

Passive Containment Cooling System Tests (PCCS)

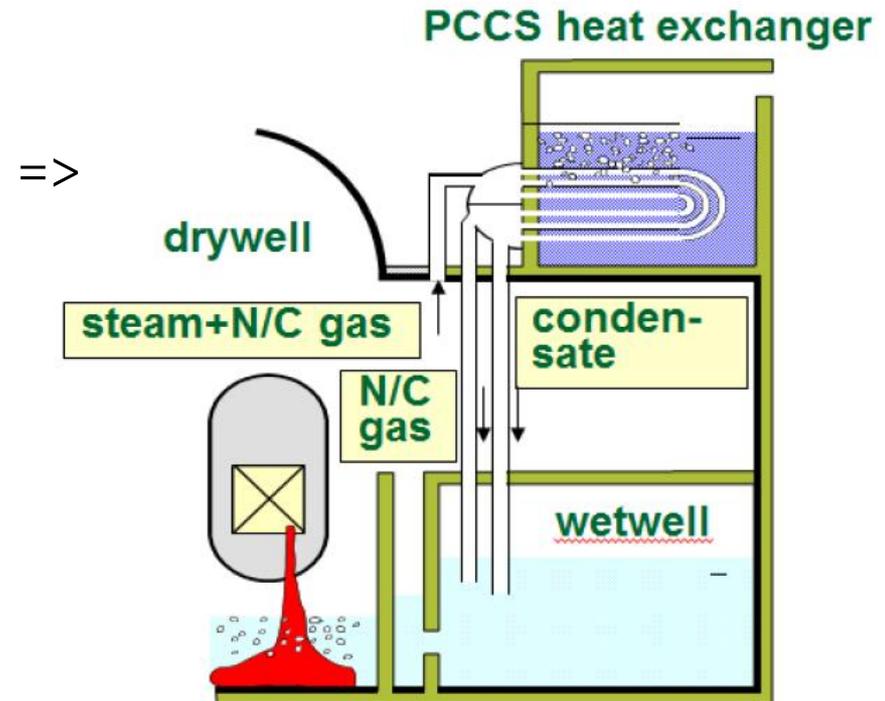
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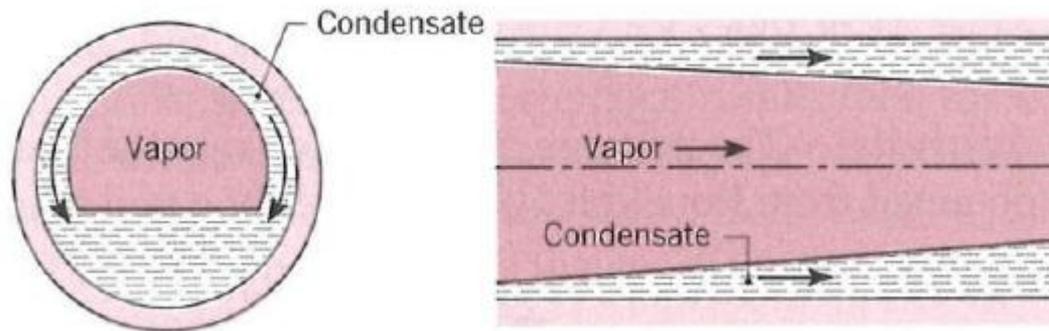
Passive Containment Cooling System Tests, PCCS project overview

- Purpose of the PCCS project was to test the performance of a Passive Containment Cooling System designed for **ABWR** containment decay heat removal.
- Fukushima accident showed that loss of electric power can deteriorate the safety functions completely and thus lead to loss of containment, which is usually the last safety barrier. If PCCS-like closed loops for containment decay heat removal had been available, containment damage and large releases could have been avoided.



PCCS project objectives

- The main goal of the PCCS project is to provide experimental data on the behavior of horizontal PCCS condenser used in Advanced BWRs for the development and validation of computer codes.
- **There is no data on horizontal PCCS in open literature;**
 - flow conditions, which affect on the aerosol behavior (deposition, condensation, retention etc.), in horizontal PCCS are significantly different from those with vertical tubes.



Condensation in a horizontal tube (Incropera & DeWitt 2002)

PCCS project scheme

- Joint efforts of **LUT** (thermal hydraulic test rig) and **VTT** (aerosol systems)
- First part: ***thermal hydraulic tests***, serves the validation of system codes
- Second part: ***aerosol tests***, serves the validation of severe accident codes.

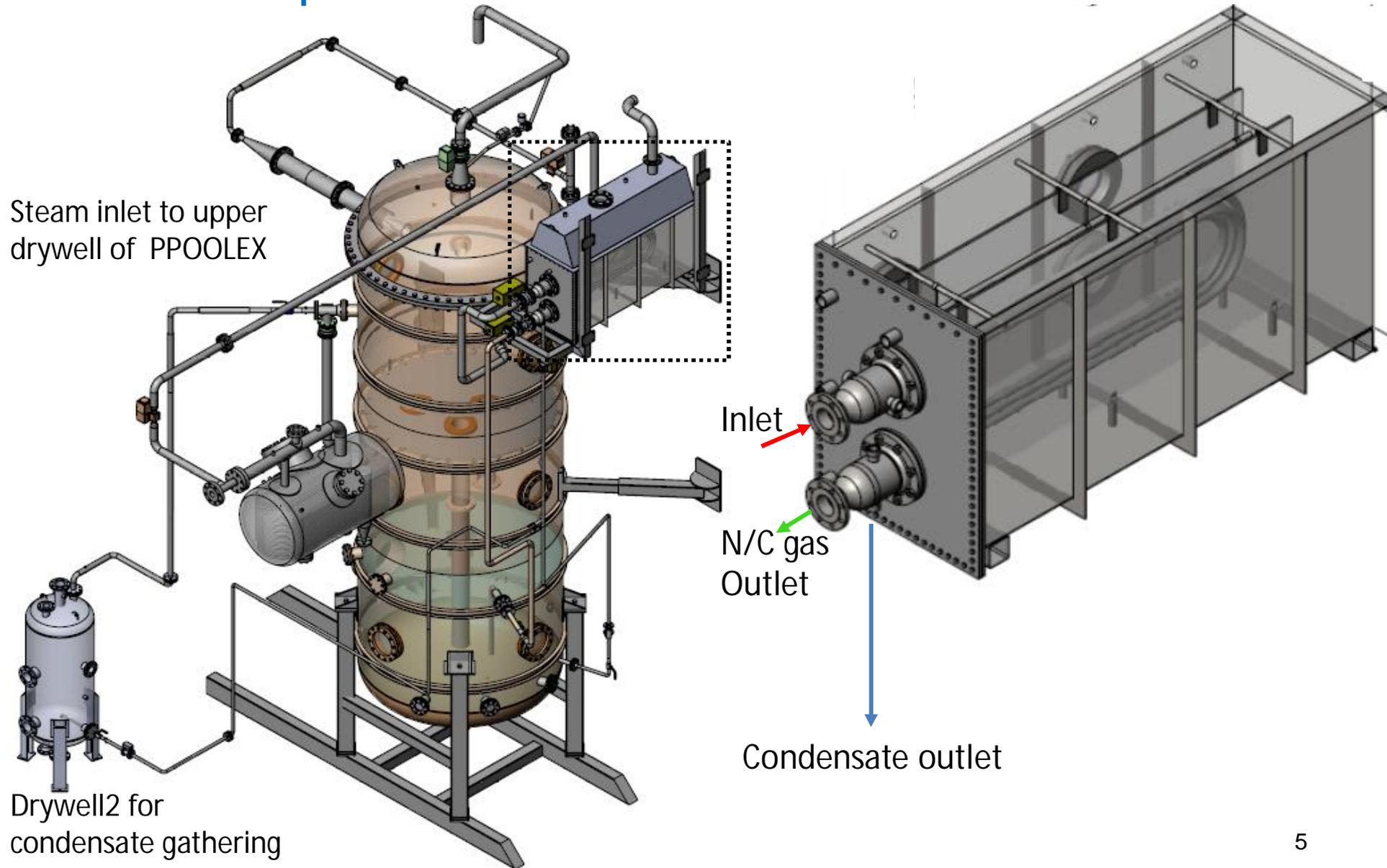
2013:

- ✓ Thermal hydraulic characteristics of the PCCS test rig attached to PPOOLEX have been defined with **6 experiments**
- ✓ VTT constructed aerosol sampling and measurement systems

2014:

- ✓ Aerosol systems (VTT) were integrated to the PCCS test rig
- ✓ Totally **4 experiments** with and without aerosols were carried out and analyzed

PCCS setup at LUT



Aerosol measurements on PCCS, main features

- Input of dry aerosol **C** (**Black carbon** particles) with fluidized bed reactor
- Measurements of input and output aerosol concentration and particle size.
- Also contents of moisture and of non-condensable gases measured
- The **steam** and **air** feed rates were varied. Air feed was provided from the aerosol generator.

Aerosol feeding and sampling devices installed to PCCS

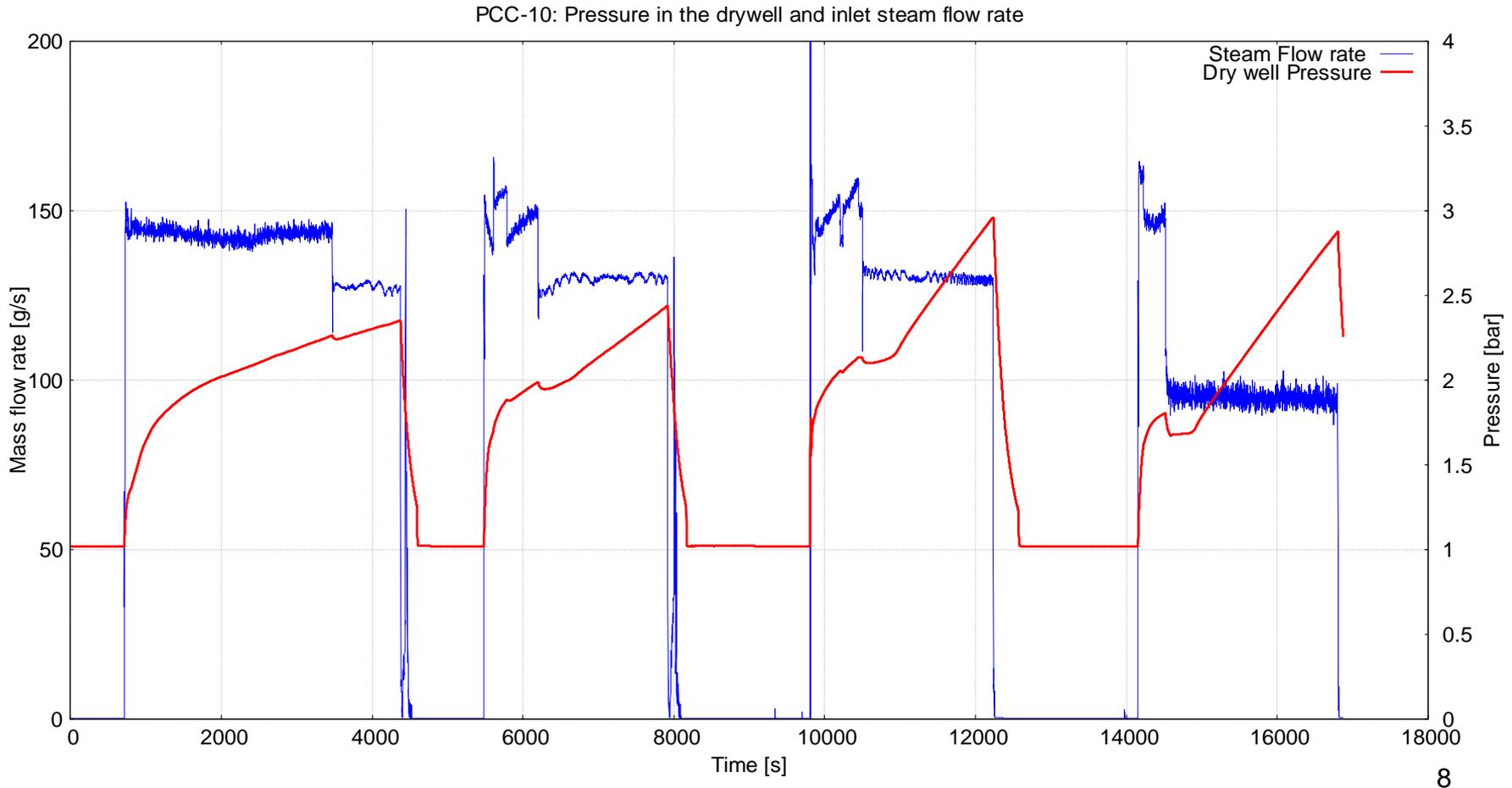
Aerosol feeder



Aerosol sampling

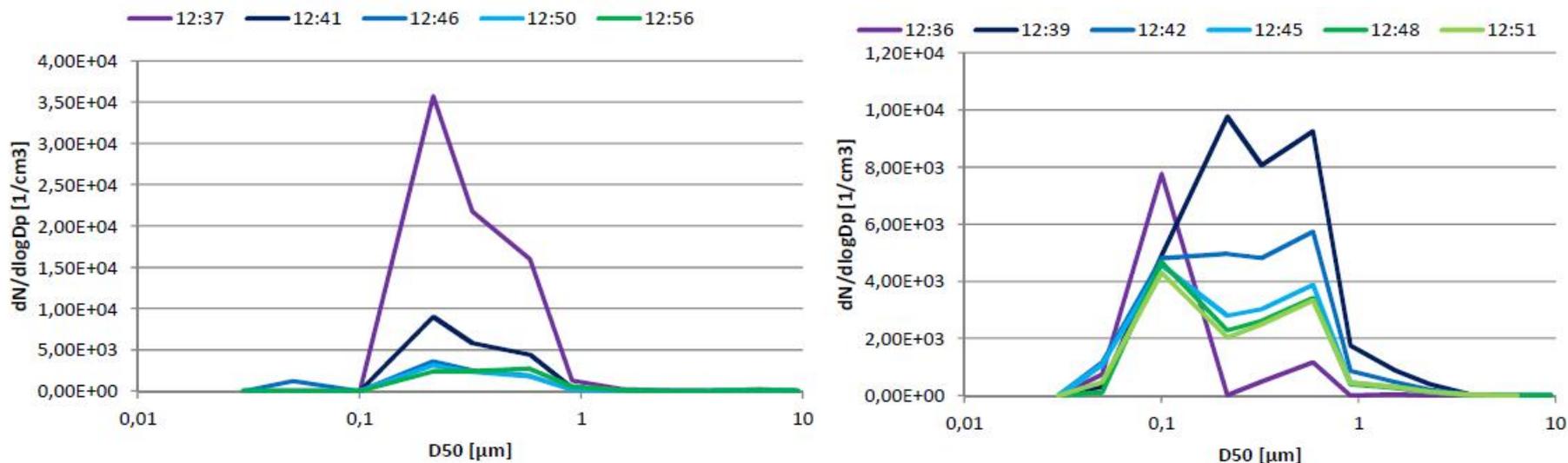


Steam flow rate and drywell pressure: PCC-10 experiment procedure with steam feed periods and intermediate ventilation phases for pressure reset



PCCS aerosol experiments, main results

- PCCS test rig characteristics defined:
 - capacity for steam condensation ~150 g/s (max.)
- In number concentration, the losses of particles in the PCCS ranged from 64 to 84 %
- In mass concentration, the particle losses were from 30 to 55 %



*Particle number size distribution at the PCCS inlet (left) and outlet (right).
Steam flow rate 130 g/s, air flow rate 240 l/min*

Conclusions

- The first experiments on the behavior of aerosols in the horizontal PCCS setup have been conducted at LUT in collaboration with VTT.
- Measurements were challenging in transient conditions.
- Heat transfer capability of PCCS setup was *within the design targets*
- PCCS acts also as a trap of particles:
 - Impact on the concentration of radiotoxic fission product aerosols prevailing in the containment atmosphere.
- The designed measurement setup was successful in analyzing the particle phase at the inlet and outlet of the PCCS with a satisfactory accuracy.
- Further experiments are needed:
 - more detailed focus on the aerosol behavior in stable conditions.

Thank you!

