1. Introduction

There are three nuclear power stations (NPSs) in operation with a total installed capacity of 5,144 MWe. The fourth NPS is under construction. These NPSs are owned and operated by TPC and the current generating capacities are sharing about 30% of the total production of electricity supplies in Taiwan. With regard to spent fuel; three NPSs operating for 40 years will produce 4,950 metric tons spent fuel. The pool capacities and spent fuel storage quantities in NPSs are shown in the Table. Spent fuels are temporarily stored in the spent fuel pools of each NPS. Although the re-racking project extending the storage capacity for the spent fuel pools has been undertaken, the TPC Chinshan NPS will still lose its full core reserve by the year 2010. Therefore, to provide assurance of the continued operation, TPC has decided to implement an Independent Spent Fuel Storage Installation (ISFSI) project after a detailed study in technical, safety, social, economical, and environmental impact. The ISFSI shall serve for dry storage of at least 1366 spent fuel assemblies. The design of the ISFSI shall be capable of accommodating 30 storage casks; and each cask shall be capable of storing at least 52 spent fuel assemblies. The ISFSI will be installed inside the Chinshan NPS, which is located at the northern tip of Taiwan, and near the coast. The chinshan NPS consists of two GE-designed Boiling Water Reactor (BWR) units with Type 4 reactor and Mark 1 containment (rated 1775 MWt each), and has been in commercial operation since 1978.

TPC has chosen vertical concrete cask type design (Universal MPC System, UMS) to ISFSI of Chinshan NPS by means of technology transfer from NAC International, which is a qualified vendor in U.S.A. Choosing an approved storage cask system from a qualified vendor is a favorable option to speed up the design and fabrication processes. However, design modifications will be done to the UMS in order to meet the domestic regulatory requirements and site-specific environmental conditions. Furthermore, TPC is expected to submit the application for construction license in 2006; preoperational test will be performed in 2008 and storage should be put into operation by the end of 2009.
Table. Pool Capacities and Spent fuel Storage Quantities in NPSs

<table>
<thead>
<tr>
<th>Reactor</th>
<th>Pool capacity (Assembly)</th>
<th>Storage quantity</th>
<th>Pool full year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assembly</td>
<td>Tones (MTU)</td>
<td>After re-racking</td>
</tr>
<tr>
<td>Chinshan 1</td>
<td>3,083</td>
<td>2,440</td>
<td>421</td>
</tr>
<tr>
<td>Chinshan 2</td>
<td>3,083</td>
<td>2,304</td>
<td>398</td>
</tr>
<tr>
<td>Kuosheng 1</td>
<td>5,026</td>
<td>3,316</td>
<td>557</td>
</tr>
<tr>
<td>Kuosheng 2</td>
<td>5,026</td>
<td>3,192</td>
<td>537</td>
</tr>
<tr>
<td>Maanshan 1</td>
<td>2,151</td>
<td>925</td>
<td>373</td>
</tr>
<tr>
<td>Maanshan 2</td>
<td>2,159</td>
<td>936</td>
<td>377</td>
</tr>
</tbody>
</table>

April 26, 2006 updated

2. Regulatory Framework

Although spent fuel dry storage concept has already been adopted in 18 countries, it is completely new to Taiwan. In order to develop and establish the regulatory requirements and inspection technology regarding the design, construction, and operation of ISFSI, the competent authority of spent fuel management in Taiwan, FCMA/AEC, had conducted many studies on spent fuel dry storage management since 1991. These studies include management policy, safety regulations, licensing review, surveillance requirements, and quality assurance performance. In addition, the effects of a postulated terrorists attack by commercial airplane attack on dry storage cask systems were evaluated in 2002. The accident scenarios include high-speed commercial airplane or fighter jet hitting against storage casks and fire impacts. The study results disclosed that the canister doesn’t fail and the jet engine turbine rotor doesn’t penetrate through the concrete cask metal liner. Additionally, fire analysis showed the fireball causes no effect on the structural stability of the canister or cask structural steel. The internal radioactive materials would not be released into environment.

The regulations for the establishment of the ISFSI in Taiwan are based on the provisions of the “Nuclear Materials and Radioactive Waste Management Act”, “Regulations for the Review and Approval of Applications for Construction License of Radioactive Wastes Treatment, Storage and Final Disposal Facilities”, and “Enforcement Rules”. In particular, the “Guideline for the Safety Analysis Report (SAR) of Spent Fuel Dry Storage Facility” guides the applicant in preparing the licensing documentations. The SAR shall specify: (1) Introduction (2) Description of site characteristics (3) Principal design criteria (4) Organizational structure, administrative management and training program (5) Facilities operations (6) Safety assessment included off-normal operations and accidents (7) Radiation protection and environmental radiation monitoring program (8) Fire protection program (9) Physical protection plan, material and accounting record management plan (10) Quality assurance plan (11) Primary decommission plan.
3. Review Program and license issue

Based on TPC’s up-to-date construction plan, an ISFSI system at Chinshan NPS must accommodate at least 1,366 spent fuel assemblies. To meet the project schedule, it is reasonable that major milestones for this project should include the following:

✧ Submit the PSAR (Preliminary Safety Analysis Report) for FCMA/AEC to review in July 2006.
✧ Obtain the construction license in 2007.
✧ Completion of ISFSI pad, all auxiliary equipment, at least two sets of casks and canister in July 2008.
✧ Completion of loading and storage of first two casks of spent fuel assemblies at unit 1 in 2009.
✧ Completion of loading and storage of first two casks of spent fuel assemblies at unit 2 in 2010.
✧ Completion of loading and storage of 100% of spent fuel assemblies in 2011.

It is important that the license will be issued in two steps: construction (based on the Preliminary Safety Analysis Report, PSAR) and operation (based on the Final Safety Analysis Report, FSAR). In the review program, experts and scholars with different disciplines will be called upon to provide technical opinions. Besides, two confirmatory evaluations regarding structural seismic analysis and radiation shielding will be carried out. Foreign technical consultation through technical cooperation will be arranged, especially in the case when unresolved issues on safety are in question, like structural seismic behavior and heat removal function. Licensing hearing is also required before issuing the construction license of ISFSI.

There are much concern about the design, fabrication, construction, and operation of first on-site ISFSI in Taiwan. On the other hand, the domestic capabilities in fabricating nuclear safety-related components can also be upgraded to become more competitive. In 2005, the FCMA/AEC has not only organized a technical review team consisted of around 30 experienced experts and scholars with different disciplines, but also has completed a preliminary review study with regard to the original UMS system, especially focusing on the design and storage conditions in Taiwan. The study results including 124 safety issues have already been transferred to TPC for future reference. Furthermore, by the beginning of 2006, the FCMA/AEC exercised a preliminary site-specific study by an ISFSI SAR with similar design concept, in order to master critical issues for a site-specific ISFSI licensing procedure in Taiwan.

The Environmental Impact Assessment of the ISFSI at Chinshan NPS had been approved in 1995, but the construction didn’t commence within three years period. According to the Environmental Protection Act Article-16, the developer shall submit an analysis of the difference between current environmental conditions and the ones at the time its development activity permission was granted and a strategy evaluation report to fulfill the environmental protection
requirements. For construction license of Chinshan ISFSI project, the recognized environmental impact document is necessary for the licensing procedure. In the following part, the application and review process of the construction license will be addressed.

The applicant (TPC) shall submit an application form enclosed with the SAR that complies with the “Guideline for the Safety Analysis Report of Spent Fuel Dry Storage Facility”, the financial guarantee statement and the recognized relevant environmental impact data to the FCMA/AEC for review. The technical review team associated with the review work steering committee (RWSC) will perform the technical review of SAR. Eight critical safety issues including structural safety, confinement integrity, heat removal, criticality safety, shielding design and radiation protection, spent fuel handling, and quality assurance of fabrication will be fully examined by the review team. Three RWSC meetings and several times of technical review meetings will be held. The three RWSC meetings are to make sure of the accrediting of the application document and reviewing schedule & plan, verifying the safety evaluation report (SER), and ensuring the summary report enclosed with the public hearing records and SER.

4. Public Communication

Public participation plays a significant role in enhancing public confidence in the FCMA/AEC and its ability to carry out its mission — to protect public health and safety in radioactive wastes treatment, storage and final disposal. The FCMA/AEC has long recognized the importance and value of public communication and involvement as a key cornerstone of strong, fair regulation of the nuclear industry.

As far as public health is concerned, to reasonably reduce the radiation influence from spent fuel dry storage facility, the radiation protection design shall ensure the annual effective dose equivalent caused to general public outside the ISFSI not exceeds 0.25 mSv, which is 25% of the dose limit for general public (1mSv in one year). In Particular, TPC demands that the acceptance criteria for general public shall be not greater than 0.05 mSv/year.

As to public communication, the application information shall be publicized and displayed within 30 days and the time period for publication and display is 60 days. The objective of this function is to provide the public an opportunity to work directly with the FCMA/AEC staff to provide a range of views, information, concerns and suggestions regarding safety issues of law or fact. During the time period for publication and display, individuals, local government agencies or non-governmental organizations may submit to the competent authorities reference comments in written document stating the name or appellation and the address; and a licensing hearing shall be held subsequently, later on the authority shall compile the transcript of the hearing within 30 days. The Figure shows construction license reviewing process.

It has been pointed out earlier in this paper that storage cask licensable from its country of
origin will provide extra benefit to public acceptance; therefore, we will seek technical consultation from the safety authority of its origin through technical cooperation, especially in the case when unresolved issues on safety are in question.

Concluding remarks

The construction of an on-site ISFSI has been chosen as a mid-term, preferred solution in Taiwan. Besides implementing preliminary review study, choosing an approved storage cask system from a qualified vendor is also a favorable option to speed up the design, fabrication processes, and licensing procedure. However, cask system design modifications must be taken in order to meet the domestic regulatory requirements and site-specific environmental conditions. Some factors to endanger the safety of spent fuel and cause risk to the public health should be re-assessed, especially the structural seismic analysis and heat removal function. In addition, public acceptance plays a critical role to succeed in construction license. In substance, guaranteeing stringent safety standards, documents transparency, and public participation over the licensing phase are our most important concerns.

As the operation of Taiwan NPSs goes into its third decade, spent fuel management is getting
more and more attentions in Taiwan. Technical supports required for spent fuel dry storage involve many disciplines. Some subjects are newly encountered in Taiwan. Although we are prepared for ISFSI licensing, we will continue technical discussions with experts and relevant organizations at home and from abroad to assure that the most state-of-the-art technologies are available and well received by the implementer and research institutes.

6. References

(1) The nuclear materials and radioactive waste management act, 2002, FCMA/AEC.
(2) Regulations for the Review and Approval of Applications for Construction Radioactive Wastes Treatment, Storage and Final Disposal Facilities, 2004, FCMA/AEC.