The Trawsfynydd station in the magnificent setting of the Snowdonia National Park in Wales.

Handling Legacy Waste Streams at Trawsfynydd

The establishment of the U.K. Nuclear Decommissioning Authority and the announcement of the Magnox Closure Program have focused funds into decommissioning U.K. sites.

And leading the way in decommissioning is Trawsfynydd.

By Simon Parsons

The nuclear industry in the United Kingdom is midway through a major transformation, with the second year of operation of the Nuclear Decommissioning Authority (NDA) and just a little more than a year since the March 30, 2006, publication of the NDA strategy for the cleanup of the U.K.'s civil nuclear sites.

This strategy includes the life cycle of the nuclear licensed sites owned by the NDA and operated by British Nuclear Group (BNG), the nuclear decommissioning and cleanup specialist (formed as a subsidiary of BNFL). BNG's operational portfolio includes 11 reactor sites, at various stages between generation and decommissioning, each working toward an end-state model of three boxes, as detailed in the U.K. government's Quinquennial review dated April 2000.

One facility that has reached a major stage in its life cycle is Trawsfynydd (pronounced traws-FIN-id), currently the only site in the United Kingdom successfully retrieving from all its legacy intermediate waste streams. Trawsfynydd is a Magnox-type nuclear power station (so-called because the natural uranium rods, used to fuel the reactor, are clad in a magnesium nonoxidizing sleeve or "can"), one of the U.K.'s first commercial nuclear power stations used to generate electricity.

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The Plant

Uniquely located in Snowdonia National Park, in North Wales, Trawsfynydd Decommissioning Site was the country's only inland nuclear power station (the rest of the U.K.'s nuclear power stations are located in coastal positions for ease of access to cooling water and effluent discharge purposes). The site is adjacent to Trawsfynydd Lake, the third largest in Wales.

The 390-MW twin reactors were commissioned and began commercially generating electricity in 1965. Trawsfynydd successfully generated electricity for 26 years and began its decommissioning and cleanup period in 1993. At the time, it was the third such facility to enter this phase. Defueling the reactor was completed within 21 months, the final fuel cask leaving the site by rail for reprocessing at Sellafield on August 8, 1995.

In the years immediately following defueling, funding available for decommissioning the site was limited, and progress was slow. Now, with the announcement of the Magnox Closure Program and establishment of the NDA, funds are focused into decommissioning the U.K. sites. Traws is considered by many to be leading the way in decommissioning.

Much of the decommissioning work on site is being carried out by a consortium of four specialist tier-2 contractors, forming the Trawsfynydd Strategic Integrated Framework, including BNG's contracting arm, Project Services, as well as Amec, Costain, and Aker Kværner.

The Waste Streams

There are six separate programs to recover waste streams operating simultaneously on the site: fuel element debris (FED), miscellaneous active components (MAC), materials arising from ponds scabbling, sludges, active waste vaults (AWVs), and resin.

Fuel Element Debris

Throughout the operational life of the station, Trawsfynydd was one of several power stations that removed the casings from the fuel elements using a desplittering machine. In this process, the rods were given a more uniform shape to increase efficiency for loading into transport skips. The spent fuel was transferred by rail in a shielded cask to the Magnox reprocessing plant at Sellafield (which will remain operational until the last Magnox station has ceased generating in 2010).

After removal, the FED was stored in two vaults within the site's ponds complex, with the south vault serving Unit 1 and the north vault serving Unit 2. FED is a solid intermediate-level waste (ILW), potentially the most hazardous material remaining on the Trawsfynydd site. As

FED recovery (south vault).

such, the removal of approximately 382 cubic meters of material to allow ongoing decommissioning has proven to be extremely challenging.

In the south vault, FED retrieval operations use a "grab-and-trolley" system to remotely recover and deliver waste into a sort cell. Here it is sorted and tamped into 3-m^3 stainless steel boxes before encapsulation in grout—in compliance with requirements—in preparation for long-term storage and eventual disposal. Once the grouting process is completed, the stainless steel box is placed inside a large concrete container, i.e., overpack, prior to storage. To date, five boxes have been filled, with work under way to fill and process the sixth.

Miscellaneous Activated Components

MAC consists of activated components such as flux flattening bars used in Magnox cores to shape the neutron flux and removed during the operational life of the station. Each reactor has an associated MAC storage vault, below ground level, containing this ILW material.

The strategy is to retrieve the MAC from the vaults, pack it into approved containers, and encapsulate it in grout to ensure the waste is in a form suitable for long-term storage. Each package is loaded into a concrete shielded overpack, which is initially stored in a designated interim ILW basement area within the Safestore buildings. The overpack-containing packages will be transferred to the site's purpose-built ILW store following its completion in October 2008.

The process of extracting the MAC waste began in 2001. Personnel remotely operated a 3-m-long hydraulic manipulator deployed from the vault roof. The waste was extracted piece by piece from within the vault and then placed into a container inside the vault. Once full, the containers were transferred from the vault into a shielded cell and placed into 3-m^3 stainless steel boxes.

Retrieval of this entire waste stream from the south vault is complete. To date, 17 packages containing 16 000 items of MAC waste are filled and immobilized in grout. The retrieval plant has since been dismantled and relocated to the north vault in preparation for commissioning work to begin on removing and packaging the remainder of this waste stream. A remotely operated vehicle installed inside the plant will speed up operations and increase the efficiency in removing the waste. One package has already been completed from the north vault, and work is currently under way to fill the second.

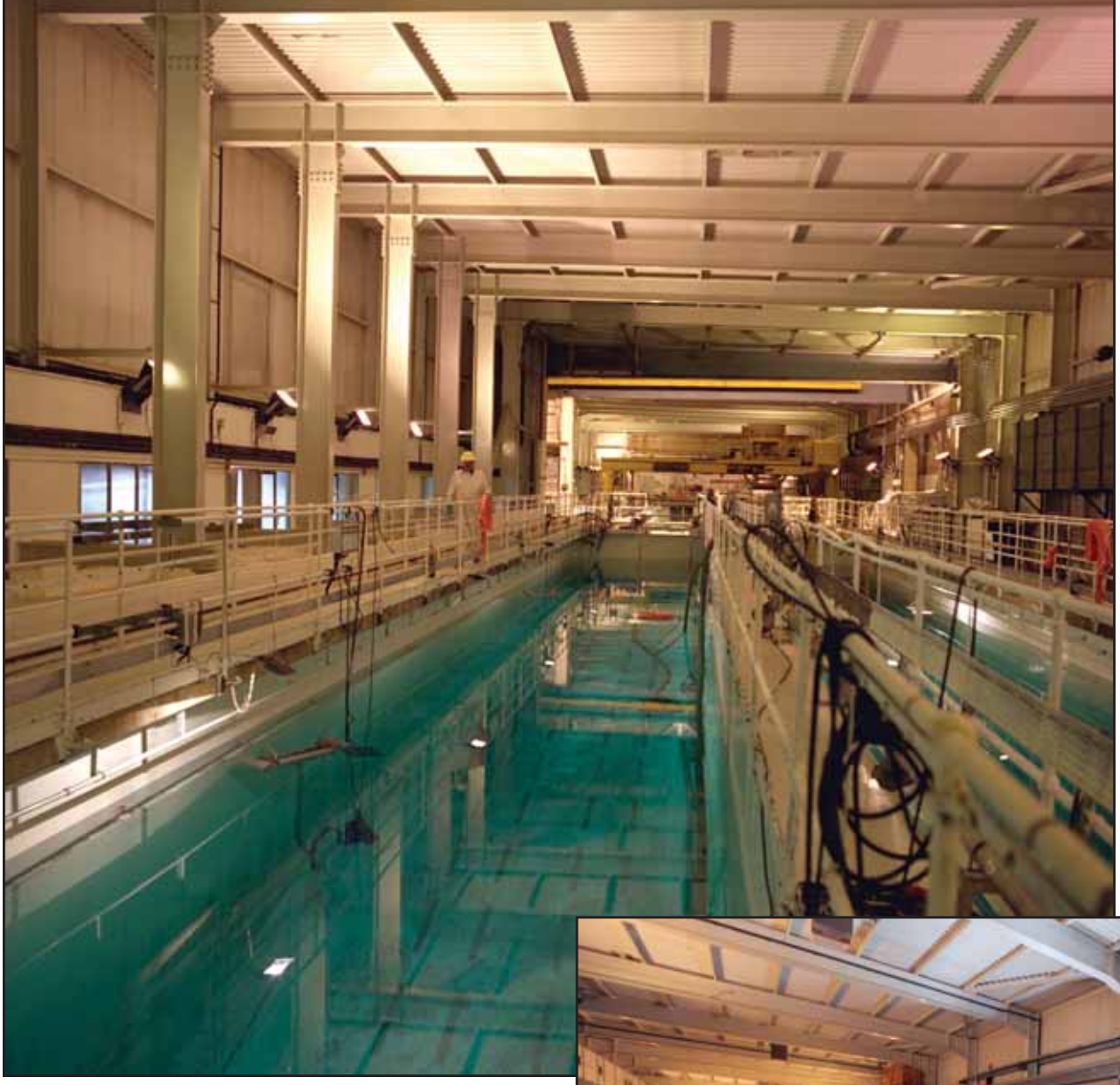
Above: *MAC recovery (north vault).*

Right: *MAC recovery, as seen with the Brokk onboard camera.*

Ponds Scabbling

As with most Magnox stations, concrete channels filled with water (ponds) cool and store the used fuel before its transport offsite for reprocessing.

To allow the demolition of the cooling ponds, contaminated concrete must first be removed from the surface of the ponds structure. The majority of the



Above: *Trawsfynydd pond.*
Right: *The pond after draining.*

contamination is in the areas that had been submerged in pond water. Following the draining of the ponds in 1997, sampling indicated that approximately 40 mm of surface material had to be removed. This measurement equates to a total of approximately 300 tonnes of concrete and embedded steel items that had become contaminated during the operational life of the station

To limit dose uptake by the workforce, BNG Project Services devised a remote system to do the work, identifying a remotely controlled demolition robot as the best solution for this task. The technologies that are capable of removing large amounts of concrete quickly are essentially "scabbling" and grinding heads, which mechanically abrade the surface of the concrete, producing a mixture of dust and fine particles.

BNG devised a waste collection and packaging system (in agreement with the U.K. low-level waste repository's acceptance criteria) designed to gather these wastes produced by scabbling. They then developed a vacuum conveying system that conveys the material under a negative pressure into a separation hopper. The material is then filtered and stored in a hopper before being discharged into a plastic-lined, mild steel box. To date, the project has 80

percent of the first four areas in the ponds complex scabbled to half the required depth and has exported the first completed package from the site to the LLW repository at Drigg, Cumbria.

Sludges

Trawsfynydd has an amount of ILW in sludge form, arising from the site's pond water and active effluent treatments. The liquid sludge waste (typically containing quantities of sand, Magnox corrosion products, and possibly small quantities of oil) is currently stored in purpose-built vaults on the site.

The main sludge vault (MSV), situated at the north end of the station's cooling ponds complex, held approximately 30 m^3 of historical sludge arisings from the site and continues to receive minor quantities of sludge from the active effluent treatment plant and the decant water treatment plant.

There is a requirement to process the wastes into an acceptable form for long-term storage by fully immobilizing the material, both physically and chemically. First, workers used vertical shaft mixers to resuspend the sludge and allow transfer to the site's transportable ILW solidification plant for cement encapsulation into large liners, which are in turn placed into the concrete overpacks.

Once the levels of sludge in the MSV were lowered, personnel installed a wash system to remove accumulations of sludge that had gathered on parts of the vault's internal structures. A new conditioning plant will be used to process the remaining dilute sludge. Recently manufactured, a transportable radioactive sludge dewatering unit will be positioned onsite to begin the final stages of work on this waste stream and to handle Trawsfynydd's current operational sludge arisings. Once the sludge is retrieved and processed into an accepted product and the MSV washed out, using nonaggressive techniques, removal of the remaining plant and equipment will commence.

AWV B3 being emptied.

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Active Waste Vaults

The AWVs comprise a series of underground reinforced concrete vaults with sealed shielded covers, housed within an overbuilding. The nine vaults of the AWV area contain waste arising from operation and early decommissioning activities at the site. The waste within the vaults includes a range of materials falling into the LLW and ILW categories, some of which do not currently have any routes to disposal and as such are classed as "orphan" wastes.

Retrieval work has already begun, with the removal of waste from each of the vaults to determine its characteristics and disposal requirements. Waste that has been identified as suitable for disposal at the LLW repository will be directly exported for disposal using current arrangements. Oil and oily waste will be removed from the AWVs and placed in alternate secure storage. ILW will be placed into cleared vaults ready for subsequent processing into a compliant form (3-m^3 stainless steel ILW boxes placed into overpacks for interim storage). Subsequently, the project will develop suitable processes and equipment to process the oil and oily waste into a form suitable for disposal or long-term storage.

Once again, the end point for the work package will arrive when all waste has been retrieved from the vaults and either disposed of or packaged into a form acceptable to a final repository, leaving the AWV in a state ready for the subsequent removal of the remaining plant and equip-

Resin drums in interim storage.

ment. To date, five out of the nine vaults have been emptied and the ILW inventory reduced from 51 to 18 m^3.

Resin

Trawsfynydd has three resin vaults (RV1, RV2, and RV3) that require emptying and removal to allow further decommissioning. The spent resin originated during operation from the station's effluent treatment plant (incorporating filters and ion exchange facilities) to remove particulate and dissolved species, principally cesium-137.

Personnel deployed a remotely operated vehicle inside the vaults to retrieve bulk wastes in preparation for processing via the resin solidification plant. The plant will produce a compatible polymer-encapsulated drummed product to be stored as ILW onsite.

The completion point will arrive once all the resin, sand, fines, and waste material identified in the waste inventory have been transferred from RV1, RV2, and RV3 and all retrieval equipment and the tools used for this process decontaminated and removed. Retrieval of bulk resin has been completed from RV1, and retrieval operations are about to commence at RV2.

More than 1700 completed resin drums have been produced to date, with some 250 in total expected to be produced from the remaining two resin vaults.

Building It Up to Knock It Down

A variety of new construction activities is under way on the site, enabling many projects essential for the site's wider waste management and decommissioning strategy. The most obvious of these is the construction of the new ILW store, which will be used until a national repository becomes available in line with the U.K. government's

The ILW store under construction.

Turbine hall demolition.

Committee on Radioactive Wastes Management recommendations.

Construction work on the ILW store commenced in October 2005, and the structure is now well under way. The store has been designed for the medium-to-long-term storage of retrieved and packaged wastes that have been generated from ongoing decommissioning operations.

The core of the building will comprise an 88.5-m-long, 31-m-wide reinforced concrete box, divided into four separate areas. Two storage vaults will house packaged waste in either Type 1803 drums or compliant stainless steel containers within concrete overpacks. The facility will also contain a receipt/maintenance bay and a waste package inspection cell.

The handling system for the ILW packages will include two 45-tonne-capacity overhead cranes, each servicing both vaults, and a mechanical handling system within the inspection cell. An external cladding envelope support-

Last section of Boiler 6 being removed.

ed on a structural steel framework will provide protection to the concrete box structure from the North Wales weather.

December 2005 saw the commencement of work to reduce the height of the two 170-foot reactor buildings. Each building houses six boilers, arranged three on either side of the reactor. Each boiler is around 130 ft tall and 18 ft in diameter, weighing 1000 tonnes. Initially, work will begin to reduce the height of the old boilers by about one-third—by cutting them into sections, the first time such an operation has been carried out anywhere in the United Kingdom. Following the completion of this phase, work will begin to lower the reactor building roofs. Work on four boilers has been completed at the time of writing.

Reducing the height of the boilers, constructed of solid steel up to seven inches thick, is a huge challenge. New technologies and techniques have been developed to facilitate their safe removal. Using a specially developed boiler lifting rig, workers will lower the cut sections, weighing up to 105 tonnes each, into suitable storage spaces in the building.

Free Release

Innovative retrieval techniques will handle both radioactive and conventional waste streams at Trawsfynydd, resulting in the vast majority of waste being strictly monitored and, where appropriate, free-released for recycling and recovery. For example, concrete from demolition work has been monitored, certified as radiologically clean, and reused or recycled as hardcore and aggregates for other construction projects on the site.

Ferrous materials being removed from the boilers and supporting pipe work have also undergone stringent monitoring procedures and have been authorized for release onto the general market as a valuable and high-quality recyclat.

Approximately 21 600 tonnes of scrap metal has been released in this way since the company secured an exclusive recycling contract with European Metals Recycling. In addition, around 35 000 m^3 of inert waste (including rubble and aggregates from demolition work) has been used for infill operations in the turbine hall footprint, and 40 000 tonnes of excavation material is being used for landscaping the site. In total, Trawsfynydd has managed to recycle around 97 percent of all waste materials generated from decommissioning.

Our aim will always be to minimize the quantity of waste that has to be specially handled, treated, packaged, and consigned to intermediate storage (in advance of a decision on a national repository for high-level and intermediate-level waste) or dispatched to the U.K.'s LLW repository. In doing so, we are delivering value to the NDA and in turn to the U.K. taxpayer. ■

Simon Parsons is the site director at Trawsfynydd. For additional information, contact Dan Gould, with British Nuclear Group, at dan.gould@britishnucleargroup.com.