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Decommissioning and Dismantling of the Floating Maintenance Base 'Lepse' – 13316

D Field and K Mizen, Nuvia Limited

ABSTRACT

The Lepse was built in Russia in 1934 and commissioned as a dry cargo ship. In 1961 she was re-equipped for use as a nuclear service ship (NSS), specifically a floating maintenance base (FMB), to support the operation of the civilian nuclear fleet (ice-breakers) of the USSR. In 1988 Lepse was taken out of service and in 1990 she was re-classified as a 'berth connected ship', located at a berth near the port of Murmansk under the ownership of Federal State Unitary Enterprise (FSUE) Atomflot.

Lepse has special storage facilities for spent nuclear fuel assemblies (SFA) that have been used to store several hundred SFAs for nearly 40 years. High and intermediate-level liquid radioactive waste (LRW) is also present in the spent nuclear fuel assembly storage channels, in special tanks and also in the SFA cooling circuit.

Many of the SFAs stored in Lepse are classified as damaged and cannot be removed using standard procedures. The removal of the SFA and LRW from the Lepse storage facilities is a hazardous task and requires specially designed tools, equipment and an infrastructure in which these can be deployed safely.

Lepse is a significant environmental hazard in the North West of Russia. Storing spent nuclear fuel and high–level liquid radioactive waste on board Lepse in the current conditions is not acceptable with respect to Russian Federation health, safety and environmental standards and with international best practice.

The approved concept design for the removal of the SFA and LRW and dismantling of Lepse requires that the ship be transported to Nerpa shipyard where specialist infrastructure will be constructed and equipment installed.

One of the main complexities of the Project lies within the number of interested stakeholders involved in the Project. The Lepse project has been high focus on the international stage for many years with previous international efforts failing to make significant progress towards the objective of decommissioning Lepse. The Northern Dimension Environmental Partnership (NDEP) approved an internationally funded project to identify and prioritise nuclear and environmental hazards in NW Russia. Within this project the Lepse was recognised as being one of the highest nuclear hazards in NW Russia.

Removal of SNF, SRW & LRW from Lepse requires innovative design and development of bespoke equipment. The main drivers of the NDEP Donors are first to safely transport Lepse in 2012 from her current berth close to the local population in Murmansk to the nominated dismantling shipyard, and secondly to raise Lepse from the water in 2013 onto the slipway at the dismantling shipyard.

A description is provided of the approach and progress towards preparing the Lepse for the removal of SFAs and other radioactive waste, to decontaminate and then dismantle the vessel under international donor funding.

INTRODUCTION

Russia has operated a fleet of civilian nuclear powered icebreaker ships in the seas to the north of the country since NS Lenin was put into service in 1959. Conventionally powered floating maintenance bases (FMB) are used to support these nuclear icebreakers and permit them to operate for long periods without returning to port. FMBs have provision for storage of new fuel assemblies, spent nuclear fuel assemblies (SFAs) and liquid radioactive waste (LRW). Thus nuclear fuel or LRW that needs to be unloaded from the icebreakers can be transferred directly into storage tanks in the FMB while both vessels are at sea. The fleet of nuclear icebreakers and their associated support ships are operated by the Federal State Unitary Enterprise (FSUE) 'Atomflot' based at Murmansk.

FMB Lepse was built in Russia in 1934 and commissioned as a dry cargo ship. In 1961 she was re-equipped for use as a floating maintenance base and operated in this capacity for over 30 years. In 1994 an incident occurred in rough seas that resulted in release of stored LRW, causing contamination of parts of the vessel. After the incident FMB Lepse was taken out of service and berthed at the Atomflot shipyard. Because of high radiation levels within the ship her crew is not permanently on board the vessel. The ship's safety is monitored from a dedicated facility located nearby. Periodic surveys are performed of the ship and continuous monitoring of radiation is performed using the ship's sensors, whose signal is transmitted to the monitoring facility.

Over 600 SFAs are stored in the storage facilities on board, many of which are damaged and stuck within their storage tubes. For this reason normal techniques and equipment are not suitable for retrieval of all SFAs, and the high gamma radiation levels within the SNF storage tank room will require remote operations to be used for unloading the SNF.

LRW that could safely be recovered from the LRW storage tanks has already been removed. About 50 m^3 of high and intermediate level LRW remains in the tanks. Some of this liquid is required to provide shielding for the stored SFAs but all will need to be removed or immobilized before the vessel structure can be prepared for disposal or long term storage.

Storage of nuclear and radioactive wastes in these conditions is not acceptable with respect to Russian Federation health, safety and environmental standards or with international best practice. FMB Lepse has been identified as one of the highest environmental hazards existing in North West Russia. Some years ago it was therefore agreed that FMB Lepse would be decommissioned and dismantled within a project supported by international funding.

DESCRIPTION

International Support

In the early 1990s funds were made available by various countries and international agencies to help reduce environmental and military threats that existed after the break-up of the USSR. The European Bank for Reconstruction and Development (EBRD) was set up at this time to administer some of these international funds.

The European Commission (EC) formed such a funded programme with the title 'Technical Aid to the Commonwealth of Independent States' (TACIS). Between 1995 and 2005, under various international projects, Russian and Western companies developed possible technical solutions for

removal of the SNF and radioactive waste (RW) from Lepse. In addition to technical studies, international collaborative projects were undertaken with the Russian regulatory bodies to develop suitable safety standards for this non-standard decommissioning project.

Despite this technical input over ten years, before being able to start the industrial phase of the project, additional steps were identified to meet the requirements of the different project stakeholders:

- consolidate all available technical data
- breakdown the project into suitable stages
- develop a concept design as a set of design organisational documentation (SDOD)
- gain acceptance of the SDOD by the Russian Authorities.

To achieve this end, the EC initiated a project within the TACIS Programme entitled "Conceptual design, development and approval of documentation on SNF/RW removal from the FTB "Lepse" and its further decommissioning". The project included a feasibility study and selection of the best options for the SNF/RW removal and decommissioning of Lepse. It then required development of the SDOD and a project cost estimate to facilitate authorisation of the concept design by the Russian authorities. The contract to implement the project was awarded in 2005 to a Russian design company supported by specialist Russian subcontractors. The project was completed in the autumn of 2007.

A specially created team of international experts known as the Lepse Expert Panel (LEP) undertook an independent assessment of the deliverables for this TACIS project. The LEP confirmed in principle that the results of the project could be used as an input to the implementation phase of Lepse decommissioning project. A main recommendation by the LEP was to appoint an international consultant to work closely with the Principle Designer that would develop the concept design into a technical design. They believed that this approach would reduce the risk of developing a technical design that needed to be changed retrospectively after independent review.

In 2008 EBRD issued a Grant Implementing Agreement (GIA005) [1] funded by the Northern Dimension Environmental Partnership (NDEP) Support Fund. The project had the objective to develop a detailed design for decommissioning of the FMB Lepse and to procure the equipment and infrastructure improvements needed for decommissioning the Lepse.

An independent review of the cost estimate for the decommissioning project, based on the SDOD, was undertaken in 2009 that could be used as the basis for initial estimates for the project procurement packages.

Early in the process of considering options for reducing the environmental threat posed by the Lepse, the RF had set up a "Lepse Co-ordination Committee" to co-ordinate the actions needed. This committee was chaired by FSUE Atomflot and included most of the Russian stakeholders. It advised RosAtom on the work being undertaken both using RF and international funding.

Project Stakeholders and Organisation

This project is complex both technically and organizationally. There are a lot of stakeholders, and as with any project, success relies on understanding the roles of each of the stakeholders and managing their different objectives to achieve the optimum outcome for the project. The main stakeholders for the Lepse decommissioning project are:

- The Russian Federation (RF), represented by RosAtom - the Government department responsible for civil nuclear decommissioning in Russia
- The international donors, represented by the NDEP Assembly of Donors – providers of the funds allocated to the project
- The EBRD - administrator of the NDEP funds in accordance with EBRD financial and environmental policies
- Independent regulators responsible to monitor the safety of different aspects of the project
- The Federal Centre for Nuclear Radiation Safety (FCNRS) – the beneficiary of the funds, appointed by RosAtom as the organization responsible for managing the project to decommission the Lepse
- FSUE Atomflot – owner of FMB Lepse and responsible for safety of the stored SNF until it is accepted by the reprocessing organization (P.O. Mayak)
- Ship Repair Yard (SRY) Nerpa – the facility identified within the SDOD where the decommissioning work will be done
- Nuvia Limited – the International Consultant (IC) contracted under the project to assists FCNRS with managing the project both technically and commercially
- Aspect-Conversion – the Principal Designer (PD) contracted under the project to develop the SDOD into a technical design
- Supply organisations - contracted under the project to supply goods and services
- The population that could be significantly affected if the Lepse was not safely decommissioned - this population cannot be clearly defined but includes the inhabitants of the Murmansk area and neighbouring countries such as Norway, Finland and Sweden

FCNRS as the beneficiary of the GIA holds the responsibility for interfacing with EBRD and RosAtom, for managing the project and for placing contracts to achieve the objectives of the GIA. The invoices submitted to FCNRS by Contractors for the Lepse project are paid by EBRD directly to the contractors after the invoices have been approved by FCNRS. This method of dispersing funds by EBRD is part of their policy to ensure accountability and transparency in the use of international donors' funds.

The recommendation by the LEP that international experts should work within the project, rather than just act as retrospective reviewers, was addressed by forming an integrated project management unit (IPMU) comprising FCNRS and an IC. The first contract competition that FCNRS managed under GIA005 was for an IC to become part of the IPMU. The role of the IC is to work closely with FCNRS and to support them both technically and commercially. The IC holds no executive powers within the IMPU, but reviews all contract deliverables and must

confirm that these meet the requirements of the contract before contractor invoices are paid by EBRD.

The winner of the competition to act as IC for this project was Nuvia Ltd, which is based in the UK and part of the French Nuvia Group of nuclear engineering specialists. After being appointed, Nuvia set up a dedicated Moscow office within easy access of the FCNRS offices. The structure of the IMPU is shown in Figure 1 and was designed to facilitate communications between FCNRS and Nuvia team members at all levels within the IMPU.

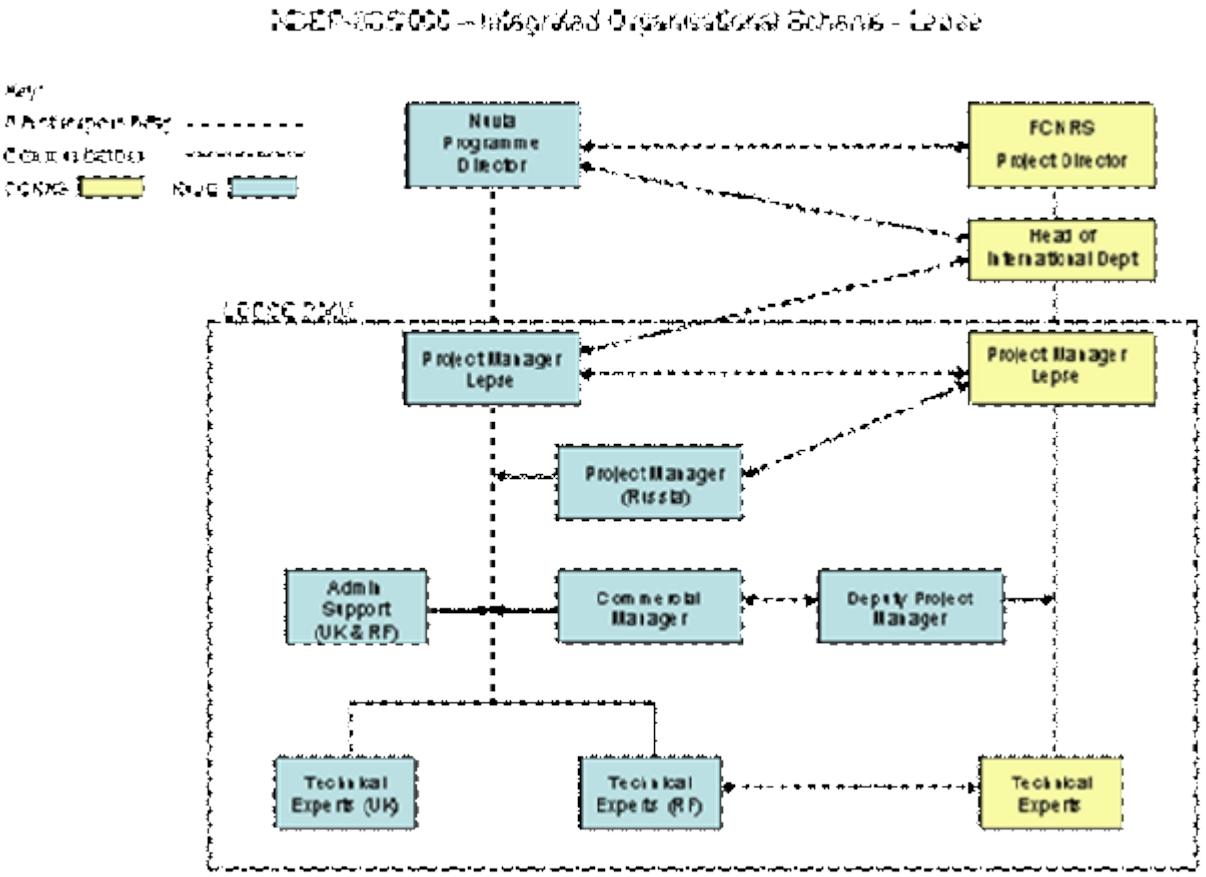

Figure 1: Structure of the IPMU

Day to day project management communication is mainly undertaken between the Russian speaking Nuvia staff based in Moscow and the FCNRS project management staff. The UK based project management staff correspond regularly by e-mail with the FCNRS staff and meet on average monthly either in Moscow or in the Murmansk area where the Lepse is located.

Day to day communication between the main Russian speaking technical experts is facilitated by using an existing Nuvia office in St. Petersburg where both FCNRS and Nuvia technical experts are based. Nuvia Technical experts based in the UK attend project meetings with FCNRS experts both in the Nuvia Moscow office and in the offices of project contractors.

As well as administering the NDEP funds, EBRD provides from their procurement department commercial guidance to the IMPU and technical guidance from their nuclear projects department.

The IPMU must supply to EBRD for their non-objection documentation covering strategic decisions, procurement and critical technical issues.

The RF "Lepse Co-ordination Committee" reviews and approves important issues that arise within the project and usually invites IMPU representatives to their meetings.

Scope of the GIA

The GIA005 issued in 2008 did not cover the complete project of defueling and dismantling the Lepse, since some of the practical work associated with this was be undertaken using RF funds. The original scope of the GIA was extended in 2011 to include some preliminary dismantling and the works of lifting Lepse out of the water and placing her onto the slipway at the Nerpa dismantling shipyard, this amended Grant became 'GIA005A'. The scope of the GIA at December 2012 includes the following activities:

- Develop a procurement strategy and plan that maximises international competition to supply the services, infrastructure improvements and equipment required
- Develop the SDOD into a technical design, approved by Russian regulators taking into account the infrastructure available for decommissioning nuclear service ships in NW Russia
- Prepare FMB Lepse for transport and transport her from the berth at the FSUE Atomflot shipyard to SRY Nerpa and place her on a slipway
- Modify and provide the infrastructure required at SRY Nerpa to undertake the SNF removal, dismantling and waste packaging.
- Procure the equipment required to undertake the defueling, dismantling and waste packaging
- Separate the Lepse hull into sections on the slipway and install the section containing the SNF storage tanks into a containment shelter

The procurement plan developed by the IPMU to achieve these activities is shown in Figure 2

DISCUSSION

Project Challenges

It will be no surprise, having considered the history of various FMB Lepse decommissioning projects, that the work being undertaken within GIA005 also presents significant challenges both technically and organizationally.

Some of the current technical challenges were identified in the SDOD and some have been recognised while developing the technical design. These challenges include:

- Limited information on the condition of the SNF stored on board the Lepse. There are records of what type of SFAs are stored in each location, but it is not know precisely which SFAs are stuck in their storage tube and cannot be recovered by standard processes. Nine of the SFAs that were too swollen to fit into standard storage tubes are stored in an over-sized caisson. The degree of damage to these SFAs is not known, nor whether they can be recovered from their storage caisson without further damage to the SFA.

- Very high gamma dose rates existing in some areas of the ship that will prevent not only manual SNF recovery but also manual dismantling operations
- LRW existing in the SFA cooling circuit that includes isolating valves that cannot be relied on to isolate the LRW before removal of equipment
- Insufficiently developed waste acceptance criteria for the storage of high and intermediate level waste
- Construction of a nuclear rated containment within the constraints of existing shipyard infrastructure

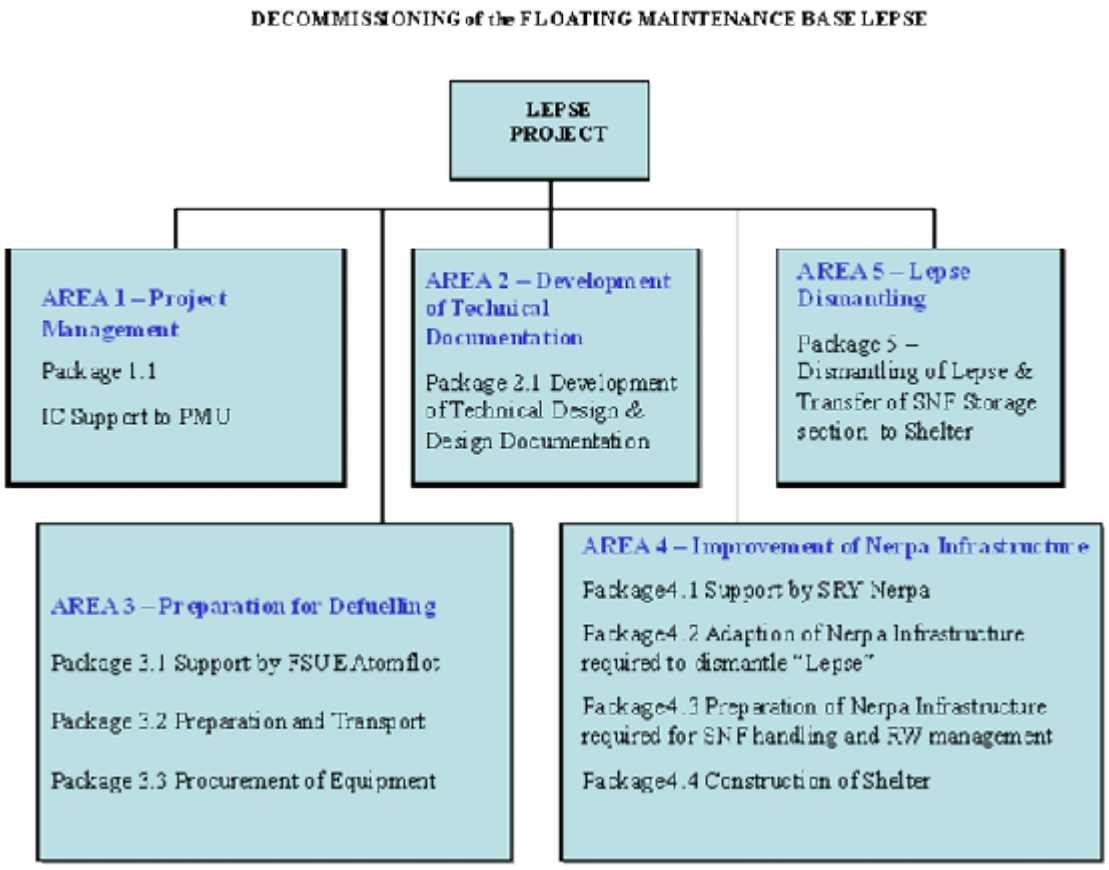

Figure 2: Structure of Procurement Packages for GIA005

The commercial and organizational challenges to successful completion of the project can be as difficult as the technical issues. The non-technical challenges include:

- Limited availability of suppliers that are qualified and experienced sufficiently to undertake the specialized work required. This is compounded by the need for suppliers to obtain Russian security and operational licenses for nuclear contracts
- Obtaining value for money in procurements where only one organization is able to deliver the services required, so competitive pricing does not apply

- The need for non-Russian speakers to review technical documents produced in Russian. There is a requirement for contractors to supply key deliverables in both the Russian and English languages but it would not be cost-effective to manually translate all documents and drawings. Although automatic translation software is used by the IPMU to assist with this challenge, the quality of the translation for such technical documents can be very poor.
- SRY Nerpa holds the necessary licenses and experience for dismantling the Lepse, whilst FSUE Atomflot has the licenses, experience and responsibility to safely store and manage the SNF. This results in a split of responsibility within the same package of work. A form of contract must be developed that respects the responsibilities of both parties and provides a safe and cost-effective outcome.
- Managing the expectations of a large number of project stakeholders with very different perspectives and priorities presents a significant project management challenge to the IPMU.

Progress to 2012

By the end of 2012 five of the ten planned contracts under GIA005 were underway with the tender documentation for a sixth contract issued.

- After an international competition, Nuvia was appointed as the IC in April 2010 (procurement 1.1) and has been integrated into the IPMU team for almost three years.
- A pre-qualification stage was held for a Principal Designer consultancy contract (procurement 2.1), and following a pre-tender meeting three compliant proposals were received and evaluated by the IPMU. Aspect-Conversion was appointed as the PD in June 2011. The contract started with an options study to establish the optimum solutions for developing the decommissioning design. The technical design documentation has now been completed for the SNF retrieval equipment and handling processes, and for the RW handling equipment processes.
- Design is well underway for the Large Storage Packages (LSPs) that will store the larger higher activity items for which no processing infrastructure is yet available. Design is also underway for the containment shelter that will permit retrieval and packaging of the SNF recovered from the SNF storage tanks. An illustration in Figure 3 shows the SNF storage tanks with the LRW activity reduction equipment in place.
- The contract was signed in October 2011 for FSUE Atomflot to provide support services as the owner of FMB Lepse (procurement 3.1). This contract has enabled the technical designs for defueling and dismantling to be reviewed by and agreed with FSUE Atomflot.
- In August 2011 a contract was signed with FSUE Atomflot as a directly selected contractor to establish the optimum method of transporting the Lepse to Nerpa shipyard, and to prepare the Lepse for transport (procurement 3.2).
- Four possible options for transporting the Lepse from the Atomflot shipyard to SRY Nerpa were considered by the IPMU. The options considered were towing the Lepse afloat, towing in a floating dock, towing using additional floatation devices and transport

on a heavy lift ship or barge. The option of towing the Lepse afloat was shown to be the optimum method, and a Safety Assessment was produced for this method of transport.

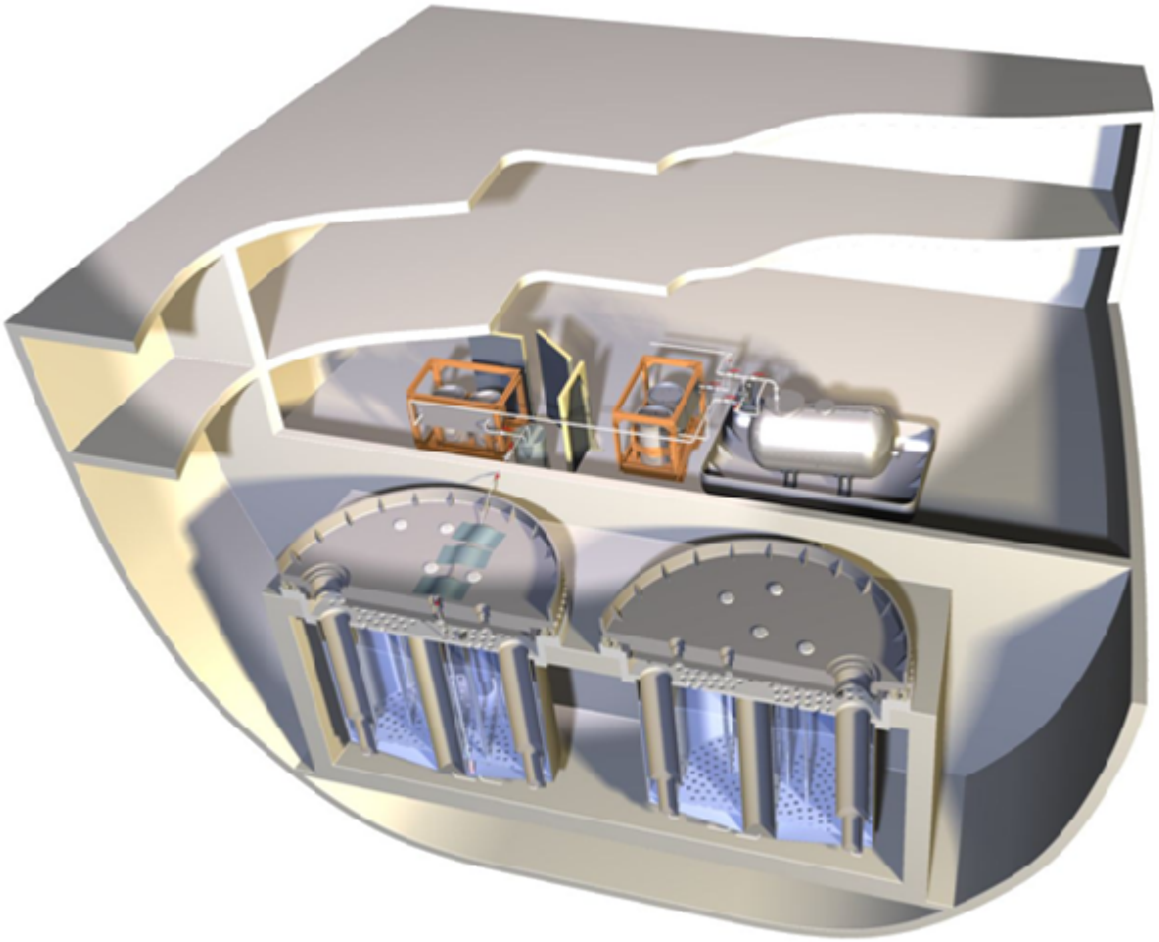

Figure 3: SFA Storage Tanks Showing SFAs removed ready for activity reduction of LRW

- By September 2012 FSUE Atomflot had completed the preparation of the Lepse for towing and on Friday 14th September 2012 FMB Lepse was towed safely from the Atomflot shipyard to SRY Nerpa. (Figure 4). The Lepse is now safely berthed at SRY Nerpa awaiting completion of the infrastructure required to place her onto the slipway and commencement of initial dismantling.
- The contract was signed in December 2011 for SRY Nerpa to provide support services as the operator of the Nerpa shipyard (procurement 4.1). This contract has enabled the technical designs for dismantling and modification of the infrastructure at the Nerpa shipyard to be reviewed by and agreed with SRY Nerpa
- The Tender documentation for work to adapt the Nerpa shipyard infrastructure required to dismantle FMB Lepse (procurement 4.2) has been non-objected by EBRD as a directly

selected contract with SRY Nerpa. The tender has been issued to SRY Nerpa and a costed proposal is schedule to be received in early January 2013.

Figure 4: FMB Lepse being towed out of the Atomflot shipyard

Programme to Completion

The schedule for completion of the work under GIA005 is fully detailed and baselined using MS Project software. This shows a completion date of March 2016 for the work that is currently funded. The critical path for the project includes the detailed design and procurement of special equipment required to retrieve the SFAs from their storage locations. The tender documentation for this work (procurement 3.3) has been reviewed in draft by the IPMU but is awaiting final outputs from the PD before it can be formally considered by EBRD.

In addition to the equipment required for SNF handling, contracts need to be placed for provision of the infrastructure required at SRY Nerpa to permit SNF and RW handling (procurement 4.3) and design and supply of the containment shelter (procurement 4.4) that will be used during SNF retrieval from storage.

The IMPU has provided a proposal to EBRD to increase the scope of GIA005 to include the operational work to recover and package the SNF for re-processing, to manage the RW and to

prepare the Large Storage Packages for long term storage before transport to the Saida Bay long term storage facility. This would be jointly funded using NDEP and RF funds. The draft schedule for completion of this extended scope of work is September 2017.

CONCLUSIONS

It has not been possible in this short paper to provide detailed technical descriptions of the challenges presented by decommissioning of the FMB Lepse with her hazardous cargo and the solutions proposed to overcome these obstacles. We hope however that the reader can appreciate a flavor of both the technical and organizational challenges of implementing a nuclear clean-up project funded by international donors. The project is not yet complete, but very good working relationships that have been established both within the IMPU and with the wide range of Russian and international stakeholders. Project progress to date is slower than had been hoped, but very good when compared with previous attempts to resolve this difficult environmental problem. The IMPU believes that the effort expended to date will be worthwhile if the FMB Lepse can be safely defueled, dismantled and packaged for long term storage under GIA005.

ACKNOWLEDGMENTS

This paper is published with the permission of RosAtom, EBRD, FCNRS and Nuvia Limited. The progress made to date in this project is due to the assistance of all IMPU team members and project stakeholders, which is gratefully acknowledged.

REFERENCES

1 GIA005 - EBRD “Decommissioning of the Floating Maintenance Base (FMB) “Lepse” Currently Moored in FSUE “Atomflot”, Murmansk, Russian Federation” June 2008