# Transient Analyses of the Prototype Fast Breeder Reactor "MONJU" Performed by the Plant Dynamics Analysis Code CERES

## Background

The flow pattern of the coolant in a reactor vessel (R/V) changes into the complexity at the trip of fast breeder reactor (FBR), and the temperature changes according to it. In designing the reactors, it is necessary to keep enough safety margin in consideration of the effects.

CRIEPI has been developing the plant dynamics analytical code CERES to evaluate the integrity of actual plant systems or to design new plant systems. This code is a plant dynamic characteristic analysis code for FBR that adds multi-dimensional thermal-hydraulic analysis function, and, up to now, the function has been verified by the water experimental tests. The remaining subject was to confirm the prediction accuracy of the temperature change at the plant transition.

On the other hand, prototype reactor "MONJU" exists as FBR which can generate electricity in Japan. And the precious data at the reactor trip test from 40% electricity was obtained in December 1995.

## Objects

The analyses using the CERES code for the reactor trip tests of prototype reactor "MONJU" are performed. The calculated temperature changes of some parts are compared with the measurement results of a actual plant, the characteristics on the thermal-hydraulic of "MONJU" are clarified, and the CERES code is verified.

## Principal Results

1. The plenum in the R/V was modeled by two dimensional thermal-hydraulic model and the analyses were performed within the range of the primary, the secondary and the auxiliary cooling systems. Good agreements with measurements of the temperature of each part could be confirmed (Fig.1). The sodium in the middle body plenum that has stagnated usually under normal operation is maintained in the high temperature compared with sodium at the other parts after reactor trip, and it has a possibility to influence the R/V exit temperature slightly in a long-term transition. As a result, it was able to explain the small difference of the R/V exit temperature calculated by one dimensional network code.

2. The analyses that modeled the plenum in R/V by three dimensional thermal-hydraulic model were performed. The boundary conditions were the R/V entrance sodium temperature and the flow rate. The temperature gradient is appeared in a perpendicular direction in an upper plenum of R/V because the comparatively low temperature sodium flows out from the reactor core after reactor trip. As for the temperature gradient and the gradient change behavior, the analyses corresponded to the test results well during the transient (Fig.2).

3. The analyses, focused on an inlet plenum of the intermediate heat exchanger (IHX) situated between the IHX inlet nozzle and the heat transfer part, were performed. The plenum was modeled by 3 dimensional thermal-hydraulic model. As a result, the thermal-hydraulic characteristics in this plenum that were not clear up to now could be clarified, and the temperature change behavior at the IHX exit agreed to the test result well.

From above-mentioned calculation, the validity of the multi-dimensional thermal-hydraulic analysis performance of the CERES code could be confirmed, and some thermal-hydraulic characteristics of the "MONJU" could be clarified. It was verified that the CERES code can be used to evaluate an actual plant as a FBR plant dynamic characteristic analysis code.

## Future Developments

This will be applied to the design and safety analysis on a 4S reactor. Positive appeals will be made to use it to be used for preliminary operating tests of the "MONJU".

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***Reference***

Y. Nishi, et. al., "Verification of the plant dynamics analytical code CERES using the results of the plant trip test of the Prototype Fast Breeder Reactor MONJU -The verification with the steady state and plant trip conditions- Collaboration research report of CRIEPI-JNC", CRIEPI report L02 (in Japanese)

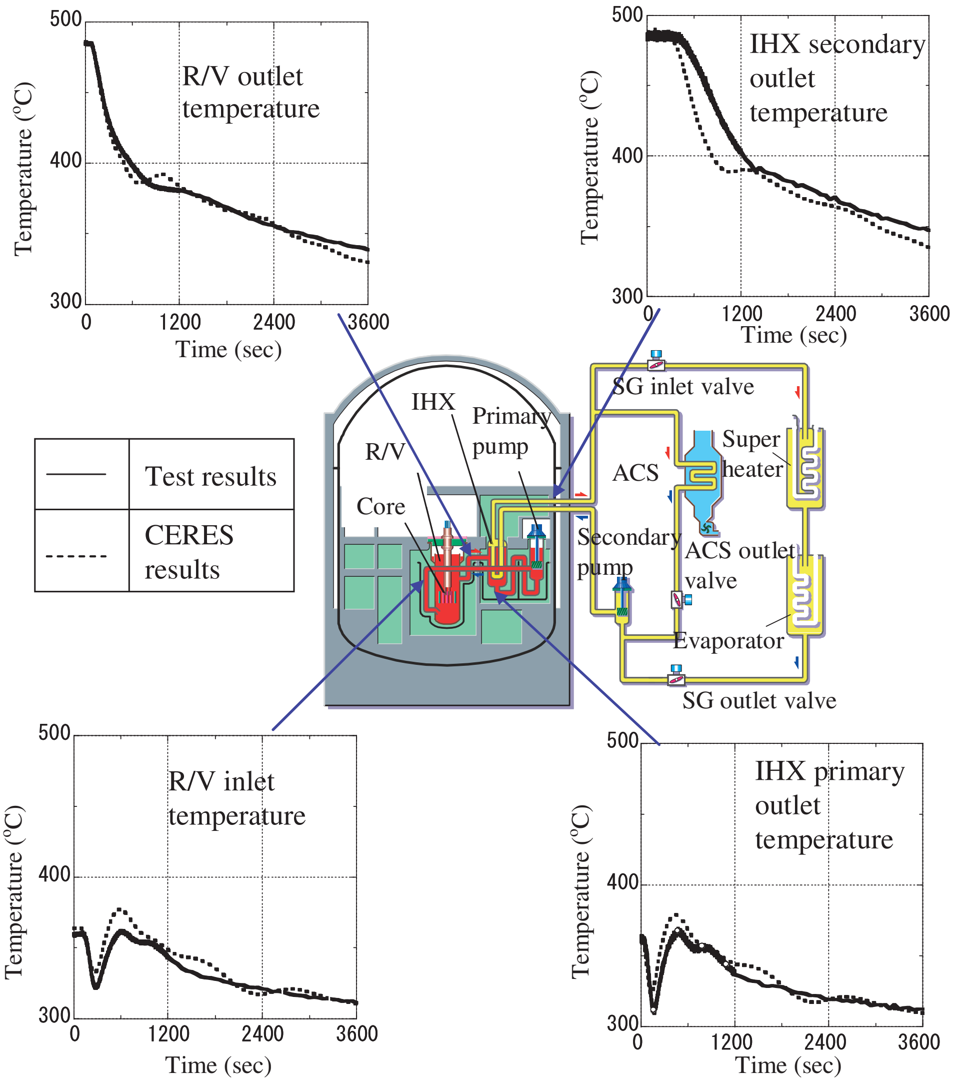


**Fig. 1** Comparison between the temperature changes in MONJU cooling system and the analytical results by CERES code

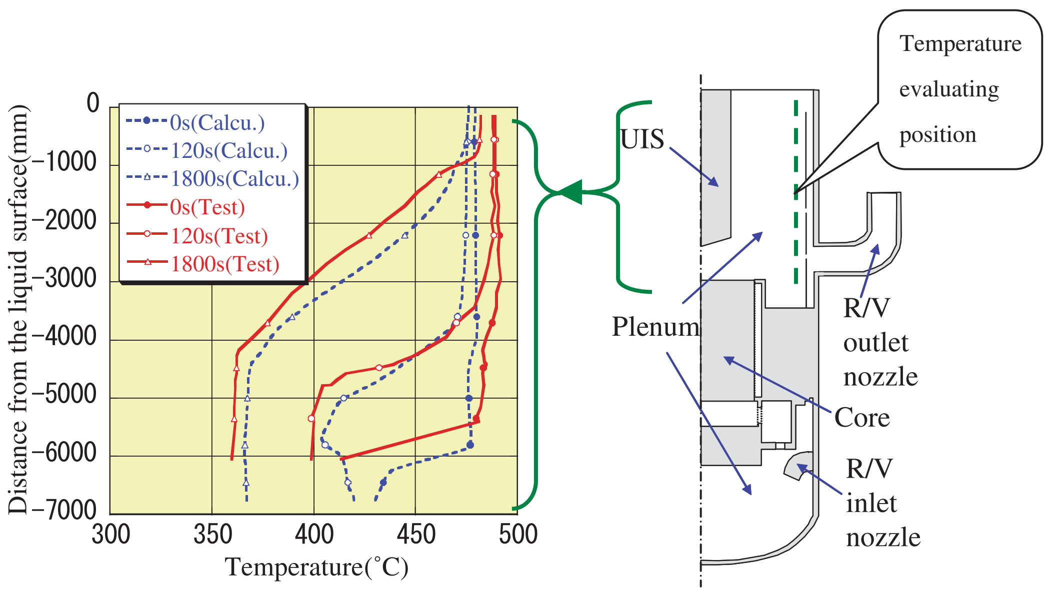


**Fig.2** Outline of R/V internal structure and the comparison between temperature changes of upper plenum in R/V