GENERAL INFORMATION

NAME OF THE FACILITY: LIQUIDUS
ACRONYM: LIQUIDUS
COOLANT(S) OF THE FACILITY: Sodium
LOCATION (address): CEA Cadarache, 13108 Saint Paul Lez Durance, FRANCE
OPERATOR: CEA
CONTACT PERSON: O. GASTALDI
(name, address, institute, function, telephone, email): Building 208, 13108 Saint Paul Lez Durance, FRANCE, Sodium Technology and Components Project Manager, +33 4 42 25 46 40, Olivier.gastaldi@cea.fr

STATUS OF THE FACILITY: In operation
Start of operation (date): Since 2008 for sodium operation. Existing since 2003 but operated with PbBi eutectic

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
The LIQUIDUS sodium facility is an experimental device to be used for studying the transmission of ultrasonic waves at a solid material–liquid sodium interface.

The main component of this device is a glove box with a volume of around 400 litres fitted with an airlock. A pot containing 3 litres of sodium whose temperature can be increased up to 500°C is installed inside the containment. Two cylindrical metal bars made of 316L steel, referred to as waveguides, are
used for conveying the ultrasonic waves.

The guides are used for transmitting, in the liquid sodium test pot, the ultrasounds emitted and received by traditional ultrasonic transducers located outside the glove box at ambient temperature. The advantage of the waveguides is that they can be employed for performing ultrasonic experiments in liquid sodium at temperatures up to 500°C without having to implement transducers capable of withstanding such conditions.

Each waveguide is cooled by a heat exchanger positioned outside the glove box allowing to reach 40°C at the outside extremity of the waveguides. A gas purification unit is employed for reducing oxygen and humidity concentrations down to 1 ppmV under argon, which is used as cover gas.

Acceptance of radioactive material
No

Scheme/diagram
Schematic view of the acoustic part of Liquidus sodium test section

3D drawing/photo
**Parameters table**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coolant inventory</td>
<td>3 L of sodium</td>
</tr>
<tr>
<td>Power</td>
<td>Around 3 kW</td>
</tr>
<tr>
<td>Test sections</td>
<td></td>
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<tr>
<td><strong>TS #1</strong></td>
<td></td>
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<tr>
<td><strong>Characteristic dimensions</strong></td>
<td></td>
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<tr>
<td>Inner diameter of sodium pot:</td>
<td>210 mm</td>
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<td><strong>Static/dynamic experiment</strong></td>
<td></td>
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<tr>
<td>Static</td>
<td></td>
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<tr>
<td><strong>Temperature range in the test section (Delta T)</strong></td>
<td>110°C to 500°C</td>
</tr>
<tr>
<td><strong>Operating pressure and design pressure</strong></td>
<td>0.5 mbar &lt; operating pressure &lt; 4 mbar</td>
</tr>
<tr>
<td><strong>Flow range (mass, velocity, etc.)</strong></td>
<td>N.A.</td>
</tr>
<tr>
<td><strong>Coolant chemistry measurement and control (active or not, measured parameters)</strong></td>
<td>No coolant purification except manual skimming.</td>
</tr>
<tr>
<td></td>
<td>Argon (cover gas) purification unit allowing to reach high gas quality (&lt; 1 vpm oxygen and moisture)</td>
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<tr>
<td><strong>Instrumentation</strong></td>
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<tr>
<td>Temperature measurement in sodium</td>
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<td>Pressure measurement in gas</td>
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<tr>
<td>Oxygen and humidity measurement in gas</td>
<td></td>
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<td>Ultrasound transmission and reflection measurement</td>
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**COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS**

Within the framework of the development of immersed ultrasound transducers operating in sodium, one major challenge is to obtain the sodium wettability of the emitting surface of the transducer at relatively low temperature (200°C). Then different samples were used to determine their ability to obtain a good acoustic coupling between solid and liquid sodium. These samples are

- Made of different materials: stainless steel, resins ...
- With different roughness surface
- And potentially with different coating materials

It was shown that the presence of gas pocket can have a major effect on the obtained coupling results. Of course the level of temperature also plays a key role.

**PLANNED EXPERIMENTS (including time schedule)**

In 2015 and 2016, a new experimental campaign will be realized on metallic sample with a specific surface preparation.

**TRAINING ACTIVITIES**

Possible, but no specific program is planned.
REFERENCES (specification of availability and language)

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Experimental study of ultrasound propagation at a liquid–solid composite interface for inspection of liquid–metal cooled nuclear reactors,

K. Paumel, J. Moysan, M. Autric, C. Gueudré, G. Corneloup, F. Baqué,
Visualization of the ultrasound-induced behaviour of gas pockets entrapped on a patterned surface. Application to inspection of sodium-cooled fast reactors,
Nuclear Engineering and Design, Volume 239, Issue 11, November 2009, Pages 2272-2278

K. Paumel, O. Descombin, J. Moysan, G. Corneloup, and J.-M. Augem,
Acoustic coupling of ultrasonic transducers for in-service inspection of sodium fast reactors,
Proceedings of the International Conference on Advancements in Nuclear Instrumentation, Measurement Methods and Their Applications (ANIMMA '09), Marseille, France, June 2009, Paper 78

François Baqué, Frédéric Reverdy, Jean-Michel Augem, and Julien Sibilo,
Development of Tools, Instrumentation and Codes for Improving Periodic Examination and Repair of SFRs,
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