# Analysis of Factory Acceptance Test Results of Severe Accidents for Wolsong 3 Simulator

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## 1. Introduction

As a part of enforcement of education of severe accident phenomena for nuclear power plant operators, KHNP is developing and implementing severe accident analysis module for full scope simulators with which operators can be trained. For CANDU type plants, L3 is developing the severe accident module for Wolsong 3 full scope simulator. In this paper, software FAT (Factory Acceptance Test) results are discussed.

## 2. Methods

FATs were performed in the L3M site in Montreal, Canada, by KHNP engineers. L3M developed the severe accident module using EPRI's MAAP4-CANDU with the help of Fauske & Associates, LLC. For the severe accident module, three FATs were performed.

### *2.1 Development of Severe Accident Analysis Module*

A new MAAP-CANDU code, MAAP-CANDU v4.07G-L3, was developed as part of this project, which is based on MAAP-CANDU v4.07F. The new code version contains changes required to implement the interface with the L3 simulator. The implementation technique is not provided to KHNP as it is an intellectual property of L3.

Except the code implementation, they provided the process of updating MAAP parameters, how to generate the initial conditions for severe accidents, and how to run severe accident scenarios. The MAAP parameter file which was sent to L3 from KHNP was reviewed and changes were made to reflect the plant specific design and geometry[1]. Main focus was on total mass, areas and volume as well as initial inventories and initial conditions. Parameters relevant to engineered safeguards such as containment coolers, containment sprays, emergency coolant injection and moderator cooling are not considered since these functions are modeled using the L3 simulator modeling tools.

### *2.2 Process of Factory Acceptance Tests*

One functional test and three severe accident cases were performed during FAT. The functional test, SATP-063 (SAS Interface), was to check the functionality of the simulator after implementing the MAAP4-CANDU code. The functional test is to verify the interface between L3 model and MAAP-CANDU model. They should be able to show that an operator action from L3 model is reflected into the MAAP4-CANDU model. The test finished successfully without any deficiencies.

Severe accident scenario that were analyzed are as follows:

- SATP-064[2], LBLOCA with loss of emergency core cooling but with moderator cooling available,
- SATP-065[3], LBLOCA with loss of emergency core cooling and no moderator cooling, and
- SATP-066[4], Station Black Out with pump seal LOCA on one coolant pump per loop.

The three tests were carried out and the resultant data were collected and compared to those of stand-alone MAAP-CANU results automatically as SBT (Scenario Based Test) data packages with the aid of L3 simulator function, SBT Manager.

## 3. Results

The purpose of the FAT tests is to verify if the responses of the simulator follow the same trend and direction as the results produced by MAAP4-CANDU stand-alone simulation. Each severe accident scenario tested here evaluates the response of the simulator in MAAP mode. The results obtained from the tests were compared to MAAP4-CANDU stand-alone results for the same tests. Most quantities of L3 integrated MAAP4-CANDU simulation follow the same trend and direction as the results produced by MAAP4-CANDU stand-alone simulation. But some quantities show different trends and need to be investigated.

A type of the discrepancies between simulator results and MAAP4-CANDU stand-alone results is shown in Fig.1, where simulation results shows continuous trend while stand-alone results gives discrete trend. After investigating this kind of situations, it is found that the time step size for storing graph data was the reason. Correcting the input file of MAAP4-CANDU code gave the same trend and direction as for the simulator results.

Another type of discrepancy was noticed in the trends of pressurizer pressure. Fig. 2 shows the trends of the simulator and the stand-alone results, respectively. This type of discrepancy comes from the difference of the system modeling. In this case, the simulator has pressurizer heaters that are modeled by L3 modeling tools, while the input for the stand-alone code doesn't. As a result of such detailed modeling capabilities, the simulator seems to produce more realistic responses than those of stand-alone code.


Fig. 1. Containment H2 Mole Fraction, where response of simulator gives continuous trend while stand-alone result shows step-change trend

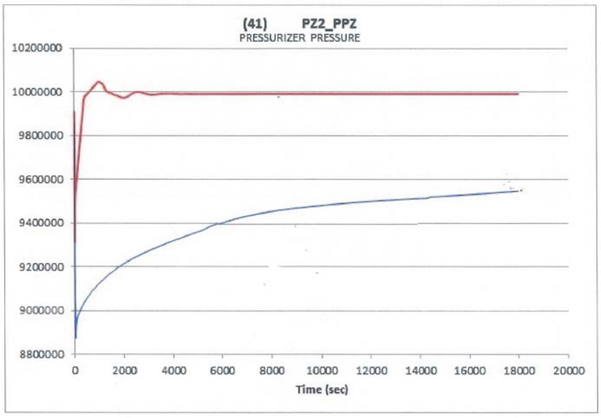


Fig2. Pressurizer Pressure, where stand-alone response is lower than that of simulator due to the lack of heater modeling

## 4. Conclusions

A brief analysis of software FAT testing results are described here. Most quantities of the simulator and the stand-alone code show the same trend and direction. For the quantities that show different trends, investigation was performed to identify the cause of discrepancies. The discrepancies are minor, but will be corrected before SAT (Site Acceptance Test). In some cases, the L3 integrated MAAP-CANDU shows more realistic data than the result of the stand-alone code. This can be more efficient for operator training of severe accident.

## REFERENCES

[1] FAI/17-0235, Wolsong 1 Parameter File Update and Reference Results for Acceptance Testing, Fauske and Associates, LLC, March 2017.
[2] SATP-064, SBT Data Package for LBLOCA NO ECC, L3MAPPS Inc., November 2019.
[3] SATP-065, SBT Data Package for LBLOCA NO ECC LOM, L3MAPPS Inc., November 2019.
[4] SATP-066, SBT Data Package for SBO, L3MAPPS Inc., November 2019.