The Initial Test Program Features for the Advanced Korean NPPs

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Introduction

Korea has developed the Advanced Power Reactor 1400 (APR1400), an evolutionary pressurized water reactor and has obtained the standard design approval in 2002. As of June 2015, eight nuclear power plants (NPPs) are in preparation for operation or under construction, four in Korea (SKN 3&4, SUN 1&2) and four in UAE (BNPP 1,2,3&4), and four NPPs are in planning in Korea (SKN 5&6, SUN 3&4). Especially, SKN 3&4 NPPs are the first construction NPPs for the APR1400 and are currently in the final stage to get Operating Licence. It is very important to demonstrate that components and systems operate in accordance with design requirements. Therefore, this study would provide summary of the initial plant test program and introduce the outstanding test program for SKN 3&4 NPPs.

Initial Plant Test Program

The initial test program for NPPs begins as systems and components are turned over to the startup organization and ends with completion of the Power Ascension Tests (PATs). The results of the testing demonstrate that components and systems operate in accordance with design requirements and meet the requirements of 10CFR50. The initial testing program consists of the following major test stages:

- Phase I - Prerequisite and Pre-operational Test
- Phase II - Pre-core Hot Functional Test (HFT)
- Phase III - Initial Fuel Loading & Post-core HFT
- Phase IV - Initial Criticality & Low Power Physics Test
- Phase V - Power Ascension Test (PAT)

For SKN Unit 3, tests of Phases I and II have been successfully completed and the initial fuel loading would proceed after getting OL. The SKN unit 4 is preparing for the CHT (Cold Hydrostatic Test).

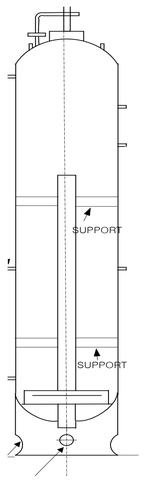
Outstanding Test Program

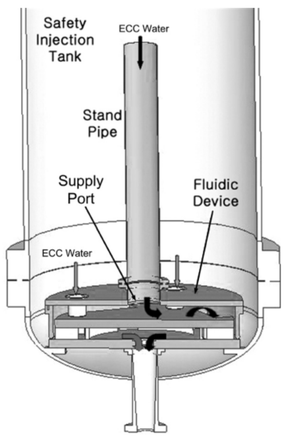
The SKN 3&4 has adopted many advanced design features and so has developed the test programs to demonstrate that the adopted advanced design features can be safely operated and the performance levels can be maintained in accordance with approved safety requirements. Among the advanced design features, the following test programs would be introduced with design features:

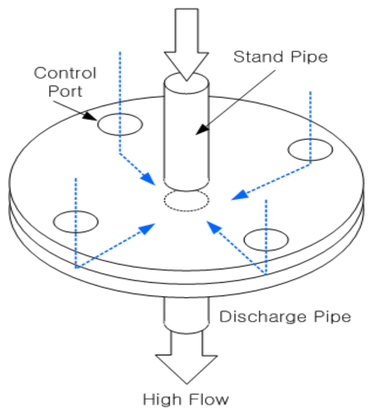
- SIT Blowdown Test with FD
- POSRV Test
- Low Power Physics Test and PAT considering FOAK unit

1. SIT Blowdown Test with FD

- Passive Fluidic Device (FD) regulates the injection flow rate effectively and extends injection time of SIT (Safety Injection Tank)
- Flowrate depends on the Stand Pipe height and resistance of Supply Port and Control Port
- SIT hydraulic performance is demonstrated by discharging SIT's contents to the RCS and confirming the K-factor to meet the criteria used in Safety Analysis.







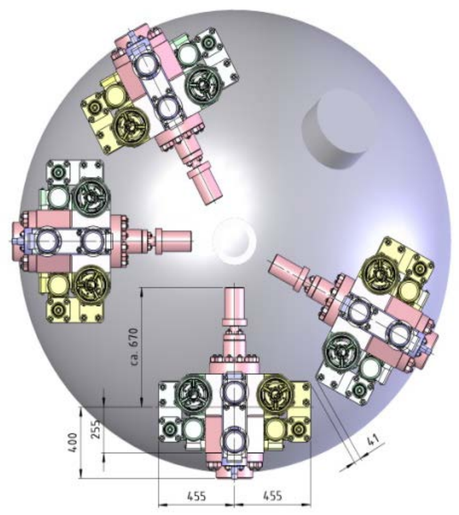
2. POSRV (Pilot Operated Safety Relief Valve) Test

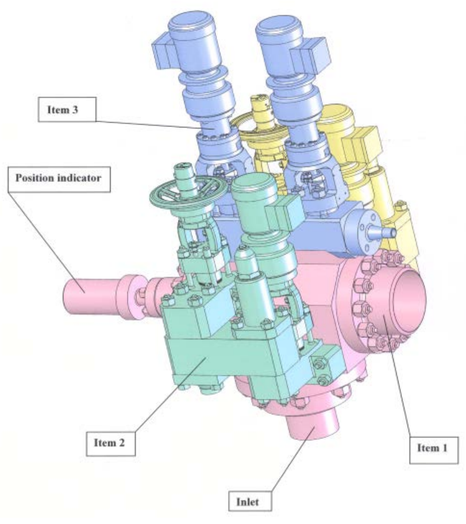
The characteristics of POSRV are as follows:

- Performing over-pressure protection and safety depressurization
- Main valve open by pilot valve actuation
- No drift of the opening set-point
- Reliable valve operation without chattering and leakage
- Low susceptibility for valve stuck-open

The following tests with special test assisting device (called SESITEST) are performed to confirm the design parameters to meet the criteria used in Safety Analysis:

- Setpoint Test of Spring Loaded Pilot Valve : Setpoint Verification
- Main Valve Operation Test with Spring Loaded Pilot Valve : Opening/Closing Time Verification
- Main Valve Operation Test with Motor Operated Pilot Valve : Opening/Closing Time Verification





3. Low Power Physics Test and PAT considering FOAK unit

SKN 3 unit is a first-of-a-kind (FOAK) unit of the APR1400. Additional test items required in a FOAK unit are referred to Reg. Guide 1.68 for objectives for initial testing. After a vendor has established a data base and has verified its codes and models in a FOAK unit, it is not necessary to re-verify the adequacy of these codes and models for a follow-on unit. The acceptance criteria applied in the follow-on unit's test program are always equivalent to, or stringent than, the applicable criteria for a FOAK unit. Obtaining agreement with theses acceptance criteria on a follow-on unit provides a high level of confidence that the FOAK tests would have also been within their acceptance criteria. With this approach, the exposure of a follow-on unit to off-normal condition (reduced shutdown margin, out-of-sequence CEA configurations, etc.) is greatly reduced and the plant startup time and cost are also reduced. The safety is enhanced by reducing the exposure to off-normal conditions and the performance is improved by reducing the duration of the testing period.

FOAK tests that are normally performed only on SKN 3 Unit
1. Low temperature/pressure low power physics test
2. Dropped/Ejected CEA test
3. Xenon oscillation control test
4. CPC power distribution measurement test (Addition of rod shadowing factor and radial peaking factor related to regulating group 4)
5. Variable Tavg Test (Addition of 20% and 80% power plateau)
6. CPC/COLSS operability test (Addition of 80% power plateau)

Conclusion

SKN 3&4 NPPs, the first construction NPPs for the APR1400, are currently in the final stage to get OL and have developed the test programs corresponding to the adopted advanced design features. SKN Unit 3 has successfully completed the tests of Phases I & II already and will perform the remaining tests of Phases III through V after getting OL. SKN Unit 4 is also expected that it will successfully complete all the necessary tests as SKN Unit 3.