

**Containers for Storage and Transport of Spent Fuel and Waste from the Operations,
Decommissioning and Dismantling of Nuclear Power Stations – 14163**

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ABSTRACT

Currently two major challenges in the nuclear power industries of Germany and the United Kingdom are being mastered with spent fuel casks of the type CASTOR® as well as with diverse containers for intermediate-level waste (ILW).

Following the decision to phase out nuclear power in Germany in 2011 (in the aftermath of Fukushima), there was an urgent need for large numbers of casks to accommodate the spent fuel. The casks are needed for the fuel from eight shut-down power stations as well as later on for nine others which will be successively shut down until 2022. In order to keep the overall costs of decommissioning and dismantling low, it is extremely important to defuel the pools at the nuclear power plant sites as quickly as possible. Per year, approx. 70-80 large casks (with a loaded weight greater than 120 metric tons) are being manufactured for loading in the coming years.

In the United Kingdom, the first generation of MAGNOX reactors is being dismantled since the 1990's. A large amount of ILW has accumulated which now has to be packaged, stored and prepared for final disposal. For these types of wastes, GNS and Siempelkamp as strategic manufacturing partner are supplying the MOSAIK® casks and "GNS Yellow Boxes®", containers made of ductile cast iron (DCI) suitable for interim storage, transport and final disposal.

The paper presents the details and results of these two large-scale projects and reports on planned future developments.

INTRODUCTION

The German company GNS Gesellschaft für Nuklear-Service mbH has more than 30 years of experience in the design, licensing and manufacture of casks for spent fuel. The main cask type for dry storage of SF from commercial nuclear power stations is the CASTOR® V, which has been developed for transport and long-term interim storage of 19 PWR fuel assemblies and 52 BWR fuel assemblies. The CASTOR® V cask design, with a cask body made of DCI, was developed and licensed in Germany in the 1990s. Casting and machining have been mainly performed by Siempelkamp.

For ILW, GNS supplies MOSAIK® casks and GNS Yellow Boxes®, both made of DCI also. These containers have been use in Germany for more than 20 years and are now being supplied to the UK for decommissioning projects at the MAGNOX reactor sites. Both container types are being cast, machined and assembled by Siempelkamp.

THE CHALLENGE IN GERMANY AFTER FUKUSHIMA

In March 2011, the German Federal Government decided to immediately shut down the eight older German nuclear power stations (NPS). Only nine units are still in operation, and their operation will be phased out until 2022, ending the use of nuclear energy for commercial power generation in Germany.

One challenge is to quickly remove spent fuel from reactor pools of shut-down plants. Besides the extension of the cask inventory parameters, the cask manufacturing and cask loading capacities have to be increased significantly. For GNS this has meant that the existing manufacturing capacities of approx. 50 large-size casks per year had to be increased to approx. 70-80 casks in the coming years. The total need for the casks to accommodate spent fuel from shutdown power stations is approximately 800 casks. The increased capacity has been realized with the aid of the subcontractors working for GNS. In order to keep the overall costs of decommissioning and dismantling low, it is extremely important to defuel the pools at the nuclear power plant sites as quickly as possible



Figure 1: CASTOR® V casks in storage on-site at the German nuclear power station Emsland

The casks are dual-purpose containers for both transport and interim storage. The storage requirements in Germany stipulate the storage in buildings on the sites of the power stations. The accident conditions to be considered during licensing include aircraft impact, among other accidents.

THE CHALLENGE IN THE UK

At various nuclear sites in the UK, approximately 290,000 m³ of ILW has accumulated over the years. This largely includes the following waste types:

- ion exchange resins
- metallic waste
- liquid effluents
- sludge mixtures

Most of these waste types are currently stored in tanks and vaults at the different nuclear sites, where they have been collected during operation of the respective site, many of which are now in the decommissioning or dismantling phase. In the past this waste was encapsulated in a cement or polymeric matrix, packaged into thin-walled stainless steel containers and placed into interim storage facilities providing shielding and protection against external impacts.

A New Strategy: MOSAIK[®] and GNS Yellow Box[®]

For a major part of the disposal of the above-mentioned wastes, the containers of the types MOSAIK[®] and GNS Yellow Boxes[®] were selected. With approximately 7,000 units sold, the MOSAIK^{®1} cask is the most successful ILW transport and storage container worldwide. It 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.

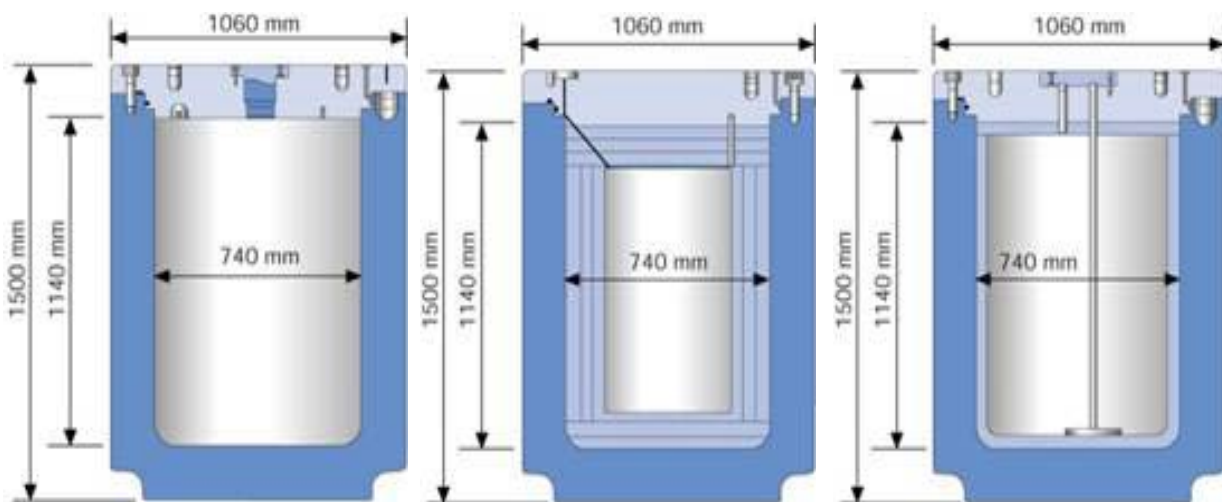


Figure 2: Different MOSAIK[®] variants

For waste streams which require less shielding, the GNS Yellow Box^{®2} offers adequate mechanical robustness at significantly lower costs per volume. This container type holds approximately 3 m³. With their 15-16 cm thick walls, they can withstand severe conditions.

¹ Registered Trademark in the European Union

² Registered Trademark in the UK

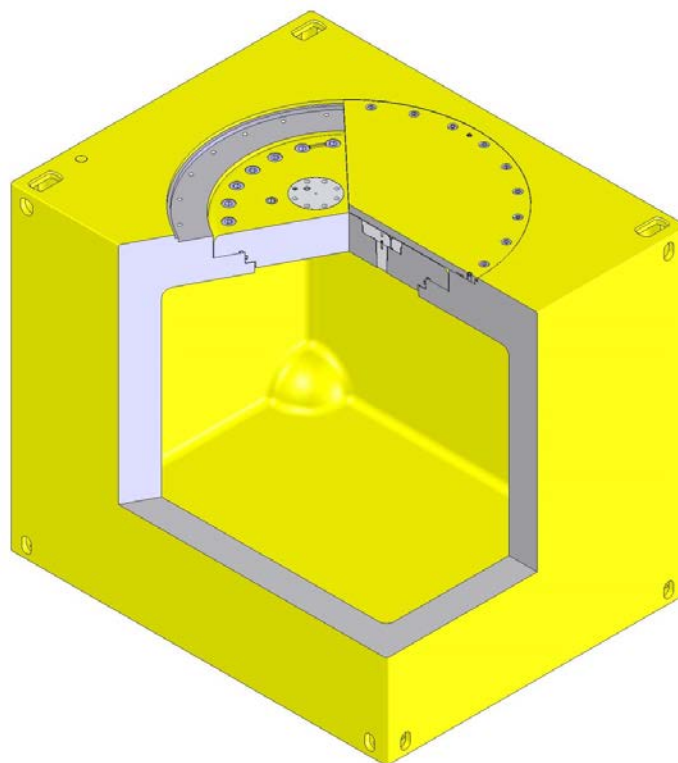


Figure 3: The GNS Yellow Box®

There are no severe issues concerning the chemical compatibility of the wastes 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, the retrieval of the waste from the vaults still seems to be a challenge.

Current Projects

A number of MOSAIK® and GNS Yellow Box® containers have been delivered to various Magnox sites. At Bradwell tests for drying of liquid and solid simulant material have been completed successfully. Since November 2013, a GNS FAVORIT® plant has been in regular operation drying ILW sludges. At EDF Energy's Sizewell B site, MOSAIK® casks are currently being filled with resins. In total 55 MOSAIK® casks are to be filled with resins and subsequently de-watered.

New Developments

The GNS Yellow Box® has 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 requested to have a container of the same structural integrity but with a larger usable clearance, ideally giving access to the whole container cavity. Therefore GNS has developed a new 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.

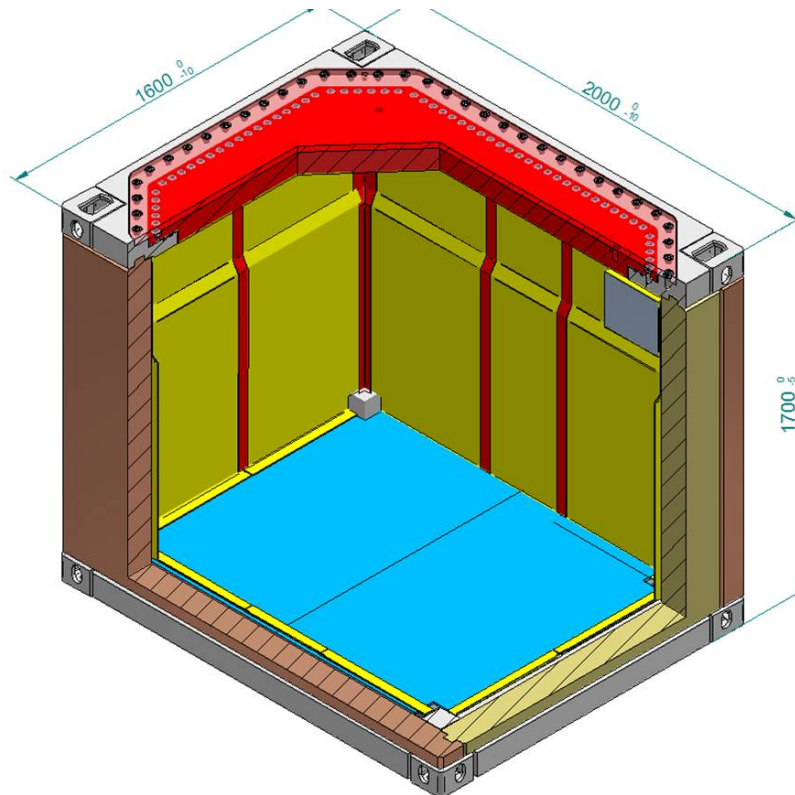


Figure 4: The Sandwich Container with rectangular lid

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 the “Sandwich Container”.

In parallel, Siempelkamp has developed and conceptually licensed a DCI version of such a container, called SNT BlueBox, with special emphasis on UK-specific requirements for the planned final waste disposal facility.

Future Prospects

Besides Magnox, other companies in the UK are planning to adopt the new strategy. This results in a huge market for robust, self-shielding containers. MOSAIK[®], GNS Yellow Box[®] and SNT BlueBox 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.

GNS and Siempelkamp produce customized cask solutions for different uses and varying requirements worldwide. After mastering the major challenges in Germany during the years 2011-2013, GNS and Siempelkamp are now prepared to launch new cask projects onto the international market.