

## Comparison of Domestic Safety Review and European Union(EU) Stress Test After Nuclear Accident in Fukushima Daiichi NPPs

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### 1. Introduction

Shortly after the nuclear accident in Fukushima Daiichi nuclear power plants(NPPs), Korean regulatory authority, earlier than any other countries, conducted a safety review for all domestic nuclear facilities. With the same purpose, The European Union(EU) nuclear regulators group established stress test criteria and procedures, and utilities performed a self-review in accordance with those criteria and procedures. For Wolsung nuclear unit-1, the stress test was additionally conducted for deciding the continued operation of NPP, even though the safety review had been conducted after Fukushima NPP accident.

Thus, this study is to compare the process, criteria, and results of the safety review performed in domestic NPPs and EU stress test performed in Cernavoda NPP. From the comparisons, the effectiveness and necessity of the stress test to decide the continued operation of NPPs is discussed, and the improvement items for safety enhancement are derived.

### 2. Description of Korea NPP and Romania Cernavoda NPP

#### 2.1 Korea Nuclear Power Plant

When the Fukushima nuclear accident had occurred, South Korea was under operating 21 nuclear power plants(PWR 17 Units, PHWR 4 Units) and under construction 7 nuclear power plants(PWR). Kori unit 1(PWR) was under the extended operation and Wolsung unit 1 was preparing for the extended operation. These plants cover up to about 31% of Korea's total energy production. These plants are located near the beaches because of using sea water as cooling water.

#### 2.2 Romania Nuclear Power Plant

Romania has one nuclear power plant, Cernavoda NPP, with two units in operation, PHWR of CANDU 6, each with a design gross output of 706.5 MWe. Unit 1 and Unit 2 started commercial operation on the 2nd of December 1996 and on the 1st of November 2007, respectively. Cernavoda NPP Units 1 and 2 cover up to 19% of Romania's total energy production. Cernavoda NPP site is located adjacent to the Danube River that is providing required cooling water flow. The plant is using river water as cooling water. The plant may be affected by the severe weather events (drought, flooding, ice cover by low temperature, etc.).

### 3. Comparison of Domestic Safety Review and EU Stress Test

#### 3.1 Comparison of progress process

Korea regulatory authority (government side) established a check plan for national NPPs immediately after the Fukushima NPP accident. Regulatory authority performed the safety review for all domestic NPPs for approximately 1 month within 12 days after the Fukushima accident, and it was required utility to complete the measures of improvement items derived from the safety review by 2015.

EU nuclear regulator group established the stress test criteria for approximately 3 months, and all EU utilities performed self-assessment for 5 months according to the criteria. The results of assessment were reviewed by regulatory authority for each country. The regulatory authorities issued a national report and submitted the report to EU nuclear regulators group. EU nuclear regulators group performed a peer review about the report, and they derived final improvement items and required to measure the improvement items.

Cernavoda NPP also performed a self-assessment according to the criteria.

Therefore, it is believed that the safety review process of EU stress test is more systematic than that conducted in domestic NPPs.

#### 3.2 Comparison of check criteria

The safety review in Korea was performed on 6 review fields and 27 main check items, which were enveloped the operating NPPs, research reactor, nuclear fuel cycle facilities, medical institution, and fire protection field, etc. Thus, the check items were not specific and the scope was too wide, so that, it was possible to be intervened the opinions of expert in review process about the check results.

On the contrary, the specific and detailed criteria were provided in the EU stress test. The criteria required to evaluate the threshold event beyond design basis and other initial incident and to make sure a cliff edge effect at 3 fields such as earthquake and flood, loss of power and ultimate heat sink, and severe accident management. Thus, a report of same type can be issued from the self-assessment that is performed by those criteria.

Therefore, it is indicated that the criteria used for EU stress test was more specific than the safety check criteria applied to domestic NPPs, although the check items of EU stress test are limited to accident prevention.

### 3.3 Comparison of check results (of Cernavoda NPP)

The safety review on domestic NPPs was conducted under the assumption of the worst's accident beyond design basis accident such as a Fukushima accident, and 50 improvement items, including earthquake automatic stop system in 6 fields, were derived. These improvement items also were reflected to nuclear power plants under construction.

EU stress test for Cernavoda NPP evaluated in 3 fields and derived 13 design change items. The 50 improvement items derived from domestic safety review were including the contents of these 13 items. Thus, it is believed that domestic check derived more powerful improvement items than EU stress test (of Cernavoda NPP). In addition, Cernavoda NPP derived 12 extra improvement items, including purchase portable diesel pump. These items are similar to 10 extra improvement items derived from domestic NPP's, or already applied.

Although the environment of Cernavoda NPP is different from that of domestic NPPs, domestic NPPs need to review to dig a deep well for supply domestic emergency water within plant during severe drought and purchase a small mobile diesel generator to supply electric power for water pump of the deep well.

Table 1. Cernavoda design changes (included in domestic check results)

Provide an additional mobile DG set and the connections to the existing EPS buses
Provide a seismically qualified location on site for the storage of the mobile equipment required for emergency conditions
Improve the seismic robustness of the existing Class I and II batteries
Provide a facility to open the MSSVs after a SBO
Provide connection facilities required to add water using fire fighters trucks and flexible conduits to supply the primary side of the RSW/RCW heat exchangers and SGs under emergency conditions.
Provide permanent connection facilities required to add water from outside the S/B using fire fighters trucks to supply the Spent Fuel Bay
Improve seismic robustness for the site Emergency Control Center
Provide facilities to inject water in the calandria vessel from outside R/B
Provide facilities to inject water in the callandria vault from outside R/B
Install a filtered venting Containment
Install Hydrogen Passive Autocatalytic Recombiners in R/B
Install a R/B H <sub>2</sub> concentration monitoring system
Improve the existing CSP monitoring loops environmental qualification and extend the measurement domain

## 4. Conclusions

This study compared the safety review performed in domestic NPPs and EU stress test conducted in Cernavoda NPP's. The comparison showed that the process and review criteria of EU stress test was more systematic and specific than those used in domestic NPPs. But it was indicated that the improvement items resulted from the safety review performed in domestic NPPs are more comprehensive and powerful than EU stress tests (Cernavoda NPP) results. Therefore, it is believed that the effectiveness and necessity of EU stress test for long-term operation of domestic NPP are doubtful. To prepare the difficult situation that the domestic water can not be provided to plant due to the future severe drought or earthquake, Domestic NPPs need to review to dig a deep well within plant and purchase a small mobile generator truck to supply electric power to water pump of the well.

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