FDS5 Simulation of PRISME INTEGRAL Test, PRS_INT_4

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1. Introduction

The reliance on fire modeling has playing a key role in the risk-informed and performance-based fire protection field. The ability to accurately predict fire behavior using the fire models is of high utility for hazard assessment, investigations and performance based design.

Validation is the process of determining the degree of agreement between fire model outputs and real world events for one or more results of interest. The goal of validation is to quantify confidence in the predictive capability of the model [1]. Validation in NUREG-1824 [2] entails comparing the model prediction with full-scale fire experiments and quantifying the results.

The objectives of this study, focused on the fire model validation, are to compare the FDS5 prediction results with the PRISME INTEGRAL test data and to validate FDS5 model.

2. PRISME INTERAL Tests

OECD/NEA PRISME project is an international co-operation project to investigate fire and smoke propagation from the fire room to adjacent rooms under various conditions and room configurations by means of experimental data using DIVA test facility owned by French Institut de radioprotection et de sûreté nucléaire (IRSN) as described in Fig. 1.

The experimental tests of PRISME project are composed with DOOR tests, LEAK tests, and INTEGRAL tests. The INTEGRAL test series focuses on studying the heat and mass transfer of hot gases and smoke in the various 3 or 4 rooms linked by open doors.

The objective of INTEGRAL 4th test series (PRS_INT_4) is to investigate the propagation of smoke for a realistic fire scenario in an assembly of 4 rooms confined and ventilated. The fire source is a TPH (liquid hydrogenated tetra-propylene) pool fire with a surface area of 1.0 m^2. The rooms connected each other with doorways are ventilated at a rate of 3,100 m^3/h with the specific configuration presented in Fig. 2.

3. Simulation Methods and Results

3.1 Fire modeling of PRS_INT_4

A fire propagation of the PRS_INT_4 test is modeled with FDS5 [3] as shown in Fig. 3. The geometry of the rooms is nodalized with the number of cells of 192x94x45 which results in the each cell size of 10cm x 10cm x 10cm.

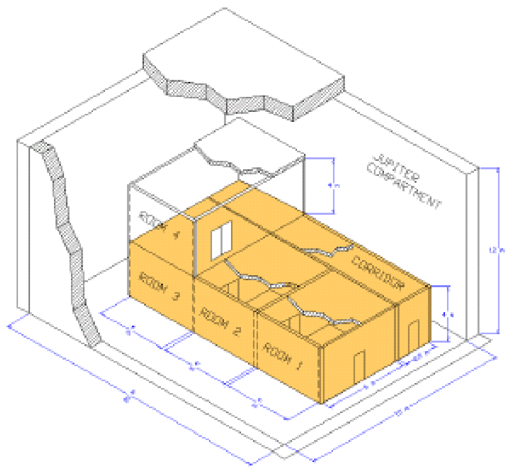

Fig 1. Room configuration in DIVA test facility

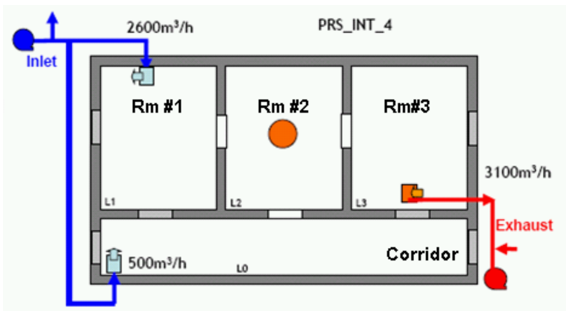

Fig. 2. Specific configuration of PRS_INT_4 test

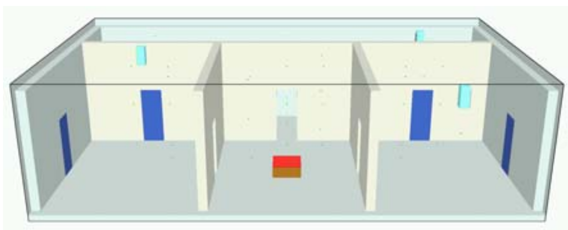

Fig. 3. FDS5 modeling for PRS_INT_4 test

The ventilation rate is fixed as 3100 m^3/h during the whole simulation and the radiative fraction and soot yield rate of the fire source is set to 0.35 and 0.01, respectively, as default values built in the FDS5. Heat release rates (HRR) of the fire source obtained from the mass loss data of PRS_INT_4 test are slightly modified to use as input of the FDS5, as compared in the Fig. 4.

3.2 Simulation Results

The simulation results are compared with the experimental data to assess the FDS5 capability. The parameters to compare the experimental data in this study include the gas temperatures in the compartment and the concentrations of O_2.

Fig. 5 shows the comparison of gas temperature predictions at the south-west side of the fire room with those of the experimental data. The overall trends of the temperature predictions are similar to those of the experimental data. The temperatures are generally under-estimated and the temperature profiles as shown in Fig. 5 are similar to HRR profile. This means HRR profile is a critical factor to predict the compartment fire propagation.

Fig. 6 shows the comparison of O_2 concentration predictions of the upper and lower elevation at the fire room with those of the experimental data. The O_2 concentrations are over estimated.

HRR profile relies on the value of pyrolysis rate of combustion for the fuel provided in the PRISME INTEGRAL test report. HRR curve used in FDS5 simulation is established from the mass loss data taken from the test report.

The reason for the discrepancies between the simulation results and the experimental data is mainly due to the HRR values. Therefore, further works are to be needed to investigate the dependency of HRR to the major parameters

4. Conclusions

The fire simulation using FDS5 is performed for PRISME INTEGRAL test results, PRS_INT_4. After comparing simulation results and experimental data, the reason for the discrepancies between the simulation results and the experimental data is mainly due to the HRR values and it is found that the most important factor to consider the simulation of compartment pool fire is the prescribed HRR in order to validate the FDS5 capability. Therefore, further works are to be needed to investigate the dependency of HRR to the major parameters

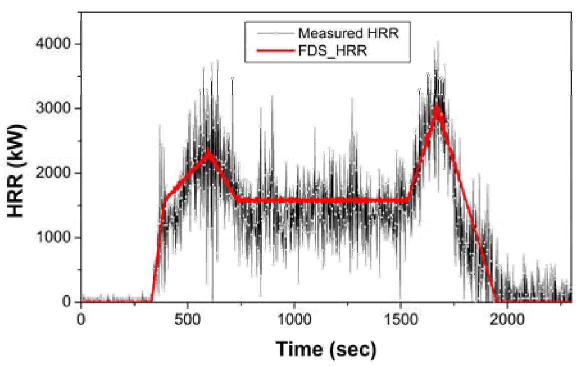

Fig. 4. HRR of PRS_INT_4 test

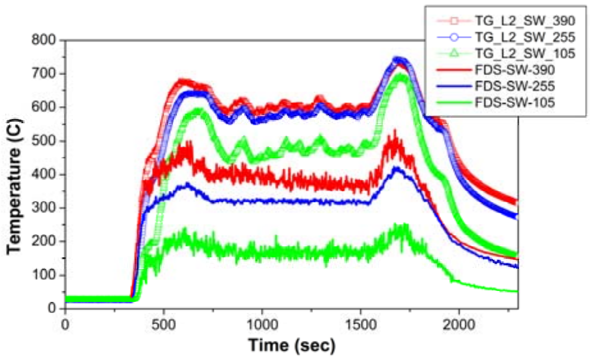

Fig.5. Comparison of Gas Temp. in Compartment

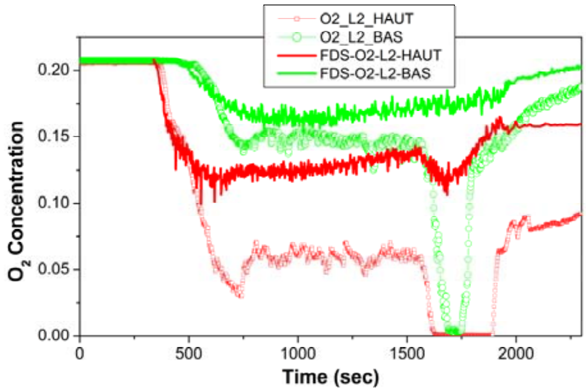

Fig. 6. Comparison of O_2 Concentration

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