NKS-R Status Report

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NKS-R Programme Manager

Summary status of the activities initiated 2011

- 6 new and 1 continued activity
- All contracts are issued and signed (total 9)
- 12 first invoices received, 6 missing

Additional financers 2011

Additional financers:

- Fortum contract ok, p.o. ok, invoice sent to Fortum
- TVO contract ok, waiting for purchase order

Summary status of the activities initiated 2010

- Only minor delays

- 4 of 7 projects are completed

- 3 final reports are being revised

- 1 final reports still missing; expected to be delivered in May

Completed projects

Project	Running period	Partners	Total NKS funding [kDKK]
Decom-sem	2010	Studsvik, SKB	100
IACIP	2008 - 2010	IFE, Vattenfall	850
INCOSE	2009 - 2010	KTH	600
MOSACA	2008 - 2010	VTT, KTH, Risk Pilot	1300
NROI	2008 - 2010	Chalmers, VTT	1450
POOL *	2007 - 2010	VTT, KTH, LUT	2000

* 1 final report missing

Decom-sem

Decom-sem	**2010**	**Studsvik, SKB**	**100**

- Seminar on decommissioning of nuclear facilities

- Studsvik 14.9 – 16.9.2010

- About 130 participants from several countries including Sweden, Germany, Denmark, Finland, Norway

- Power companies / NPP:s, consultants, suppliers, authorities and research centres were represented

- Presentations, papers, posters available on NKS webpage

- The seminar was very much appreciated -> plans for a new seminar in 2012

Decom-sem

IACIP

IACIP	**2008 - 2010**	**IFE, Vattenfall**	**850**

- Verification of nodal transport code VNEM (Variational Nodal Expansion Method) by comparing it to plant data from Ringhals-3 PWR

- 2008, comparison with hot stand-by condition, without feedback effects

- 2009, VNEM neutronics module was implemented in a light water reactor core simulator CYGNUS (PWR version), including feedback effects, comparisons with hot-operating cases

- 2010, core follow calculation of whole cycle 1A of Ringhals-3, studying the intra-nodal burnup tilt effect

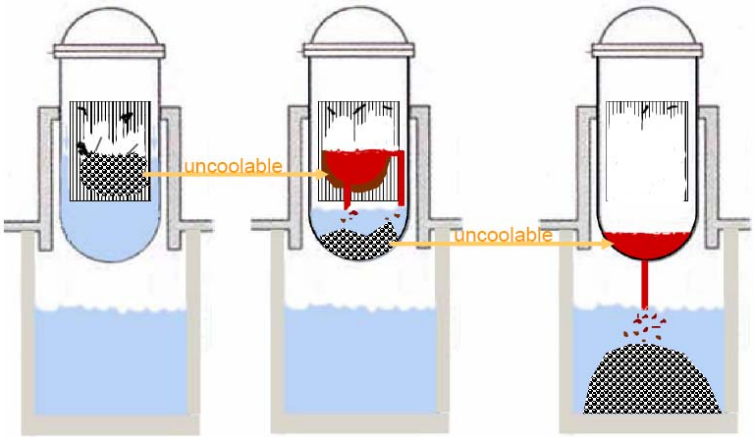
- Comparison with neutron detector readings are excellent

- A preliminary 2D numerical benchmarking was performed for BWR cores, to investigate the applicability of VNEM to a BWR core

INCOSE

INCOSE	**2009 - 2010**	**KTH**	**600**

- In-vessel coolability and steam explosion risk in Nordic BWRs (which uses cavity flooding as SAM) during severe accident



- Next four slides by courtesy of Weimin Ma at KTH

(a) in the core ***(b)*** in the lower plenum ***(c)*** in the reactor cavity
Fig.: Debris bed formation during different stages of a severe accident scenario.

In-vessel Coolability and Steam Explosion in Nordic BWRs

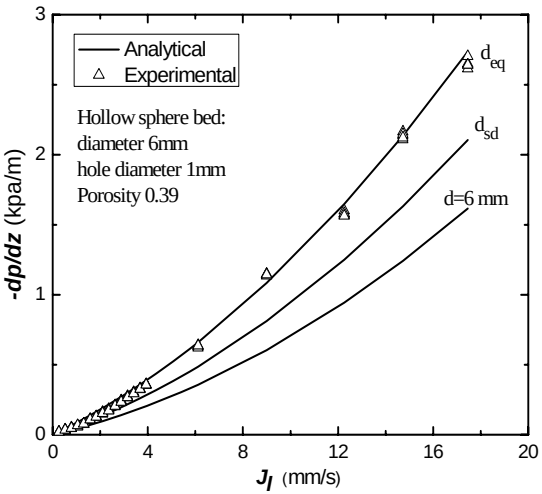
Weimin Ma

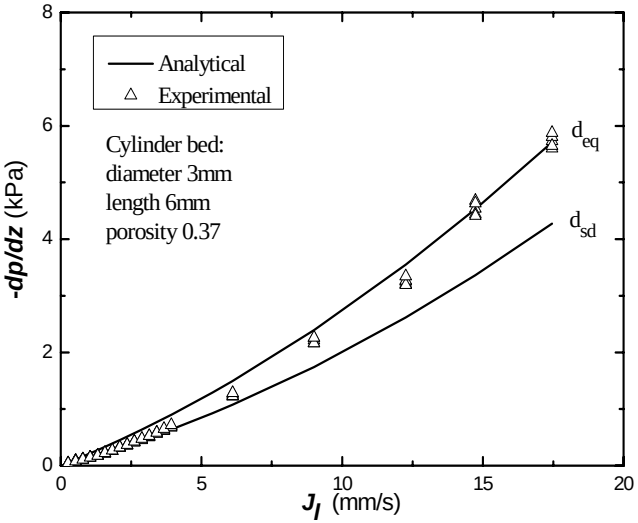
Division of Nuclear Power Safety - NPS

Royal Institute of Technology - KTH

Highlights of INCOSE research

- **Topic 1**: Friction laws of particulate beds packed with irregular particles, which are of important to coolability analysis of debris beds.

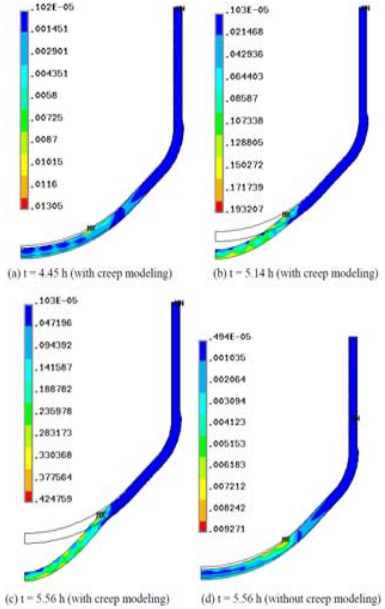




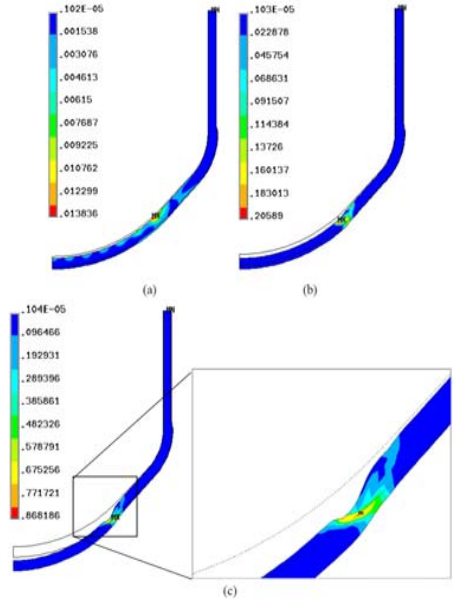
- The POMECO-FL experimental data suggest that the Ergun equation is applicable if the effective particle diameter of the particles is represented by the equivalent diameter of the particles, which is the product of Sauter mean diameter and shape factor of the particles

Highlights of INCOSE research

- **Topic 2**: Creep of the lower head of a BWR under thermo-mechanical loads.



ballooning

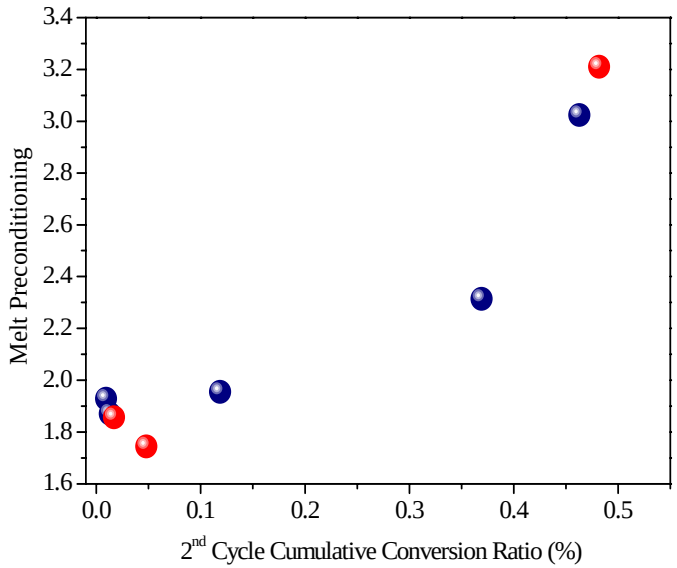


Localized creep

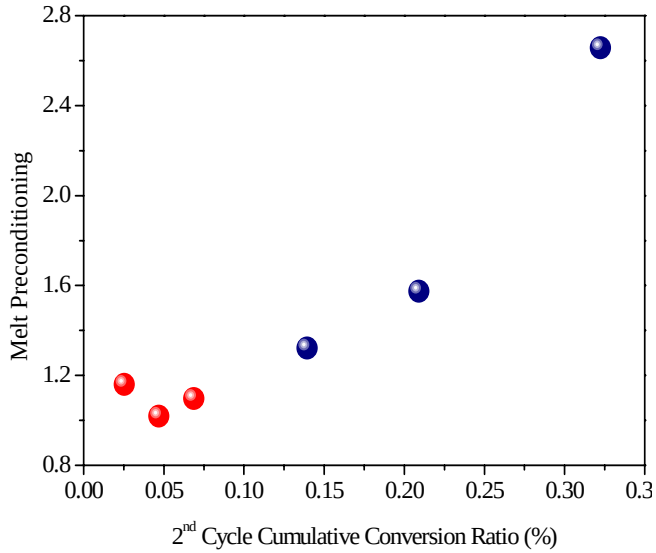
- One-way coupling between PECM model for melt pool heat transfer and ANSYS thermo-structural mechanics was developed to analyze the vessel creep, and the results revealed two different modes of vessel failure: a ‘ballooning’ of the vessel bottom and a ‘localized creep’ concentrated within the vicinity of the top surface of the melt pool.

Highlights of INCOSE research

- **Topic 3**: Effect of binary oxides mixture's properties on steam explosion.



high melt superheat: ~200 °C



low melt superheat: ~100 °C

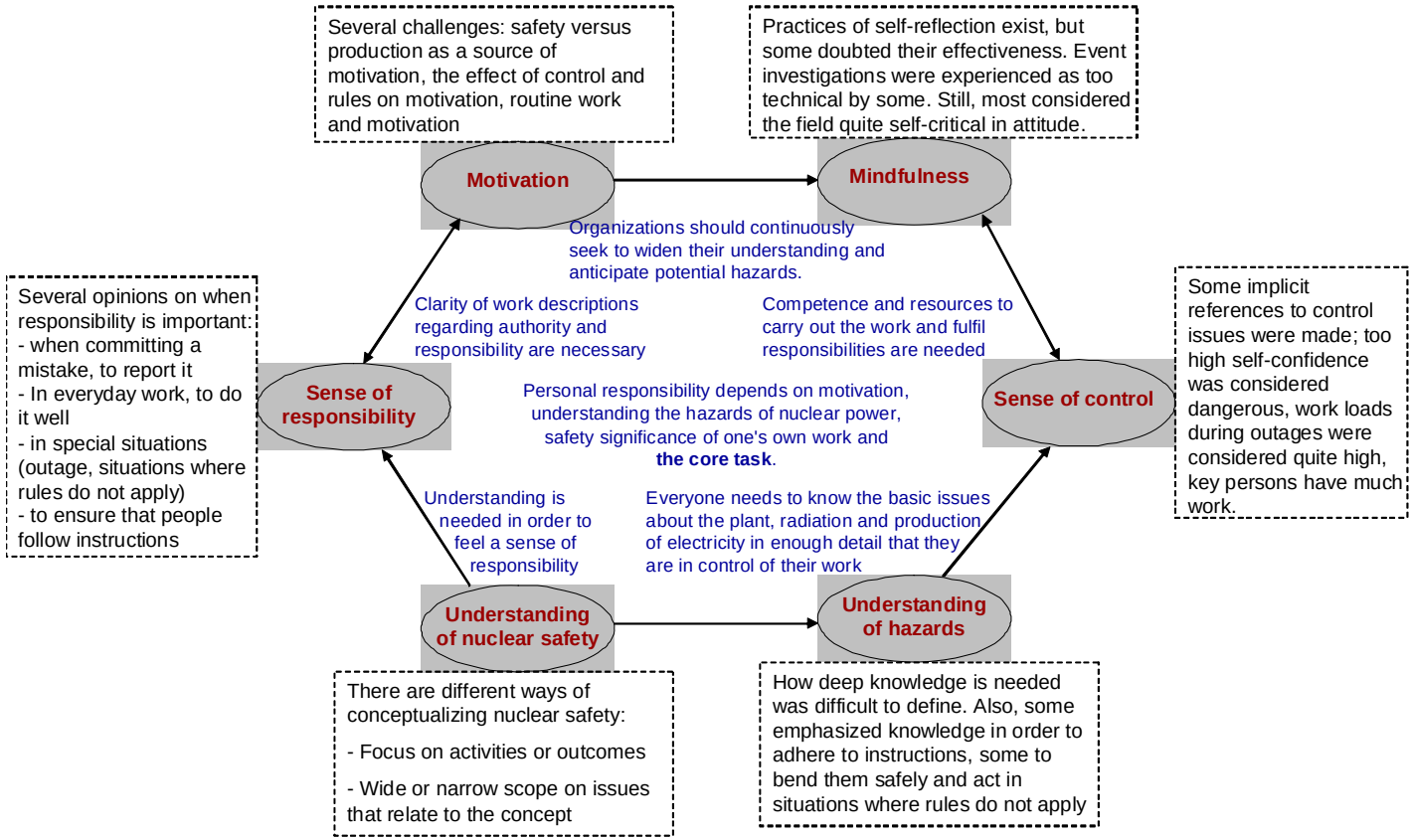
- The results of steam explosion experiments performed at low melt superheat (100 °C) using oxidic mixture of WO_3-CaO detect an apparent difference in steam explosion energetics between the eutectic and non-eutectic materials.

MOSACA

MOSACA	**2008 - 2010**	**VTT, KTH, Risk Pilot**	**1300**

- Nuclear safety culture in Finland and Sweden
  - History and present; Nordic developments, incidents,
  - Developments and challenges, including contractors' role in the Nordic nuclear industry
- Data was collected by interviews (Sweden: OKG, RAB, FKG, RiskPilot, Vattenfall, SSM, KSU, SKB / Finland: LO, STUK, Posiva, OL, Fortum)
- Definition of safety culture, how to evaluate nuclear safety, the model of key psychological safety culture dimensions

MOSACA


Several challenges: safety versus production as a source of motivation, the effect of control and rules on motivation, routine work and motivation
Practices of self-reflection exist, but some doubted their effectiveness. Event investigations were experienced as too technical by some. Still, most considered the field quite self-critical in attitude.
Motivation
Mindfulness
Organizations should continuously seek to widen their understanding and anticipate potential hazards.
Several opinions on when responsibility is important:
- when committing a mistake, to report it
- In everyday work, to do it well
- in special situations (outage, situations where rules do not apply)
- to ensure that people follow instructions
Clarity of work descriptions regarding authority and responsibility are necessary
Competence and resources to carry out the work and fulfil responsibilities are needed
Some implicit references to control issues were made; too high self-confidence was considered dangerous, work loads during outages were considered quite high, key persons have much work.
Sense of responsibility
Personal responsibility depends on motivation, understanding the hazards of nuclear power, safety significance of one's own work and the core task.
Sense of control
Understanding is needed in order to feel a sense of responsibility
Everyone needs to know the basic issues about the plant, radiation and production of electricity in enough detail that they are in control of their work
Understanding of nuclear safety
Understanding of hazards
There are different ways of conceptualizing nuclear safety:
- Focus on activities or outcomes
- Wide or narrow scope on issues that relate to the concept
How deep knowledge is needed was difficult to define. Also, some emphasized knowledge in order to adhere to instructions, some to bend them safely and act in situations where rules do not apply

MOSACA

Conclusions and recommendations:

- Knowledge and understanding: the safety significance of one's work

- Learning from past incidents (root causes and common contributing factors), also from human factors and safety culture point of view

- The concept of nuclear safety is all but clear -> needs to be discussed openly

- Contractors role: work as information carriers but also a challenge to manage

- Mindfulness and constant development, remain humble; safety is a dynamic non-event (absence of accidents), require constant work to achieve

- History shows: Important to maintain long-term focus in the nuclear field

NROI

NROI	**2008 - 2010**	**Chalmers, VTT**	**1450**

- Experimental study on iodine chemistry

- Behaviour of iodine in the containment during a (hyp.) severe accident

- Data can be used in severe accident propagation simulation codes (ASTEC, COCOSYS) and plant analysis -> work ongoing in SARNET

-> contribute to a better determination of the source term of iodine during a (hyp.) severe accident

NROI

- 2008, radiolytic oxidation of elemental iodine

- 2009, radiolytic oxidation of organic iodine

- 2010, methyl iodine (organic iodine) experiments,

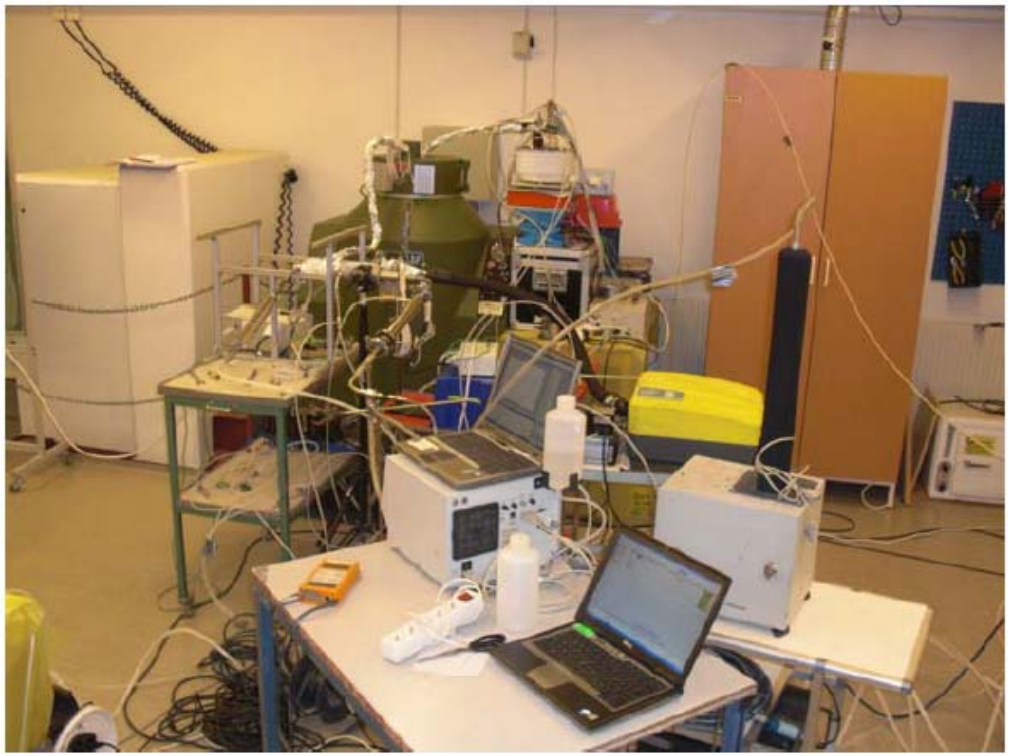
    - VTT, EXSI facility: effect of ozone, UV-radiation

    - Chalmers: effect of gamma radiation

- Example of findings: When gaseous iodine (organic and inorganic) is exposed to radiation and ozone, iodine particles are formed, iodine oxides (I2 especially converts easily to particles)

- Chalmers & VTT co-operation in iodine oxide in containment research continues in NKS-R activity AIAS 2011

NROI



EXSI facility.

POOL

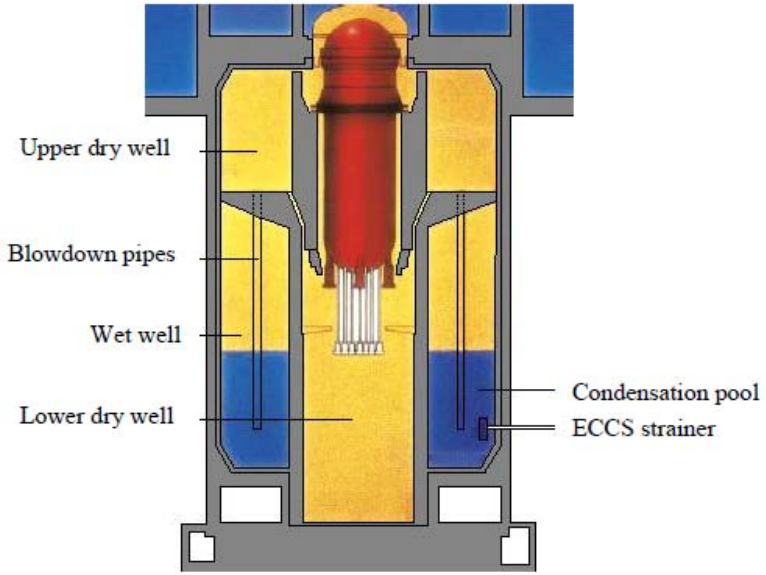
POOL	**2007 - 2010**	**VTT, KTH, LUT**	**2000**

- Condensation pool experiments and development of simulation codes

- LUT: experiments, VTT: Fluent analysis, KTH: Gothic analysis

- PPOOLEX facility: BWR pressure suppression containment with drywell and wetwell. Steam condensates in the pressure suppression pool during a (hyp.) main steam line break.

POOL



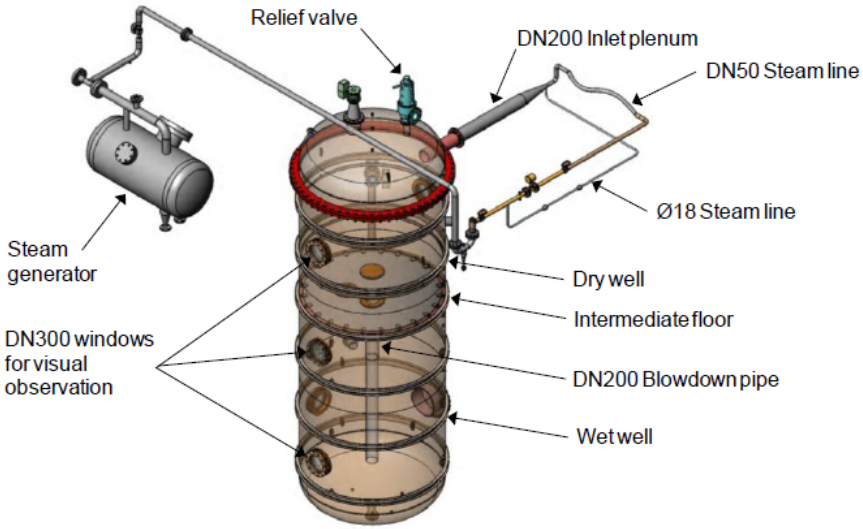
Olkiluoto type BWR containment.

- Improve understanding of the thermal hydraulic phenomena occurring in the pressure suppression containment

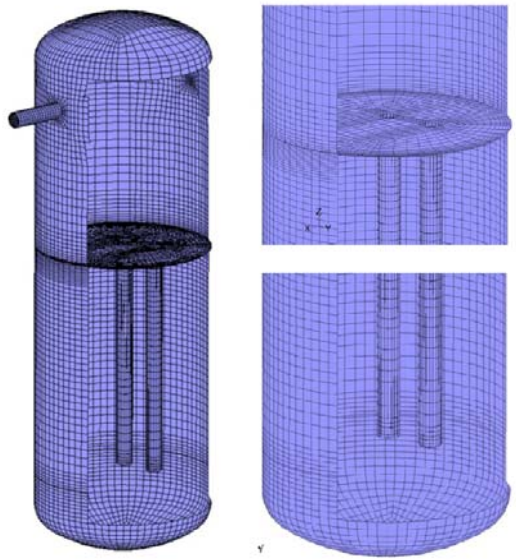
- Define mechanical loads on the pool structures during blowdown of air and steam in the condensation pool

- Experiments give validation data for numerical methods

POOL



PPOOLEX test vessel.



Surface mesh of the CFD model for experiments with two vent pipes.

POOL

- The CFD simulations predict well the main features of the experiments

    - Development still needed in simulating the direct contact condensation and interfacial area of the bubble

- GOTHIC is a useful tool in reactor applications for complex fluid-physics scenarios

    - Was further developed to be better suitable for simulating the steam injection -> implementation of “effective heat source” and “effective momentum” approaches

- Same project team continues in NKS ENPOOL 2011

Thank you