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Results of International Cooperation on the Reactor Pressure Vessel Integrity Evaluation During Severe Accident

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INTRODUCTION

- In the world we had already several severe accidents (SA). It is necessary to perform maximum to avoid any SA and increase the safety of any NPP.
- The strengthening of the NPP and the RPV Integrity assessment are long term and very important programme of the UJV Rez a.s.
- In cooperation with the IAEA PIRT and OECD/NEA CAPS Status Report RPV Integrity projects we are focused on the RPV Integrity assessment as part of the In Vessel Melt Retention (IVMR) strategy.

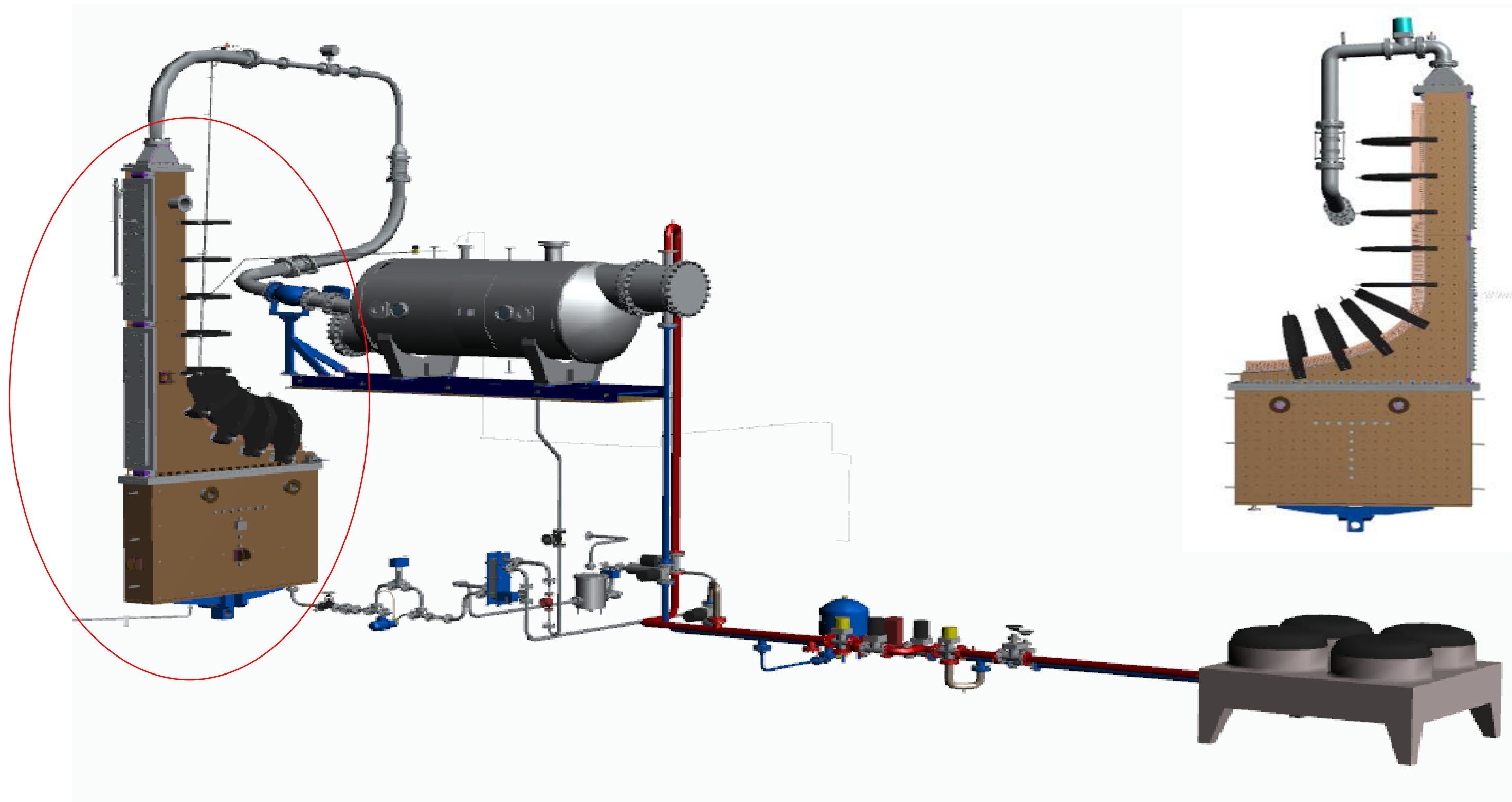
EXPERIMENTAL ACTIVITIES BESTH 2

- Experimental work to verify the IVMR started in 2012, on small test facility developed in our Institute. First experiments were focused on chemical effects, effects of impurities in the cooling media. Following experiments were already termohydraulic.
- The experimental facility was small and therefore there was clear need to build facility which will fully simulates real design of the RPV and reactor pressure vessel cavity.

EXPERIMENTAL FACILITY THS-15

- In the year 2015 started construction of the large scale facility THS-15 (Thermohydraulic Stand 2015), at the same year started the EC project HORIZON 2020 IVMR which we were leading together with the French IRSN.. This facility with all dimensions, geometry, cooling possibility, fully simulates the condition in the RPV cavity VVER-1000. The height of the THS-15 is in scale 1:1, width of the half of the cavity is 1:1, the RPV segment is in 1:95 in comparison with real VVER-1000. The heat flux generated inside the RPV with melted corium during the SA, is simulated with heated Cu with maximum 2.3 MW/m². The Cooper segments cooled, are covered with 3 mm steel. This is unique in comparison with other world large scale experimental facilities. Scheme of the facility build is seen on the next slide.

EXPERIMENTAL FACILITY THS-15



EXPERIMENTAL TESTS RESULTS

- The experimental work was divided on several phases. First the thermal losses were evaluated as well as other uncertainties. In following phases the coolability of the different heat profiles provided by analytical calculations was measured. During each experiment the stability of the cooling was measured, specifically if the cooling crisis will occur, also conditions for cooling, effect of pressure on the steam release through available space and many other effects.

SAFETY MARGIN INCREASE TO THE CHF

- Several tests were performed with target to increase the margin between the HF and CHF, including variants to increase the cooling effectiveness.
- Also were finished tests with application of the SJ technology which provides increase the roughness of the cooled surface.
- Based on results on the THS-15, the margin to the CHF was increased more than 20% in the cylindrical part of the RPV. As the critical heat fluxes are in the cylindrical part, these safety margin increase is relevant.

STATUS OF THE RPV INTEGRITY ASSESSMENT

- After the end of the HORIZON 2020 IVMR project, any new EC project for continuation of this work was not open. But the IAEA PIRT and OECD/NEA CAPS Status Report on RPV Integrity started, with goal to continue the SA mitigation, but most importantly to assure the RPV integrity during the IVMR.
- The OECD/NEA project is focused to provide the Status Report on the RPV Integrity. Needed data are prepared in three sections: Material Database, Integrity Assessment and Criteria and Assessment and Methodology.
- At present in the Material Database Section, the most of the data are available for the VVER-1000 RPV material, including the creep data.
- In early July 2022, there will be plenary meeting with all participants to summarise the present data of Section 1 and Section 2.

THE CZECH CONTRIBUTION TO THE IAEA AND OEC/NEA PROJECTS

- The management of both the IAEA and OECD/NEA projects asked UJV to provide the data from our tests on the THS-15 with confirmation on safety margin to the CHF and also the results from our project on the RPV Integrity. We have received agreement from TACR and Regulatory Body SUJB to share the results.
- The increase of the margin to the CHF by 20% with SJ application is very valuable.
- Detail analytical calculations with the ASTEC Code confirmed, that with the SJ application the outside RPV temperature is lowered by 50 deg C from 350 to 300 deg C for the IVMR LB LOCA. It means very important information for final RPV Integrity calculations.

CONCLUSIONS

- Our large scale tests on the THS-15 facility are unique in the world and highly appreciated for significant contribution to the nuclear safety.
- It is very important to share our experimental and analytical data with the IAEA PIRT and OECD/NEA projects.
- At the end of this year, first conclusion data will be available for OECD/NEA Status Report on the RPV Integrity IVMR.
- Also the IAEA PIRT project will provide further data on the Phenomenology Identification Risk Table for the IVMR assessment.
- All described results are very important for existing and also for new built NPPs.

Many thanks for your attention.



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