Proposal for a New CRP on "Benchmark Analysis of a MONJU Turbine Trip Test"

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Hiroaki OHIRA
Japan Atomic Energy Agency (JAEA)

Overview of the previous Monju CRP

- *IAEA's Coordinated Research Project on "Benchmark Analyses of Sodium Natural Convection in the Upper Plenum of MONJU Reactor Vessel" was carried out between 2008 and 2012 with the aim to improve the Member States' analytical capabilities in the field of fast reactor in-vessel sodium thermal hydraulics.*
- *Eight research organizations from seven countries with an active programme on Sodium-cooled Fast Reactors – namely China, France, India, Japan, Republic of Korea, Russian Federation and USA – contributed to this CRP.*
- *The experimental data for the benchmark analysis were provided by the JAEA and concerned the measurements of thermal stratification of sodium observed in the MONJU reactor vessel at a turbine trip conducted in December 1995 during the original start-up tests.*

- *This CRP allowed validation of the different thermal-hydraulics codes used by the involved organizations, and helped identification of the key parameters that affected the thermal stratification phenomena in the upper plenum of an advanced Sodium-cooled Fast Reactor (SFR).*

Main outcomes:

- *Analytical capabilities of the participating organizations in the field of fast reactor in-vessel sodium thermal hydraulics, especially meshing and algorithm selection criteria, were improved by this CRP,*
- *In the steady state calculations, two kinds of solutions were obtained by different calculation approaches. The momentum driven solutions were considered as the actual flow,*
- *Turbulence models based on the standard k-ε model for high Reynolds number and the thermal capacity of UIS did not largely affect the moving up rate of the thermal stratification front,*
- *Since the pressure drop of the flow holes on the inner barrel strongly affected the moving up rate of the thermal stratification front, the CRP participants mainly concluded that the shape of the flow hole edge is an important factor for the prediction of this phenomena.*

New Monju CRP

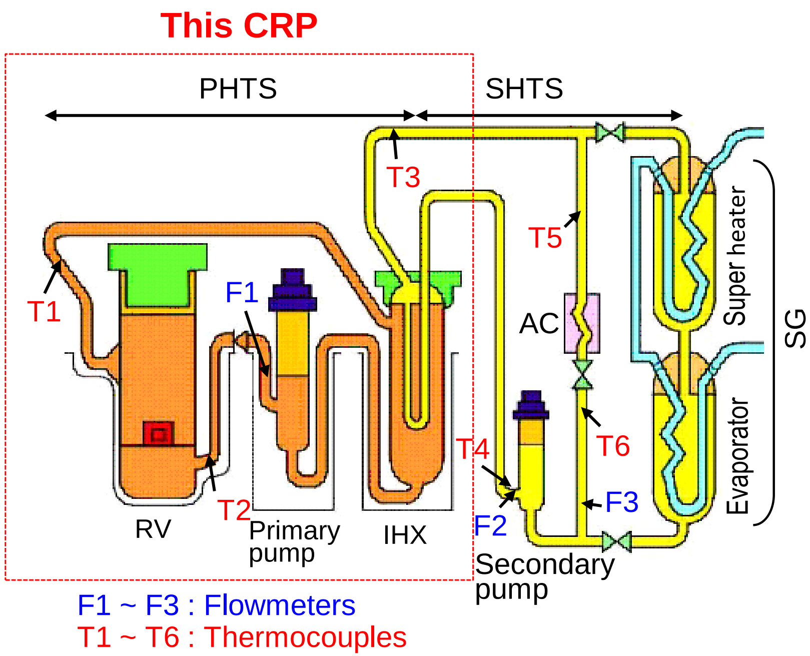
Title; "Benchmark Analysis of a MONJU Turbine Trip Test"

Background

- *Plant dynamics analyses using system codes also become important roles for the licensing procedures; the verification and validation (V&V) of these codes should be conducted using actual reactor data.*
- *IAEA has already launched benchmark analyses applied using SFR transient data such as EBR-II Shut Dawn Heat Removal Tests and PHENIX Natural Circulation Test.*
- *These V&V include multi-dimensional effects of large regions such as the upper plenum of MONJU reactor vessel, the cold pool of EBR-II and the hot and cold plenum of PHENIX.*
- *For these simulations, modeling techniques for the system codes should be advanced by using the CFD simulation results or some coupling simulation codes should be developed.*
- *The comparison of modeling method between the different codes and the discussions of the key parameters for the transient effects becomes so important.*

Objectives

- In order to develop modeling and simulation capability using system codes, the plant dynamics analysis of MONJU PHTS (Primary Heat Transport System) are performed under the turbine trip test from the 40% rated power condition,
- The key parameters and important functions of the codes that affect the natural circulation of SFRs are also derived through comparisons between the test data and simulation results,



Heat Transport System on Monju

- In particular this CRP focuses on the development of flow network models which simulate the thermal-hydraulics in the reactor upper plenum and IHX inlet plenum.

Scope

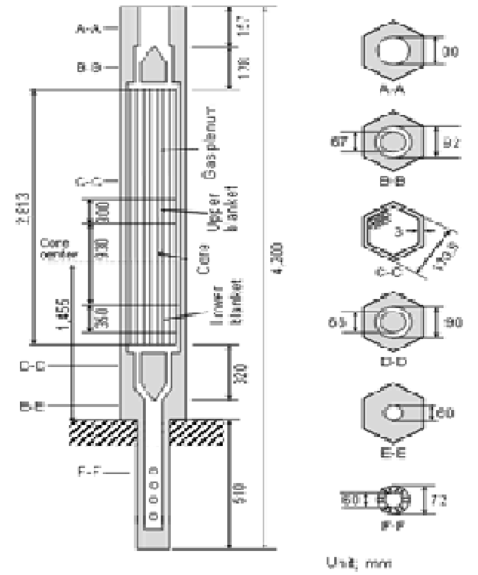
- *Development of an analytical model of Monju PHTS for system code, which includes flow network models of the upper plenum of RV and the inlet plenum of IHX.*
- *The plant dynamics simulation under the turbine trip test from the 40% rated power condition. Additional calculations such as CFD calculations and/or coupled calculations, etc., if needed.*
- *Derivation of the key parameters and important functions of the codes that affect the natural circulation by comparisons between the test data and simulation results,*

Data provided by JAEA (1/3)

1. Geometry data

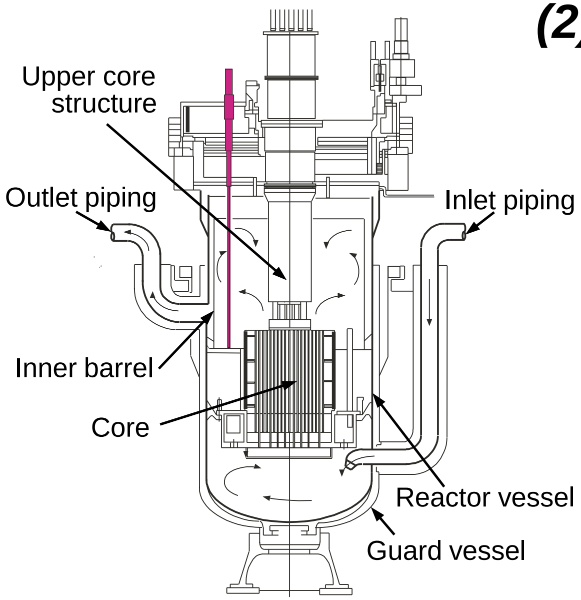
(1) Core subassemblies:

- *The cross section of each subassembly and sizes of main regions,*
- *Power of each subassembly*.



(2) Reactor vessel (RV):

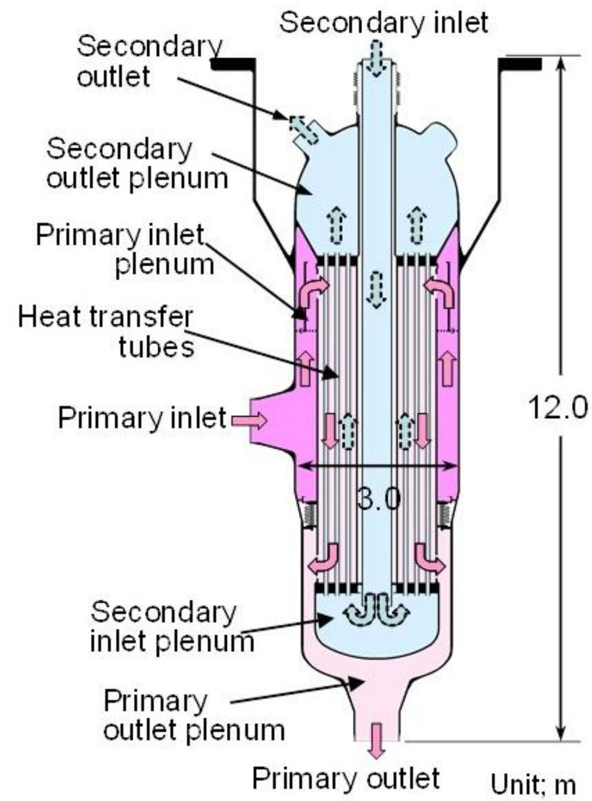
- *The cross section, sizes and volumes of the main regions, such as the high and low pressure plenum, the inlet plenum and the middle plenum.*



Data provided by JAEA (2/3)

(3) Intermediate heat exchanger (IHX):

- *The outer and inner diameter, numbers, height, and materials of the heat transfer tubes,*
- *The outer and inner diameter of the shell,*
- *The volumes of the inlet and outlet plenum of both PHTS and SHTS.*



Data provided by JAEA (3/3)

(4) Primary heat transfer piping:

- *Lengths, the outer and inner diameters.*

(5) Others

- *The detail geometry and test data concerning the upper plenum were already delivered to the participants of the previous MONJU CRP: These data will be published as an IAEA's TECDOC before starting this new CRP.*

2. Boundary conditions

- *The inlet temperature and flow rate of IHX secondary side,*
- *Basic specifications of primary sodium pump,*

3. Measured data

- *The inlet and outlet temperature of RV,*
- *Flow rate of PHTS,*
- *Outlet temperature of IHX secondary side, and*
- *The vertical temperature distribution of the RV upper plenum.*

Schedule (1/3)

(1) 2017 – 2018

- *JAEA will provide the geometry data and boundary conditions of the PHTS described in the above section in the 1st RCM,*
- *The CRP members will develop the analysis model of the PHTS for their own system codes especially focused on the flow network models of the RV upper plenum and IHX inlet plenum, and the plant dynamics analysis will be carried out.*

Schedule (2/3)

(2) 2018 – 2019

- *JAEA will provide the test data and compile participants' results,*
- *Participants will summarize the analysis methods, the modeling difficulties and the problem solution methods in the blind calculations,*
- *In the 2nd RCM, participants will discuss the differences between the test results and simulation results, and derive the key parameters and important factors for the flow network models which affect largely to the plant dynamics.*
- *Participants will modify the analytical model based on the discussion in the 2nd RCM and recalculations (final calculations) of the system codes will be performed. Additional calculations such as CFD calculations, etc. will be also performed if needed.*

Schedule (3/3)

(3) 2019 – 2020

- In the 3rd RCM, the final results will be discussed and the key parameters and important factors of the flow network models derived in the 2nd RCM will be reconfirmed or new ones will be derived. The participants will also discuss and decide the contents of the final report.
- All participants described the final report of IAEA and the draft will be accomplished by the end of 2020.

(4) 2021

- The draft final report will be finalized in the 4th RCM and the TECDOC will be published within this year.

Thank you for your attention!