

## MULTI-FUNCTIONAL CONTAINMENT ATMOSPHERE MONITORING SYSTEM - HERMETIS

### Accurate In-Containment Atmosphere Concentration Measurement During Accidents

**Framatome's HERMETIS provides accurate information on combustible gas concentrations by automatically taking superheated micro samples from the containment atmosphere during an accident.**

#### Challenge

The high energy content of hydrogenous gas mixtures formed during severe accidents can threaten or even jeopardize the integrity of a containment, which is the last barrier against large unfiltered releases of activity to the environment.

Adequate management of severe accidents is complicated, as the standard instrumentation is likely to be lost or to provide unreliable data in degraded plant conditions.

Monitoring of the containment atmosphere and its combustible gas concentration, is essential to interpret accident progression, initiate appropriate mitigation actions and monitor the effectiveness of countermeasures.

#### Solution

Framatome's HERMETIS automatically extracts micro samples from inside the containment at representative locations. The sample taken is superheated directly after the extraction, therefore the volumetric concentrations in the sample remain unchanged this allows for accurate determination of the hydrogen and steam concentration. The micro-samples are transferred outside the containment to the analysis module.

The in-situ micro sampler installed inside the containment is a passively working equipment entirely made from stainless steel withstanding even harsh environmental conditions during severe accidents.

Additionally, the use of micro samples and the installation of the analysis module in mild environmental conditions outside the containment minimizes the dose and other environmental exposures to both the operator and the analysis module itself.

The hydrogen and steam concentration determined are used to evaluate the potential combustion regime within the containment and the resulting risk to the containment integrity. In addition, the effectiveness of mitigation measures initiated are continuously monitored and the implementation of additional mitigation measures can be evaluated based on the available data.

Optionally, the HERMETIS system can be equipped with a carbon monoxide measurement, which allows the detection of molten core-concrete interaction. An optional oxygen measurement completes the functionality of the system providing benefits for containments with inert conditions.

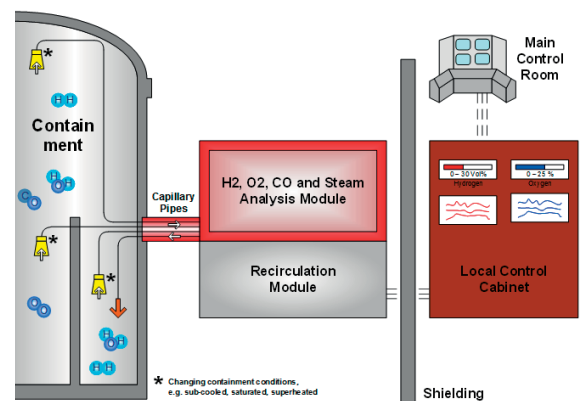


Illustration of a HERMETIS installation

#### Customer benefits

- Modular design qualified for both design-basis accidents and severe accidents.
- High accuracy for gas concentration measurements.
- Reliable information on the combustion regime inside the containment for severe accident management and emergency planning.
- Customized according to the needs and requirements (type of measurements, number of measuring points).

## Technical information

### Available measurements:

- Hydrogen: 0 ... 30 vol.-%
- Steam: 20 ... 70 vol.-%
- Containment pressure: 10 bar<sub>abs</sub>
- Oxygen: 0 ... 25 vol.-%
- Carbon monoxide: > 0.1 vol.-%

### Allowable ambient conditions:

- Pressure: Up to 10 bar<sub>abs</sub>
- Temperature: 170 °C (short term > 250 °C)
- Activity concentration (sample): > 10<sup>15</sup> Bq/m<sup>3</sup>
- Accumulated adsorbed dose: up to 5000 kGy<sup>1)</sup>

<sup>1)</sup> Equipment installed inside the containment

### Micro samplers installed inside the containment are fully tested and qualified for the following severe accident exposures:

- Temperature, pressure
- Presence of aerosols
- Operation of spray including boric acid and other additives
- Combustion

### Micro samplers (installed inside the containment) and the process module (installed outside the containment) are tested and qualified for the following external events:

- Safety shutdown earthquake
- Airplane crash

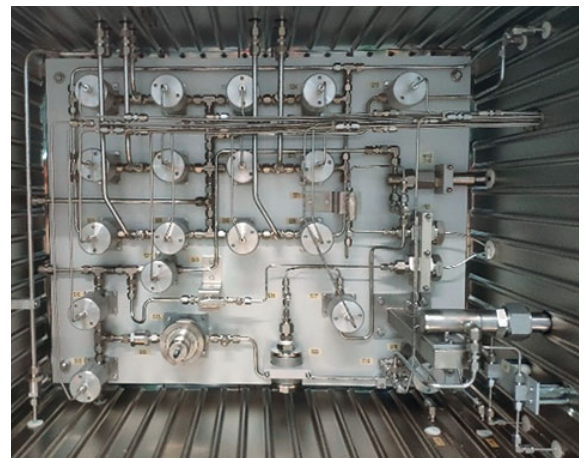
### Qualification according international nuclear standards (IEEE, YVL, KTA)



Process module



In-situ passive, micro sampler

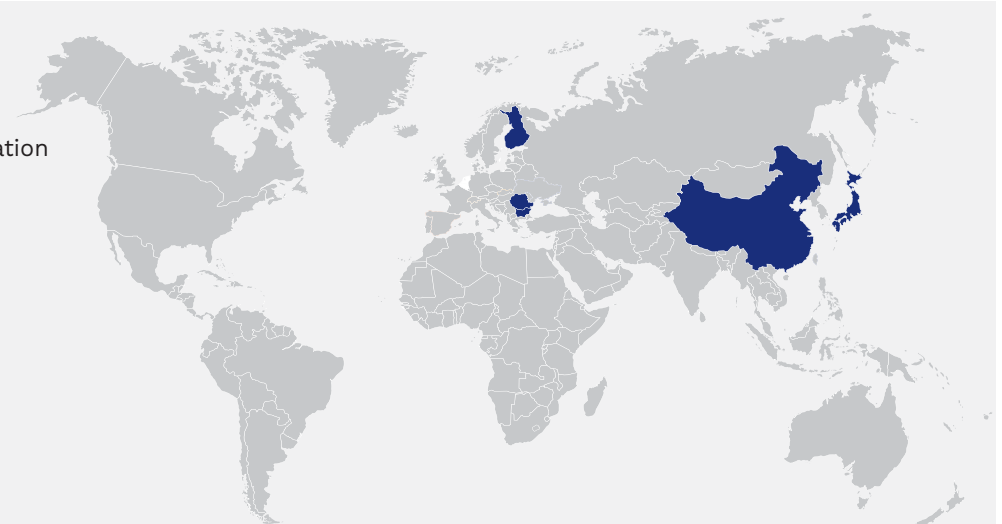


Inside view of the analysis module (part of the process module)

## References

Framatome's HERMETIS application has been designed, installed, commissioned and licensed in nuclear power plants of the following countries:

- Bulgaria: 2 (PWR)
- China: 2 (PWR)
- Finland: 1 (PWR)
- Japan: 1 (BWR)
- Romania: 2 (PHWR)



PWR: pressurized water reactor  
BWR: boiling water reactor  
PHWR: pressurized heavy water reactor

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