

Profile LFR-13

SHAKESPEARE

BELGIUM

GENERAL INFORMATION

NAME OF THE FACILITY
ACRONYM
COOLANT(S) OF THE FACILITY
LOCATION (address):
OPERATOR
CONTACT PERSON
(name, address, institute, function, telephone, email):

SHaking Apparatus for Kinetic Experiments of Sloshing Projects with EArthquake REproduction
SHAKESPEARE
Water, mercury
von Karman Institute for Fluid Dynamics, Waterlooesteeweg, 72 – 1640, Sint-Genesius-Rode, Belgium
VKI
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STATUS OF THE FACILITY
Start of operation (date):

In operation
2014

MAIN RESEARCH FIELD(S)

- Zero power facility for V&V and licensing purposes
- Design Basis Accidents (DBA) and Design Extended Conditions (DEC)
- Thermal-hydraulics
- Coolant chemistry
- Materials
- Systems and components
- Instrumentation & ISI&R

TECHNICAL DESCRIPTION

Description of the facility

SHAKESPEARE is a 3-axis shaking table for the reproduction of seismic excitations. Its purpose is to support the seismic safety assessment of MYRRHA and particularly the study of sloshing of the liquid coolant. The shaking table is equipped with three independent plateaus, each moving in one axis by the force of a hydraulic piston actuator. A compressor is used to supply the circuit with oil under high pressure, which is distributed to the three pistons through fast action valves. This allows the piston to change direction quickly and

permits fast dynamic response of the table. A central computer controls the position of each actuator in time and allows for realistic 3-axis earthquake signals to be reproduced.

The shaking table has a square shaped top surface of 1.5m and is designed for loads up to 500 kg. It can allow a maximum displacement of 45mm in each direction (stroke of 90 mm). It can follow frequencies up to 10 Hz and simulate seismic signals with accelerations of up to 1.1g.

On SHAKESPEARE is last mounted a Plexiglas model at scale 1/25 of the design 1.6 of MYRRHA. The model represents the cylindrical geometry with spherical bottom of the reactor vessel, machined in a square block of Plexiglas to reduce optical distortions for visualization and optical measurement techniques. The model is filled with water at the same ratio of height/radius as MYRRHA and is subjected to model earthquake excitations in the form of a displacement time history for the design conditions. The motions of the liquid surface inside the reactor vessel are studied and forces are measured on different parts of the model.

Acceptance of radioactive material

No

Scheme/diagram

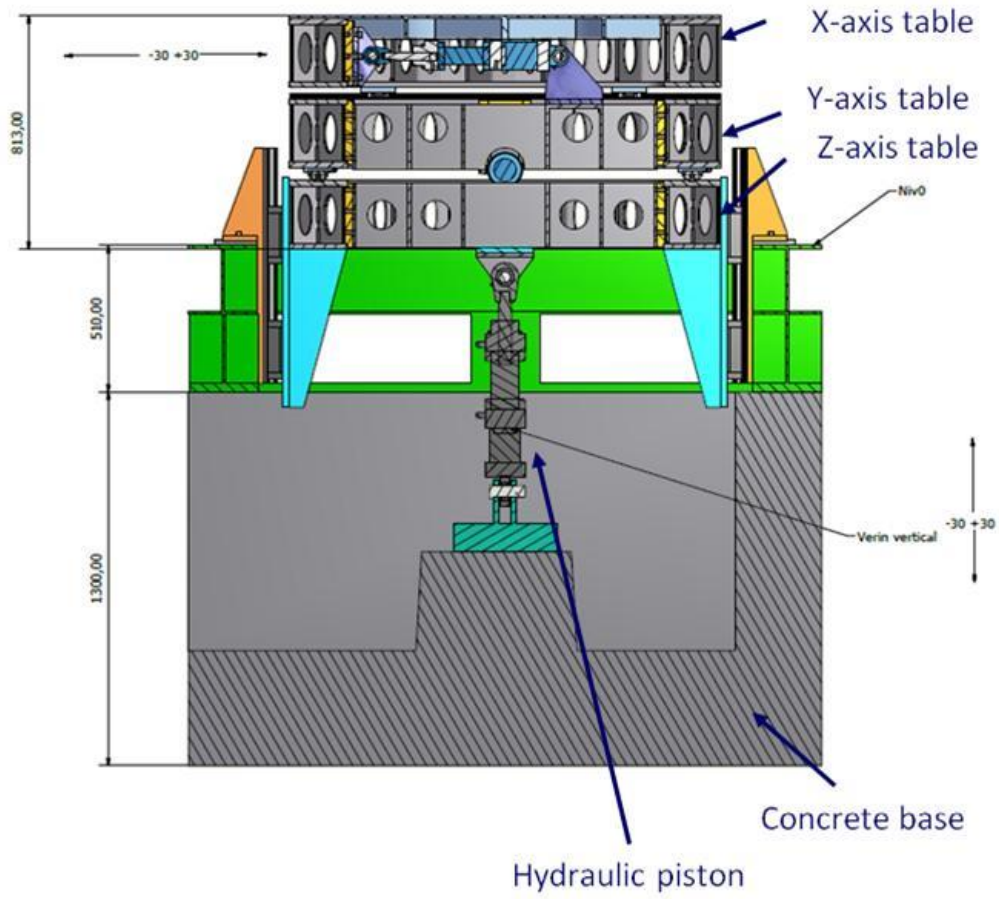


FIG. 1. Design of the SHAKESPEARE facility.

3D drawing/photo



FIG. 2. Experiment of sloshing in cylindrical tank on the SHAKESPEARE facility.

Parameters table

Coolant inventory	Water, mercury
Power	N/A
Test sections	
TS #1	<u>Characteristic dimensions</u> 1.5m square test surface
	<u>Static/dynamic experiment</u> Dynamic – earthquake simulation
	<u>Temperature range in the test section (Delta T)</u> -
	<u>Operating pressure and design pressure</u> atmospheric
	<u>Flow range (mass, velocity, etc.)</u> -
Coolant chemistry measurement and control (active or not, measured parameters)	-

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

Sloshing experiments have been performed since January 2014 in simple cylindrical tanks using water and mercury. Flow visualization and tracking of the interface position in time through Digital Image Processing has been performed for simple sinusoidal excitations for different amplitudes and frequencies, as well as realistic earthquake simulations (DBE of 0.3g). A study of the effect of the liquid properties on the sloshing behaviour inside the reactor has shown small differences between water and mercury for the studied excitations, mainly for the shape of the surface and ejection of droplets for mercury.

An updated model of MYRRHA based on version 1.6 has been constructed at the end of 2014 and first qualitative tests with water have been carried out to study the effect of internal components on sloshing.

PLANNED EXPERIMENTS (including time schedule)

Experiments using the model of MYRRHA v1.6 (scale 1/25) are planned for 2015, including flow visualization, force measurements on instrumented components, acceleration and pressure on different parts of the model of the reactor for a Design Basis Earthquake and beyond design situations. The purpose is to provide an experimental database for CFD code validation.

Moreover, validation of the scaling laws will allow measurements on the reduced scale model to be extrapolated to the MYRRHA sloshing situation.

TRAINING ACTIVITIES

The facility is used for student projects where seismic excitation or shaking of a model is required.

Training activities can be planned at VKI in agreement with SCK•CEN.

REFERENCES (*specification of availability and language*)

1. MYRILLAS K., PLANQUART P., M. BUCHLIN J.-, "Sloshing Phenomena – Experimental and Numerical study", in Fluid Mechanics and chemistry for safety issues in HLM nuclear reactors, ISBN-13 978-2-87516-064-5, VKI LS 2014-02, November 2013, Rhode-Saint-Genese, Belgium. (English)