http://dx.doi.org/10.5516/NET.06.2013.708

CONSIDERATIONS REGARDING ROK SPENT NUCLEAR FUEL MANAGEMENT OPTIONS

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Received July 15, 2013

In this paper we discuss spent fuel management options in the Republic of Korea (ROK) from two interrelated perspectives: Centralized dry cask storage and spent fuel pyroprocessing and burning in sodium fast reactors (SFRs). We argue that the ROK will run out of space for at-reactors spent fuel storage by about the year 2030 and will thus need to transition centralized dry cask storage. Pyroprocessing plant capacity, even if approved and successfully licensed and constructed by that time, will not suffice to handle all the spent fuel discharged annually. Hence centralized dry cask storage will be required even if the pyroprocessing option is successfully developed by 2030.

Pyroprocessing is but an enabling technology on the path leading to fissile material recycling and burning in future SFRs. In this regard we discuss two SFR options under development in the U.S.: the Super Prism and the Travelling Wave Reactor (TWR). We note that the U.S. is further along in reactor development than the ROK. The ROK though has acquired more experience, recently in investigating fuel recycling options for SFRs. We thus call for two complementary joint R&D project to be conducted by U.S. and ROK scientists. One leading to the development of a demonstration centralized away-from-reactors spent fuel storage facility. The other involve further R&D on a combined SFR-fuel cycle complex based on the reactor and fuel cycle options discussed in the paper.

KEYWORDS : ROK - U.S. Agreement for Nuclear Cooperation (123 Agreement), Enrichment and Reprocessing (ENR) Rights, Spent Nuclear Fuel (SNF) Management, Dry Cask Storage, Independent Spent Fuel Storage Installation (ISFSI), Pyroprocessing, Korea Advanced Pyroprocessing Facility (KAPF), Sodium Fast Reactor (SFR), Super-Prism, Travelling Wave Reactor (TWR)

1. INTRODUCTION

In this paper, we discuss near-term prospective nuclear energy cooperation measures, related to the back end of the nuclear fuel cycle that may be implemented by the U.S. and the Republic of Korea (ROK) as part of a comprehensive program of long-term nuclear cooperation. These suggestions represent a perspective on near-term measures the ROK might consider to enhance its nuclear cooperation with the U.S. Korean experts may have a parallel suggestions; an exchange of opinions may eventually lead to mutually acceptable and practical cooperation. Importantly, none of these propositions prejudice the results of the extension of the agreement for nuclear cooperation between the U.S. and the ROK (the 123 Agreement) (1). Some of these proposals may be implemented independently of these discussions, and may enhance the prospects for a successful conclusion of the negotiations. We then suggest a joint long-term nuclear energy development program that will require changes to the current 123 Agreement. These changes are not imminent and may be worked into the extension Agreement as step-wise conditional modifications reflecting future trends in nuclear cooperation.

2. THE SPENT FUEL STORAGE PROBLEM IN ROK NUCLEAR POWER PLANTS

There are currently twenty-three operating nuclear reactors in the ROK, located at four sites. These reactors, at 20.7 GWe total generating capacity, provide 35% of the ROK's electricity supply. The ROK's goal is to have 40 reactors in operation by 2030, providing 59% of total generation. Four of the operating reactors are 700 MWe class Canadian type CANDU natural uranium heavy water reactors, the rest are mostly 1,000 MWe pressurized water reactors (PWRs) fueled with low enriched uranium oxide (LEU). A summary of the nuclear energy system of the ROK is shown in Figure 1 below (2).

Currently, all spent nuclear fuel (SNF) from operating ROK nuclear power plants (NPPs) are stored on plant sites, mostly in the SNF pools attached to each reactor. This practice is referred to as on-site wet storage. It is expected that the SNF storage pools in these NPPs will be full (saturated) within the decade. The ROK may arrange for several additional years of pool storage via various mechanisms. For example, they may upgrade to high density racking of all SNF pools; ship SNF from saturated pools, to relatively empty SNF pools located on the same site; and they might transport SNF by ship between NPP sites. Fuel transshipment between NPP sites, each located in a different province of the ROK, requires logistical planning, regulatory approval, and consent of both province authorities – a non-trivial bureaucratic hurdle. These temporary measures will eventually run their course, SNF pools will approach saturation, and the fundamental problem of SNF disposition will remain.

To demonstrate the saturation delay achieved using these enhanced on-site SNF wet storage techniques, we plot the space available in the SNF pools of two different scenarios or 'systems' at the Kori site in Figure 2. In the first scenario we allow transshipment of SNF between only the four oldest reactors, Kori 1-4; in the second scenario, we allow transshipment of fuel between six reactors, Kori 1-4 and the new Shin-Kori 1-2 (as they come online in 2011 and 2012 respectively). We assume historically reasonable fuel burnup, capacity factors and power levels as well as the best available information about pool capacity and inventory status. In the first scenario when transshipment is allowed only between the four reactors, the fuel pools saturate in 2018. In the second scenario, taking advantage of the two new fuel pools upon commissioning of Shin-Kori 1-2, pool saturation is reached in 2024. While immediate saturation is only mitigated by this scheme, it does serve to delay the problem by six years at the Kori site. If additional new units are commissioned at Kori, more pool space

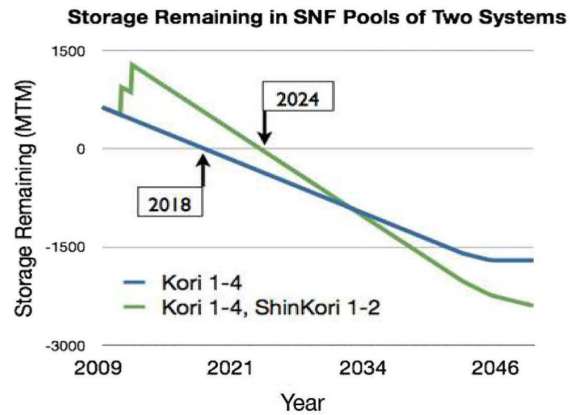

Fig. 2. Space Remaining for SNF Storage in Reactor Fuel Pools of Two Systems with Shipment of SNF between the Reactor Pools in Those Systems. Zero Crossing Represents Saturation of Fuel Pools and Negative Values Represent Excess Fuel. By Taking Advantage of the Space Made Available by Two New Reactors (Shin Kori 1-2) we Delay Saturation at the Kori Site by 6 Years.

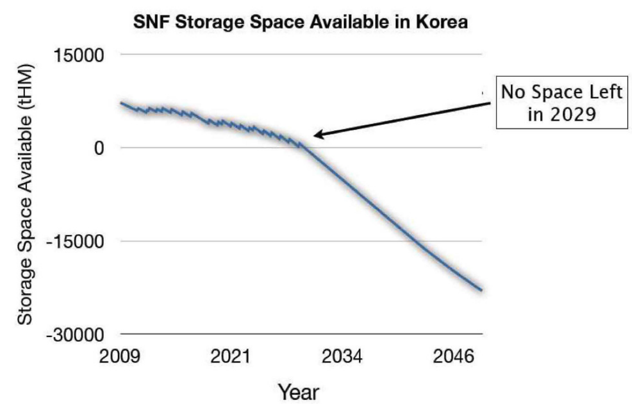

Fig. 3. Saturation of Spent Fuel Storage Pools Assuming Inter-Site Transshipments

Fig. 1. Current Nuclear Power Plants in the ROK and Near-term Construction Plans (3)