Preparations for Final Disposal in Konrad

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The duties of GNS range in this case from development of conditioning methods, including development and qualification of the cask and emplacement systems, processing of the waste and loading of the casks, to documentation of the containers to be placed in final storage and control of delivery to the Konrad repository.
Currently, more than 30 countries all over the world are using controlled nuclear fission to produce electricity and are thus contributing to environmental protection by reducing the emission of pollutants. Simultaneously, this will prolong the availability of global coal, natural gas and oil resources.

Safe disposal is part of the safe operation of a nuclear power plant. The residual materials and radioactive waste arising from the operation and subsequent shutting down of nuclear power plants need to be recycled safely or disposed of without any hazard to the environment. In Germany, GNS Gesellschaft für Nuklear-Service mbH is in charge of all operations regarding disposal of the wastes and residual materials from the nuclear power plants in Germany. GNS is therefore assigned a responsible duty, particularly against the background of the nuclear phase-out decided in Germany.

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GNS – Competence for Nuclear Services
The GNS group

Sites in Germany:

1. Essen
2. Mülheim a. d. Ruhr
3. Duisburg
4. Jülich
5. Ahaus
6. Gorleben
7. Karlsruhe
8. Peine
9. Alzenau

Further Sites:
- Pilsen (CZ)
- Creys-Malville (F)
- Maubeuge (F)
- Bristol (UK)

The following wholly or partly owned companies are members of the GNS group:

- Acta Technologie GmbH, Alzenau 100%
- Brennelement-Zwischenlager Ahaus GmbH 100%
- Brennelementlager Gorleben GmbH 100%
- WTI Wissenschaftlich-Technische Ingenieurberatung GmbH, Jülich 100%
- Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH (DBE), Peine 75%*
  * at equity

Shareholders of GNS:

- EnBW über Südwestdeutsche Nuklear-Entsorgungs-Gesellschaft mbH
- Vattenfall
- e.on
Waste Management

Statutory regulations place the operators of nuclear power plants and other nuclear facilities under an obligation to safely dispose of radioactive waste arising from the operation and dismantling of their plants.

GNS treats all types of low and intermediate level waste (LLW/ILW) and applies suitable conditioning processes to ensure acceptability of the waste for interim storage and subsequent final disposal. Stationary and mobile, predominately in-house developed equipment is used to treat the waste. Furthermore, these are also offered for sale. With the aid of the customised solutions, all operators of nuclear facilities are also able to benefit from the know-how gained over four decades of successful waste treatment.

Parts of the radioactive residual materials arising can be reused or recycled. Contaminated ferritic material is, for example, added to the casting material for the production of GNS shielded casks of the MOSAIK® type. This effectively contributes to a reduction of waste quantities.
Engineering Services from a Single Source

Processing of radioactive materials from nuclear power plants is subject to the strictest safety and quality regulations. Ranging from preparing studies and feasibility analyses, individual planning of waste management plans, including design and production of conditioning facilities, handling systems and designing the necessary packaging to periodic maintenance and inspection of the facilities – the GNS engineering team provides competent, comprehensive support to its customers.

GNS provides basic groundwork for the development of future-oriented process engineering technologies. Turnkey facilities including buildings can be planned, erected and commissioned in cooperation with the subsidiary WTI. Each facility developed by GNS is supported to the time of commissioning, including approval procedures and technical documentation.

GNS takes care of the complex approval procedures for building and operating interim storage and conditioning facilities as well as for transport of casks and containers and compiles the documents required for granting of approvals or licences.

In addition, GNS has an extensive range of special tools designed to meet the requirements of the Nuclear Safety Standards Commission regulations regarding their use in nuclear power plants.
Dry Solid Waste

Protective clothing, cleaning cloths, metal parts, insulation materials, cables and filters are examples of dry solid radioactive waste occurring during the operation and shutting down of nuclear facilities. To this end, GNS has developed the mobile hydraulic supercompactor FAKIR, which significantly reduces the volume of this waste. Depending on the kind of waste, a reduction in the volumes by a factor of up to 10 is possible.

GNS itself is operating a hydraulic supercompactor FAKIR at its locations in Duisburg and Jülich respectively. GNS can also tailor the device to specific conditions on site; it can be designed, built and commissioned to meet the customer’s individual requirements.

An even greater reduction in volume is achieved by incinerating combustible parts of the waste. GNS is offering this disposal solution to its customers as an integrated service ranging from preliminary planning to storage of the products.

GNS closely cooperates with various operators of incineration plants. The highest priority is to meet the strict emission protection requirements during combustion. After incineration, most of the radioactivity in the untreated waste is contained in the ashes which are then processed by GNS to create products acceptable for final disposal. These products can no longer ferment or putrefy and are therefore suitable for long-time storage.
Wet Solid Waste

Some of the waste accruing during the operation and decommissioning of nuclear facilities is wet. In order to obtain a waste product suitable for interim storage and final disposal, this waste needs to be dried. To this end, GNS has designed the mobile drying facility PETRA® for use in nuclear facilities.

PETRA® works according to the principle of vacuum drying. Additional energy, supplied by heating the stainless steel drums containing the waste in heating chambers, accelerates the drying process. Using the mobile drying facility, sixteen drums with a volume of 200 litres, twelve 280L drums or eight 400L drums can be dried simultaneously in two heating chambers. A programmable logic controller (PLC) allows automatic operation without supervision.

Systems for use in the widest array of nuclear facilities can be adapted to varying framework conditions. The highest possible degree of flexibility and profitability is achieved through modularity. * UK registered trademark
GNS uses the mobile vacuum drying facility FAVORIT® for volume reduction and solidification of activated liquid waste (such as evaporator concentrates and sludge) arising during the operation and decommissioning of nuclear facilities. The extent of volume reduction depends on the solid matter content of the liquid waste. The resulting products are suitable for transport and interim storage and meet the requirements for final disposal of radioactive waste.

The facility designed by GNS dries liquid waste in drying containers using the principle of vacuum drying. Following a decrease of the internal pressure in the container, free liquid is drained off the waste to be dried. Simultaneous heating of the waste containers by means of jacket heaters or, alternatively, by means of circulating-air heating cabinets for drums accelerates the drying and prevents icing of the interior of the cask. Depending on the specific activity of the liquid wastes, either MOSAIK® II casks or 400-/200-litre drums are used.

The volume made vacant can be refilled with waste which in turn can be dried. This process is repeated until an adequate filling level is achieved.

Virtually any required throughput can be obtained by combining several modules.
Powder resins are being used for treatment of the water in nuclear power plants with boiling water reactors. They need to be replaced at regular intervals and disposed of as radioactive waste. To meet the requirements for interim storage and final disposal, GNS is operating the mobile powder-resin transfer facility PUSA for conditioning of dry powder resins and other dry filter aids. The facility was developed and built by GNS and the modular design of the facility enables adjustment to specific conditions on site.

The PUSA facility is used in individual campaigns at the power plants. Using a vacuum lifting method (negative pressure), dry, free-flowing powder resins are transferred from 200-litre drums into GNS Yellow Box®. A programmable logic controller (PLC) allows automatic operation of the facility.

The waste conditioning plant FAFNIR® can transfer bead resins used to treat water in the nuclear power plant into MOSAIK® II casks suitable for final disposal both from the power plant’s own storage tanks and from pre-filled nodular resin containers. Due to the individual installation options provided by FAFNIR®, specific conditions on site can be accommodated.

Conditions for interim storage or final disposal require that the resin-filled waste containers contain less than 1% free water. To fulfil this criterion, GNS has developed the mobile dewatering facility NEWA®. These facilities likewise consist of modules which can be adjusted to local requirements.

* UK registered trademark
Core Components

During the operation and shut down of nuclear facilities, reactor internals and core components need to be disposed of. For this purpose, GNS has developed various devices for cutting and packaging core components for underwater use in the wet storage pool, e.g. the cutting and packaging facility ZVA.

The ZVA facility is a flexible conditioning device which cuts these components and then compacts them inside a cask to reduce the volume.

To be suitable for interim storage and final disposal, the cask contents must not exceed a defined residual moisture value (e.g. to prevent formation of radiolysis gases). Therefore, the casks need to be dried after they have been filled. For this purpose, GNS has designed and built the mobile drying facility KETRA®. Just like other GNS drying facilities it operates according to the vacuum drying principle and can be adapted to the local conditions owing to its modular structure.
During operation of nuclear facilities and their shut-down, large quantities of radioactively contaminated materials arise, including metal components such as pipes, valves, heat exchangers and other devices made of steel, or concrete components and rubble. GNS provides specific disposal solutions for these as well, while always checking whether or not a component can be reused.

Ideally, one can dispose of these components by way of free-release for reuse or recycling. The contaminated parts may need to be decontaminated before they are released. At its operating sites, GNS has appropriate facilities that can process such contaminated metal components. Even large components (up to 100 t) can be treated. Following their release, the components may either be conventionally recycled, provided that the products do not exceed permitted limits, or they are disposed of to a conventional waste dump.

Another way of disposing of contaminated metal is controlled recycling for nuclear applications. In order to achieve this, slightly activated scrap is melted down under a licence for handling radioactive substances in accordance with §7 of the German radiation protection ordinance. The raw material produced in this way is used to manufacture castings such as containers, shields or other components which are reused in nuclear facilities or for the final disposal of radioactive waste. GNS cooperates with foundries in Germany, Sweden and the U.S. and provides complete service packages for this disposal procedure too.
The radioactive waste to be delivered to an interim storage or final disposal site has to be packaged into suitable types of waste containers. Depending on the kind of waste, the packagings are cylindrical or box-shaped with different types of construction, size, wall thickness and weight. The specific requirements imposed on the container types are laid down in the corresponding storage conditions, for instance the final storage conditions for the German Konrad repository for ILW/LLW. GNS develops and manufactures such packagings for which unlimited suitability is proven as part of the type tests.

**Steel Sheet Containers**

Steel sheet containers are box-shaped, large containers made of sheet steel with a framework of steel sections and ISO corner fittings and possibly, additional interior installations such as steel or concrete shieldings. They are made in different designs as accident-proof or non-accident-proof packagings in various standardised sizes according to the Konrad requirements. All containers have coatings for protection against external and internal corrosion and to facilitate decontamination. They are suitable for holding interior containers such as 200-litre or 400-litre drums and may be grouted with filling material as required.
The GNS Yellow Box® is a box-shaped container made of ductile cast iron. The GNS Yellow Box® is used as packaging for radioactive waste from water treatment plants of nuclear facilities which require higher shielding levels. The maximum payload is about 1,600 kg for the Konrad repository or up to 6,000 kg for other uses.

The lid of the container has connections for filling with the PUSA powder-resin transfer facility or the FAFNIR® waste conditioning plant. The container is provided with a coating which can be easily decontaminated and it can be handled at its ISO corners with a spreader.

For final storage in the Konrad repository, the GNS Yellow Box® has a type approval as accident-proof package of waste container class II and as IP-2 package.

* UK registered trademark for the ductile cast iron container GC VI-15
The "Cladded Concrete Shielding (UBA*)" cask for transport and storage is an IP-2 package for a maximum of 1,500 kg dry solid radioactive waste.

The cylindrical cask body consists of an outer and inner steel jacket. The intermediate space is filled with concrete. Depending on the necessary shielding, concrete mixtures with different densities can be used. Protection against corrosion is ensured by a coating which can be decontaminated.

The casks are suitable for transport with fork-lift trucks. Furthermore, suspension points are provided at the lid. The waste material can be put into the casks in bulk or in drums with volumes between 200 and 400 litres which may be grouted with concrete inside the UBA.

For disposal in the German Konrad repository, the container has a type approval as an accident-proof and non-accident-proof package of waste container class I.

Cladded Concrete Shielding (UBA)
MOSAIK® Cask

GNS develops and markets MOSAIK® casks made of ductile cast iron for all kinds of intermediate level radioactive waste occurring during the operation and shut down of nuclear facilities. The MOSAIK® casks are designed as transport and storage casks for e.g. core components or conditioning of ion exchange resins or evaporator concentrate. As the casks can be equipped with the respective necessary connections, waste can be directly conditioned inside MOSAIK® casks with methods and facilities developed by GNS so as to be suitable for final disposal.

To accommodate various kinds of waste, the cask types have different volumes, wall thicknesses or lid systems and may have additional lead inserts and filter systems. These are the main features of the particular versatility of the MOSAIK® concept. Contaminated metal with a low radioactive level and a suitable metallurgic composition can be processed by the recycling method to manufacture the casting material for MOSAIK® casks.

For transport in accordance with ADR** MOSAIK® casks are available with Type B(U) approval certificate or casks which are used as containers for IP-2 packages.

* UBA= Unmantelte Betonabschirmung
** European accord for international transport of dangerous goods on the road (Accord Européen relatif au transport international des marchandises dangereuses en route)
The GNS SBoX is a container for interim storage and final disposal and can be used for all kinds of radioactive waste from nuclear facilities. It consists of welded heavy-walled steel sheets. With an empty load of 16,500 kg, the maximum payload is normally about 8,500 kg.

The GNS SBoX can be delivered with an integrated heating system, which enables short drying times and a low surface temperature during and after drying. This reduces the overall drying cycle time significantly.

The GNS SBoX is available with a round or rectangular lid system. There are connections for drying and filling facilities integrated in the lid, which come with separate closure lids. For protection against mechanical damages and ingress of dust the lid of the GNS SBoX is additionally covered with a protection plate.
Disposal from nuclear power plants and other nuclear facilities is impossible without transport of radioactive materials. These transports are subject to strict domestic and international regulations and are reliably organised and performed by GNS on the basis of 40 years of experience in conjunction with dependable partners.

GNS takes care of the transport of low and intermediate level waste (such as operational and decommissioning waste from nuclear power plants) and organises transports of spent fuel and high level waste e.g. from the reprocessing of fuel assemblies.

GNS provides the necessary transportation equipment such as freight containers (including its own 20” ISO-containers of different types), load securing systems and casks such as the CASTOR® or MOSAIK®.

For these transports, GNS commissions specialised and qualified companies that have the necessary transport licences.
A large volume of data and information needs to be acquired, documented and updated along the route that radioactive waste or residue takes from creation to treatment, conditioning, transport to interim storage and delivery to a final disposal site in order to guarantee control of origin, condition in compliance with safety requirements and whereabouts.

To meet the statutory requirements, the operators of the German nuclear power plants jointly with the conditioning plants and the external interim storage sites have been using the AVK waste tracking and documentation system developed by GNS in a data network, the so-called AVK network, since 1991.

As a modern and user-friendly documentation, evaluation and reporting system, AVK is equipped with a flexible open program architecture. Accordingly, the system is easy to adjust to changing requirements and tailor to specific applications.

AVK is suitable for documentation and tracking of all radioactive and chemical substances which require supervision and can therefore be used by all institutions with an obligation to maintain appropriate documentation or who wish to introduce a documentation system at their own initiative.
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The Task

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Evaluation systems

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All plants have a permit according the German Radiation Protection Ordinance and comply with the applicable guidelines for machines.
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