GENERAL INFORMATION

NAME OF THE FACILITY: LIquid MEtals Test Stand 1
ACRONYM: LIMETS1
COOLANT(S) OF THE FACILITY: Lead-Bismuth Eutectic (LBE)
LOCATION (address): SCK•CEN, Boeretang 200, 2400, Mol, Belgium
OPERATOR: SCK•CEN
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STATUS OF THE FACILITY
In operation
Start of operation (date):

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
LIMITS1 is an experimental set-up designed for mechanical testing of materials in an LBE environment in order to investigate mechanisms and kinetics of material/liquid metal interactions that influence mechanical properties of the material. The vessel consists of an autoclave in which the experiments are performed and a dump tank. Oxygen control is done via a controlled gas flow of an adjustable argon hydrogen mixture with an H\textsubscript{2} concentration of up to 20%. Oxygen control can be performed in both the autoclave and the dump tank. Each of these are equipped with two Bi/BiO\textsubscript{2} oxygen sensors. The autoclave houses a mechanical testing device that can be operated in a gas atmosphere or under stagnant LBE. Possible tests include tensile tests, fracture toughness tests, slow strain rate tests, constant load tests and crack growth rate experiments. The maximum load of the device is 20kN and the displacement rates range between $3 \times 10^{-6}$ to $9 \times 10^{-2}$ mm/s. The temperature range from 550°C down to room temperature. Obviously, below the melting point of the coolant only experiments in a gas atmosphere are possible.

Acceptance of radioactive material
No

Scheme/diagram

FIG. 1. Scheme of the LIMITS1 facility

3D drawing/photo
**Parameters table**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coolant inventory</td>
<td>3.5 l</td>
</tr>
<tr>
<td>Power</td>
<td>3.5 kW</td>
</tr>
</tbody>
</table>

**Test sections**

<table>
<thead>
<tr>
<th>TS #1</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Characteristic dimensions</strong></td>
<td>15 cm x 20 cm</td>
</tr>
<tr>
<td><strong>Static/dynamic experiment</strong></td>
<td>Static</td>
</tr>
<tr>
<td><strong>Temperature range in the test section</strong></td>
<td>550°C - RT</td>
</tr>
<tr>
<td><strong>Operating pressure and design pressure</strong></td>
<td>4 bar</td>
</tr>
<tr>
<td><strong>Flow range</strong></td>
<td>Stagnant LBE</td>
</tr>
</tbody>
</table>

**Coolant chemistry measurement and control**

<table>
<thead>
<tr>
<th>Coolant chemistry measurement and control (active or not, measured parameters)</th>
<th>Oxygen control via controlled gas flow Ar, Ar+5% H₂, Ar+20% H₂. Double set of Bi/BiO₂ sensors installed in both tanks</th>
</tr>
</thead>
</table>
**COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS**

LIMITS 1 was mainly used in the MYRRHA materials qualification programme and for various EU projects including FP6-EUROTRANS-DEMETER, FP7 GETMAT and FP7 MATTER. The work focused on the assessment of Liquid metal embrittlement (LME) of austenitic and ferritic martensitic steels in LBE. An extensive set of tests were performed on various samples of T91- ferritic-martensitic steel and on 316L austenitic steel. Various possible influencing factors for LME embrittlement such as the applied strain rate, the surface preparation of the sample, the oxygen concentration of the melt, the test temperature and crack pretreatment were investigated. No evidence for the susceptibility of austenitic steels for LME embrittlement was found. Ferritic-martensitic steels do show LME albeit that significant plastic deformation is necessary to initiate LME.

**PLANNED EXPERIMENTS (including time schedule)**

The planned experiments in LIMITS I are the following:

- Mechanism of LME
- LBE effects on tensile, fracture toughness, s
- Screening tests for SCC
- Effect of irradiation on LME susceptibility
- Demonstration of austenitic stainless steel immunity to LME
- Usability range of T91

**TRAINING ACTIVITIES**

Training activities are possible, availability allowing and after prior agreement under supervision of SCK-CEN Qualified staff.

**REFERENCES (specification of availability and language)**