Robust Self-Shielded Containers for Use as Transport, Storage and Disposal Packages for ILW in the UK

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1. The Situation

The 2010 UK Radioactive Waste Inventory [1] lists approximately 290.000 m³ of intermediate level waste (ILW). The waste streams contributing to this amount comprise amongst others:

- Sludge Mixtures
- Ion Exchange Media
- Metallic Waste
- Liquid Effluents

Most of these waste streams are currently stored in tanks and vaults at different nuclear sites, many of them in their post-operational phase, where they have been collected during operation of the respective nuclear power station or site. According to the principles set out in the Joint Regulatory Guidance [2] ILW has to be brought into a passively safe condition.

So far the so-called “baseline programme” involved encapsulation of the waste in a cement or polymeric matrix, packaging into thin-walled stainless steel containers and storage in interim storage facilities (ISF) providing shielding and protection against external impacts. For implementation of the “baseline programme” an ISF and an encapsulation plant would have to be erected at each nuclear site. After privatization of the nuclear sector, research sites and shut down nuclear power stations have been consolidated under custody of the Nuclear Decommissioning Authority (NDA). Given that there are only limited budgetary funds assigned to the NDA a good share of these funds would have had to be spent for erection of new buildings for the next couple of years without being able to reduce the risk that the ILW waste streams constitute.

2. A New Strategy

Hazard reduction, however, was to be implemented as a matter of urgency at some of the older nuclear sites, namely some of the Magnox reactor sites. Therefore, following the acquisition of BNFL’s Reactor Sites Management Company by EnergySolutions ideas were developed to optimize the decommissioning process and waste handling. Instead of erecting new buildings for encapsulation and storage at an expenditure of several hundreds of millions pounds sterling before any waste could have been retrieved from the vaults a concept was developed that would more or less immediately lead to a significant hazard reduction. If the same or at least comparable level of passive safety could be established by using high integrity containers that provide shielding and mechanical robustness, the encapsulation facility would be obsolete and the storage facility would not have to be as massive as in the baseline concept. This means that there would not be such a high

upfront investment necessary, the expenditure profile could be smoothened, the overall expenditure reduced and that a much earlier hazard reduction could be obtained.

The question “Are there containers available on the market which offer enough mechanical robustness and shielding?” had to be answered in the first place.

3. MOSAIK® and GNS Yellow Box®

With approximately 7,000 units sold the MOSAIK®[1] cask is the most successful ILW transport and storage container worldwide. The MOSAIK® cask is available both as a Type B(U) and as an IP-2 variant. The cask can be equipped with additional internal lead shielding resulting in a usable volume between 130 liters and 490 liters. Different lid geometries allow connection of the casks to different kinds of waste processing facilities.

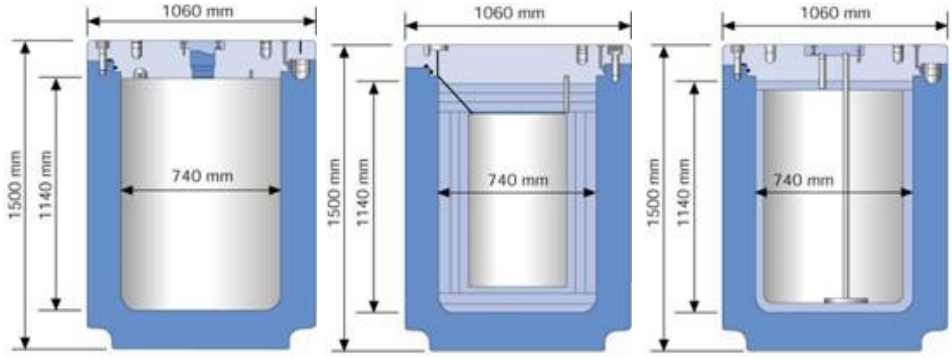

Figure 1: Different MOSAIK® variants

For waste streams that do not require as much shielding the GNS Yellow Box®[2] offers adequate mechanical robustness at significantly lower costs per volume. The container holds approximately 3m³.

Both containers are ductile cast iron containers. With their 15 cm or respectively 16 cm thick walls they are able to withstand severe conditions. Type testing and approval procedure have been subject of several presentations and papers before at PATRAM conferences as well as other international symposia. The second question then was: “Are these containers that have been utilized in Germany for more than two decades for various types of waste also suitable for all of the Magnox waste streams?”

[1] Registered Trademark in the European Union
[2] Registered Trademark in the UK

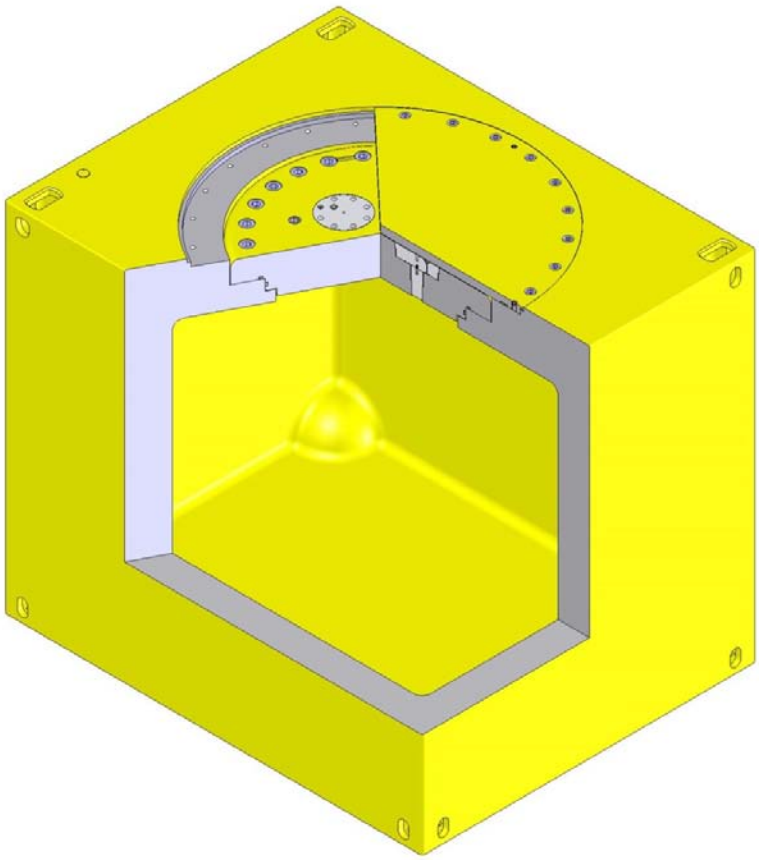

Figure 2: Cutaway of a GNS Yellow Box®, net volume approx. 3 m³

A closer look at the different waste streams revealed no severe issues concerning their chemical compatibility with the container material. For a number of waste streams drying of the waste prior to or – given that there are adequate drying facilities available – after loading into the containers was identified as being the only waste processing step needed. However, retrieval of the waste from the vaults still seems to be a challenge.

At the same time when Magnox South Ltd. investigated the use of MOSAIK® and GNS Yellow Box® containers British Energy (today EDF Energy) made a BPEO study exploring treatment of ILW ion exchange resins. The most advantageous options according to the study were Hot Supercompaction and Drainage of Resins in MOSAIK® casks. In 2010, after a tender procedure British Energy decided to award a contract to GNS comprising

- Changes to the Resin Transfer System to accommodate the GNS resin processing plant
- Processing of waste currently stored in the room designated to be used as a storage facility for filled MOSAIK® casks
- Preparation of Safety Case documents
- Preparation of Disposability Case (LoC) documents
- Delivery of MOSAIK® casks
- Processing (Filling of MOSAIK® casks and draining) of ILW resins

4. GDF Qualification

There are plans for a UK repository for ILW to be erected by the NDA's Radioactive Waste Management Directorate (RWMD). This repository is envisaged to be constructed in a deep geological formation and is therefore called Geological Disposal Facility (GDF).

Currently communities are invited to express their interest in participating in the site selection process. There is a set of preliminary criteria that waste packages should fulfill for acceptance to the GDF but changes to these conditions are still possible to accommodate different package designs. For packages that in the opinion of RWMD will be acceptable RWMD issues a so-called Letter of Compliance (LoC). The LoC procedure is divided into three stages

- Conceptual Stage
- Interim Stage and
- Final Stage.

For all Magnox waste streams a conceptual Stage Letter of Compliance (cLoC) was issued by RWMD. For the Sizewell-B ILW resins the procedure to obtain an interim stage Letter of Compliance (iLoC) was successfully completed in 2012. Only a few action points remain which were agreed to be adressed in the final stage. This was the first LoC submission to reach this stage using a novel packaging concept in more than 20 years in the UK. Currently GNS and its subcontractor EnergySolutions EU Ltd. are closing out the remaining action points to put RWMD in a position to issue the fLoC.

5. Special Issues

The qualification of packages for the GDF currently comprises some requirements that exceed the requirements set by the IAEA regulations even for Type B(U) packages. For instance there is a higher requisition for the Thermal Test. Packages shall be able to withstand a 1000 °C fire for one hour without suffering damages that would lead to a release of more than A_2 (IAEA: 800 °C, 30 min.). A further example is the so-called "Drop on aggressive feature" requirement which means that a container could drop onto another container from height. The drop height assumed in the GDF requirements is 7.5 m which is significantly more than for the otherwise comparable Drop 2 according to IAEA TS-R- 1.

6. Current Projects

A number of MOSAIK® and GNS Yellow Box® containers have been delivered to various Magnox sites. At Bradwell a first test drying of liquid simulant material has been completed successfully. Magnox Ltd intends to perform additional tests with solid material.

At EDF Energy's Sizewell site filling of MOSAIK® casks is scheduled to commence in autumn 2013. In total 55 MOSAIK® casks will be filled with resins and subsequently de-watered.

7. New Developments

The GNS Yellow Box® has got a round lid of the same size as a MOSAIK® lid. This limits the use of the larger cavity to items that fit through the small lid opening. Magnox therefore requested a container of the same structural integrity but with a larger usable clearance, ideally giving access to the whole container cavity. GNS therefore together with its partner Eisenwerk Bassum GmbH developed a container with a rectangular lid that has a usable clearance only insignificantly less wide and long than the cavity. This container is welded from 120 mm thick steel plates. A special design enhances stability of the joints, patent pending.

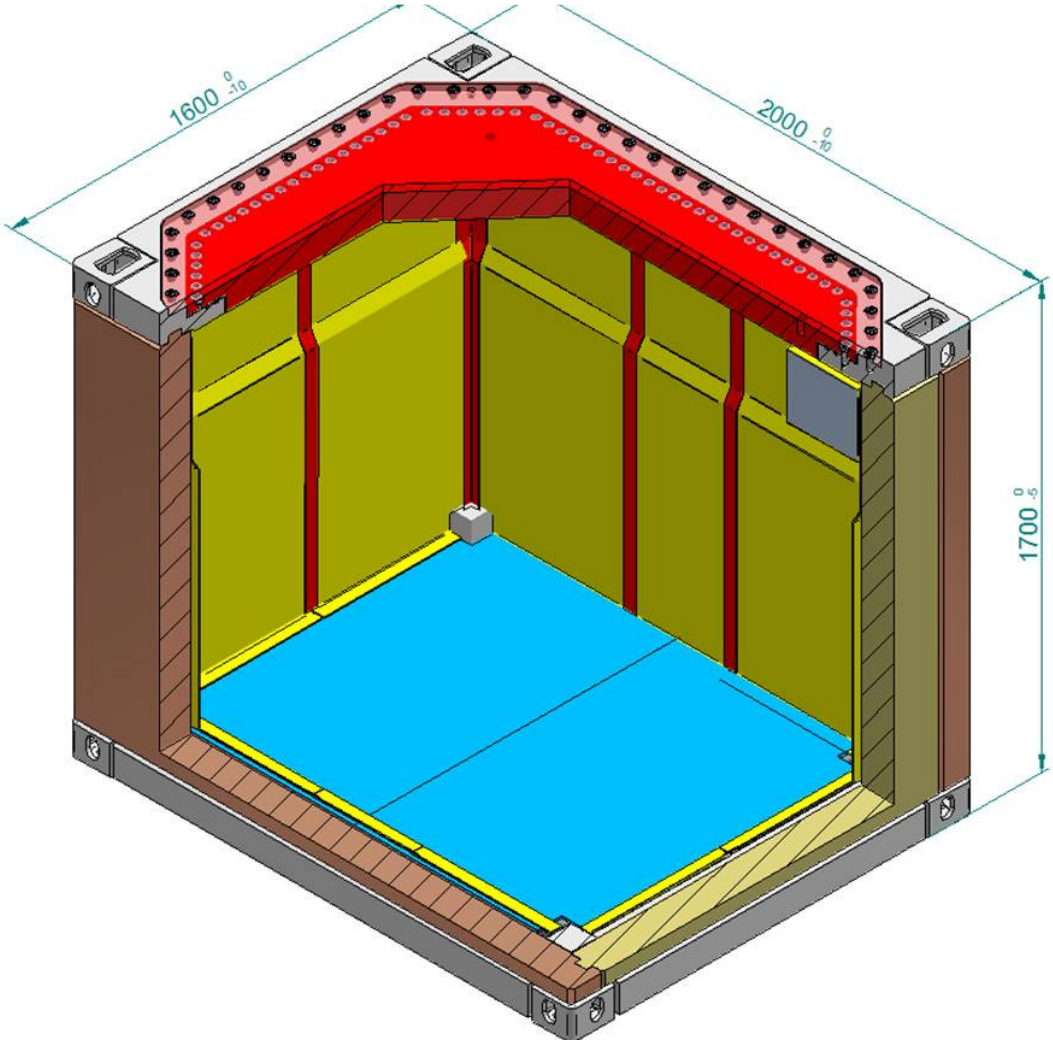

Figure 3: Sandwich-Container, rectangular lid

The container can be equipped with internal electrical heating and insulation elements to accelerate drying. It was proved in tests that compared to the GNS Yellow Box® drying times can be reduced significantly by the internal heating system. The container is called “Sandwich Container”.

A drop test from 9 m onto a target exceeding GDF requirements was performed. A second drop test container on container to account for the “aggressive feature” requirement is scheduled for autumn this year. There is also a variant with a round lid just as the GNS Yellow Box®.

8. Future Prospects

Based on more than 25 years of experience in Germany MOSAIK® and GNS Yellow Box® have made a groundbreaking move to Great Britain. Besides Magnox other site licence companies are planning to adopt the new strategy which results in a huge market for robust, self shielding containers.

MOSAIK® and GNS Yellow Box® are part of a system which also comprises waste processing facilities like drying plants, handling equipment or packaging devices. The system is also transferable to other countries.

[1] Pöyry Energy Limited, „The 2010 Radioactive Waste Inventory," NDA/ST/STY(11)0004, URN 19D/985, February 2011.

[2] Health and Safety Executive (HSE) / The Environment Agency (EA) , „Fundamentals of the Management of Radioactive Waste (Joint Regulatory Guidance)," December 2007.