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INTRODUCTION OF PASSIVE RESIDUAL HEAT REMOVAL SYSTEM FOR SMART

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ABSTRACT

An international demand for small modular reactors (SMRs) is steadily rising, especially in Middle East and North Africa (MENA) region. SMART (System-integrated Modular Advanced ReacTor) developed by KAERI (Korea Atomic Energy Research Institute), is the earliest deployable SMR in the world. She officially acquired the standard design approval (SDA) from the Nuclear Safety and Security Commission (NSSC) on 4 July 2012. The SMART safety enhancement project was followed in the next four years with intense support of the Government, resulting in an in-depth development of the most advanced passive safety features including passive residual heat removal system (PRHRS). Recently, the pre-project engineering (PPE) was officially launched between KAERI and K.A.CARE (King Abdullah city for atomic and renewable energy) in pursuit of the construction of SMART and developing human resources capability. In this international cooperation, preparation for SMART construction and training of NSSS designers chosen from Kingdom of Saudi Arabia are being conducted satisfactorily. SMART is originally designed to produce 100 MW of electricity, or 90 MW of electricity and daily 40,000 tons of desalinated water concurrently, which is sufficient for 100,000 residents. During PPE project, however, the thermal power is increased by 10 % in consideration of the local environment, where a first-of-a-kind (FOAK) SMART may be constructed. Moreover, an optimization of the passive safety system is also being performed in this project.

SMART is designed with passive safety systems in order to ensure the safety of the reactor. The PRHRS is one of the passive safety systems, which is activated after an accident to remove the residual heat from the core and the sensible heat of the reactor coolant system (RCS) through the steam generators (SGs). The system consists of four independent trains and each train is composed of an emergency cooldown tank (ECT), a PRHRS heat exchanger (PHX), and a PRHRS makeup tank (PMT). Each train is connected to a set of two SGs. When an accident occurs, which demands an activation of PRHRS, the main steam isolation valve (MSIV) and feedwater isolation valve (FIV) are closed automatically, and the PRHRS outlet isolation valves are open simultaneously. Then a closed loop of natural circulation is formed through the SGs, the PHX, and the connecting pipelines. Only by using natural circulation of two phase flow, the PRHRS removes residual and sensible heat for at least 72 hours since an accident occurs even without any operator's intervention or aid of external AC power. The PRHRS shall be designed to bring the temperature of the RCS below a safe shutdown condition within 36 hours after an accident occurrence and to maintain this state until at least 72 hours. This condition may be continuously maintained beyond 72 hours if the ECT is refilled periodically. The cooling rate of the RCS shall not exceed the maximum allowable limit during the operation of the PRHRS.

In this presentation, introductory information of SMART is delivered. Design history and the current status of the PPE project is touched shortly. Systematic configuration of the PRHRS is briefly illustrated and description of each component is also provided. Furthermore, safety functions of the system are identified and thermal performance predictions are also presented graphically. At the end of the presentation, the audience will understand how passive safety systems maintain the reactor safety and finally find out how important the natural circulation is, especially in the design of the PRHRS.