Transactions, SMiRT-24
BEXCO, Busan, Korea - August 20-25, 2017
Division IX (include assigned division number from I to X)

THERMAL-HYDRAULIC VALIDATION TESTS AND THEIR ANALYSES ON PASSIVE SAFETY INJECTION SYSTEM FOR SMART

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ABSTRACT

Thermal-hydraulic experimental studies with a large-scale integral test facility, system-integrated modular advanced reactor-integral test loop (SMART-ITL), have been conducted to validate the performance of the prototype small modular reactor (SMR), SMART. The SMART-ITL was designed with conserved height, 1/7 of diameter and 1/49 of area & volume scaling ratios from the prototype. After Fukushima accident, the passive safety systems have been being added on SMART and experimental or analytic validations of their capability are essential for retaining of nuclear safety. There are two types of passive safety systems equipped in SMART-ITL, passive residual heat removal system (PRHRS) and passive safety injection system (PSIS). The PRHRS prevents the over-heating and over-pressurizing of the reactor coolant system (RCS) by two-phase natural circulation in the accident conditions. There are four trains in the test facility and each train of PRHRS is composed of emergency cool-down tank (ECT), heat exchanger (HX), makeup tank (MT), valves, and pipes. Once the PRHRS trip signal is activated, the PRHRS is immediately triggered to start opening the bypass valves which connect to the secondary system. Then, the steam generated from the steam generator is fed into the PRHRS heat exchanger submerged in the ECT and the condensed water returned to the feed water line of the secondary system to cool the primary system. The PRHRS was designed to reduce a coolant temperature under safety shut down temperature by 36 hrs after accident and maintain it during 72 hrs. The PSIS consists of four core makeup tanks (CMTs), four safety injection tanks (SITs), and a two-stage automatic depressurization system (ADS). The CMTs and SITs are connected with pressure balance line (PBL) on the top and injection line (IL) on the bottom to reactor pressure vessel (RPV). The CMT is activated at high pressure condition at the moment after short term of accident and the SIT is operated at lower pressure condition when the pressure of RPV reduced under design set-value. The PSIS is designed to refill the coolant into RCS during 72 hrs after accident.
In this study, the experimental facility will be introduced and experimental & analytic results with single train PSIS during small break loss of coolant accident (SBLOCA) will be touched. The investigation about characteristics of the experimental & analytic results and thermal hydraulic phenomena with the single train PSIS are expected as valuable study.