Transactions of the Korean Nuclear Society Autumn Meeting
PyeongChang, Korea, October 30-31, 2008

A Development of Base Technology for a Level 2 Risk Assessment and Application

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1. Introduction

Both the systematic analysis and prediction tools essential for the development of an optimized accident management process, and a preliminary evaluation system for a PWR severe accident management has been developed in Korea. The system is composed of a localized computer code, MIDAS with a graphic simulator and a severe accident database (DB) with a DB management system for a Korean standard NPP. In order to both resolve the long-lasting issues and to evaluate new strategies, it is vital to have a domesticated severe accident analysis computer code with which a model improvement and a new model addition as well as the implementation of GUI for a user-friendliness can be made easily. A well-designed and efficient DB management system is also necessary to predict an accident progression and to assess severe accident management strategies. Recently, KAERI established a plan to develop an integrated accident management system (IAMS) via an effort to minimize a level-2 PSA uncertainty and to add risk information to a previous deterministic safety analysis frame. This IAMS (see Figure.1) including both a risk-added phenomenological DB and improved computer tools as an accident analysis engine will be applied to an emergency support for an expert, operator training, and to the development of optimized severe accident strategies. This paper introduces the base technologies (see the green colored circles in Figure.1) developed for a Level 2 risk assessment and application such as the IAMS.

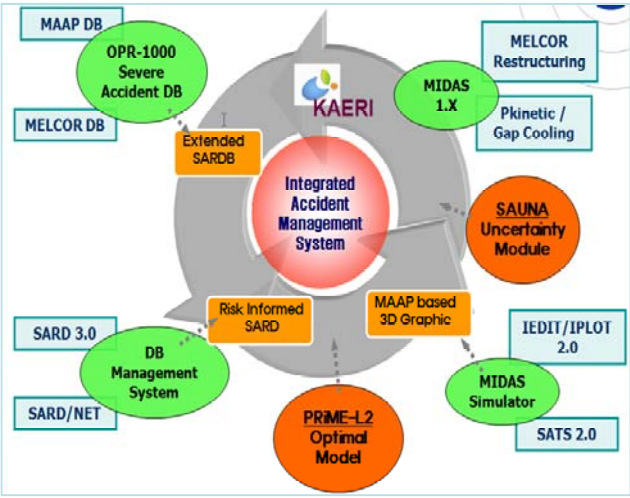

Figure.1 Integrated Accident Management System developing in Korea for PWR

2. Computational Aids Technology

First, MIDAS (Multi-purpose IntegrateD Assessment code for Severe accidents) 1.0 version [1] has been developed for a code domestication, based on MELCOR as the reference code [2]. The code has a completely new data transfer structure using the Fortran 90 features which allocate the storage dynamically and use the user-defined data type, leading to an efficient memory treatment and an easy understanding of the code. The comparison processes before and after the code restructuring show almost identical results with negligible error bounds. The information about a core degradation, fission product release characteristics, and aerosol transport inside the tube and in the containment obtained from the ISP-44/46 were used for a model improvement for the fission product behavior. As the old version 1.0 of MIDAS can not simulate the anticipated transient without scram (ATWS) sequence, a point-kinetics model has been implemented in MIDAS 1.1 [3] which was tested against the RETRAN [4] for the ATWS simulation and showed a similar trend. Also the gap cooling module in MIDAS 1.2 [5] can be turned on by the input and this model has been implemented by the addition of new models with user's control options for input/output variables. As additives, input and output processors are also developed which are called IEDIT and IPLOT, respectively.

Second, the MIDAS simulator shown in Figure.1 and is called as SATS [6] is the MIDAS (or MELCOR) based training graphic simulator, developed to provide a multi-purpose tool for severe accident analyses and training. It has two main features: one is to provide graphic displays to represent severe accident phenomena and the other is to process interactively given user inputs and simulates them, such as real-time valve and pump operations. Together with the severe accident safety parameter display system (SPDS) and computerized SAMG (Severe Accident Management Guidance) module (HyperKAMG), SATS will provide the best environments for a severe accident training tool. New version of SATS 2.0 [7] has been released recently with the MIDAS code as a severe accident simulation engine. Thanks to the restructured MIDAS, SATS 2.0 can now use the display variables directly from the code instead of using pointers. Also the interfacial program for the SATS-HyperKAMG system, which connects the online SAMG to the graphic simulator, and the SATS menu structure have also been improved for a user's convenience.

3. Data Base Technology

First, In order to set up the database set for the OPR-1000, MELCOR DB has been constructed to support the MAAP DB developed in the previous phase [8]. The MAAP DB [9] has been generated for the various sequences of large LOCAs, medium LOCAs, small LOCAs, station black outs, loss of off-site power, loss of feedwater and steam generator tube ruptures, using the recent version of MAAP 4.0.6. However, MELCOR DB has been constructed with MELCOR1.8.5-OPR1000 for only the typical high and low pressure scenarios as the representative cases for the time being. Specifically, to construct the MELCOR DB, a new MELCOR1.8.5-OPR1000 input deck has been developed [10], as the old input deck caused too much CPU time or stopped the calculation sometimes. The new deck has been finalized by comparing it with the MAAP results. In that process, MELCOR variables are redefined in order to compare them with the corresponding MAAP variables. Regarding the DB variables, about 840 major variables including the thermal-hydraulic information on the reactor coolant system, hydrogen behavior (generation and combustion), reactor pressure vessel behavior (temperature, failure time, etc), containment behavior and source term are generated. Also the effect of the safety systems is analyzed through the sensitivity study, which is added to the MAAP DB.

Second, The DB management system, SARD [11], has been upgraded to manage the MELCOR DB in addition to the MAAP DB. Specifically, the SARD/PC 3.0 has been developed and released. It can manage the MAAP DB and MELCOR DB using an automatic MDB generation and DB search for the selected DB. Version 3.0 has been extended to generate the MELCOR DB data bank and to search the DB from the given initial or boundary conditions. In order to maximize the SARD access for remote users, the SARD/NET environment has been set up by using the remote desktop connect utility. It allows multi-users to use the SARD through the network at the same time.

4. Conclusion

Domestically in Korea, a mid/long-term R&D is being performed to find a way for a Level 2 PSA (L2) uncertainty decrease and all the computer tools and DB already developed will be improved in the process. Three major works such as 1) an optimal severe accident management expert system (SAMEX), 2) an optimized L2 uncertainty evaluation system, and 3) a plant risk evaluation measure, are to be performed as shown in Figure.2. Through the development of SAMEX, we expect to develop optimal accident management methodology including an risk-informed accident diagnosis and prediction system (RI-SARD), extended DB (SARDB) and a MAAP-based severe accident management simulator (SAMS). From the PSA point of view, L2 model quality is not as good as the Level1 PSA model due to the large uncertainties in severe accidents. In order to reduce these uncertainties, an optimal L2 model for OPR-1000 (PRiME-L2) and a MAAP-based uncertainty analysis module (SAUNA) are to be developed. Related with a risk measure, an LERF/LLRF (Large Early/Late Release Frequency)-plant specific risk connection will be studied.

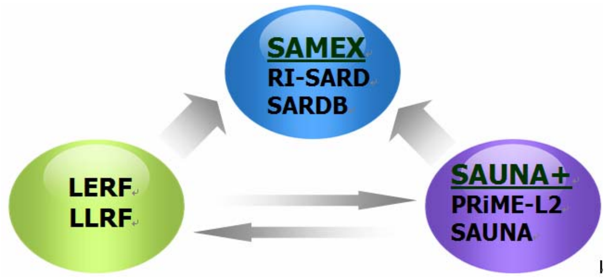

Figure.2 Connection Flow between Three Major Future Works for Final IAMS

ACKNOWLEDGMENTS

This project has been carried out under the Nuclear R&D Program by Ministry of Science and Technology (MOST) in Korea.

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