THE SLIDES IN THIS ENCLOSURE 2 MAY BE MADE PUBLIC.

ENCLOSURE 2

REDACTED PRESENTATION SLIDES

CASTOR® geo69

Organization and content of the upcoming 10 CFR Part 71 application for package approval

GNS Gesellschaft für Nuklear-Service mbH

GNS Corporate Information

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

Organisation

Dr. Hannes Wimmer
Chairman of the Management Board

Dr. Jens Schröder
Member of the Management Board

Georg Buth
Member of the Management Board

CEO	CTO	CFO
Strategy, Sales, Communications	Casks for HLW and Spent Fuel	Controlling
Waste Management	Casks for LLW/ILW	Finance, Taxes, Procurement
Waste Management Projects LLW / ILW / HLW	Cask Loading and Service	IT Systems, General Administration
WTI	Equipment and Systems Engineering	Human Resources, Legal

The Company

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

Turn over > 250 Mio. Euro
Employees about 450

Shareholders

Subsidiary

wti

- Jülich
  - Conditioning and packaging of solid LLW

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

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
- **Operation of Storage Facilities** (until mid 2017 part of GNS, now part of government owned BGZ)






Further international Development

- **Germany is phasing out of Nuclear Energy**
  - Last spent fuel cask to be delivered for German market in 2025
  - Last casks for waste of reprocessing to be delivered ca. 2035

- **Focus on international customer**
  - Almost 100 CASTOR cask for dry storage of spent fuel contracted for customers outside Germany in the past three years

- **Target Markets**
  - *Europe:* Belgium, Switzerland, Spain, Czech Republic
  - *Asia:* Japan, Korea, Taiwan, (China)
  - *Rest of the World:* South Africa, (USA)

GNS

CASTOR® Spent Fuel Management

CASTOR® Casks by GNS


First CASTOR® cask
Still in operation/storage


Transport of a CASTOR® cask


CASTOR® casks at indoor storage facility

- Since the very first dry storage cask loading in 1983 the design principle of CASTOR® casks remains unchanged
  - CASTOR® casks by GNS are Dual-Purpose Casks
    - No overpack required for transportation and storage
    - Shielding is performed by the cask itself
    - "Load & Go" / "Store & Go"
  - CASTOR® casks consist of a monolithic DCI cask body and metal sealings in all lids of the containment
    - No welding seams
    - Suitable for long-term storage
    - Major cost savings compared to forged steel
  - CASTOR® casks features continuous pressure monitoring
    - 24/7 monitoring for any possible leakage

The CASTOR® Concept

Dual-purpose casks of GNS fulfil all protection goals during transport and dry interim storage:

- **Safe enclosure of the radioactive contents**
  - Monolithic cask body (ductile cast iron)
  - Double barrier lid system (forged steel)
  - Lid system permanently monitored for leak-tightness during interim storage
- **Shielding of radiation**
  - Thick-walled cask body (about 350 to 400 mm)
  - Polyethylene rods inside the cask wall and PE plates at both ends
- **Dissipation of decay heat**
  - Radial cooling fins machined into the cask wall enlarge the surface of the cask
- **Guarantee of subcriticality**
  - The design of the cask and its components (lids, basket, impact limiters) guarantee subcriticality under standard and accident conditions.

CASTOR® Variety

- Customized to a variety of reactor types including: PWR, BWR, VVER 440, VVER 1000, MTR, etc.
- Type B(U)F package design approval certificates (incl. validations) including:
  - Germany,
  - Belgium,
  - Czech Republic,
  - Netherlands,
  - Switzerland,
  - France,
  - UK,
  - USA.
- Storage licenses in many countries worldwide

GNS Casks Worldwide

GNS has already developed and manufactured almost 1700 casks for High Level Waste and Spent Fuel.

Casks loaded and in interim storage:

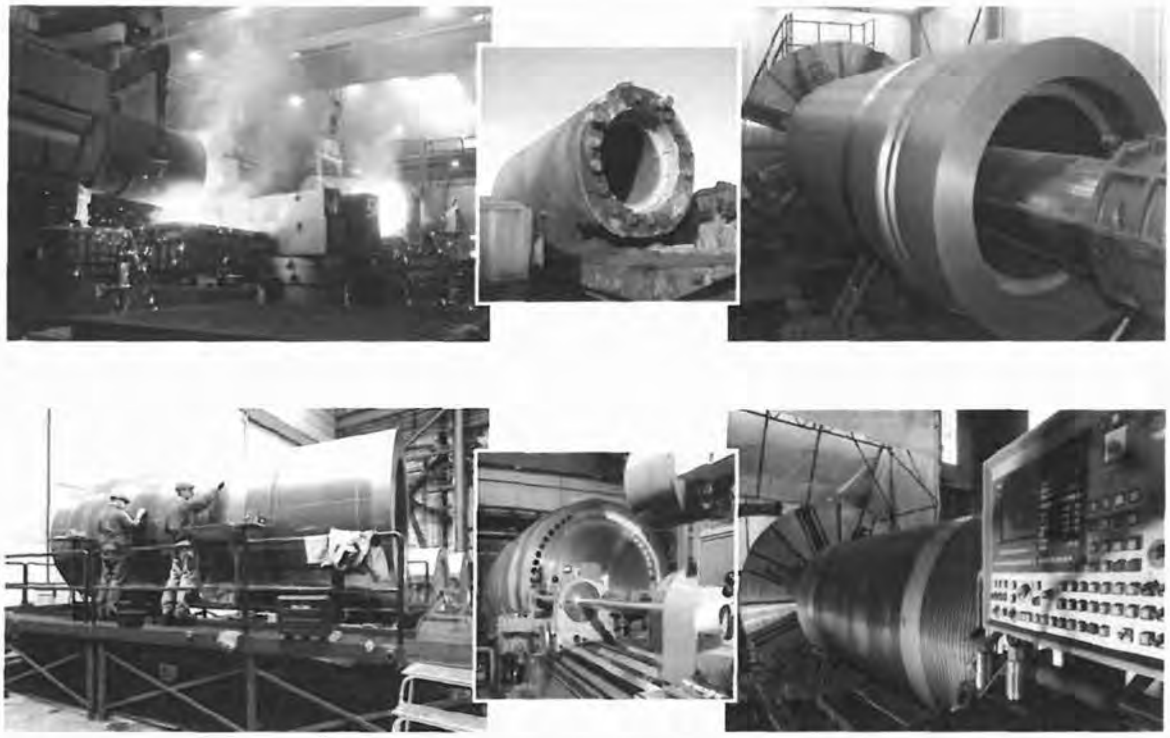
Germany	1266
Lithuania (Ignalina)	203
Czech Republic (Dukovany, Temelin)	124
USA (e.g. Surry)	35
Switzerland	14
Bulgaria (Kozloduy)	13
Belgium	7
South Africa	4

Additional casks delivered to:

- Finland, France, the Netherlands, Russia, Korea

As of December 2018

Manufacturing of the CASTOR® Cask Body



Assembly of CASTOR® Cask

GNS Cask Assembly at Mülheim

- Up to 80 Spent Fuel/HLW casks per year
- Assembly of ILW casks
- Training and testing facilities

GNS

CASTOR® geo and CLU

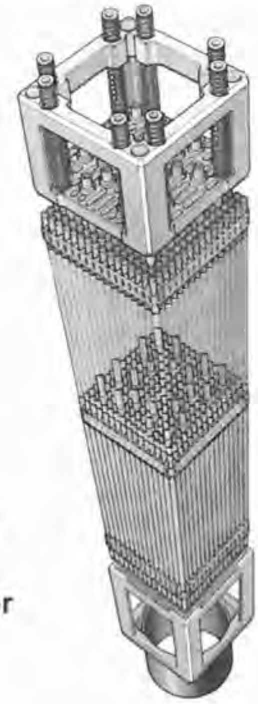
„German Fuel“ vs. Rest of the World

- German PWR fuel features larger diameters compared to international established PWR fuel
  - KWU: Ø = 230 mm
  - Areva : Ø = 214 mm
  - Westinghouse: Ø = 197 / 214 mm
  - CE-Type: Ø = 207 mm

→ **Baskets optimized for fuel with largest diameters result in smaller amounts of FA per cask**

- German NPPs run larger burn-ups compared to most other countries in the world
- German NPPs have a demand for shorter cooling times compared to most other countries

→ **Baskets optimized for rather hot fuel result in smaller amounts of FA per cask**



The CASTOR® geo Family

- Customized basket design
  - Optimized for high fuel capacity
- Established design principles incl. DCI cask body
  - Major cost advantages compared to forged steel cask bodies
- Based on standardized modules and components
  - Saves time and funds for licensing
- Standardized handling and dispatch of the casks
  - Savings in equipment due to standardizations

Storage Configuration

Basket for 32 PWR FA

First Customers for New Casks

- **Belgium:**
  - 30 CASTOR® geo contracted in 2016
  - Delivery from 2021 onwards
    - Units 1-3 of Tihange NPP
    - Units 3-4 of Doel NPP
- **Switzerland:**
  - 51 CASTOR® geo contracted in 2016
  - Delivery from 2024 onwards
    - Gösgen NPP

The CASTOR® CLU System

Next Challenge for GNS:
Complete defueling of dated US-type NPPs prior to decommissioning

Boundaries

- Crane Capacity often around 100 US-tons (90,7 Mg) with no option to upgrade
- Reasonable spent fuel specifications in terms of burn-up, cooling times etc.
- Demand for accelerated defueling as many of the old plants retire with immediate decommissioning.

The CASTOR® CLU System

CLU → Cask Loading Unit

- Canister based system for internal transfer increases FA capacity with given pool crane
- Dual Purpose Cask with bolted double lid system for storage and public transport
- Smooth licensing expected since majority of the existing reviewed safety cases of the CASTOR® cask might be re-used for the CLU system

CASTOR® CLU System – Glossary

CLU → Cask Loading Unit

- Canister is loaded under water and dispatched next to the pool while placed in the CLU
- Canister is closed by a dedicated lid with a bayonet locking system
- Canister handling inside plant within the CLU
- Bottom of CLU removable into the lock in order to lower the canister from the CLU into the CASTOR® cask
- Transports and storage inside the established CASTOR® casks with standard lid / sealing system

Quality Assurance

This document contains business and trade secrets of GNS.
v2

Quality Assurance

- GNS Integrated Management System is based on ISO 9001:2015
- Meets the requirements for quality management (QM) in accordance with IAEA SSR-6 and with the German regulation BAM-GGR 011 "Quality Assurance Measures of Packagings for Competent Authority Approved Package Designs for the Transport of Radioactive Material"
- Scope includes the development, manufacturing and operation of packagings of approved packages for the transport of radioactive material.

Quality Assurance

- Quality Assurance Program (QAP) acc. to ASME Section III Division 3 is implemented separately to the Integrated Management System (IMS) of GNS
- The Quality Assurance Manual (ASME-QAM) is in compliance with NQA-1 Part I
- QAP implemented and established at GNS in year 2018
- ASME Survey scheduled for April 8-11, 2019
- GNS intends to become N3 stamp holder

Quality Assurance

- The 10 CFR Part 71 Subpart H requirements are implemented in a Quality Assurance Manual (QAM II) which refers to the ASME-QAM
- Description of the Quality Assurance Program will be part of the Subpart D application
- Procedure of acceptance of QA Program by NRC to be defined
- Quality Project Manual (QPM) serve project-specifically as interface to regulatory, codes & standards, and customer requirements

Project Introduction

This document contains business and trade secrets of GNS.
v2

Project Objectives

- Package approval of CASTOR® geo69 as Type B(U)F package according to 10 CFR Part 71
- Challenges
  - Design of a class TC transport containment according to ASME BPVC Edition 2017, Section III, Division 3, part WB
  - Conversion of design and manufacturing specifications to US-compliant standards
  - Adoption of US-compliant standards of safety-proofs and licensing applications

Licensing Procedure

- Applicant:
  - **GNS Gesellschaft für Nuklear-Service mbH**,
    Frohnhauser Straße 67, 45127 Essen, Germany
- Contents of application:
  - Package description in accordance with §71.33
  - Package evaluation in accordance with §71.35
  - Quality assurance description in accordance with §71.37
- Time schedule:
  - Submission of SAR and QA description in December 2019
- URENCO USA Inc. will support GNS

Targeting Market

Proprietary Information withheld per 10CFR2.390

[redacted]

Targeting Market

Proprietary Information withheld per 10CFR2.390

[redacted]

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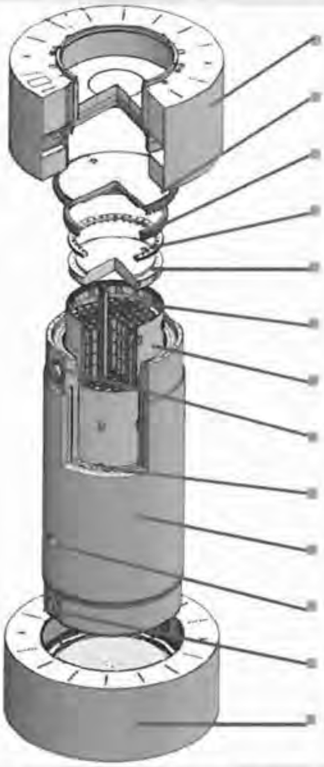
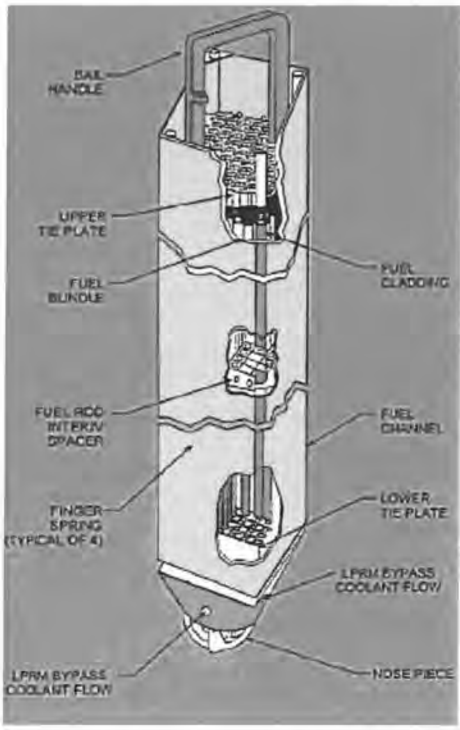
Technical Description of the Cask Concept

Package Overview – Main Components



- Lid Side Shock Absorber
- Cask Lid with axial Moderator, Bolts and Gaskets
- Thread Ring
- Tightening Ring with Bolts, Seals and Gasket
- Canister Lid
- Basket for 69 BWR-FAs
- Canister
- Trunnion
- Radial Moderator
- DCI Cask Body
- Name Plate
- Tilting Stud
- Bottom Side Shock Absorber

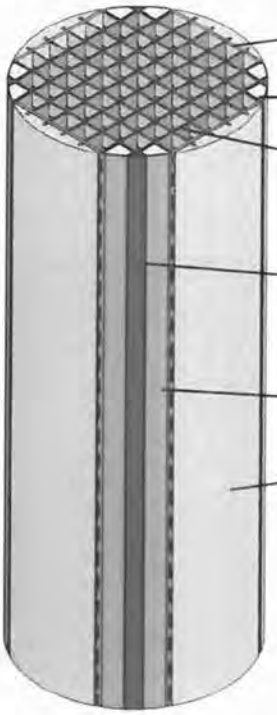
Applied Radioactive Content



- BWR Fuel Assemblies with or w/o Fuel Channel
- Dimensions (nominal)
  - Cross Section ≤ □140 mm
  - Overall length ≤ 4450 mm
  - Total weight ≤ 322 kg
- Data of Fresh Fuel
  - Fuel Type UO_2
  - Weight HM ≤ 185 kg
  - Length active zone ≤ 3810 mm
  - Enrichement 3.0 … ≤ 4,6 wt-%
- Irradiation
  - Burnup 20 … ≤ 60 GWd/MgHM
  - Cooling Time ≥ 10 years … 40

Description of cask concept - Basket

Proprietary Information withheld per 10CFR2.390



- Outer sheet: Aluminium Alloy
- B_4C Filling for n shielding
- Structural sheets for FA positioning: [redacted]
- Boronated Aluminium angle for shielding: Al-B_4C-MMC-10
- Housing for filling: Aluminium Alloy
- Aluminium segments for heat transfer: Aluminium Alloy
- Capacity for 69 BWR-FAs

Description of cask concept - Canister

Proprietary Information withheld per 10CFR2.390

[redacted]

- - - - - : Supplement Containment boundary for Burnup > 45 GWD/MgHM
- Welded stainless Steel Liner [redacted] and Bottom [redacted]
- Bolted lid, sealed by metal gaskets
- Geometry (Lo/li, Do/di): [redacted]
- [redacted]
  → Able for Handling of loaded Canister

[redacted]

- [redacted]

Description of cask concept - Cask Containment

Proprietary Information withheld per 10CFR2.390

[redacted]

- - - - - : Containment boundary for Burnup < 45 GWD/MgHM
- DCI CASTOR® cask → Excellent Experience in Germany
  - Monolithic cast Cask Body [redacted]
  - Accordance with ASME Sec. II (DCI SA-874M) → Qualification
  - Geometry (L_o/l_i, D_o/d_i): [redacted]
    - [redacted]
- Bolted Cask Lid with double metal Gasket
  → Excellent Experience, experimental investigation

[redacted]

- Integrated Moderator Rods in the Cask Wall
  → Qualification necessary?
- Handling via Lid Side Trunnions
- Tilting via Bottom Side Tilting Studs

Description of cask concept - Transport Configuration

- Lid and Bottom Side Shock Absorbers
  → Sufficient for Load protection for ACT, worst case 9 m Drop orientation
- Shock absorbing Material (PU)
  → NRC acceptance for other designs
- Transport Frame
  → Interface with Transport Vehicle
- No load application on Trunnions during Transport
  → Weight load directly on Cask body

Safety related Function of Main Components

Safety Related Function	Containment	Subcriticality	Shielding	Heat Tranfer	Cask Handling
Basket		x	x	x	x
Canister	x (1)		x	x	
Canister Lid	x (1)		x		x
Tightening Ring	x (1)				
DCI Cask Body	x		x	x	
Moderator rods inside Cask Body			x		
Cask Lid	x		x		
Cask Lid Bolting	x				
Moderator Plate			x		
Retention Ring					
Lidside Trunnion					x

x - Main Function

(1) - Supplement Containment, if Burnup > 45 Gwd/t

Materials of Main Components

Component	Raw Product	Material Group	Construction Code
Basket	rolled Plate	boronated Aluminium	ASME Section II and Section III, Div.3 Subsection WD (1)
Basket	Extrusions	Aluminium	ASME Section II and Section III, Div.3 Subsection WD
Canister	rolled Plate	Stainless Steel	ASME Section II and Section III, Div.3 Subsection WB
Canister Lid	Forging	Stainless Steel	ASME Section II and Section III, Div.3 Subsection WB ANSI N14.6
Tightening Ring	Forging / Plate	Stainless Steel	ASME Section II and Section III, Div.3 Subsection WB
Metallic Gasket - Typ Helicoflex HN200	Commercial Product	Silver/Stainless Steel	(2) - ANSI N14.5
DCI Cask Body	Casting	Ductile Cast Iron	ASME Section II and Section III, Div.3 Subsection WB
Moderator rods inside Cask Body	Plate	Polyethylene	(2)
Cask Lid	Forging	Stainless Steel	ASME Section II and Section III, Div.3 Subsection WB
Cask Lid Bolting	Forging	Stainless Steel	ASME Section II and Section III, Div.3 Subsection WB
Metallic Gasket - Typ Helicoflex HN200	Commercial Product	Silver/Stainless Steel	(2) - ANSI N14.5
Moderator Plate	Plate	Polyethylene	(2)
Retention Ring	Forging / Plate	Stainless Steel	ASME Section II and Section III, Div.3 Subsection WB
Lidside Trunnion	Forging	Stainless Steel	ANSI N14.6
Impact limiter	Foam	Polyurethan	(2)

(1) - Alternative Material not within the Code

(2) - No Code requirement

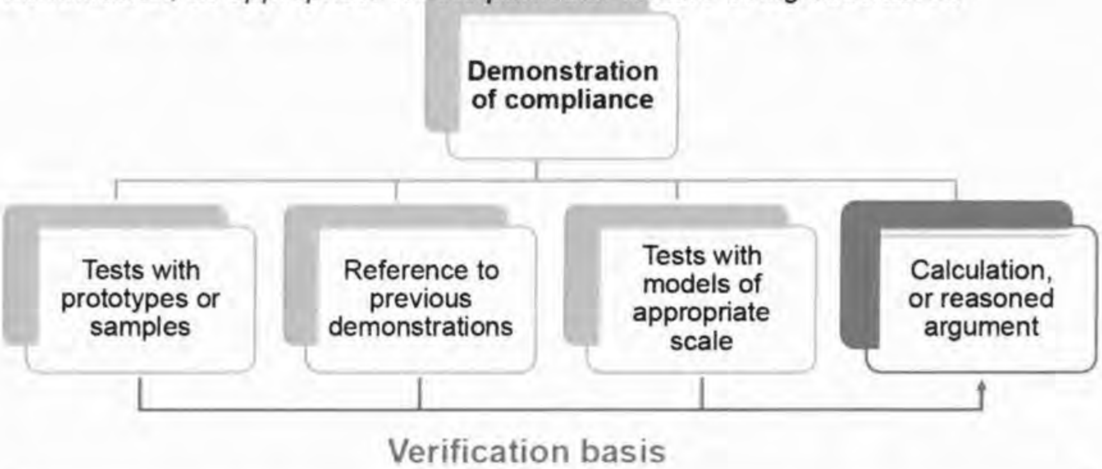
Safety Proofs

Safety Requirements (10 CFR 71 et al.)

- Criticality safety → Verification of max. k_{eff}
- Activity retention → Verification of max. leak rate
- Radiation shielding → Verification of max. dose rate
- Structural integrity → Verification of stress tests (NCT, ACT)
- Passive heat dissipation → Verification of thermal loads
  - 10 CFR 71, e.g. §§ 71.55, 71.59, 71.71/.73, 71.107
  - NRC Reg. Guide 7.4 → Leakage test requirements
  - NRC Reg. Guide 7.6 → Mechanical load criteria
  - NRC Reg. Guide 7.8 → Load combinations
  - NRC Reg. Guide 7.9, Ch. 6
  - Further cited standards, e.g. ASME Sec. III; ANSI N14.5, N14.6

Design Methodology

The effects on a package … , must be evaluated by subjecting a specimen or scale model to a specific test, or by another method of demonstration acceptable to the Commission, as appropriate for the particular feature being considered.



The safety analyses of the CASTOR® geo69 will be carried out by means of calculations which are verified by various tests with samples and scaled models.

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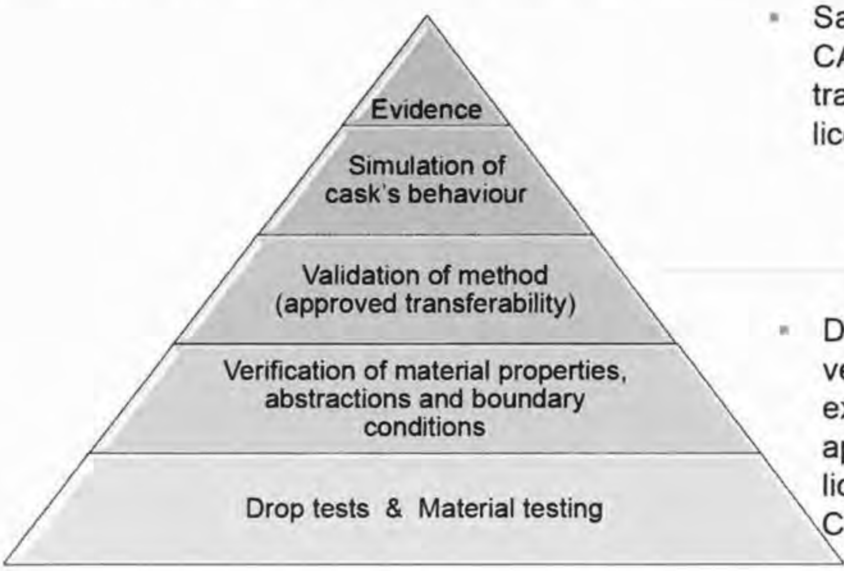
Approach to Demonstrate Safety



- Safety Case of CASTOR® geo69 for transport and storage licensing applications

- Design methodology verified by numerous experiments and approved within several licensing processes of CASTOR® casks

The applied cask type is based on the established CASTOR® concept, which relies on the long-term tested and continuously licensed, fabricated and applied cask design.

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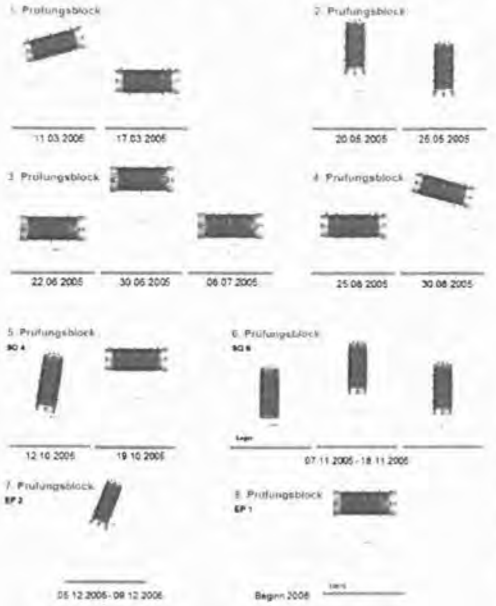
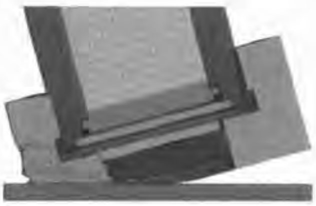
Drop Tests with a Half Scale Cask

- Instrumented drop tests sequences (2005 – 2006) according to Type B(U)F accident conditions



Codes & Standards – Mechanics



Design Calculations

- Numerical FE-codes
  - LS DYNA® (dynamic), ANSYS® (quasi-static)
- Analytical calculations
- International standards like FKM-Guideline, VDI etc.

Experimental base, e.g.

- GNS has executed more than 100 drop tests (9 m, pin drop) on unyielding targets
- Drop test program DROPrund (2009 – 2012)
  - Validation of numerical calculations for cylindrical impact limiters with German competent authority
- Drop test program CASTOR® HAW/TB2 (2005)
  - 17 drop tests for transport and storage licenses with 1:2 scale model
- Material and component tests, e.g.
  - Wall segments, basket segments, bolts, gaskets
  - Material behaviour (ductile cast iron, stainless steel ...)

All applied codes are verified by several cask and component tests.

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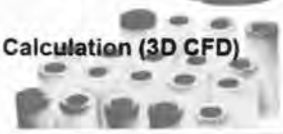
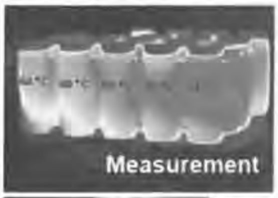
Codes & Standards – Thermal





Design Calculations

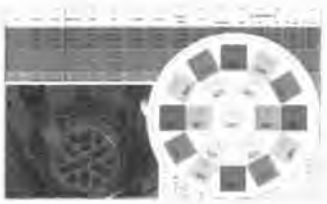
- ANSYS®-THERMAL, Version 15
- FLUENT from ANSYS®-CFD

Experimental base

- Validation of ANSYS®-THERMAL with examples from SANDIA-Benchmarks
- Validation of CFD-methods
  - Comparison with measured cask surface temperatures in the interim storage facility in Gorleben
  - Heat transfer of casks under a cover - Comparison of analytical methods with CFD and experimental results
- Fire tests under accident conditions performed

Thermal behaviour of CASTOR® concept is tested and approved.

Codes & Standards - Nuclear



Codes

- Nuclide inventory
  - SAS2H and ORIGEN-S from the SCALE 5.1
  - WTI programs OBERON and LOAD-CHECK
- Shielding
  - MCNP6 Ver 1.0
  - ENDF/B-VII continuous energy cross section data
- Criticality
  - KENO-VI from SCALE 5.1 code package
  - 238-group ENDF/B-V cross section data
  - CENTRM/PCM for self shielded resonance cross sections

Validation

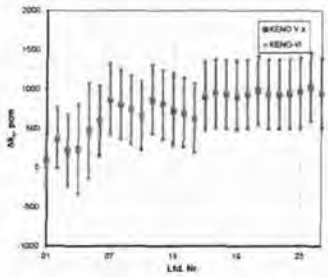
- Comparison of the measured and calculated values for CASTOR® V casks with similar design properties
- Benchmark experiments from ICSBEP Handbook
  (International Criticality Safety Benchmark Evaluation Project - ICSBEP)

The applied codes are verified by international benchmarks and measurements on loaded casks.

Criticality Safety – Code and Validation

- Validation by statistical analyses of ICSBEP benchmark experiments
  - 9 LEU-COMP-THERM experiments with 138 critical rod configurations (thermal neutron spectra with uranium fuel)
  - 6 MIX-COMP-THERM experiments with 79 critical rod configurations (thermal neutron spectra with MOX fuel)
  - Different absorber materials between the fuel rods

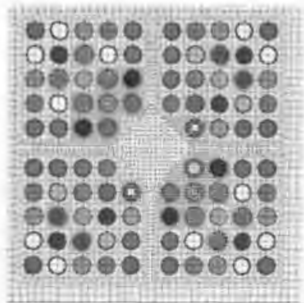
Validation provides uncertainty of the code as a contribution to Δk_U



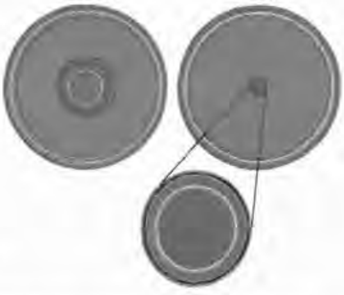
Inventory – Methods and Codes

- Main objective
  - Neutron (NSS) and gamma source strength (GSS)
  - Decay heat (DH) and radionuclide activities
- Methods and codes
  - 1D-transport code SCALE/SAS2 from Oak Ridge National Laboratory (ORNL)
  - 2D-transport codes
    - SCALE/TRITON from ORNL
    - HELIOS from Studsvik Scandpower
  - Burnup and Decay
    - SCALE/ORIGEN-S
- Typical fuel parameters
  - Enrichment up to 4,9 wt.-% ^{235}U
  - Burnup: typical 60 - 65 GWd/t_{HM} up to 80 GWd/t_{HM}

SCALE/TRITON-Model

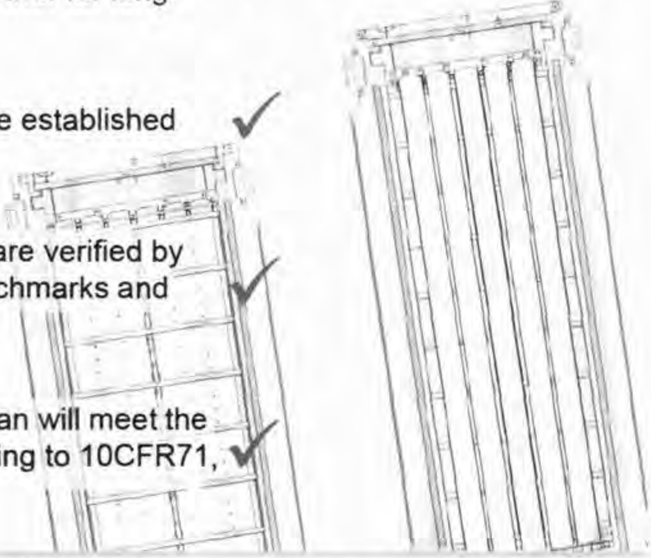


SCALE/SAS2-Model
UOX MOX



Conclusion

- The CASTOR® design is proven and internationally accepted for transport and storage ✓
- GNS has more than 35 years of experience with CASTOR® casks and is a reliable partner for long-term future activities ✓
- The CASTOR® geo69 is based on the established CASTOR® concept ✓
- The used codes and methodologies are verified by several casks, component tests, benchmarks and measurements on loaded casks ✓
- A established quality management plan will meet the specific requirements of NRC according to 10CFR71, Subpart H ✓



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Package Components

Cask Body – Ductile Cast Iron

Proprietary Information withheld per 10CFR2.390

Ductile Cast Iron (DCI)

- Referenced at ASME BPVC
  Section III, Divsion 3, Subsection WB and WC for use and construction of transport and storage containments
- According Casting Specification
  - Section II - SA-874 (American Standard)
  - Section II – SA/JIS G5504 (Japanese Standard)
- Mechanical Properties
  - Tensile Strength ≥ 300 MPa
  - Yield Strength ≥ 200 MPa
  - Elongation ≥ 12 %
  - Fracture Toughness ≥ 50 MPa $m^{1/2}$ at -40 °C, rapid-load test
- GNS Fabrication Expierence
  - More than 1200 castings of cask bodies
  - More than 10.000 test samples
  - Tensile Strength (avg) [redacted]
  - Yield Strength (avg) [redacted]
  - Elongation (avg) [redacted]

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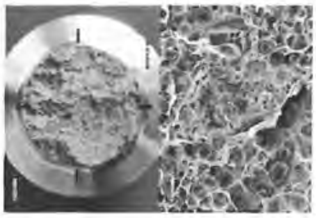
Cask Body – DCI - Material Tests

- Tension tests at IWM Freiburg (2005 – 2008) with specimens made of DCI
- Round specimens with different notch shapes defining the multi-axiality
- Main Result
  - Determination of the failure strain depending on the multi-axiality under tension



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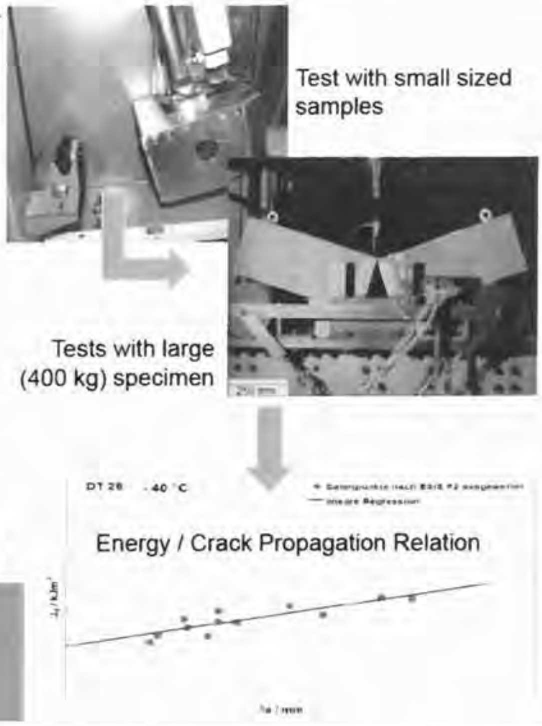
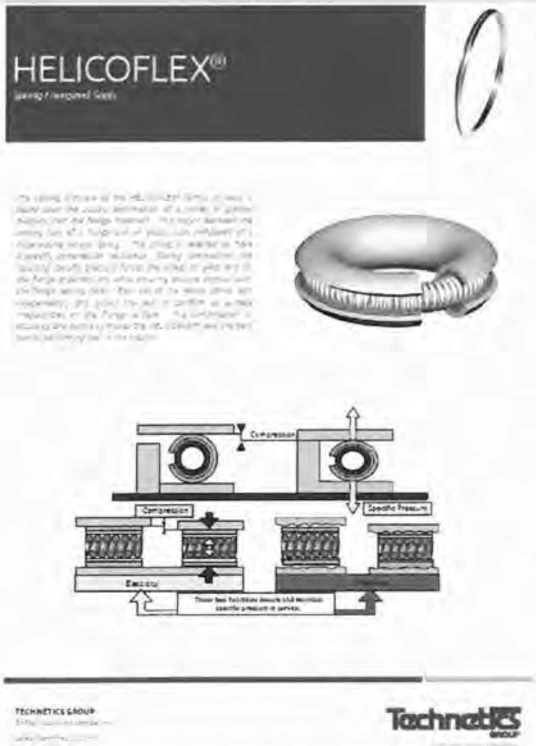
Cask Body – DCI - Material Tests

- Determination of the fracture toughness of DCI at -40 °C (since 2004)
  - The dynamic fracture toughness is required for fracture mechanical evaluation
  - Exclusion of unstable crack propagation under dynamic loads
- Main Results
  - Database of fracture toughness values and correlations between microstructure and strength
  - Influence of sample size and establishing of a specific test method



Verified lower bound value for fracture toughness under dynamic loads at low temperature.

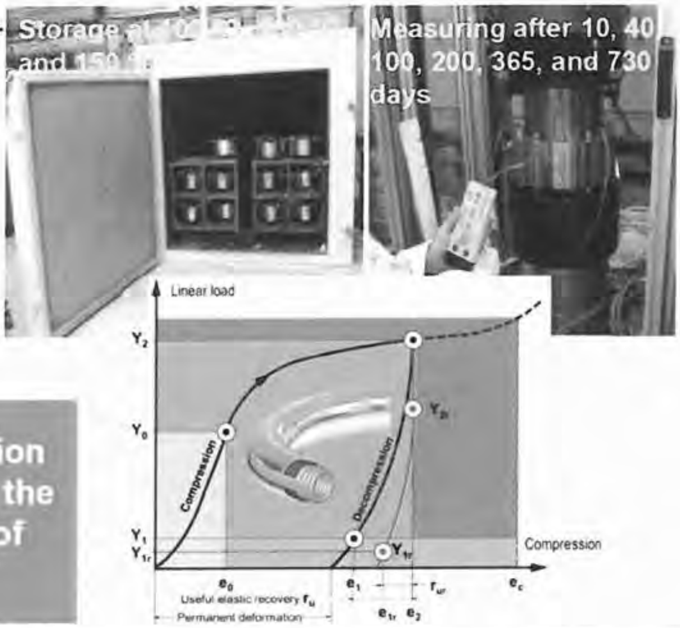
Lid System - Metallic Gasket



- Commercial Component, which is established as gasket for nuclear applications.
  - Typ B(U) transportation packages
  - storage systems for spent fuel
  - Reactor pressure vessels
- Metallic gasket serves for
  - High degree of tighness (10^{-8} Pa m^3/s)
  - Longterm stability and function
  - Broad range of application expierence gained by GNS since 40 years of application with loaded CASTOR® casks
- Material has already been accepted by NRC within 10CFR71 and 10CFR72 licencing cases
  - 72-1000 – CASTOR® V/21 stored onsite of NPP Surry / USA

Lid System – Material Test

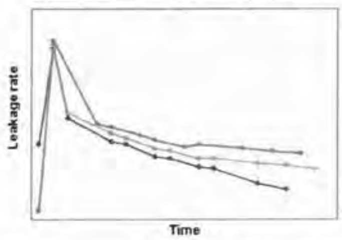
- Long-term tests at laboratory of CEA/Technetics Pierrelatte, France (2012 – 2018)
- Prognosis about the long-term characteristic of the used metallic gaskets
- Time-dependent behaviour of:
    - Restoring seal force Y_1
    - Useful elastic recovery r_u

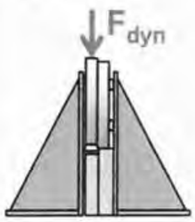


Knowledge of the time evolution of main sealing parameters of the used gaskets over a period of more than 40 years.

Lid System – Component Tests

- Testing of lateral displacement of the lids (2011 – 2014)
- Time-dependent recovery of leakage rate after impact within one week
- Even for extreme lateral movements of the lid up to 5 mm
    - Bolting assures sufficient pre-stress
    - Gasket remains sufficiently tight





Under extrem mechanical conditions the lid system maintains its integrity.

Lid System – Cask Tests

- Examination of the lid system after drop, measuring of the
  - Leakage rate
  - Remaining pre-stress in the bolts
  - Roughness of the sealing surfaces
  - Lid displacement

Verified leakage rates under accident conditions.

Impact Limiter – Polyurethan Foam

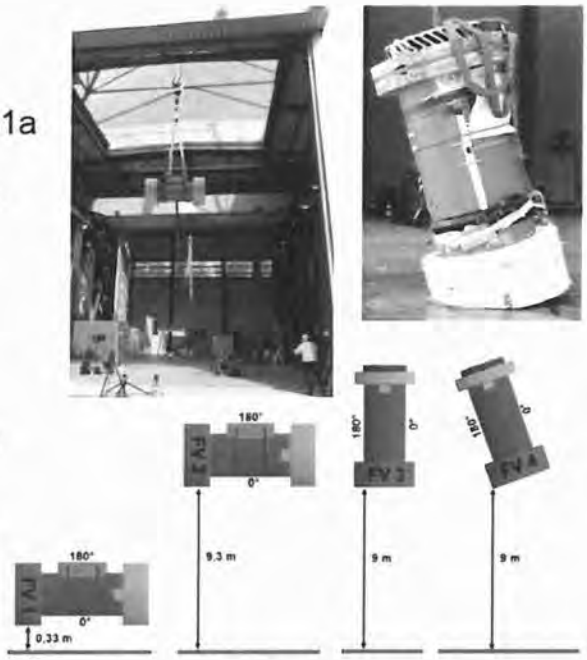
- Commercial Material, which is established as impact absorbing material for Typ B(U) transportation packages.
- Material has already been accepted by NRC within a 10CFR71 licencing case

Examples (limited set) of licensed Radioactive Material Packages using LAST-A-FOAM® FR-3700

Package Model No.: **TRUPACT II** US Certificate No.: **USA/9218/B(U)F-85** Licensee: **U.S. Department of Energy**	Package Model No.: **RH-TRU 72-B** US Certificate No.: **USA/9212/B(M)F-85** Licensee: **U.S. Department of Energy**
Package Model No.: **125-B** US Certificate No.: **USA/9200/B(M)F-85** Licensee: **U.S. Department of Energy**	Package Model No.: **NUHOMS® MP187 Multi-Purpose Cask** US Certificate No.: **USA/9255/B(U)F-85** Licensee: **Transnuclear, Inc.**
Package Model No.: **F-423** US Certificate No.: **USA/9299/B(U)-85** Licensee: **MDS Nordion**	Package Model No.: **Traveller STD and Traveller XLR** US Certificate No.: **USA/9279/AF-96** Licensee: **Westinghouse Electric Company**
Package Model No.: **UX-30** US Certificate No.: **USA/9196/B(U)-85** Licensee: **Duratek**	Package Model No.: **New Powder Container (NPC)** US Certificate No.: **USA/9294/AF-96** Licensee: **Global Nuclear Fuel**

Impact Limiter – Cask Tests

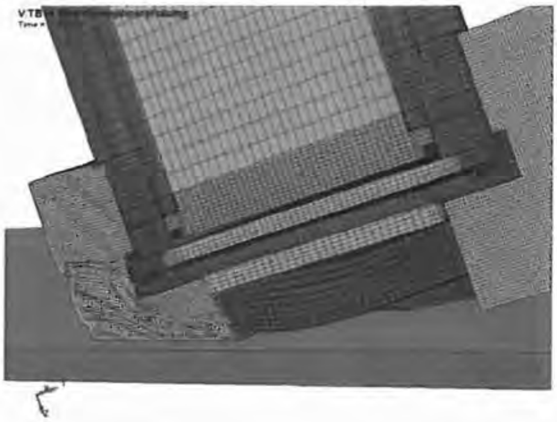
- Drop test programme with cylindrical impact limiter for validation test
  - Drop tests with CASTOR® V/TB1a half scale model based on CASTOR® V/19 and CASTOR® V/52
- 4 drop tests
  - For all relevant orientations
  - At operation temperature range (up to 80 °C)



Experimental database for verification established.

Impact Limiter – Cask Tests

- Comparison between calculation and drop test
- FEM simulation



- High-speed picture of the drop test

The applied numerical model is reliable for the simulation of high dynamic impacts with large deformations.

Basket Material – Boronated Aluminium MMC

Proprietary Information withheld per 10CFR2.390

EPRI

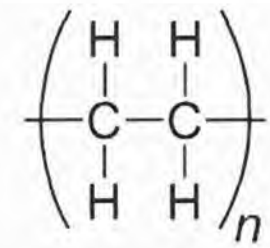
Handbook of Neutron Absorber Materials for Spent Nuclear Fuel Transportation and Storage Applications

2009 Edition

[redacted]

- Basket Material serves for
  - Geometrical boundary for lodgement carrying the F/A
  - Neutron absorbtion function to maintain subcriticality
  - Thermal conductivity
  - *Structural stability under all conditions of design*
- Boronated Aluminium Alloy as Metall Matrix Compound (MMC)
  - 10 wt.-% of B4C
  - [redacted]
  - No degradation during aeging due to thermal treatment before use
    - Time-independant structural properties
  - Candidate material:
    - [redacted]

Moderator Material – Polyethylen



- Commercial Component, which is established as neutron moderator for nuclear applications.
  - Typ B(U) transportation packages
  - storage systems for spent fuel
- Polyethylene serves for
  - Efficient moderation of neutron within the cask body
    - Highest partial density of hydrogen within a solid material
    - Cylindrical rods in deep bore holes
    - Plates between the lids and in the cask bottom
  - Broad range of application expierence gained by GNS since 40 years of application with loaded CASTOR® casks
- Material has already been accepted by NRC within 10CFR71 and 10CFR72 licencing cases
  - 72-1000 – CASTOR® V/21 stored onsite of NPP Surry / USA

Discussion