

Drop Test Facility

Key words

drop test, impact, drop tower, radioactive materials transport packages, containers

Fields of application

Drop tests with full scale casks and big cask models of containers for the transport, interim and final storage of radioactive materials

Methodology and instrumentation

Drop tests from 9 m height onto a rigid, non-resilient surface (2.600.000 kg) and from 1 m height onto a punch. The container has to be dropped in a way, which causes the most possible damage. To exclude tilting effects, a special detaching device for abrupt release has been developed by BAM. Drop tests are carried out in ambient air temperature or with deep frozen containers (-40°C). The test objects are equipped with strain gauges and acceleration sensors. The fast measuring system records data of the high dynamic strains and accelerations in the range from 3 ms to 50 ms. 128 measuring channels with analog bandwidths up to 200 kHz (-3dB) and sampling rates per channel up to 10 MHz can be used. Information about kinematics and the course of the impact are obtained with high speed camera and laser-optic odometers and velocimeters. After the drop tests the containers undergo some other inspections, for example helium leak tests for the quantification of the leakage rate.

Items tested

full scale casks and big cask models of containers for the transport, interim and final storage of radioactive materials or container components and assemblies of all kind up to 200.000 kg

Quantities / characteristics tested

strain (dynamic), acceleration [0 - 500.000 m/s²], velocity [0 - 20 m/s], path (dynamic) [0 - 300 mm] , force (dynamic) [0 - 2 MN], temperature [- 70°C – 1000°C], leakage rate [up to 10⁻¹² Pa m³/s]

Uncertainty / reliability of results

Depending on the test method 1% - 5 %

Qualification and quality assurance

The BAM drop test facility for big full scale casks up to 200.000 kg is for the time being worldwide unique. The tests are conform with the national and international conventions based on the IAEA Regulations for the Safe Transport of Radioactive Material.

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Further information

The drop test facility consists of three main assemblies: the drop tower with hoist, the test hall with moveable roof and overhead crane and tertiary the foundation with an impact pad area made of steel plates. The facility is supplemented with offices, measurement and observation rooms. The site has an access road for heavy goods vehicles.



The height of the drop tower, a steel tube construction, amounts 36 m. It stands over a lightweight construction hall on four drilled piles. The hoist in 33 m height can lift test objects up to 200.000 kg and to a drop height of 30 m.

The hall is divided in two areas for preparation and testing. An 80 t overhead crane for handling has been installed. The roof of the hall under the drop tower features a 10 m x 12 m retractable gate. In order to handle the test objects, three side walls are fitted with large rolling gates.

The unyielding foundation consists of a reinforced concrete block (14 m x 14 m x 5 m) whose impact pad area consists of three 22 mm thick mild steel plates with total dimension of 4,5 m x 10 m x 0,22 m. The overall mass of the foundation is more than 2.600.000 kg and is suitable for test objects with a mass of 200.000 kg. This meets the requirement of a foundation with the tenfold mass compared to the test objects. To get information about the strain and the performance of the foundation, sensors and strain gauges are placed in it.

The release of the test objects is carried out with special detaching devices developed by BAM to exclude tilting effects.

Technical data of the drop test facility:

Drop tower

- Height of drop tower with drilled piles: 36,10 m
- OF hoist: 33 m
- Base: 24 m x 22 m
- Clearance at 20 m height: 23,5 m x 19,5 m
- drilled piles: 14,00 m

Unyielding target

- Concrete block dimensions: [L x W x D]:
14 m x 14 m x 5 m
- Concrete block mass: 2.450.000 kg
- Steel reinforcement mass: 103.000 kg
- Target area dimensions: [L x W x D]:
10 m x 4,5 m x 0,22 m
- Main target area mass: 43.000 kg
- Ancillary target area mass: 17.000 kg
- Target area material: S235 (mild steel St 37)

Hoist

- Capacity: 200.000 kg
- Maximum hook clearance: 30,00 m



9 meter drop test of a full-scale cask model (181.000 kg)

Detaching devices

1. Electro-hydraulic detaching device
maximum detaching mass: 200.000 kg
principle: cracking of bolt by hydraulic impression cylinder
2. Electro-mechanical detaching devices
maximum detaching mass: 5.000 and 20.000 kg
principle: double action knee lever mechanism

Lightweight construction hall

dimensions: 19.80 m x 31,00 m

height: 15 m

equipment: Twin beam overhead crane with 80.000 kg hoist capacity

Working area of the overhead crane: 14,00 m X 24,00 m

Portable measuring data acquisition system

Dynamic strains and accelerations measurements in the range from 3 ms to 50 ms

128 measuring channels with analog bandwidths up to 200 kHz

(-3dB) and sampling rates per channel up to 10 MHz



Electro-hydraulic detaching device for test object masses up to 200.000 kg



Portable data acquisition systems for dynamic strain and acceleration measurements



Leakage testing of the closure lid system of a cask

Publications:

- Karsten Müller, Matthias Minack, Bernhard Droste
The New BAM Drop Test Facility for Big Full-Scale Cask
Proc. of 14th International Symposium on the Packaging and Transportation of Radioactive Materials (PATRAM 2004), Berlin, Germany, September 20-24, 2004
- Karsten Müller, Thomas Quercetti, Bernhard Droste
Measurement techniques and preliminary results of drop tests with full-scale spent fuel transport and storage casks
Proc. of 7th International Conference on Radioactive Materials Transport 2005, Cambridge, UK, September 27-29, 2005
- Bernhard Droste Karsten Müller, Matthias Minack
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Proc. of 7th International Conference on Radioactive Materials Transport 2005, Cambridge, UK, September 27-29, 2005