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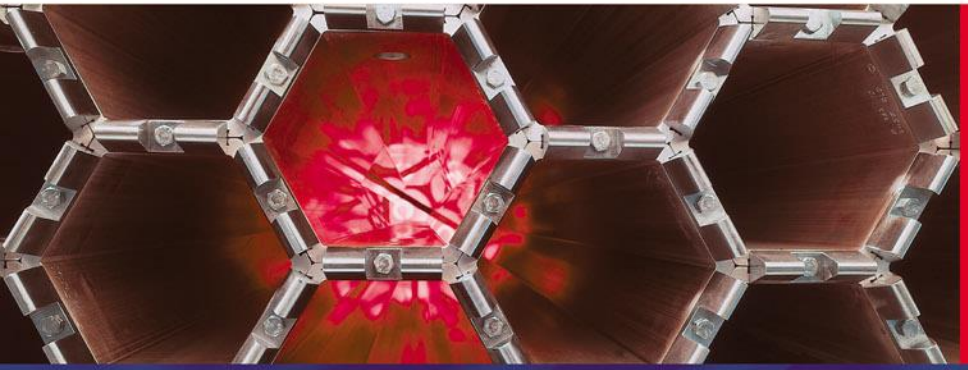

Michal Tanzer
Lenka Rinke

VERIFICATION OF THE KNI-LM ASSEMBLY FOR THE REACTOR COOLANT LEVEL MONITORING SYSTEM

Introduction

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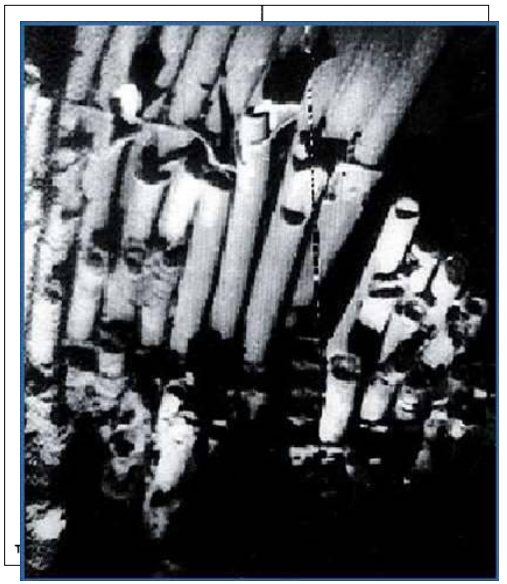

Based upon experiences from the LOCA at the NPP TMI-2 (USA, PA, 03/1979) – the operated PWR NPPs were equipped with the system **PAMS** (Post Accident Monitoring System).

The system **PAMS** belongs among NPP monitoring systems.

The **PAMS** design results from the Regulatory Guide 1.97.

One part of the system **PAMS** is the system **RVLIS** (Reactor Vessel Level Instrumentation System) that utilizes signals from two **special KNI-LM assemblies**.

Object of the system RVLIS

- Monitoring of coolant reserve in the primary circuit
- Detection of the coolant level occurrence in the RPV
- Severe accident management (prevention of severe accident conditions for reactors and spent fuel pools – see NPP Fukushima)

SKODA JS produces the KNI-LM assemblies and installed the **RVLIS system** at (VVER 440/V-213):

- **NPP Dukovany (EDU, 4 units)**
- **NPP Jaslovske Bohunice (EBO-V2, 2 units)**

System RVLIS monitoring principle

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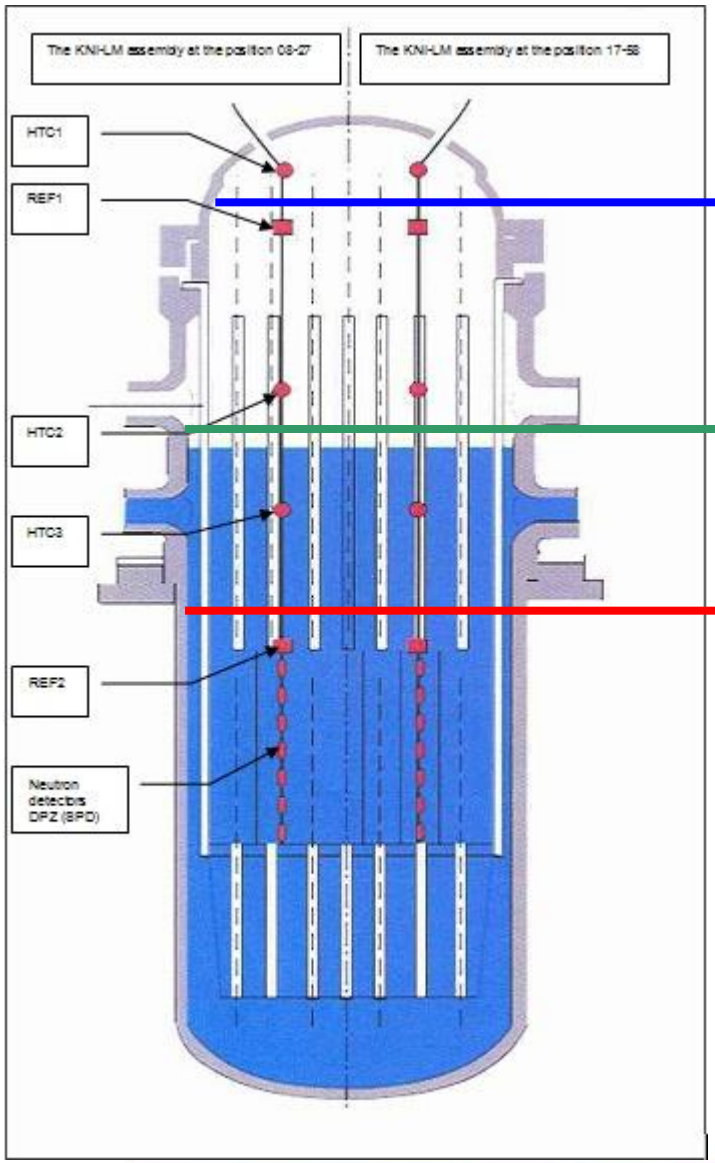

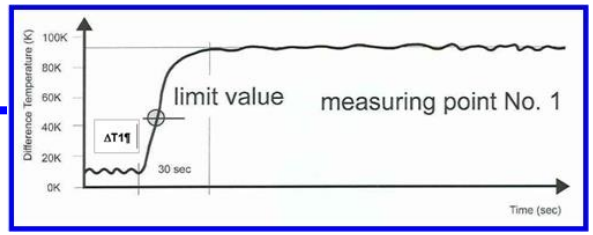

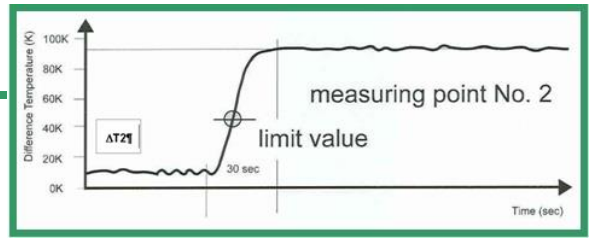

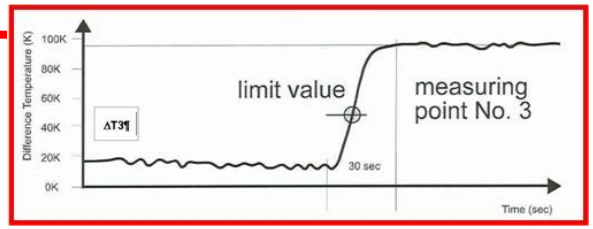

- 2 KNI-LM assemblies in the RPV
- Vertical direction, length 9,5 m
- 3 measuring points (heating elements HE + + HTC)
- 2 reference points (REF)
- Beta-emission rhodium neutron detectors

Monitoring principle :

- A difference between the HTC and the REF signals and change of this value is used for indication of the coolant level inside the reactor (change of the heat-transfer coefficient α [W/m^2/K])

Motivation

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- Experimental verification of the KNI-LM assembly function for different types of the measuring points construction effect/damage (HTC 1, HTC 2, HTC 3) in different ambient media (water/air)
- Creating of the simulation 3D finite elements method (FEM) model of the KNI-LM assembly for further analyses

Aims

- To carry out the KNI-LM assembly experimental measurements in the laboratory and evaluate this measurement for (HTC 1, 2, 3) in water/air
- To create the simulation 3D FEM model of the KNI-LM assembly measuring points and carry out the FEM thermal analysis
- To compare the experimental and the FEM model data and validate the FEM model on the basis of the experimental results

Experimental measurements

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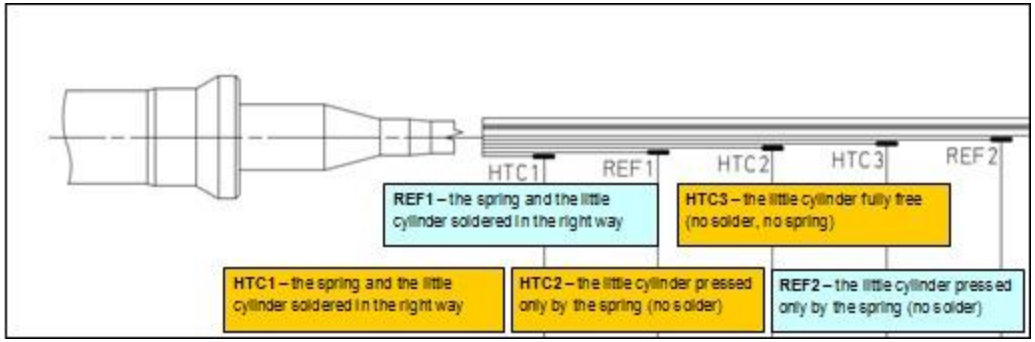

FEM model

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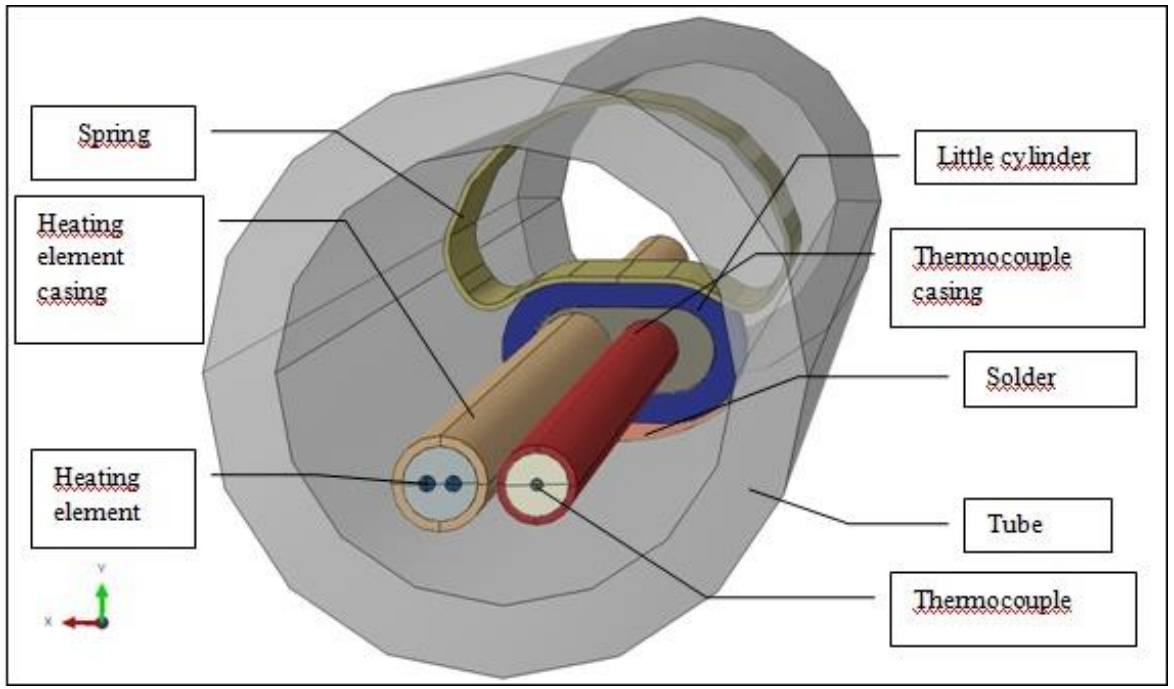
- KNI-LM assembly length 200 mm (6 m)
- 3D model (ŠKODA JS technical documents)
- Three configurations (HTC 1, HTC 2, HTC 3)
- Surrounding ambient water/air
- Heat transfer – convection, radiation
- Step "Coupled thermal-electric (Steady-State)"
- Boundary conditions
- Material properties (α [W/m^2/K], λ [W/m/K])
- Mesh (DC3D8), (DC3D10)
- Constraint type "TIE"



Results

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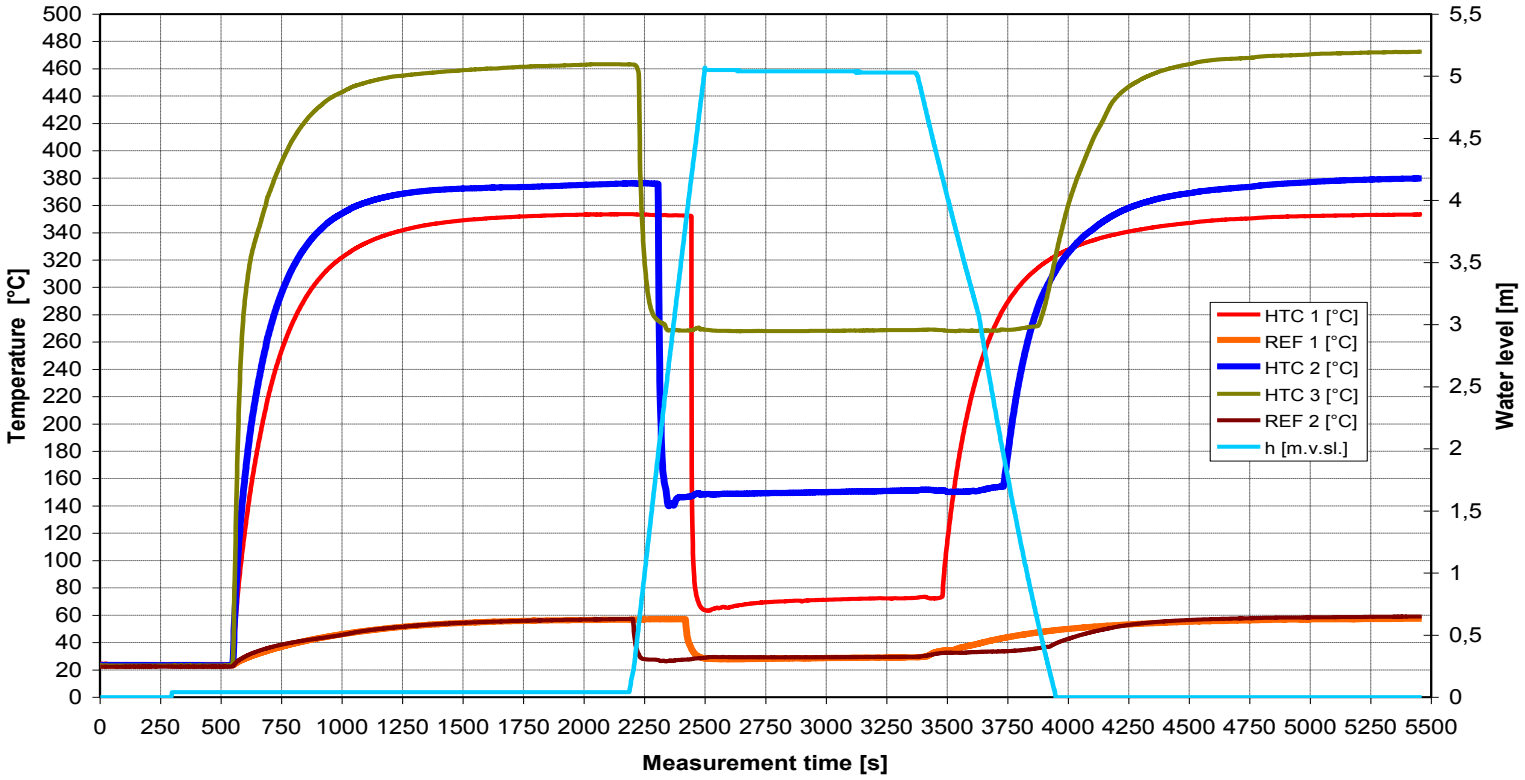
Special Made Experimental KNI-LM Assembly, Current *I* = 2,6 A
Reaction of the individual measuring points on the heating and water immerse



KNI-LM ASSEMBLY MEASURING POINT CONFIGURATION	TEMPERATURE IN WATER [°C] MAT. MODEL / EXPERIMENT		TEMPERATURE IN AIR [°C] MAT. MODEL / EXPERIMENT	
HTC 1	70	70	350	350
HTC 2	91	150	366	370
HTC 3	300	270	500	460

Conclusion

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- The KNI-LM assembly experimental measurements in the laboratory were carried out and evaluated for (HTC 1, 2, 3) in medium of water/air
- Functional 3D FEM models of the KNI-LM assembly was created for (HTC 1, 2, 3) in water/air
- FEM thermal analysis was performed
- Experimental measurement and FEM simulation results were compared
- FEM model of KNI-LM assembly was validated on the basis of the experimental measurement results

- The acquired results of experimental as well as calculation part will be used for other types of tasks in the field of operational state simulations and they are significantly important in the field of safety measurements in nuclear energy.

- Optimization of the minimal heat current for accurate KNI-LM assembly function
- Simulation of the real operational reactor conditions + LOCA conditions