

SKB defect assessment information

- TR-05-17: Probabilistic analysis and material characterisation of canister insert for spent nuclear fuel. Summary report. (Andersson et al)
 - Material characterisation.
 - Semi-analytical determination of defect distributions.
- TR-05-18: Pressure tests of two KBS-3 canister mock-ups. (Nilsson et al)
 - Two mock-ups tested.
 - Global collapse at 130 and 139 MPa, respectively.
- TR-05-19: Probabilistic analysis of canister inserts for spent nuclear fuel. (Dillström)
 - Initiation of crack growth dominates (over the local collapse event) when the external pressure is below the baseline case, i.e. 44 MPa.
 - Local collapse is strongly dependent of external pressure. Eccentricity of cassette is of great importance.

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- TR-06-43: Earthquake induced rock shear through a deposition hole. Influence of shear plane inclination and location as well as buffer properties on damage caused by the canister. (Börjesson, Hernelind)
 - Elasto-plastic modelling of copper and cast iron insert.
 - Elasto-plastic modelling of both Na-bentonite, Ca-bentonite and cemented bentonite. Bentonite density: 2000 and 2050 kg/m³.
 - Amount of shear: 10 and 20 cm. Shear angle: 22.5, 45 and 90 degrees.
 - Rather large degree of plastic deformation in copper lid.
 - Damaging effect on the copper and steel is larger when a limited amount of bentonite around the canister is cemented compared to the case of no cementation.
 - Damaging effect on copper and steel increases with amount of shear bentonite density.
- R-06-87: Earthquake induced rock shear through a deposition hole when creep is considered – first model. Effect on the canister and the buffer. (Hernelind)
 - Creep modelling of copper (K. Pettersson).
 - Elasto-plastic modelling of cast iron insert.
 - Elasto-plastic modelling of both Na-bentonite, Ca-bentonite and cemented bentonite. Bentonite density: 2000 kg/m³.
 - Amount of shear: 20 cm. Shear angle: 90 degrees.
 - 11.5% creep strain in copper lid.
 - Implementation of creep model into ABAQUS has been questioned.

SKB defect assessment information

- TR-06-09 (SR-Can, pp 503):
Preliminary results show that the insert has a high damage tolerance.
- TR-06-09 (SR-Can, pp 546):
Volume between fuel channels and periphery of the insert can be inspected with ultrasonic. Volume between fuel channels are more difficult to inspect. Ultrasonic might work, otherwise radiographic methods will be used.
- TR-07-12 (RD&D Programme 2007, pp 173):
Ongoing damage tolerance analyses of the insert indicate that the material that cannot be tested does not add anything from strength viewpoint.
- TR-07-12 (RD&D Programme 2007, pp 501):
Fracture mechanical properties of copper are extremely insensitive to stress risers which means that limited local defects do not affect the mechanical integrity of the copper canister.

SKB defect assessment information

- R-08-129 (NDT Reliability – Final report. Reliability in non-destructive testing (NDT) of the canister components):

- Copper cylinder/lid: Ultrasonic testing

- FSW: Ultrasonic testing



- Insert: Three different ultrasonic testing techniques are used to test the different zones of the cast iron insert.

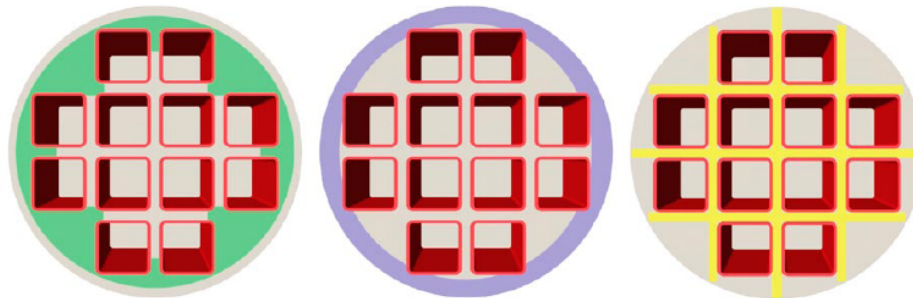


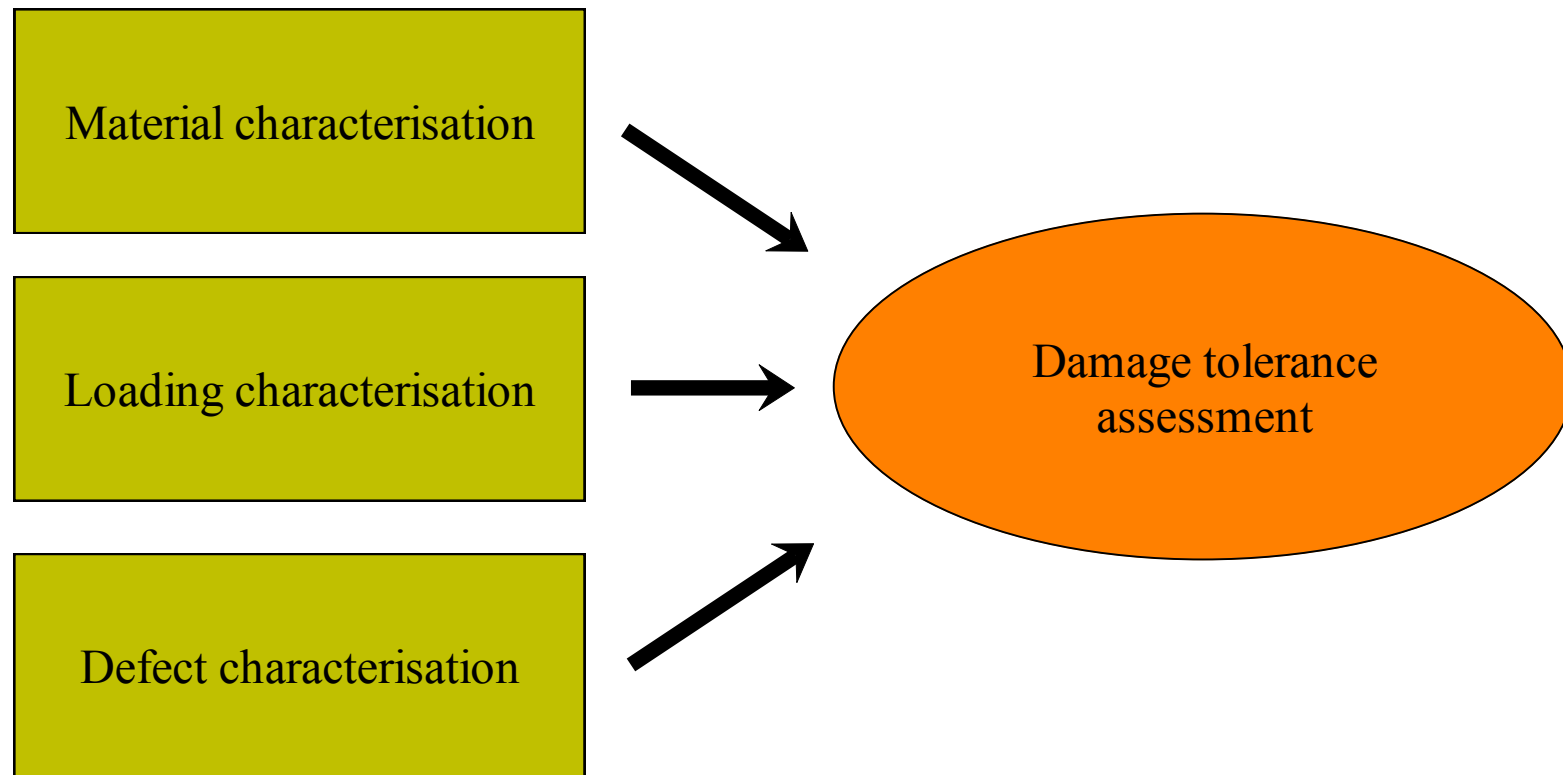
Figure 3-7. Inspection zones of the cast iron insert. (a) Normal incidence inspection, (b) angle inspection, and (c) transmission technique.

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SKB reports to be published:

- Earthquake analysis (Hernelind et al) (some results presented at BRITE meeting December 2008).
 - New copper creep model (R. Sandström).
 - Tensile stresses in copper lid.
- Damage tolerance of the insert (some results presented at BRITE meeting December 2008)
 - Results indicate high damage tolerance of cast iron insert.
 - Provide basis for quality inspection.
- Design basis
 - Interaction with damage tolerance assessment.

Planning of the evaluation of SKB's damage tolerance assessment



Planning of the evaluation of SKB's damage tolerance assessment

- Deterministic / probabilistic approach.
- Interaction with design basis.
- SKI reports
 - SKI Report 2003:12 “Mechanical integrity of copper canister lid and cylinder – Sensitivity study”.
 - SKI Report 2004:58 “Numerical modelling of mechanical integrity of the copper-cast iron canister – A literature review”.
 - SKI Report 2006:36 “Mechanical integrity of canisters using a fracture mechanics approach”.
- Further research do be done by SSM?

Effect of radiation on insert ductility

- L. Brissonneau, A. Barbu and J.-L Bocquet (CEA, France), 2004: Gamma and neutron radiation of an iron insert with a content of copper may result in embrittlement caused by copper precipitation hardening. A copper content of 0.05% should be an upper limit for the low carbon steel container.
- TR-07-12 (RD&D Programme 2007, pp 273): Problem was recognized.
- SKB answer September 2008 on TIL/F2 – Damage tolerance of canister components : Copper content has now been restricted to max 0.05%.