REACTOR INSTITUTE DELFT

Country report 2018: the Netherlands

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- HOR (RID Delft)
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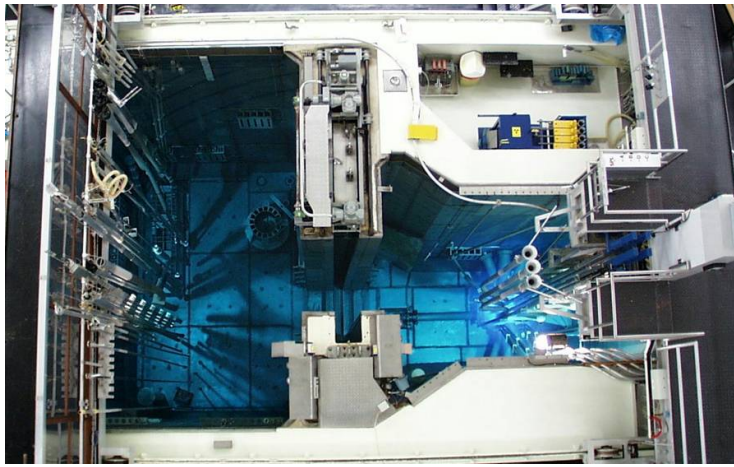
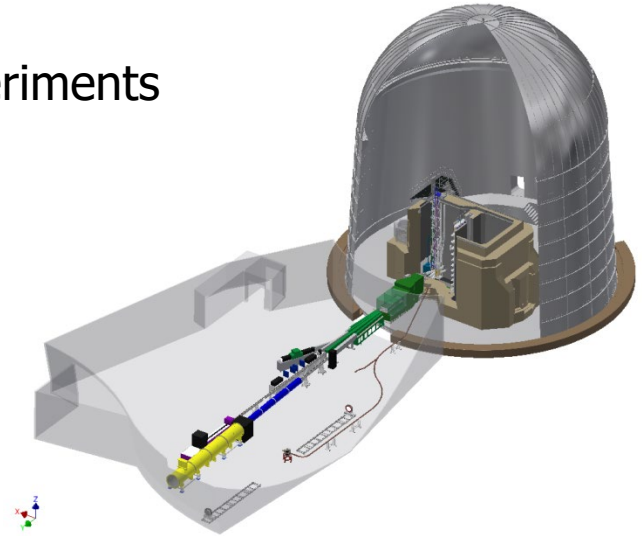
  - OYSTER
-

Description of HOR facility



- 2 MW open pool-type research reactor
- Forced cooling by light water
- Moderator: light water
- Reflector: Be
- Operational: weekdays 24hrs.
- Research facilities:
  - Neutron Beams/ Neutron Scattering Experiments
  - Neutron Activation Facilities
  - Positron Beam (POSH)



Performances Indicators

2018

availability	
A1	**A2**
92 %	46 %
unscheduled shutdowns	
B1	**B2**
12	2

Performances Indicators

2018

- Unscheduled shutdowns [1/2]
  - 2x scram due to loss of external power
  - Automatic rundown due to partial loss of internal power
  - Automatic rundown due to wrong reading of power range by the computer of the automatic power regulation system
  - Higher noise on neutron flux channels after core exchange. After unloading and reloading for inspection, the noise had disappeared.
  - 2x manual scram to investigate potential leak between outer part and inner part of beam tube. In this beam tube an irradiation facility was installed.

Performances Indicators

2018

- Unscheduled shutdowns [2/2]
  - Manual scram after loss of compressed air due to automatic closing of containment isolation valve due to installation of wrong solenoid.
  - Manual scram due to electronic filtering in flow sensor (primary flow) setting too high, see next slides for explanation
  - Multiple scrams due to higher fluctuations in the primary flow due to a lower electronic filtering setting

Performances Indicators

2018

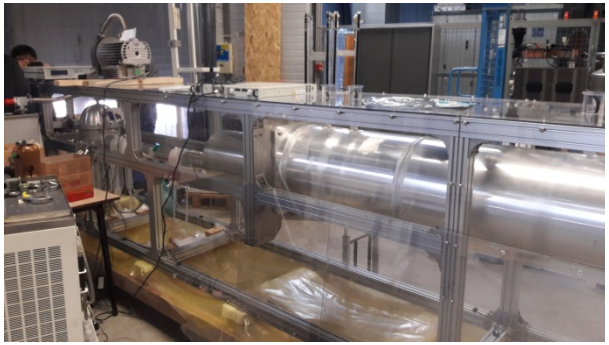
- Notification to Authority
  - Electronic filtering in flow sensor (primary flow) setting too high. Response of the flow sensor not in line with the Safety Report.

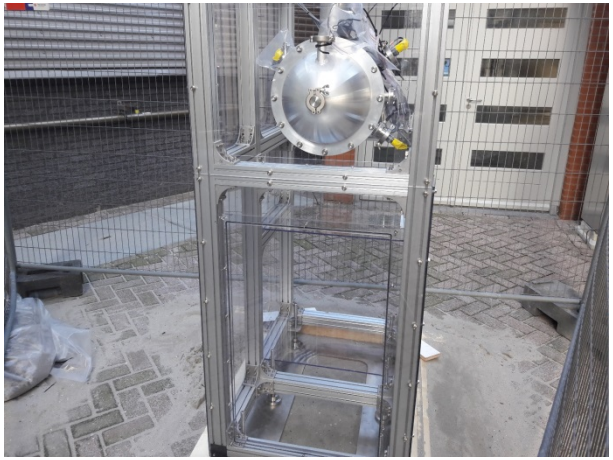
Electronic filtering flow sensor

- Primary flow sensor: Orifice with dP measurement
- Vibrations causes spikes on the signal that can cause spurious trips (SCRAM)
- To cope with this the filtering time constant in the flow sensor is adjusted to a higher value → smooth signal but slow response
- In the HOR safety report is stated that the SCRAM on primary flow low should be activated within one second. This was not the case with the adjusted filtering time constant
- We performed some calculations to prove that there was still enough margin to the safety criteria.
- Modified the dP tubing with a small pin hole to get rid of the spikes without a slower response. Set the time constant to a lower value to reach the one second response

Mock Up of CNS In Pool Assembly

- 1 to 1 copy of moderator cell including vacuum chamber
- Without the third barrier, but used outside in open air
- Fully equipped with pressure and temperature sensors
- Purpose:
  - Test the thermosyphon working
  - Measure the void fraction in the moderator chamber with neutron tomography
  - Test the He Refrigerator control system
  - Train the operators



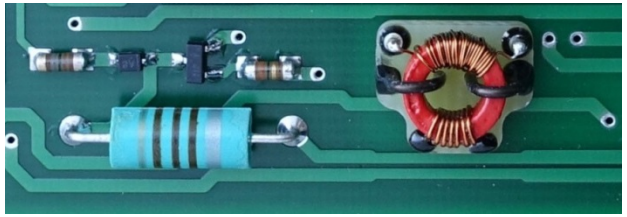


OYSTER and parallel projects [1]

- Reactor shutdown may 6th 2019, license irrevocable
- Preparing the reactor pool for the beam tube modifications
  - Unloading of the reactor core
  - Removing of obstacles: Nitrogen Box, fission product monitor, lead shielding etc.
- Replacement of primary and secondary system including Heat exchanger, control valves and pump.
- Beam tube modification
  - Cutting of beam tube R2 and R3
  - Placing a modified ring with adapter for a Quick Release Clamp
- Installing of CNS In Pool Assembly including support frame

OYSTER and parallel projects [2]

- Renewal of the Reactor Protection system voting logics
  - Current system works with relay's
  - New system has the same logics and functionality but with an extra input for the CNS
  - New system is designed on basis of the ProSafe-SLS system:
    - ProSafe-SLS is a Safety Instrumented System specially designed for applications which require the highest Safety Integrity Levels (SIL 3 and SIL 4)
    - Logic functions are processed by bi-stable magnetic core elements, which have inherent fail-safe characteristics. Amplifying transistors serve only to restore any energy lost by the pulse-train as they pass through these magnetic logic elements



Thank You!