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Development and qualification of waste packages for SFR Silo

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Ringhals - the largest power plant in Sweden
• Owners: Vattenfall (70.4 %) and E.ON (29.6 %)
• Number of reactors in operation: 4
• Production capacity: approx. 28 TWh/year
• Installed power: 3642 MW
• No. of employees: approx. 1514
• Covers approx. 20 per cent of the total demand for electricity in Sweden.
• Ringhals AB with subsidiary Barsebäck Kraft AB
Why developing a new package for SFR Silo?

• No existing waste package for metallic and other inorganic scrap to be disposed in SFR Silo

General target:
• Maximised payload and net volume
• A package designed to fulfil physical resistance requirements without taking waste form and solidification of the waste into account
• A design which fulfils requirements for alternative waste routes
• A wish to develop a basic package design common for all Swedish waste generators
• The handling or long term safety must not be jeopardized
The Vattenfall Ringhals perspective

- A type 24 package for SFR Silo is urgently needed
- A strong team is required
  Ringhals – waste owner
  Studsvik - waste treatment and technical consultants
  KG-gruppen – production logistics and mould production
  WSP – technical calculations and simulations
- A tight dialogue with SKB is a must
- The alternative routes (SFR Silo, SFR BMA and SFL) should all be possible with the same design
- Try to merge the common need in the Swedish nuclear industry regarding a common type 24 package and the Ringhals need for the SG-project
The Swedish system

Power plants

Fuel
Interim
Storage

CLAB

Studsvik

> 95 %

< 5 %

Power plants

Repository
Spent fuel
Operational waste
Long lived nuclides
Not built

Repository (SFR)
Operational waste
Short lived nuclides
In operation
**Ringhals steam generators**

October 2005, mSv/h (mrem)

- < 0.003 (0.3)
- 0.035 (3.5)
- 0.150 (15)
- 0.080 (8)

**Radioactivity inventory**

- Total: 92 TBq, 34 Ci
- Co-60: 0.65 TBq, 2 Ci
- Fe-55, Ni-63: 33 TBq, 89 Ci

**Activity distribution**

- 95% in the tube bundle
- 5% in the primary chambers

4700 tubes (~75 km)

21 m

200 t

110 t

4.4 m

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Technical concept

- Remote operated cutting cell
- Additional shielding
- Separation of steam dome
- Arrival and inspection
- Melting
- Segmentation
- Blasting Tubes & parts
- 80-85%
- 15-20%
Design and qualification of steel package mould

Disposal site waste acceptance criterias:
• Cubic form 1,2x1,2x1,2 meters
• Maximum gross weight of package: 5000 kg
• Maximum surface dose rate: 500 mSv/h
• Compression strength resistance (static vertical load from 42 packages with maximum weight)
• Resistance against major breakdown at free fall from 9 meters without taking solidification of the waste into account
• The package must fulfill the general long term safety requirements

Project optimisation targets:
• Maximise net volume (>95%)
• Minimise tare weight to allow high waste weight
• Minimise void
• Allow a maximum activity 2 TBq of which 0,5 TBq gamma emitting nuclides
Suitable waste forms

- Metallic scrap
- Inorganic non metallic scrap
- Residues from cutting, mechanical decontamination and melting
- Ashes from incineration
- Organic waste < 1% of total activity
Physical tests or 3D simulation?

Verification of the design - two different ways:

• physical test
• simulation of the resistance

➢ Simulation has the advantage that it can be a combination of optimisation and verification.
➢ Simulation was selected for this project.
Simulation of compression strength resistance

- Static load of 42 packages with maximum weight (5000 kg each)
Simulation of compression strength resistance.

Local deformations of the mould walls and bottom plate

Maximal deformation
mould walls = 3 mm

Maximal deformation
bottom plate = 6 mm

Acceptable
Simulation of free fall from 9 meters - case 1

Metallic scrap, without solidification or additive material, horizontal fall towards the ground
Simulation of free fall from 9 meters – case 2

Metallic scrap, without solidification or additive material, 45 degrees angle towards the ground – the worst case!

Acceptable
Summary

Project guidelines:
• Safety first - the principle of precaution is ruling
• Maximum net volume and payload
• Minimisation of void
• The same mould should be qualified for several different disposal routes (SFR BMA, SFR Silo and SFL)