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A Brief Assessment of North Korea's Capacities for Building an Experimental LWR

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1. Introduction

On November 2010, North Korea revealed the construction site of 100 MWt (thermal) experimental LWR in the early stage with a target operation date of 2012. And they claimed that their first LWR construction project is proceeding with strictly domestic talent and resources [1].

Introduction of LWR imposes various technical challenges [2], even though North Korea has experiences in the construction and management of graphite-moderated and gas-cooled reactor [1]. So, there are doubts about whether they can successfully complete the project in time without any external support.

In this paper, to estimate the fate of the LWR construction, we focused on the North Korea's capability to deal with the technical challenges which differ from those of gas-graphite reactor.

2. Technical challenges and capacity

2.1 National electricity grid capacity

According to IAEA recommends, a single power plant should comprise no more than 5-10% of the national electricity grid capacity [2]. As of 2009, North Korea's grid capacity is 6,928 MWe [3]. Estimated electrical power of the experimental LWR is 25-30 MWe [1], only about **0.4% of the national grid capacity**. Therefore, **North Korea's national grid capacity is enough to accommodate the LWR**.

2.2 Enrichment capacity

The reactor will be fueled with 3.5 % uranium dioxide fuel, and a full fuel load is 4 ton-U. North Korea insists that LEU fuel for this LWR is provided from Yongbyon uranium enrichment plant [1].

Fig. 1 shows the time required to produce a fuel load for the reactor, as the various operation scenarios. Operation condition of yongbyon enrichment plant is the same as Scenario 2 [1]. If the plant is operated like Scenario 2, **more than 2.3 yr is needed to produce the enough LEU**. Therefore, **North Korea's enrichment capacity is slightly insufficient.**

In addition, if we consider the time to fabricate the enriched uranium into a LWR fuel, the Start-up date for operation seems to be postponed a little bit more.

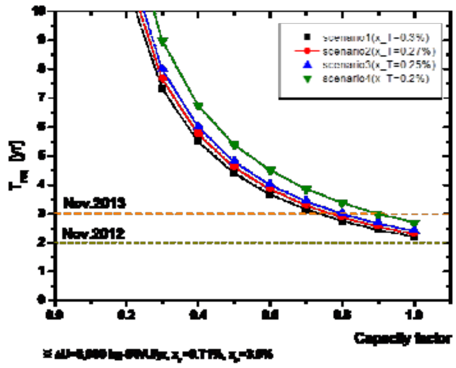

Fig. 1. The time required to produce a fuel load for the reactor, as the various operation scenarios (as a function of enrichment plant capacity factor and tails assay (x_T))

2.3 Fuel manufacturing capacity

In this part, main technical challenges to North Korea might be as follows [1];

(i) UO_2 conversion process
(ii) Fuel Cladding techniques

Lack of information about the state of art in the related industries of North Korea, it is impossible to evaluate exactly. North Korea's LWR fuel manufacturing capacity is estimated to behind in the world-class technology about 20 years [4]. However, considering that these techniques were already proven technology in 1960's [5,6], **they can manufacture the low performance sintered uranium dioxide or uranium metal alloy clad with stainless steel**. Therefore, North Korea will manage to manufacture the LWR fuel with low performance.

Table I: History of PWR Fuel material [5]

Generation	1st	2nd	3rd	4th	5th	6th
Period	1960's			1970's	1970's ~1980's	1990's
Clad Material	348SS	304SS	304SS	Zry-4	Zry-4	New Zr Alloy

2.4 Nuclear plant materials and components manufacturing capacity

Nuclear plant materials and components, especially those of 1st loop system, of LWR must endure high pressure and temperature. It is impossible for North Korea to produce those durable materials and components on the same level as those of the typical 1,000 MWe LWR, in a short period of time. So, to produce the related stuffs with their poor techniques, **North Korea is willing to accept efficiency reduction by lowering the operation temperature and pressure**. According to a brief analysis, in case of typical LWR(1,000 MWe/2,815 MWt), if they reduce the efficiency from 35% to 25%, operation temperature became lower about 100℃ than before, and operation pressure became 1/5 than before[7].

3. Conclusions

Through a brief analysis, we conclude that North Korea can build that small scale experimental LWR with lower performance than typical 1,000 MWe LWR, but the start-up date is likely to little bit delayed.

The experimental LWR will be the important factor for determine the incentives for North Korea in the denuclearization talks such as six-party talks. And construction period of the reactor will influence the strategy of the related negotiations. Therefore, we should be keeping an eye on the construction progress of it. And further studies on the safety aspect or the capability to management of that reactor will be needed.

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