
AREVA

Manufacturing of a New MOX and UOX Transport Cask

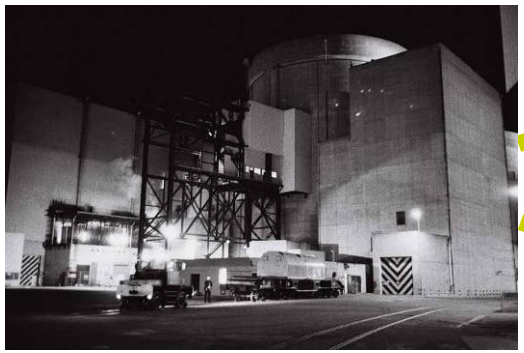
Hervé RIPERT

LOGISTICS

AREVA

TN®112: a New Transport Cask

- **A new transport cask designed to transport:**
  - **PWR used fuel 17x17 from 900 MWe power plants**
  - **Capacity**
    - Up to 12 MOX assemblies
    - or MOX mixed with UOX used fuel assemblies



900 MW reactor

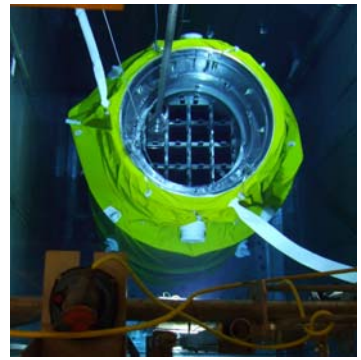
Used fuel

AREVA La Hague reprocessing plant

High Performance Cask

Performance:

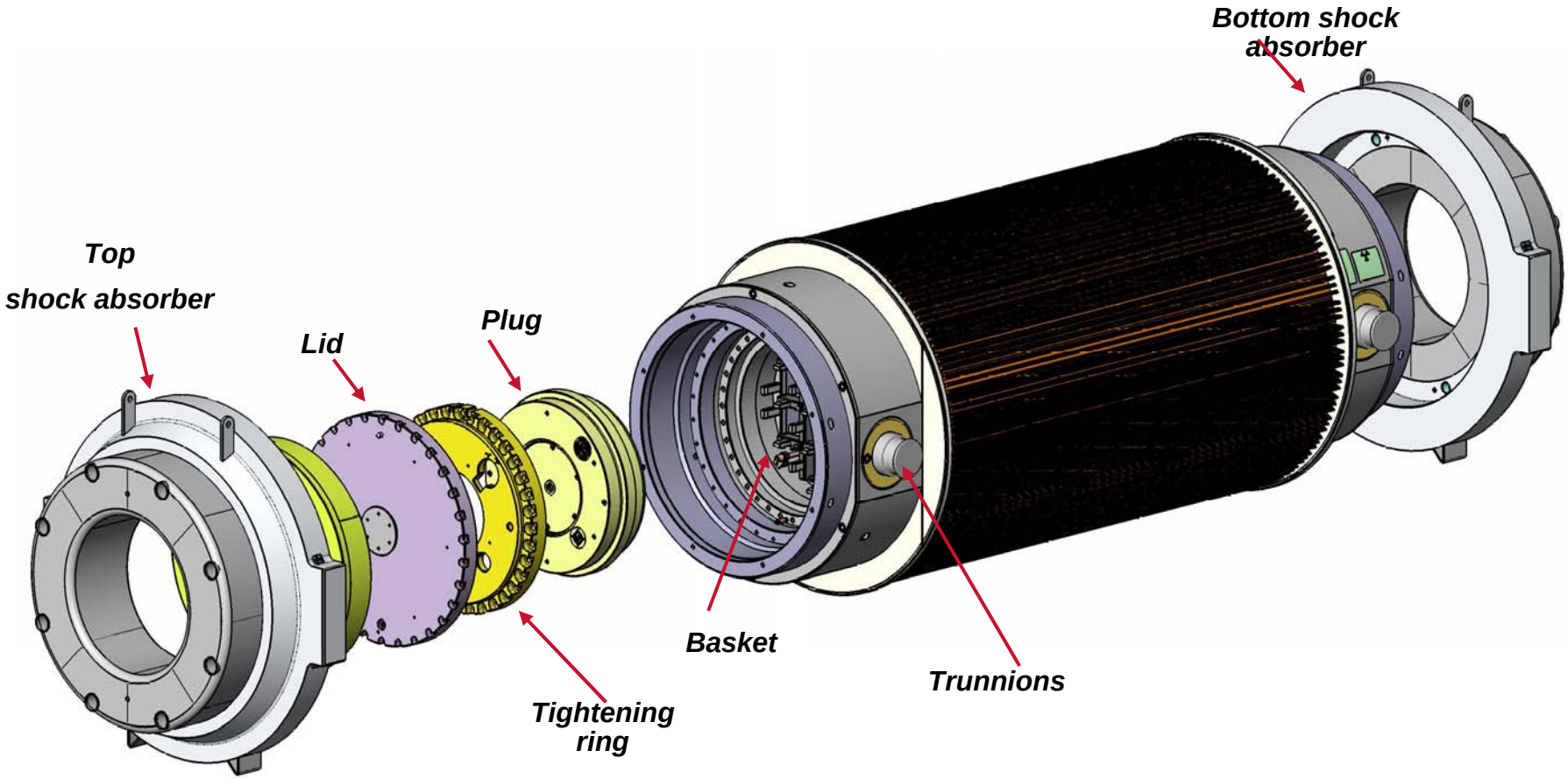
- **Maximum thermal power: 50 kW**
  - 4.16 kW /assembly
- **MOX enrichment: 9.3 %**
- **Maximum average burn-up: 50,000 MWd/tU**
- **Cooling time 392 days for UOX and 839 days for MOX**
- B(U) type certificate in accordance with AIEA regulations (2005 edition) (F/396/B(U)F-96 (Aa))



Main features

- **Loaded weight: 114.5 t**
- **Cavity diameter: 1,220 mm**
- **Cavity length: 4,136 mm**
- **External diameter: 2,790 mm**
- **External length: 7,001 mm**

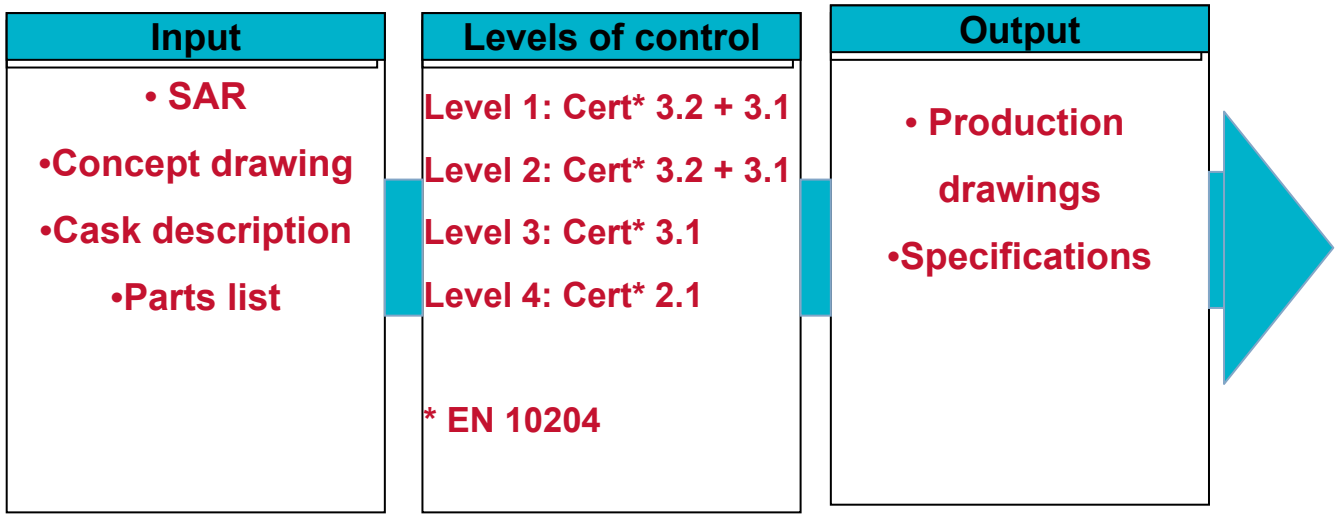
TN®112 Cask Diagram



Manufacturing Phases

- *Technical specs*
- *Procurement of materials*
- *Special process qualification*
- *Destructive tests*
- *Welding operations*
- *Non destructive tests*
- *Final tests*

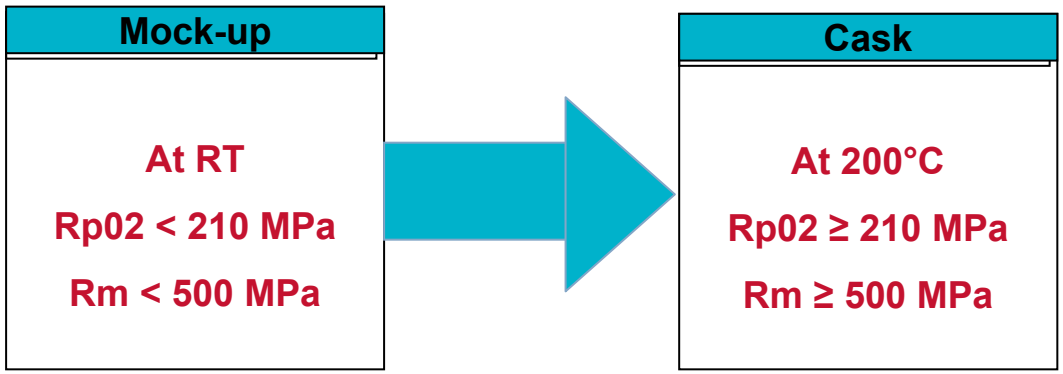
Preparation of the Technical Specifications



- Levels of controls are defined according to impact of failure on safety and maintainability
- Type controls (according to safety functions)
  - chemical analysis
  - mechanical tests
  - Non-destructive tests
  - dimensional tests

Procurement of the Containment Material

- **Austenitic stainless steel forging**
  - **No complex brittle fracture analysis in dynamic conditions at -40°C**
- **Selection of steel grade**

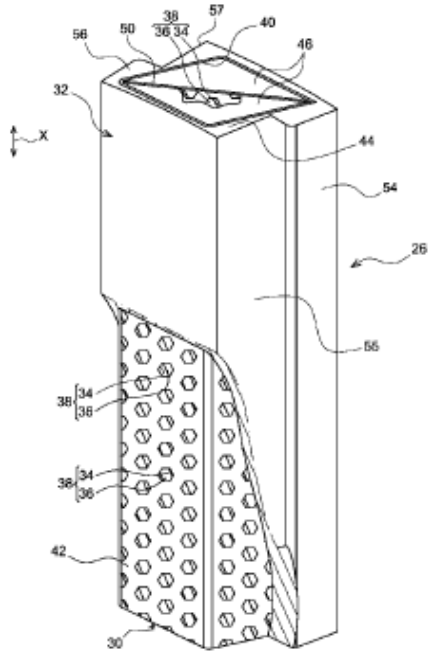


- **A single requirement for the forge master**
- **Solution: a high strength austenitic stainless steel**

Reinforced Lead

- High density gamma shielding material (patent application N° WO 2008/125409)
- Location between the primary and secondary containment
- The new material is made of a lead matrix reinforced with perforated high strength steel
- Reinforced to avoid plastic deformation at the maximum service temperature 200°C
- Prevent the following risk
  - lead settlement in the 9-m axial drop conditions
  - filling the radial thermal expansion gap

    ⇨loss of radial shielding



Neutron Shielding

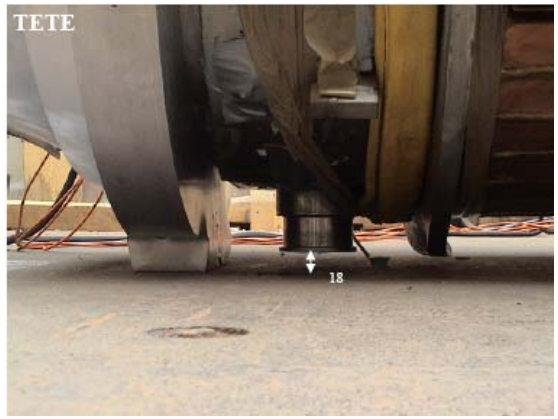
- **TN Vyal B™ resin (patent application N° WO 03/050822)**
  - **optimized shielding properties**

TN neutron shielding materials	TN®12	F	TN Vyal B™
H 10^{22} at/cm3	4..3	5	5.1
B 10^{22} at/cm3	9	9	8.7
Density	1.45	1.8	1.8

  - **enhanced thermal properties**
    - maximum service temperature 160°C
    - greater than TN®12
  - **Improved chemical stability**
    - new resin for the matrix
  - **Fire resistance properties are excellent**
    - M1 (self extinguishing) - NF P 92-501
    - F0 (toxicity of the smoke) - NF F 16-101

Aluminium Forging

- **Shock absorbing material**
  - **Minimum and maximum value**
    - Rp0.2
    - Rm
    - A%



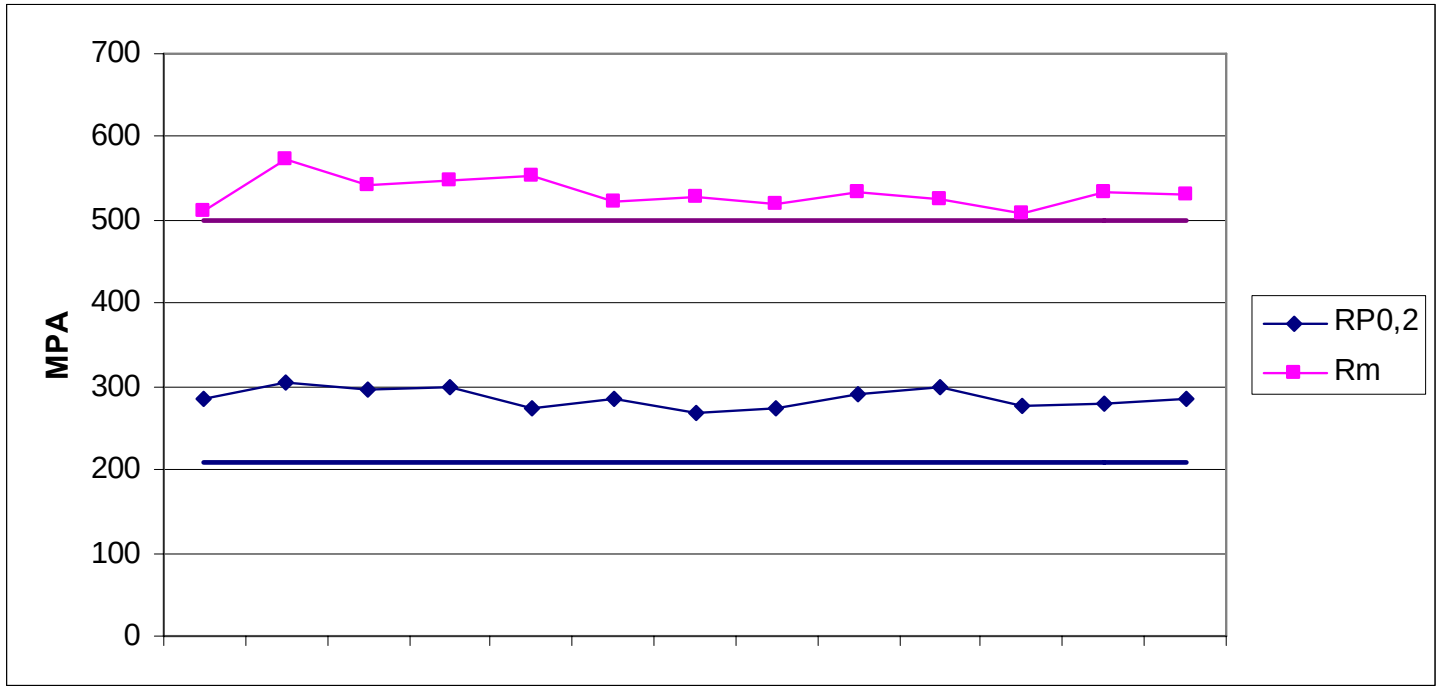
Al-B_4C Metal Matrix Composite (MMC)

- **Neutron absorbing material for the basket**
  - **Alcan's Al-B4C Metal Matrix Composite (MMC)**
  - **Testing of Mechanical performance**
    - Samples are taken from each extruded length for tensile testing
  - **Testing of Distribution of 10B**
    - Area density checked by transmittance measurements (10B/cm2). One sample per extruded length
    - Thermal ion mass spectrometer
      - Sample having the worst area density from neutron transmittance is tested in order to determine the minimum actual 10B content in the profiles used for the basket
- **Design takes into account the neutron absorber material as a structural component**

Destructive Test

High strength austenitic forging

Tensile test results at 200°C



Non-Destructive Tests

- **Stainless steel forging**
  - **Ultrasonic test – Quality level 3 – EN 10228-4 – DGS method**
- **Primary and secondary containment welds**
  - **Ultrasonic test – EN1714 level 2**
  - **Penetrant test - EN 1089 Level I**
- **Gaskets / gasket seats / containment welds**
  - **Helium leaktightness tests with mass spectrometer – EN 13185**

Final Tests

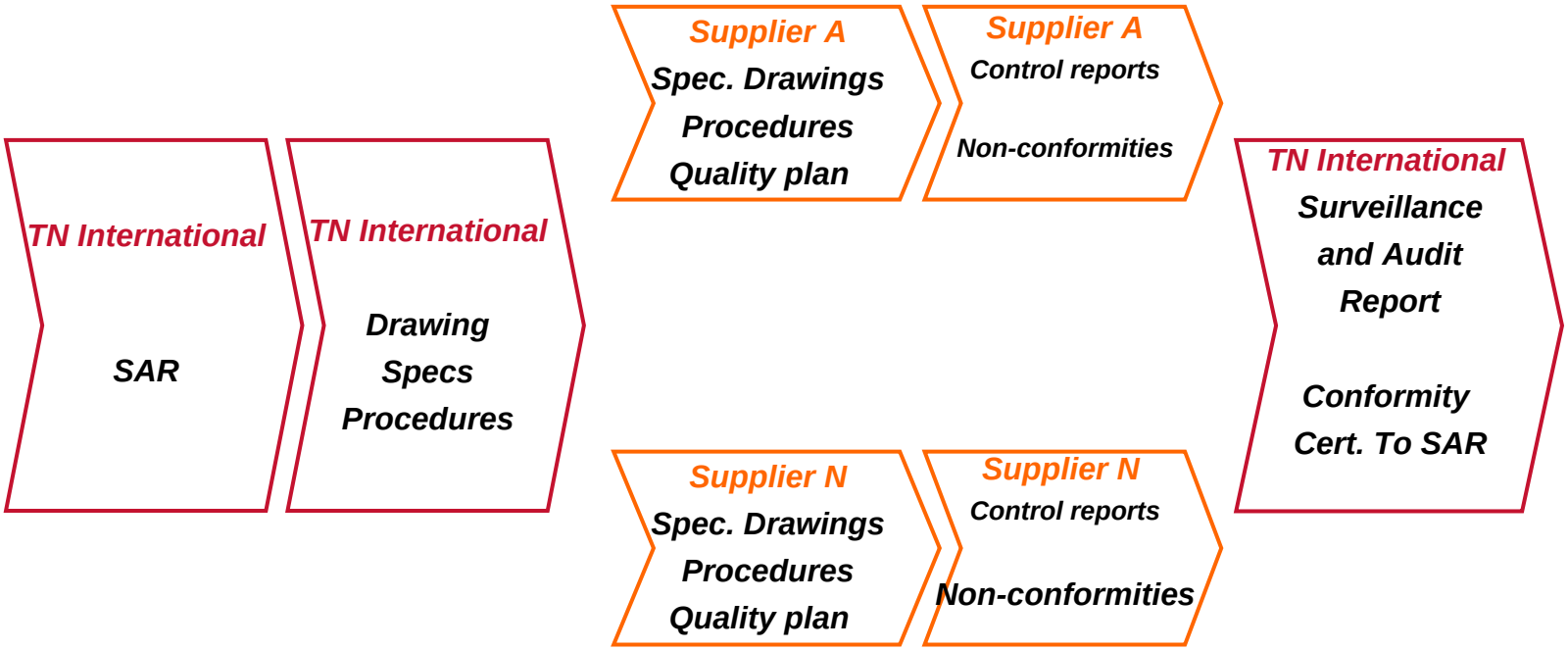
- Load test
- Hydro test
- Draining test
- Operational test with orifice-connecting tools and skirt
- Interface test assembly and disassembly of removal components
- Thermal test
- Leaktightness test

Quality Control

- **Checking of the manufacturing documents (from the supplier)**
  - **Purchasing specifications**
  - **Drawings**
  - **Quality plans**
  - **Welding Procedure and supporting Welding qualifications**
  - **Control procedures (NDT. dimensional test. load test…)**
- **List of manufacturer subcontractors (checked and approved)**
- **Inspection according to quality plans Hold and Witness point (monitoring of the control operations of the supplier independent from the production – redundancy)**
- **Checking of the data records at completion of the work (quality plans. material certificates. control records. Non-conformity and deviation…)**

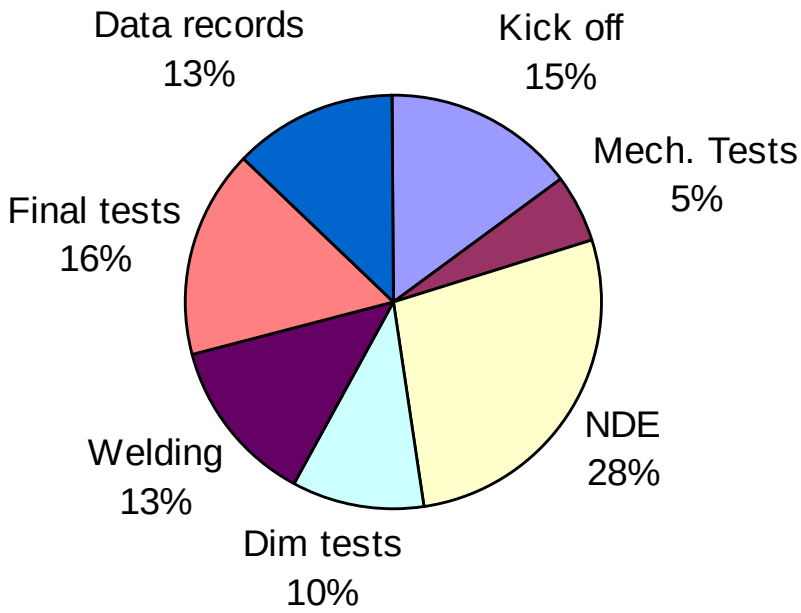
⇨ **High level of quality**

Quality Documentation Flow Chart



On-Site Control

More than 140 days of inspection



Conclusion

- **New materials**
  - high strength forged austenitic stainless steel
  - neutron shielding with Vyal B^{TM} resin
  - aluminium metal matrix material used as neutron absorber
  - soft aluminium for shock absorption
- **High level of quality**
  - ISO9001 Certification of suppliers
  - Quality control independent from production
  - Quality audit
  - TN International surveillance of production and control operations