Development of Integrated Analyzing and Training Simulator for Spent Nuclear Fuel Pool, CAREPooL

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1. Introduction

The Comprehensive Analyzer of Real Estimation for spent fuel POOL (CAREPOOL) has been developed for evaluating temperature and criticality of a spent nuclear fuel pool (SFP) during the normal and accident conditions.

2. CAREPOOL System

2.1 Management of Spent Nuclear Fuel

The management of spent nuclear fuel function provides a management tool for spent nuclear fuel in the SFP. The fuel assemblies both in SFP and reactor side can be shown graphically in the screen. The loading/discharge into reactor/SFP sequence can be checked respectively in the CAREPOOL. (Fig. 1)
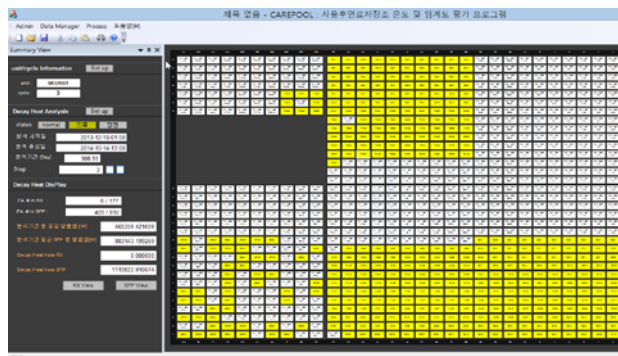
2.2 Decay Heat Calculation

SFP at nuclear reactor sites contains used fuel assemblies and cooling of the used fuel is required to remove the decay heat generated by radioactive decay. ORIGEN-S code was embedded in the CAREPOOL to calculate the decay heat of each fuel assembly. All of the calculated decay heat loads will be used for a temperature calculation of SFP.

2.3 Estimation of the Time to Boil/Fuel Uncovering

A basic heat balance equation was used to estimate the SFP temperature using the heat load calculated in the previous step. The characteristics of typical SFPs and associated cooling systems at reactor sites in the Korea were applied. Accident simulation like station black out leading to loss of SFP cooling or inventory is possible. Emergency cooling water injection pipe installed subsequent to the events at Fukushima 2011 is also modeled in this system. (Fig. 2)
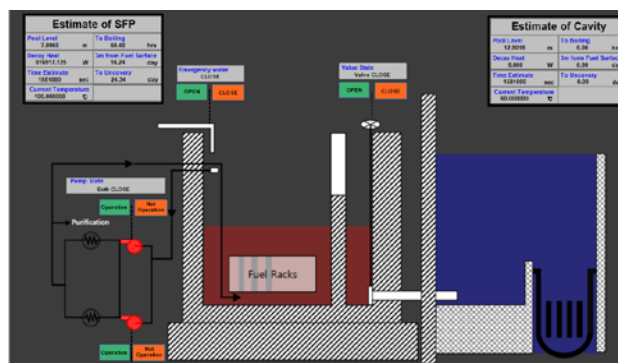
2.4 Criticality Evaluation

Criticality evaluation module, Helios code, has been embedded in the CAREPOOL system. The infinitive multiplication factor can be estimated regarding to variation of temperature and boron concentration in the SFP. (Fig. 3) A bipolar amplifier was modeled in
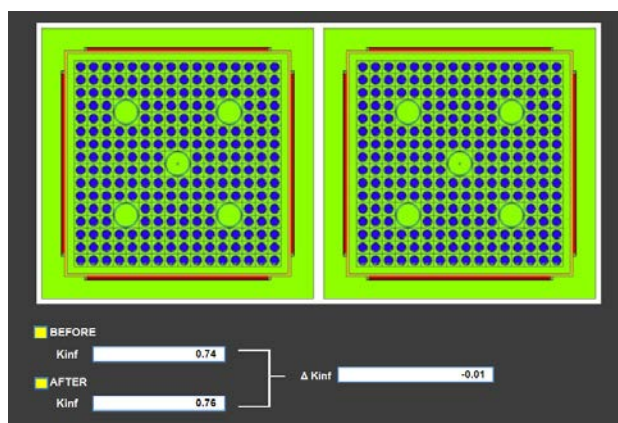

Fig. 1. Management of Spent Nuclear Fuel

Fig. 2. Estimation of the Time to Boil/Fuel Uncovering

Fig. 3. Criticality Evaluation

3. Conclusions

The CAREPOOL provides four main functions- management of spent nuclear fuel, decay heat

calculation by ORIGEN-S code [1], estimation of the time to boil/fuel uncovering by thermal-hydraulics calculations, criticality evaluation by Helios code [2]. All of these are integrated into the GUI based CAREPOOL system. The CAREPOOL would be very beneficial to nuclear power plant operator and trainee who have responsibility for the SFP operation.

REFERENCES

[1] C. V. Parks, "OVERVIEW OF ORIGEN2 AND ORIGEN-S: CAPABILITIES AND LIMITATIONS" (1992)

[2] Stamml′er, R.J., et al., " HELIOS methods, Studsvik Scandpower Internal Report" (1998).