INPP Workshop on Reactor Dismantling

Jörg Viermann, GNS Gesellschaft für Nuklear-Service mbH
Competence for Nuclear Services

A medium-sized company founded in 1974, based in Essen/Germany.

- Competence Centre of the German utilities for the management of spent fuel and all nuclear wastes (HLW/ILW/LLW) from the operation and the dismantling of the **German power plants**

- **Worldwide operations**:
  - as one of the leading manufacturers of casks for ILW (MOSAIK®) and spent fuel/HLW (CASTOR®, CONSTOR®)
  - for processing of every kind of radioactive waste, decommissioning and related engineering services
The Role of GNS in Germany

We take care of ... (i.e. Competence and Responsibility of GNS)

- Spent Fuel and HLW
  - Packaging, Loading, Transport
- Operational and Decommissioning Waste (LLW/ILW)
  - Treatment, Packaging, Transport
- Interim Storage HLW/SF
- Repository HLW/SF
- Interim Storage LLW/ILW
- Repository Konrad

Responsibility of the Utilities

Responsibility of the Federal Republic of Germany

GNS
History of GNS

1974
- Formation of GNT Gesellschaft für Nukleartransporte
- Beginning of CASTOR® development

1977
- Re-naming to GNS Gesellschaft für Nuklear-Service mbH

1979/1980
- Business Area „Nuclear Casks“ established

1980
- Business Area „Nuclear Waste Management“ established

1985
- First licence for the GNS conditioning site at Duisburg
- Development of AVK-System
- Activities from DWK taken over (incl. Ahaus and Gorleben interim storage facilities)

1988
- Interim Storage Activities transferred to the State

1989/90
- Dedicated to nuclear services for four decades!

2017

Dedicated to nuclear services for four decades!
Shareholders of GNS

- 48% PreussenElektra
- 28% RWE
- 18.5%* Südwestdeutsche Nuklear-Entsorgungs-Gesellschaft mbH (EnBW Kraftwerke AG, PreussenElektra GmbH)
- 5.5% VATTENFALL

* Süddeutsche Nuklear-Entsorgungs-Gesellschaft mbH (EnBW Kraftwerke AG, PreussenElektra GmbH)
The Company

- Headquarters Essen
  - Corporate Functions
  - Project Management and Controlling
  - Development of Casks and Equipment

- Duisburg (until 2018)
  - Free release
  - Conditioning and packaging of solid LLW

- Mülheim
  - Cask assembly (SF, HLW, ILW)
  - Training and Test Facility

- Jüllich
  - Conditioning and packaging of solid LLW

Turn over > 250 Mio. Euro
Employees approx. 450
Competence Areas of GNS

- Management of nuclear waste from operations and dismantling of nuclear power plants (ILW/LLW)
- Management of spent fuel as well as ILW and HLW from the reprocessing of German spent fuel abroad
- Casks for transport and storage of spent fuel and nuclear waste (HLW/ILW)
- Consulting, engineering and equipment
- Preparations for final disposal
Management and Treatment of Wastes and Residues

- Conditioning of operational and decommissioning wastes in GNS-owned facilities
- Deployment of GNS-owned mobile facilities to the customers site
- Realisation of waste treatment campaigns in cooperation with external partners
- Development and distribution of tailored disposal solutions
- Operation and maintenance of the German waste tracking and documentation system (AVK)
GNS Equipment for Waste Treatment

Aim: Packaging for final disposal
Measures: Volume reduction, drying/solidification

- for **solid** waste
  - supercompactor FAKIR
  - drying facilities PETRA and KETRA

- for **liquid** waste
  - solidification facility FAVORIT

- for **resins**
  - conditioning facilities PUSA and FAFNIR

- for **core components**
  - GNS underwater scrap shears
Management of Spent Fuel and HLW

- Casks for spent fuel and HLW
- Cask Service
- Retrieval of German waste from reprocessing abroad
- Engineering and equipment
GNS Casks for Spent Fuel, HLW and ILW

**CASTOR®**
- Transport and Interim Storage
  - Spent Fuel
  - HLW
  - Up to 56 kW heat load
- Monolithic cask body made of ductile cast iron
- Bolted double lid system
- Pressure monitoring
- Interior neutron moderator
- Machined cooling fins

**CONSTOR®**
- Transport and Interim Storage
  - Spent Fuel
  - Up to about 25 kW heat load
- Sandwich cask body
- Welded steel plates with headring made of forged steel
- Filling with CONSTORIT
- Welded and bolted lid system
- Welded-on cooling fins

**MOSAIK®**
- Transport, Interim Storage and Final Disposal of ILW
- Monolithic cask body made of ductile cast iron
- Bolted lid system
- Different lid systems and wall thicknesses
- Optional lead inserts and filter inserts

Workshop on Reactor Dismantling INPP, Ignalina, 8th November 2018, Vie / 11
GNS Casks Worldwide

GNS has already developed and manufactured well over 1500 casks for High Level Waste and Spent Fuel.

Casks loaded and in interim storage:

- Germany 1206
- Lithuania (Ignalina) 177
- Czech Republic (Dukovany, Temelin) 119
- USA (e.g. Surry) 35
- Bulgaria (Kozloduy) 13
- Switzerland 12
- Belgium 7
- South Africa 4

Additional casks delivered to:

- Finland, France, the Netherlands, Russia, Korea

As of July 2018
GNS Waste Treatment Facilities and Equipment
Waste Treatment Facilities and Equipment

Portfolio

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Quivers and Equipment for Damaged Fuel Rods</td>
<td>• Hydraulic Compactors</td>
<td>• Vacuum Drying Facilities</td>
<td>• Consulting</td>
</tr>
<tr>
<td>• Cask-Handling Equipment</td>
<td>• Supercompactors 1200 – 2000 t</td>
<td>• Type FAVORIT</td>
<td>• Project Management</td>
</tr>
<tr>
<td>• Recooling Equipment</td>
<td>• In-Drum-Compactors</td>
<td>• Type PETRA</td>
<td>• Certified IPMA-Projectmanager</td>
</tr>
<tr>
<td>• Grapples for Pellets, Drums, Casks etc.</td>
<td>• Vacuum Drying Facilities</td>
<td>• Resin-Filling Facilities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Type KETRA</td>
<td>• Type FAFNIR</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Type PETRA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Heating Systems</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Engineering Services
In-Drum drying facilities for liquid waste

4 Leg In-Drum Drying Facility for Evaporator Concentrate incl. Infrastructure

<table>
<thead>
<tr>
<th>Year of Manufacture</th>
<th>Scope of GNS Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>Development, Design, Assembly, Commissioning and Training</td>
</tr>
<tr>
<td>Waste Stream</td>
<td>Evaporator Concentrate</td>
</tr>
<tr>
<td>Process in brief</td>
<td>Vacuum Drying in 200-l-Drums with Heating Jackets</td>
</tr>
</tbody>
</table>
Drying cabinets for solid waste

Drying chambers for 200-l- and 400-l-Drums

<table>
<thead>
<tr>
<th>Year of Manufacture:</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope of GNS Supply:</td>
<td>Development, Design, Assembly, Commissioning and Training</td>
</tr>
<tr>
<td>Waste Stream:</td>
<td>Pellets, Mixed Waste, Sludge</td>
</tr>
<tr>
<td>Process in Brief:</td>
<td>Vacuum Drying in 200-l- and 400-l-Drums with Heating Cabinets</td>
</tr>
</tbody>
</table>
Drying cabinets for solid waste

Seven Modular Vacuum Drying Kits including Infrastructure

<table>
<thead>
<tr>
<th>Year of Manufacture</th>
<th>Scope of GNS Supply</th>
<th>Waste Stream</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>Development, Manufacture, Assembly and Commissioning</td>
<td>Pellets, Mixed Waste, Sludge (400-l-Drums also possible)</td>
</tr>
<tr>
<td>Status:</td>
<td>In operation</td>
<td></td>
</tr>
<tr>
<td>Waste Stream:</td>
<td>Vacuums</td>
<td></td>
</tr>
<tr>
<td>Process in brief:</td>
<td>Vacuum Drying in 200-l-Drums with Heating Cabinets</td>
<td></td>
</tr>
</tbody>
</table>
Waste Treatment Facilities for Solid Waste

Vacuum Drying Facility Type PETRA for the Treatment Centre Saida (Сайда Губа) / Murmansk, Russia

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year of Manufacture:</strong></td>
<td>2012</td>
</tr>
<tr>
<td><strong>Status:</strong></td>
<td>In operation</td>
</tr>
<tr>
<td><strong>Scope of GNS Supply:</strong></td>
<td>Development, Manufacture, Certification, Assembly and Commissioning</td>
</tr>
<tr>
<td><strong>Waste Stream:</strong></td>
<td>Pellets, Mixed Waste, Sludge (400-l-Drums also possible)</td>
</tr>
<tr>
<td><strong>Process in brief:</strong></td>
<td>Vacuum Drying in 200-l-Drums with Heating Cabinets</td>
</tr>
</tbody>
</table>
Waste Treatment Facilities for Liquid Waste

Eight Leg In-Drum Drying Facility for Evaporator Concentrate incl. Infrastructure

<table>
<thead>
<tr>
<th>Year of Manufacture:</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status:</td>
<td>In operation</td>
</tr>
<tr>
<td>Scope of GNS Supply:</td>
<td>Development, Design, Assembly and Commissioning</td>
</tr>
<tr>
<td>Waste Stream:</td>
<td>Evaporator Concentrate</td>
</tr>
<tr>
<td>Process in brief:</td>
<td>Vacuum Drying in 200-l-Drums with Heating Jackets</td>
</tr>
</tbody>
</table>
Equipment for Casks

<table>
<thead>
<tr>
<th>Year of Manufacture</th>
<th>Scope of GNS Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>For more than 40 years</td>
<td>Development, Design and Manufacture</td>
</tr>
<tr>
<td></td>
<td>Dimensioning and Design according to KTA Regulations</td>
</tr>
<tr>
<td></td>
<td>e.g. Handling Equipment for GNS Casks, Recooling Equipment, Pellet Grapple</td>
</tr>
</tbody>
</table>

Workshop on Reactor Dismantling INPP, Ignalina, 8th November 2018, Vie / 20
D&D of RPV Internals and RPV
Nuclear Power Station Decommissioning in Germany
Nuclear Power Stations in Germany

- 7 reactors in operation
- 1 in safe enclosure
- 19 under decommissioning
- 2 completely dismantled (but storage facility remaining)
Current GNS Projects
GNS New

GNS erhält Aufträge Reststoffbearbeitung und Neckarwestheim

Die EnBW Kernkraft Neckarwestheim jewel Abfalllager (SAL), Konditionierungsanlage und Nassstrahlkabinen

In einem intensiven folgenden Ausschreiben:

- 4-Strang Infastrukturanlage
- 1 Stück Probenentnahme
- 2 Stück Kammerträger
- 1 Stück KONRAD-

Die Lieferung sowie die im Jahr 2018 vorgesehene Projektleiter "RDB-Abbau in Neckarwestheim"

Ansprechpartner:

Herr Messer (VKA)
Herr Kischke (TPA)
Herr Hoffmann (TPA)

Wichtig Voraussetzung

RDB-Abbau in Neckarwestheim

GNS startet die Wiederaufnahme der Kernschmelzrückstelle

Gemeinsam mit der Arbeitsgruppe Abba und Entsorgung der Unterhöhle des bereits 2017 vollständig ausgebrochenen 700.000 m³ Entsorgeteure zurückgeführt

Trägerwerk für Litzenheber

DU-Unterstützung (nachdrücklich)

WASTE & RECYCLING: GNS-led consortium wins German decommissioning contract

PreussenElektra has awarded a major decommissioning contract to ZerKon, a consortium of GNS Gesellschaft für Nuklear-Service, Westinghouse Electric Germany and Westinghouse Electric Sweden.

The contract covers the dismantling and packaging of reactor pressure vessel internals in six nuclear power plants that are scheduled for dismantling.

23 January 2018

ZerKon

&

ZerKon
EnBW PO

RDB-Abbau in Neckarwestheim und Philippsburg

Doppelter Auftrags- eingang im Rückbau


Die EnBW Kernkraft GmbH hatte den Abbau und die Verpackung der Fraktionsbodenschäler (FBS) und der RDB-Einbauteil ihrer abgeschalteten Kraftwerke Grün I (Neckarwestheim I) und KNP 1 (Philippsburg 1) ausgeschrieben. GNS beteiligte sich an beiden Verfahren jeweils als Teil der letztendlich erfolgreichen Bietergemeinschaften. Den Auftrag GRN I übernommen sind von der E.ON Anlagenservice geführte Arbeitsgemeinschaften mit den Firmen Werderkreis und GNS, den Auftrag KNP 1 Werder- kreis (als Vorbereiter) zusammen mit NUERM und GNS.

In beiden Arbeitsgemeinschaften ist GNS für das Materialmanagement wie die Handhabung der Kraftwerke, die Nachbehandlung von Stoffen, die Einspeisung zur Verwertung der Abfallkomponente sowie die Erstellung der Zerkleinerungs- und Endlagersortierung verantwortlich. Die genannten Aufgaben führten jeweils unter der Regie der EnBW Kernkraft GmbH statt.


Die umfangreichen Planungsarbeiten haben sich als von Nachweis zu erreichen. Das Unternehmen München/Hamburg/Bonn GmbH konnte sich unter den starken Konkurrenten aufgrund seiner langjährigen Erfahrungen aus mehr als 100 Projekten zu einer der führenden Anbieter im Bereich der Abfallentsorgung positionieren. Das Unternehmen München/Hamburg/Bonn GmbH konnte sich unter den starken Konkurrenten aufgrund seiner langjährigen Erfahrungen aus mehr als 100 Projekten zu einer der führenden Anbieter im Bereich der Abfallentsorgung positionieren.
- PO for RPV internals and RPV from Philippsburg and Neckarwestheim received July 2015

- Neckarwestheim (PWR)
  - Planning phase 20 months
  - Start of on-site work April 2017
  - Upper core plate fully segmented September 2017

- Philippsburg (BWR)
  - Planning phase 27 months
  - Start of on-site work October 2017
Handling of Parts from RPV Segmentation

- Projects at Philippsburg and Neckarwestheim power stations
- Lifting tools and baskets for cuboidal or cylindrical containers
- Shielded bell
Radiological Modelling of RPV and Internals

- **ActiAtlas®**: A new tool to reduce conservativity of activity calculations
- Based on Monte Carlo method and activation calculations
- Reduces overestimation of activity compared to conventional methods
- Better planning of necessary containers and shielding
- Verification by measurements and analyses of samples

\[\Rightarrow \text{reduced waste package volume}\]
Validation by Dose Rate Measurements

- Comparison between measured and calculated γ-dose rate (PWR), measurement inside RPV without fuel assemblies
- Match between calculation C/M = 2 .. 3 along the activated zone (similar for PWR and BWR reactors)
Wide Area of Use

- ActiAtlas® can be used to calculate activities in all areas of nuclear installations.

- Further information that can be taken into account:
  - Structural analysis
  - Space restrictions (e.g. accessibility for heavy machines)

- ActiAtlas® can be used to verify compliance with clearance limits
Application of Calculated Activities

- Disposal routes

**data:**
- Activity/radionuclide inventory
- Weight & Dimensions
- Product quality (repository)

**Determination of disposal route**

- Release of radioactive substances
  (29 StrlSchV / RP 122 / RP 95)

- Melting and recycling
  (e.g. for MOSAIK® casks or shielding blocks)

- Development of a packaging concept
  (Transport, Interim Storage & Disposal)
Upper Core Plate Segmentation

Leistungspaket 2 - Durchführungsphase

Zerlegung des OKG II

GNS
Segmentation and Packaging

Leistungspaket 2 - Durchführungsphase

Nachzerlegung und Verpackung oberer Rost

GNS
Baskets for Konrad Containers
MOSAIK® Casks for Higher Activated Components
**PreussenElektra Fleet PO**

---

**23 January 2018**

**WASTE & RECYCLING: GNS-led consortium wins German decommissioning contract**

PreussenElektra has awarded a major decommissioning contract to ZerKon, a consortium of GNS Gesellschaft für Nuklear-Service, Westinghouse Electric Germany and Westinghouse Electric Sweden. The contract covers the dismantling and packaging of reactor pressure vessel internals in six nuclear power plants that are scheduled for dismantling.
Containers
Customer-Specific Package Development

MOSAIK® II-15 U EI

MOSAIK® II-15 EI
GNS Yellow Box Data sheet

DESCRIPTION

The GNS Yellow Box® is a cuboidal container made of ductile cast iron. It is used as packaging for radioactive waste from nuclear facilities which requires higher shielding levels.

With an empty weight of ca. 18,400 kg, the maximum payload of the GNS Yellow Box® is up to 6,000 kg. The outer dimensions are 2,000 * 1,600 * 1,700 mm (l * w * h).

The round lid system [3] of the container has connections for filling with the PUSA powder-resin transfer facility or the FAFNIR® waste conditioning plant [2]. The container is provided with a coating which can be easily decontaminated. It can be handled at its ISO corners [1] with a spreader.

As GC VI-15* the GNS Yellow Box® has a maximum payload of about 1,600 kg for the German Konrad repository. Furthermore it meets the accident performance requirements for a Konrad repository disposal package and is approved as a class II waste container.

Both the GNS Yellow Box® and the GC VI-15 meet the IP-2 requirements according IAEA regulations.

* GNS Yellow Box® is a UK registered trademark for the German ductile cast iron container GC VI-15
New Container: SBoX®
SBoX® Drop Test
SBoX® Product Presentation

- More flexibility, better cost efficiency
- Welded steel container
- Same outer dimensions as GNS Yellow Box® (storage compatibility!)
- Two lid arrangements (round and rectangular)
- IP-2 certified package, tested to 9m drop height
- Optional internal heating to accelerate drying
SBoX® Advantages

- **Major advantages of internal heating system**
  - Drying process considerably shorter, higher heating temperature possible (if necessary >250°C)
  - GNS SBoX® with inner heater system can be handled much quicker after drying process, due to massive reduction of cool-down time
  - Less space required (3.2m² vs. 8.5 m²)

- **Major advantages of GNS SBoX® (compared to GNS Yellow Box®)**
  - New surface coating (Less prone to mechanical damages / spalling), easier to repair (no brush marks)
  - Available with or without internal heating system
  - Larger lid opening available
  - Lower empty weight, higher payload
  - Price
Graphite Pre-Tests

[Images of graphite pre-tests equipment and setups]