container for transport to France

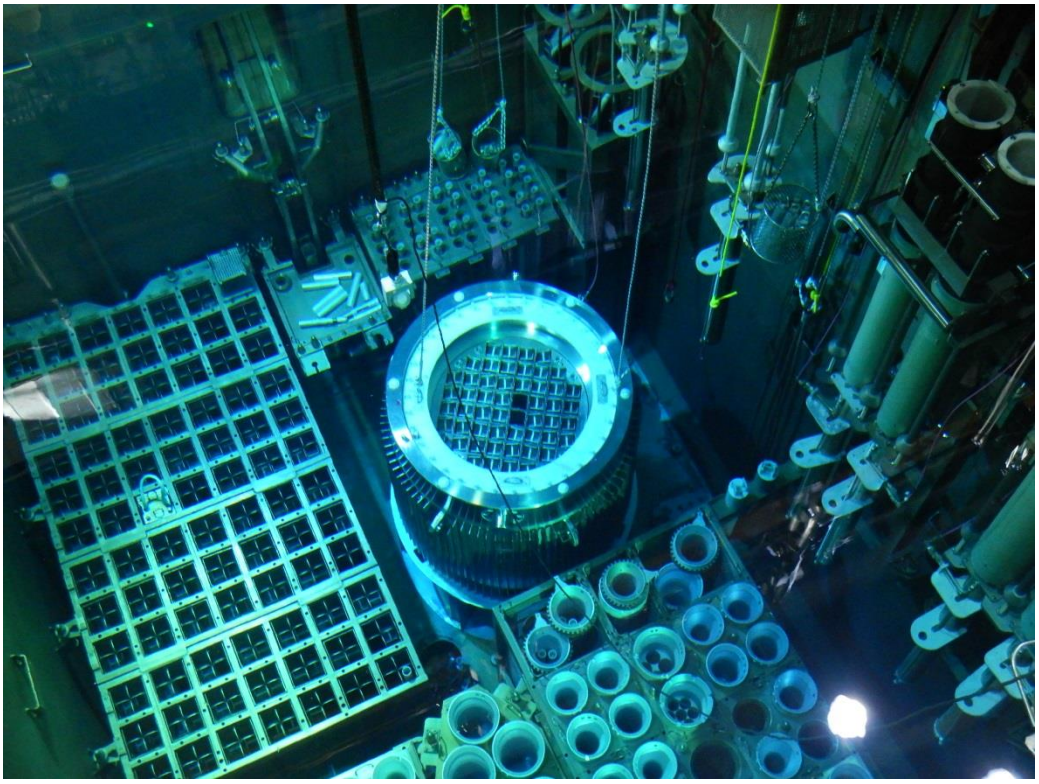

Figure 3 Loaded cask in the service pool with fuel storage rack on the left

During the loading campaign it was important to minimize disruption in the production of nuclear medicine, specifically Molybdenum 99, doping silicon and neutrons for scientific research. The movement of the casks in and out of the reactor hall required that the reactor be in the shutdown mode. To minimize loss of production, cask movements in and out of the reactor hall were therefore carefully scheduled to align with periodic shutdowns for maintenance and refueling.

All loading operations were carried out with the reactor powered up and production maintained, between the periodic shutdowns. A significant amount of assessment work was completed to demonstrate that simultaneous cask loading and production operations would not create any unacceptable hazards.

In addition to safety assessment work, clear and frequent communications with production stakeholders was vital for the minimization of disruption to production. Stakeholders were notified of the campaign two years prior to its commencement. During the campaign, stakeholders were provided frequent operational updates which included forecasts for “busy” days when production operations would have to be curtailed, and “quiet” days when productions operations could proceed as normal.

Road Transportation in Australia

ANSTO worked closely with an experienced transport company and multiple private, State and Australian government agencies to plan the road transportation from ANSTO to the awaiting ship at the port of departure. Planning commenced approximately 12 months prior to the transportation and involved regular “all-agency” planning meetings, communication with local councils and coordination

with staff at the port for the assistance of port staff and the use of port facilities, including the port crane. Planning focused on four areas: safety, security, traffic management, and communication.

In Australia, the transport of used nuclear fuel on public roads is rare. Coordinating the large number of agencies for the planning and execution of the transportation was challenging. ANSTO was fortunate to have the full support of the agencies, the resources of which ensured that the transport was completed safely and securely.

The transport date was chosen to avoid major events (e.g. concerts and sporting events), and it was completed at night, primarily to minimize disruption to road users. Prior to the commencement of the transport, thorough radiological inspections were completed to clear casks and vehicles of contamination. Orano specialists assisted with this work. The cargo was lifted onto trailers and secured, Class 7 placards were applied to the cargo and vehicles, and final vehicle safety checks were completed.

Safety briefings were conducted prior to the convoy leaving ANSTO. The departure of the road convoy was timed to align with vessel berthing and preparation activities at the port. This allowed loading operations to commence as soon as the convoy arrived at the port.

A key consideration for the transport was fatigue management as staff was working for long hours during the night. Careful planning and resourcing ensured that fatigue was not problematic.

Figure 4 The convoy departing ANSTO

Selection of Maritime Shipping Company

Orano TN is an authorized transport company and had previously carried out a shipment of ILW from the France to ANSTO in 2015. This ILW resulted from the reprocessing of used fuel from ANSTO's HIFAR reactor, which was in operation until 2007.

The activity classification for the used fuel required an INF 2 vessel. Several requirements were imposed for the selection of the vessel:

- Classification of the vessel by a well-known classification company
- No significant Port State Control deficiencies within the last three years
- No restriction of use of the vessel of any kind in any place in the world
- Flag of the chosen vessel had to meet low risk criteria under the Paris Memorandum of Understanding on Port State Control

These criteria, plus other specific criteria related to Orano TN, were documented in a specific technical condition specification, which was transmitted to potential shipping companies. The specification was used for an international call for bids. Following the bid response evaluation, the shipping contract was awarded and INF 2 certification for the chosen vessel awarded prior to the transport.

Following the selection of the vessel, Orano TN completed a thorough review of all relevant shipping documentation ahead of the arrival of the vessel in Australia. Several calculation notes required by Orano TN were submitted by the shipping company and accepted by Orano TN.

Operations and Controls at the Australian Port

Prior to the transportation date, ANSTO had interfaced with the port operator to obtain all necessary specifications and inspection and testing documentation for the port lifting equipment. It was important to confirm that the port crane and lifting accessories met all requirements for the lifting of nuclear material.

On the night of the transportation, and in the hours prior to the arrival of the convoy at the port, the ship was called in, berthed, prepared and ANSTO staff boarded to complete baseline radiological inspections in the hold. The port crane was maneuvered into position and stevedores were briefed. The convoy arrived and vessel loading commenced immediately and was completed without incident.

Post loading, additional radiological checks were completed in the hold and transportation documentation was exchanged with the vessel's captain. The vessel departed shortly after. It is important to note that a large volume of complex documentation must be completed for such a transport. ANSTO worked closely with Orano specialists to ensure that all documentation was complete and correct.

Figure 5 Vessel loading at Australian port

Continuous Communication during Maritime Transportation

The communication was of two kinds:

- The communication with the ship
- The communication between Orano TN and ANSTO

In the technical condition specification issued by Orano TN, specific communications requests were made to potential bidding companies. Orano TN requested a continuous communication system between the ship and Orano TN, which included vessel position.

The position was then relayed to the French Authorities (in accordance with arrangements made during the shipment preparation phase), and was also communicated to ANSTO.

This continuous communication between the vessel, Orano TN, French Authorities and ANSTO enabled both ANSTO and Orano TN to meet all project schedule requirements. The end result was vessel arrival at both the Australian and French ports in accordance with the project schedule.

Operations and Controls at the French Port, and Road Transportation in France

Compared to operations in Australia, a call at the French Port of Cherbourg is a routine operation. After berthing at the Orano-owned wharf, the five 20' containers were unloaded from the vessel using a mobile crane equipped with a container spreader. The five containers were loaded onto trucks, radiological inspections were completed and the trucks formed into a convoy which departed for La Hague shortly after loading was completed. All security and route arrangements, which had been proposed by Orano TN well ahead of the shipment date and approved by the Physical Protection French Authorities, were in place for the convoy.

ASN was present for all operations at the French port and completed several inspections. All ASN questions were satisfactorily addressed by the Orano TN team.

Figure 6 Vessel and loaded truck at French port


Figure 7 ANSTO and Orano team members at the French port

External Communications

Prior to the transportation, ANSTO's international liaison team contacted, via Australian Embassies, a number of key countries along the maritime transport route. This provision of notice for the transport was in accordance with the IAEA guidelines on government-to-government communications during the sea transport of irradiated nuclear fuel and high level radioactive waste.

ANSTO and Orano communications teams worked together on project media releases to provide transparency without compromising security arrangements (a balancing act). Both teams have been working for many years to communicate the benefits of nuclear science and technology, and to dispel myths surrounding the management and transportation of radioactive waste. Such work has contributed to greater public acceptance. In general, media stories covering the project were positive and there was no significant protest action.

Conclusion

The first shipment of OPAL used fuel to France presented many challenges. Key to meeting these challenges, and the overall success of the project, was the close and harmonious working relationship between ANSTO and Orano. At all times ANSTO and Orano maintained frequent and clear communications, and exchanged large amounts of data so that all issues on both sides of the globe could be resolved in a timely fashion. Also key to success was the early commencement of detailed planning for all operations. Together, ANSTO and Orano were able to meet all project deadlines and comply with all contractual requirements.

ANSTO and Orano have established a responsible plan for the long term management of OPAL used fuel. The first shipment of OPAL used fuel was a success and has paved the way for all future shipments.