A MARS AND MIDAS Linked Accident Simulation for Large LOCA in APR1400

Young Choi*, K. R. Kim, D. H. Kim, B. D. Chung
Korea Atomic Energy Research Institute
P.O.Box 105, Yusung, Daejon, Korea, 305-600

1. Introduction

A linked calculation utilizing the design-basis code MARS and the severe accident code MIDAS has been accomplished for a station blackout simulation in APR1400. The MARS code was developed by using the RELAP3/MOD3 and COBRA-TF codes, while the MIDAS code is currently under a development process using the MELCOR code. The objectives of this paper are to explain how to identify the MAR-MIDAS linked calculation outlines and the technical problems, including the MARS data transfer method, the MIDAS input generation works and so on. For the performance verification of the MARS-MIDAS linked calculation, the MARS, MIDAS and their linkage system are run independently for the same initiating event, so that their data can be compared with each other after the selection of proper variables.

2. SARD DB Results and Application Method

In this section the methodology of how explain how to identify the MARS data transfer method, the MARS and MIDAS node mapping and variable definition principles, the MIDAS input generation works.

2.1 MARS –MIDAS data transfer method

Figure 1 is a conceptual diagram of the MARS-MIDAS linkage system. Because the MARS, a DBA analysis code, and the MIDAS, a severe accident analysis code, are codes of different domains, we have to determine the linking point of the time where the two domains intersect. When determining the linking point, the two codes' calculation performance should be deliberately considered for a successful linkage. In general, however, a MARS nodalization is more complicated than that of a MIDAS, several control volumes and flow lines of MARS should be mapped and merged to a control volume or a flow line of MIDAS. MARS performs a very detailed calculation using the two-phase flow models, while MIDAS performs more detailed calculations for the containment and core behaviors.

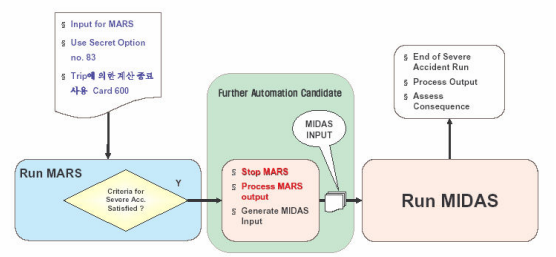

Figure 1. The conceptual diagram of the MARS-MIDAS linkage system

2.2 Input Preparation

The data following a Large LOCA was used for new input files. Mainly, the time dependant input items of the control volumes, flow lines, core and heat structures of the MIDAS were replaced by this data. The IEDIT input management system can generate input lines automatically. This system was developed at KAERI, to provide an input information display function and an automatic input generation function.

-MARS Data Input:

As an Example, according to results for the large LOCA initiators, data scenarios have been determined for analyses based on the APR1400 as shown in figure 2, the APR1400 nodalization of the MARS code is depicted. A large LOCA scenario was run under the following assumptions:

- RCP trip at t=0
- Break type: Guillotine Break at 0 sec
- SIT : Working / HPSI /LPSI : No Working

The MARS output data was saved to be transferred to the MIDAS code analysis team using the MIDAS data which defines the trip data, Rx kinetics data, volume - junction - component data, heat structure data, metal water reaction data, reflood data and control variables data. [1]

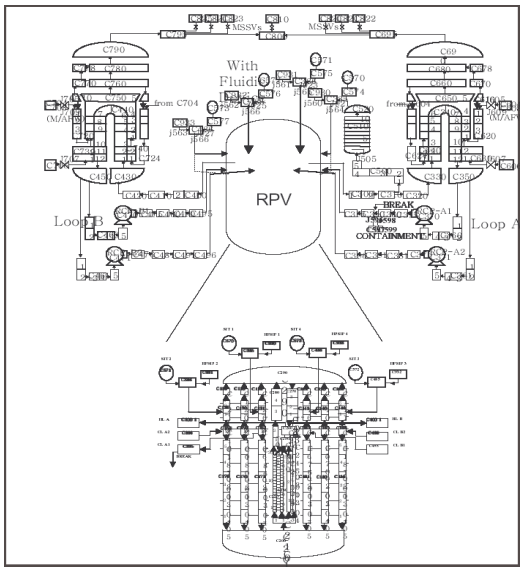

Figure 2. MARS Nodalization for a LOCA Analysis.

- MIDAS Data Input :

Figure 3 shows the APR1400 nodalization of the MIDAS code. Generally since a MARS nodalization is more complicated than that of a MIDAS, several control

volumes and flow lines of MARS were mapped and merged to a control volume or a flow line of MIDAS. Almost of all the thermal hydraulic time dependant parameters such as the pressure, temperature, mass, and so on were mapped to the MIDAS parameters by averaging their values or by taking the representative values according to the node-mapping.

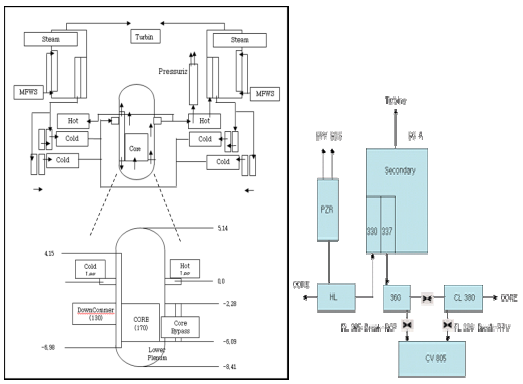

Figure 3. MIDAS Nodalization for a LOCA Analysis

2.3 MARS-MIDAS Linked Calculation

It is very difficult to verify the performance of a MARS-MIDAS linked calculation result. Since the first objective of this linked calculation was to calculate a severe accident scenario based on the MARS code data without a failure, we could say that we have built the MARS – MIDAS linkage successfully.

- *Sequence Analysis Results*

The following is an example showing initial conditions and result. several graphs showing that the linkage was made continuously will be presented through Fig .4 to Fig. 6. The advancement of a linked simulation is very similar to the MIDAS only base-case result after the core melting. The MARS – MIDAS linkage is made at 950 sec, having set DT time as 0.3 sec. In the following figures, we can see that the linkage was made smoothly and that the linked results resemble original MIDAS base-case results.

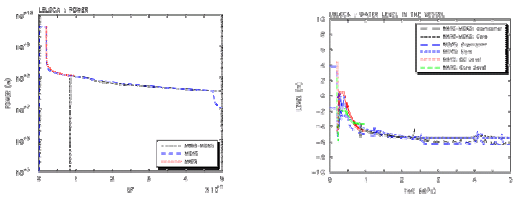

Figure 4. Decay Power / Reactor water levels of Large LOCA results

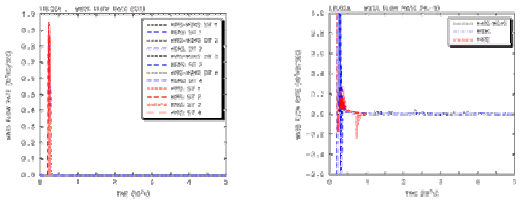

Figure 5. Mass Flow /Pressure of Large LOCA results

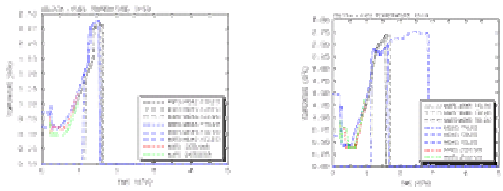

Figure 6. Fuel Temp. of Large LOCA results

3. Conclusion

MARS–MIDAS linkage has been effectively tested through a set of calculation selected in plant specific status, scenarios and parameters. In this paper, a representative design basis accident analysis code MARS and a representative severe accident analysis code MIDAS were linked through an input file based linkage and their linked calculation results were presented. The suggested input file based linkage method was proven to be acceptable through a MIDAS – MIDAS preliminary calculation, and a MARS – MIDAS linkage was built using the same linkage methods. Preparing a MIDAS input data entailed a tedious conversion works, and mapping or merging several nodes data into a MIDAS node data. By several analysis graphs, we have concluded that the linkage was made smoothly as reasonable expectations of this work. [2]

Acknowledgements

This work was performed under " The Mid- and Long-Term Nuclear R & D Program" sponsored by Ministry of Science and Technology (MOST), Korea.

REFERENCES

[1] B. D. Chung et el (1998), Modernization and Restructuring of Realistic Thermal-Hydraulic System Analysis Code, RELAP5/MOD3.2.1.2, NTHAS98, Pusan, Korea, Oct. 21-24,1998

[2] K. R. Kim (2003), Development of the GUI Environments of MIDAS Code for Convenient Input and Output Processing, 2003 KNS spring meeting, Kyungjoo, Korea, May 29-30, 2003