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Licensing program and public involvement of spent nuclear fuel dry storage in Taiwan

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Abstract

Most of the spent fuel pools at the nuclear power plants (NPPs) in Taiwan are almost full due to the insufficient capacity of spent fuel pools after 3 times rerackings for BWR units. To extend the storage capacity of spent nuclear fuel, Taiwan Power Company (TPC) has therefore begun the projeccts of spent nuclear fuel dry storage facility at Chinshan NPP and Kuosheng NPP since 2005 and 2013, respectively.

The dry storage facility is licensed in two steps including construction and operating License. During the construction and operation of the facility, the Atomic Energy Council (AEC) will intensively inspect the facility for ensuring the public safety and environmental quality. In addition, public acceptance also plays an important role for implementing the dry storage program. In order to enhance the confidence of the public, AEC held a public hearing during construction licensing review and has carried out a public observation program in construction phase at Chinshan NPP.

To assure the safety of the off-site transportation, TPC must have the approval of AEC and apply to the domestic transportation authority before shipping. The dry storage casks of Chinshan and Kuosheng were based on the NAC International products. In the future, TPC may consider using the NAC transport casks to ship the spent nuclear fuels.

This paper gives an overview of the regulatory requirements, licensing review program, and public involvement for applying spent nuclear fuel dry storage facility in Taiwan. It also gives some description of the spent nuclear fuel off-site transported plan prepared by TPC.

Introduction

In Taiwan, there are three nuclear power plants (NPPs) in operation which are operated by Taiwan Power Company (TPC). The current generating capacities account for approximately 16% of the total electricity production in Taiwan. These NPPs have been operating for more than 30 years. Periodically, about one-third of the nuclear fuel in an operating reactor needs to be unloaded and replaced with fresh fuel. Nuclear power plants must temporarily store this unloaded fuel, known as "spent fuel", in a water pool beside the reactor. Four of the spent fuel pools at two BWR NPPs in Taiwan are almost full, due to the insufficient capacity of spent fuel pools after 3 times rerackings for 40-year licensed operation period. The pool capacities and the spent nuclear fuel storage quantities for the NPPs in Taiwan are shown in Table 1. TPC has therefore begun looking for options to remove spent fuel out from the spent fuel pools and the preferred option is on-site dry storage.

Dry storage allows spent fuel to be stored for a certain period, immersed in inert gas inside a canister, typically a steel cylinder which has been welded closed. The steel canister provides a leak-tight containment for the spent fuel. Each canister is encased in additional carbon steel and concrete providing radiation shielding for workers and the public. Dry storage of spent fuel has many advantages, such as easy maintenance, low operational cost, low corrosion, low probability of radioactive release, and it does not produce secondary waste. Additionally, dry storage casks are designed to resist floods, tornadoes, typhoon damage, extreme temperatures, and other unusual events. Therefore dry storage has become a prevailing option in many countries for management of spent fuel prior to final disposal. TPC has begun establishing the spent nuclear fuel dry storage facility projects at the Chinshan NPP and the Kuosheng NPP since 2005 and 2013, respectively. This paper gives an overview of the regulatory requirements, licensing review program, and public involvement for applying spent nuclear fuel dry storage facility in Taiwan. It also gives some description of the spent nuclear fuel off-site transported plan prepared by TPC.

Table 1 Pool Capacities and Spent Nuclear Fuel Storage Quantities in NPPs

Spent Fuel Storage Status (July 2016)					
Unit		Year Of Commercial Operation	Capacity (Assembly)	Storage Inventory Fuel Assembly	Full discharge per cycle
Chinshan	#1	1978	3,083	3,074	~110
	#2	1979	3,083	3,076	~110
Kuosheng	#1	1981	4,398	4,364	~180
	#2	1983	4,398	4,388	~180
Maanshan	#1	1984	2,160	1,311	~70
	#2	1985	2,160	1,407	~70

Spent Fuel Dry Storage Licensing Program

In Taiwan, a dry storage facility is licensed in two steps: Construction License, based on the Preliminary Safety Analysis Report, PSAR and Operating License, based on the Final Safety Analysis Report, FSAR. According to Article 17 of the Nuclear Materials and Radioactive Waste Management Act, the AEC must verify that the following conditions are met before issuing a Construction License:

(1) The construction is consistent with the prescription of the relevant international conventions. The application documents shall meet the requirements of the IAEA Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (1997).

(2) The equipment and the facility are sufficient to ensure safety and protect the public health. The PSAR review shall verify that the provisions for public health and safety are adequate.

(3) The environmental impact shall be in compliance with the standards put forth by all relevant laws, statutes and decrees.

(4) The technology, the management ability, and the financial guarantee of the applicant shall be sufficient to operate the facility. TPC shall submit the financial guarantee report for ISFSI construction, operation, storage, and decommission. The Back End Management Foundation shall provide the letter of guarantee for funding of this project.

Even after the completion of facility construction, the facility may not be operated until the AEC has issued an Operating License. The construction engineering quality must be inspected, and the pre-operation test must meet qualification standards. During the construction and operation of a dry storage facility, the AEC may inspect the facility at any time, and may ask the operator to submit relevant documents. The regulative activities for licensing a dry storage facility are shown as Fig 1.

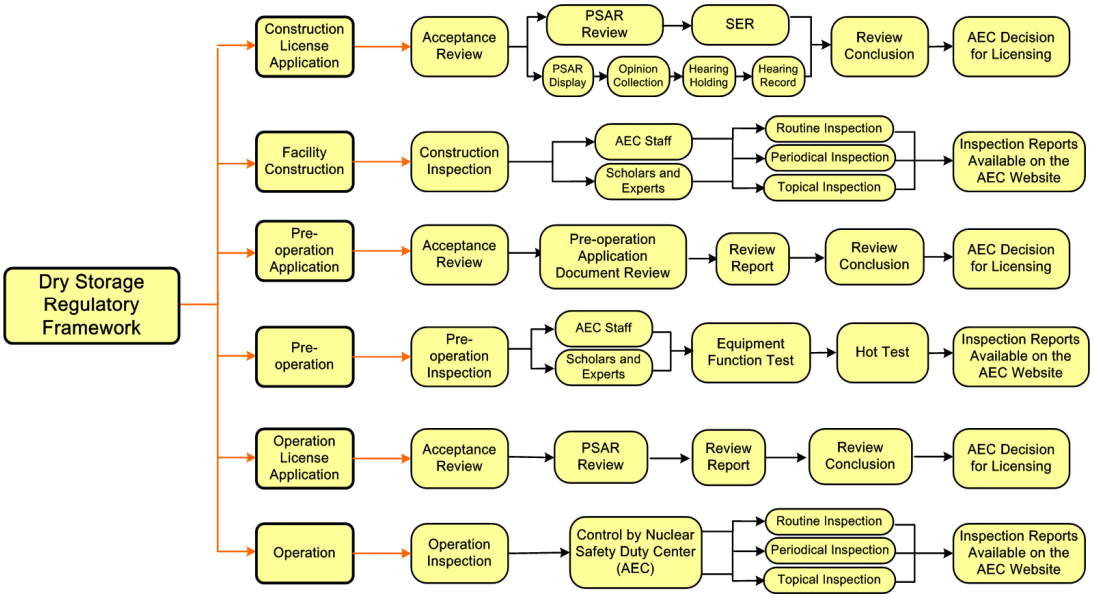

Figure 1 Regulative activities for licensing a dry storage facility

Licensing for the Chinshan Dry Storage Project

The TPC decided to implement an on-site dry storage program after performing a detailed study in 1990 on technical, safety, social, economic, and environmental impact. It was constructed at the Chinshan NPP and has provided dry storage for 1,680 spent nuclear fuel assemblies. The combined capacity of this facility with the spent fuel pools has been sufficient to store all the spent nuclear fuel generated during Chinshan's 40-year licensed operation period.

In July 2005, TPC entrusted the Institute of Nuclear Energy Research (INER) to construct the Chinshan dry storage facility. After evaluation, INER decided to introduce a concrete storage cask system, called INER-HPS, by means of a technology transfer from NAC International. The major components of the INER-HPS storage system are a transportable storage canister (TSC), a transfer cask (TFR), a vertical concrete cask (VCC) and add-on shielding (AOS) shown as Fig. 2. In March 2007, TPC submitted an application for a Construction License to the AEC. After rigorous review and validations of safety issues, e.g. shielding, thermal and structure, etc., the AEC verified all regulatory requirements and issued the construction license in December 2008.

TPC started the manufacture of transportable storage canisters (TSCs) in September 2008 and all 25 TSCs were completed by August 2010. AEC inspected the Quality Assurance (QA) activities regarding TSC fabrication quarterly until completion. TPC commenced the site construction of the facility in October 2010. The concrete pad was completed in July 2012. AEC continues to perform the inspection of constructing activities monthly. The related inspection reports and technical documents are available at the AEC website to ensure transparency to the public.

TPC submitted the pre-operational test plan for approval in November 2011. AEC reviewed and then approved the pre-operational test plan in May 2012. TPC has completed the first stage pre-operational test (i.e. cold test). After checking that the test results met the limit conditions of operation (LCOs), AEC approved the test result report in September 2013, and agreed that TPC may carry out the second stage pre-operational test (i.e. hot test). Currently, TPC is unable to perform the hot test due to a political dispute from local county government concerning the soil and water conservation plan of the facility. TPC is continuing to communicate with the local government.

Licensing for the Kuosheng Dry Storage Project

The Kuosheng NPP has been operating for more than 30 years; the spent fuel pools are insufficient storage for spent fuel. TPC has decided to use dry storage to provide additional storage to fulfill the need of the 40 years of licensed operation of Kuosheng NPP.

The storage capacity of Kuosheng dry storage facility is designed for 2,400 spent fuel assemblies. The Environmental Impact Assessment (EIA) for the project was reviewed and approved by the Environmental Protection Agency (EPA) in January 2010. TPC entrusted this project to CTCI Machinery Corporation (Taiwan) and NAC International (USA) in November 2010. The two

companies shall provide 27 MAGNASTOR concrete casks, capable of storing 87 spent fuel assemblies each. The major components of MAGNASTOR storage system are shown as Fig. 3.

TPC submitted an application for a construction license of the Kuosheng ISFSI to AEC in March 2012. Based upon the experience of the review of the Chinshan dry storage program, AEC completed the SAR review of Kuosheng ISFSI in September 2013. The reviewing conclusion of the SAR was found to be acceptable. After reviewing the additional evaluations reports of beyond design accident due to Fukushima nuclear accident submitted by TPC, AEC issued the Construction License in August 2015. TPC still needs a flood drainage permission from the local government to begin the site construction.

Figure 2 The major components of INER-HPS storage system

Figure 3 The major components of MAGNASTOR storage system

Public observation program on the construction of the spent fuel dry storage facility

The licensing for a spent fuel dry storage facility needs much more consideration than just technical or regulatory decisions. Broad public consent and measures designed to gain public acceptance have become prerequisites for implementing the ISFSI program. In order to enhance the confidence of the public, a Public Observation Program was initialized by AEC in 2011. AEC

organized an observation team including 11 community delegates (village chiefs, directors of community associations, stakeholder representatives), 3 local government officials, 2 civil engineering experts, 4 environmental NGO delegates.

Public observation activities during the construction phase are performed periodically, including site visiting, environmental background radiation monitoring, and construction quality control (Shown as Fig4). The activities for the public observation program were arranged by AEC. The observation members were invited to observe the construction quality of the SNF dry storage facility at Chinshan NPP. AEC and the utility (TPC) would respond to concerns presented by the members at the meeting. During the public observation activity, the members will be arranged to check the radiation level at the ISFSI site. Until now, there is no spent fuel stored in Chinshan ISFSI facility. The radiation level at the ISFSI site was surveyed for background radiation and remained near natural background actually. These measured data can be served as a baseline, once the spent fuel has been stored in the ISFSI site, the radiation level will be compared with that of the background radiation to demonstrate the safety of the ISFSI. Up to now, 11 Public Observations have been held since May 2011.

Concrete overpack construction survey

Communication meeting

Environmental background radiation detection (1/2)

Environmental background radiation detection (2/2)

Figure 4 Public observation activities

The public opinions proposed by the public team members have been classified into 3 categories: safety, sustainable management, and feedback. Most of the public team members agreed that the spent fuel storage facility is safe under AEC supervision. They asked TPC to implement long-term monitoring of the safety of the facility, and that the monitoring data shall be accessible to

the public. AEC demanded that the TPC must set up a comprehensive monitoring system shown as Fig. 5 to reveal the monitoring information to the stakeholders. This system can serve as a communication platform between stakeholders and TPC. In addition, AEC requested TPC to disclose real-time monitoring data on the AEC Nuclear Duty Center after the spent fuel initial loading. This data includes temperatures, dose rates, hillside slope stabilities and ground water levels. The data regarding temperature of canisters and radiation levels at the site can also be displayed in real-time on the AEC website for the public information.

With regards to sustainable management, the storage period was a priority issue concerned by the public due to the delay of repository programs in most countries worldwide. AEC has required TPC to propose a centralized ISFSI to take over the spent fuels at this site as an alternative, if the licensed 40 years storage period has expired and the repository was not available. The alternative program is shown as Fig. 6. The most common issue is feedback subsidy. As a regulatory body, AEC encouraged the TPC to have more dialogue with the local communities to get a consensus on reasonable feedback. Furthermore, AEC has granted the public observation delegates a whole-body count for radiation, instructed people in the community on radiation safety knowledge as well as usage of radiation monitoring instruments. Finally, AEC provided an instrument to each local village which may be used to measure the local environmental radiation level in the community.

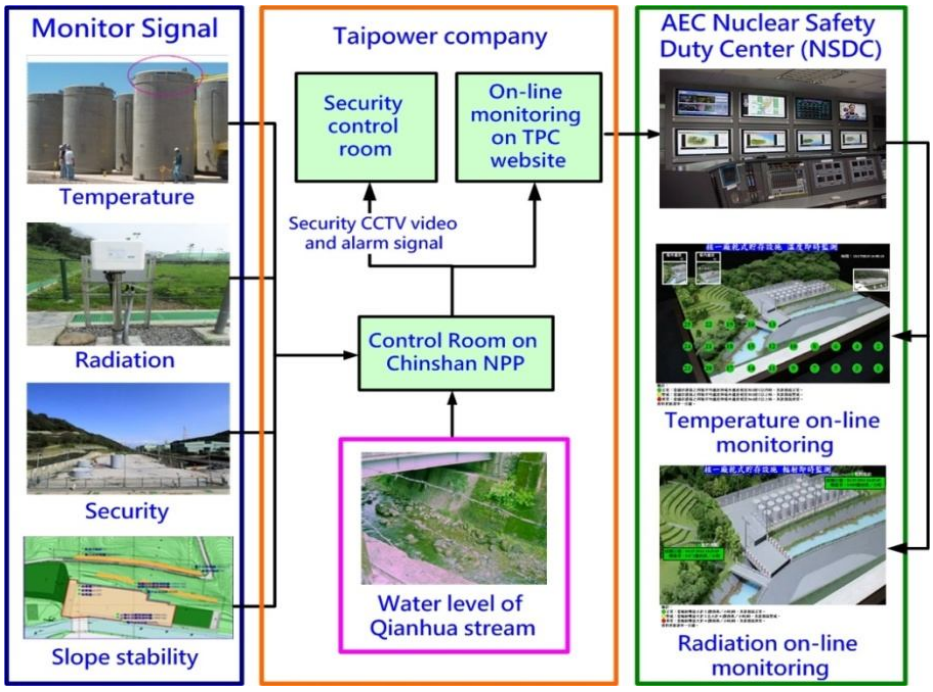

Figure 5 Monitoring System of the Dry Storage Facility at Chinshan NPP

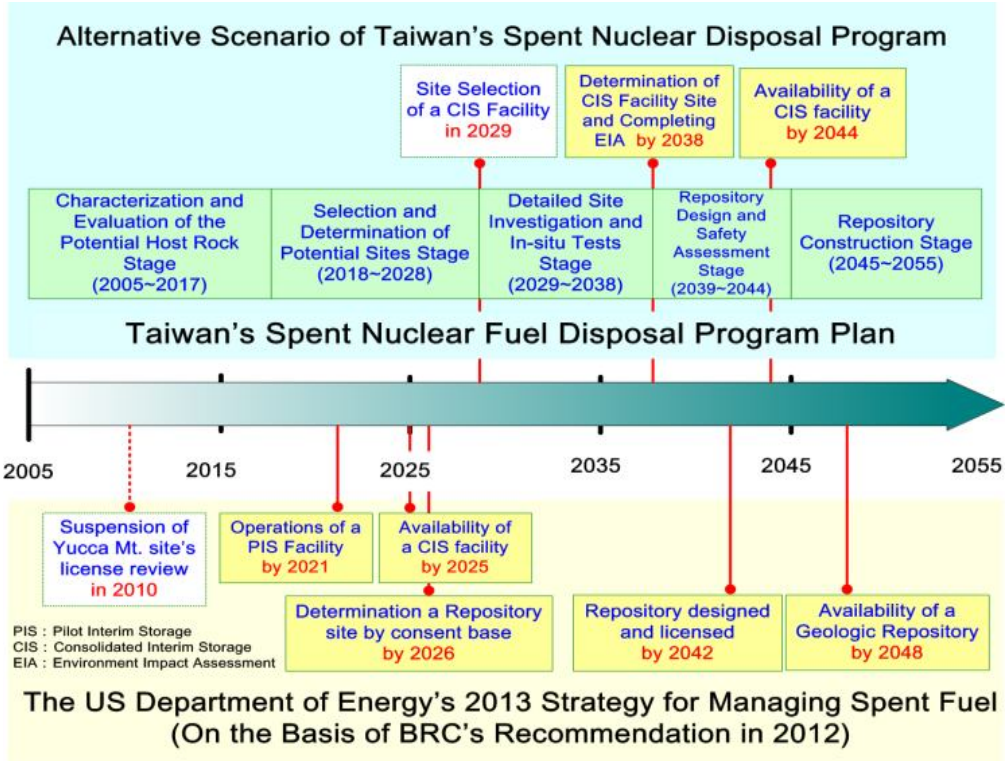

Figure 6 Alternative Program for Spent Fuel Disposal Program in Taiwan

Spent nuclear fuel off-site transportation

The feasibility of the off-site transportation of the dry storage spent fuel is a main public concern too. According to the legal provisions of the "Nuclear Materials and Radioactive Waste Management Act", the "Regulations for the Nuclear Fuels Operational Safety Management", and the "Ionizing Radiation Protection Act", applicant shall file the application to the authorities for approval of nuclear fuels transportation before they may engage.

If TPC wants to ship its nuclear fuels from a NPP to final disposal site, in addition to having the approval of AEC, it also has to apply to the domestic transportation authority for approval of the transport vehicles with right of way in accordance with the related legal provisions, in order to assure the safety of transport operations.AEC demands that the shipping casks shall be approved by the safety authorities of the original design country and be the ones that have had international performance. The design of Chinshan and Kuosheng dry storage facilities were based on the UMS system and MAGNASTOR system of the NAC International, respectively. In the future, TPC may consider using the NAC transport casks to ship the spent nuclear fuels to the final disposal site.

The feasibility of the off-site transportation of the dry storage spent fuel at Chinshan and Kousheng NPPs have been studied by TPC and submitted to AEC. After strict review, AEC found the feasibility studies were acceptable.

Conclusions

The Chinshan and Kuosheng NPP will start decommissioning in 2018 and 2021, respectively. To smoothly carry out the decommissioning operation, a dry storage facility must be constructed firstly for the decommissioning NPP to store the spent fuel safely. The spent fuel management is not only technical but also social issue that needs patience and time to resolve. In addition to safety control, AEC stimulates TPC to communicate with the public to build the consensus and improve the confidence of local residents neighboring the radwaste facilities.

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