

Nuclear Waste Management Approach for New Build Nuclear Power Plants in the People's Republic of China – 15687

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ABSTRACT

EnergySolutions continues to provide waste treatment solutions in the People's Republic of China (PRC). Currently two projects are in the installation phase at different sites (Haiyang, an AP-1000TM site and Yangjiang, a CPR-1000 site). *EnergySolutions* is also working closely with PRC nuclear regulatory officials for certification of High Integrity Containers (HIC).

This paper discusses progress on these two projects, and new information regarding current and future PRC waste management plans.

Haiyang Project

In the Shandong Province on China's northeast coast, *EnergySolutions*, as part of a consortium with China Power Investment (CPI) and Yuanda Environmental-Protection Engineering Company (a PRC state-owned company), has designed and constructed the site's Site RadWaste Treatment Facility (SRTF). The SRTF provides solid waste processing services for up to 8 AP-1000sTM. The SRTF performs the following functions:

1. Five year storage for HICs containing spent resin and filters from the nuclear power plants' waste liquid systems (WLS);
2. Sorting and Compaction System for solid waste generated from Nuclear Power Plant (NPP) operations. This system implements:
 - a) Real time radiography to screen 200 liter waste drums for prohibited items,
 - b) Pre-compaction,
 - c) High Resolution Gamma Spectrophotometry (HRGS) for waste characterization,
 - d) Supercompaction,
 - e) Solidification of compacted drums inside overpack drums which are filled with 60 MPa compressive strength grout, and
 - f) Automatic drum lidding which crimps the drum lid to the drum body.
3. Laundry services for NPP anti-contamination clothing. At the nuclear islands, *EnergySolutions* is providing mobile liquid waste processing systems that utilize *EnergySolutions* Advanced Liquid Processing System ALPSTM/Advanced Injection Method System AIMTM processing systems to supplement the NPP's WLS system when radionuclide concentrations exceed release criteria. The spent resins and filters from the nuclear power plants are placed in *EnergySolutions* supplied HICs, dewatered using *EnergySolutions* Self Engaging Dewatering System (SEDSTM), and then placed in *EnergySolutions* 8-120B Type B cask for the transport of the HIC between the NPP and the SRTF and, ultimately, to a disposal site once it is ready for operations

This paper details the Haiyang project's status, which is planned to have completed commissioning by the time this paper is presented.

Yangjiang Project

EnergySolutions is providing liquid waste treatment system (TEU) and solid waste treatment system (TES) for Yangjiang units 3 and 4 for the China Nuclear Power Engineering Company (CNPEC). The Yangjiang site is located approximately 300 kilometers west of Hong Kong. The TEU system processes floor drain, chemical drain, and process drain tanks liquids to achieve a release concentration less than 37 Bq/l. The TES system receives spent resin and filters into HIC containers which are dewatered and subsequently transported to the Yangjiang sites QT building where they are stored for a period of up to 5 years or until a disposal site are available.

- TEU (Liquid waste treatment) consists of the following unit operations:
 - ALPS™/AIM™ system, which includes two separate 8 vessel water treatment systems that consist of granular activated carbon (GAC), cation, anion ion and mixed bed media ion exchange (IX) columns; and
 - A reverse osmosis system for final polishing
- TES (solid waste system)
 - SEDS (Self Engaging Dewatering System)
 - Shielding for the loading and storage of HICs
 - Shielded transport container for the transfer of HIC to the QT building for storage
 - Shielded transfer bell for the transport of spent filters from the NPP operating area to HIC

This paper details the Yangjiang project's status which is planned to have completed commissioning by the time this paper is presented.

INTRODUCTION

EnergySolutions is providing waste treatment solutions for two reactor sites in the People's Republic of China (PRC). Both of these sites (Haiyang, an AP-1000™ site and Yangjiang, a CPR-1000 site) utilize similar systems for waste processing and storage. EnergySolutions has designed, fabricated, and has completed the vast majority of installation at both of these reactor sites. This paper describes the waste processes, implementation, regulatory requirements, and licensing processes that EnergySolutions used for these two projects. Additionally, this paper discusses future PRC plans for domestic waste disposal and status of PRC regulatory approval of these two projects as well as generic standards for approval of HICs.

Haiyang Project Overview

EnergySolutions began working with the China Power Investment Company (CPI), Shandong Nuclear Power Company (SDNPC), and Yuanda in 2010 on a Site Radwaste Treatment Facility (SRTF) (Figure 1) to support waste processing at the Haiyang Nuclear Power plants (NPP). EnergySolutions, in cooperation with Yuanda, are designing, fabricating, installing specialty equipment, and commissioning the Site RadWaste Treatment Facility (SRTF). This facility performs the following functions.

1. Receives dry active waste (DAW) from NPP operations for processing. The processing includes removal of prohibited materials, source term measurement, supercompaction, stabilization and 5-year interim storage.
2. Mobile water treatment systems to supplement the NPP WLS in the event that radionuclide concentrations exceed regulatory limits
3. Receipt and storage of spent resin and filters from the NPP WLS system.



Fig. 1. SRTF in October 2014

DAW Processing System

The SRTF system shown below (fig 2) is the sorting and compaction system. A drum containing low-level waste (LLW) is received at the SRTF and undergoes inspection using real time radiography, sorting, source term measurement, compaction, and solidification.



Fig. 2. Installation pictures

Mobile Water Treatment System

EnergySolutions has provided three mobile water treatment systems containing our proprietary ALPS™/AIM™ systems that are situated in a container that is easily mounted on a trailer for transfer between reactor units. Each system contains:

- 1) two granulated activated carbon (GAC), and
- 2) four ion exchange (IX) vessels.
- 3) three inches of internal shielding around the vessels
- 4) EnergySolutions proprietary AIM™ system
- 5) Receipt tanks and a booster pump.

These mobile treatment units will service all eight reactors at the Haiyang. Additionally, their purpose is to supplement the NPP WLS treatment system in the event that it is not able to meet the regulatory discharge requirements of 1000 Bq/l. It is expected they will be used after events such as cladding ruptures during plant operations.

Spent Resin and Filter Processing

EnergySolutions 8-120 High Density Polyethylene (HDPE) High integrity Containers (HICs) are being utilized for disposal of the spent resins and filters generated from NPP operations. Once exhausted, the spent resin and filters are loaded into the HICs. Both the filter and resin HICs are dewatered utilizing EnergySolutions SEDS™ (Self Engaging Dewatering System) shown in Fig. 3.



Fig. 3. 8-120 HIC and SEDS fillhead

After filling and dewater operations are completed, the HICs are transferred to the SRTF from the NPP in an 8-120B cask to interim storage in the SRTF. As with the dry active waste, the HICs will be stored for a period of 5 years. The SRTF has the capacity to store 240 HICs in a 6x20 array stacked two high.

Haiyang Project Progress

As of early December 2014, installation activities are very close to completion and commissioning for all of the SRTF systems are underway.

The overall approach utilized at Haiyang is being implemented throughout China at all AP-1000 NPPs. Each reactor complex is constructing a solid waste processing building in which waste is sorted, volume reduced and stored for a period of 5 years. 5 year storage is planned since low level disposal sites are not

yet operational. The local utilities are currently performing siting studies and requesting local government approvals.

Yangjiang Project Overview

In 2010, EnergySolutions began working with CNPEC on the design and fabrication of the TEU (liquid waste treatment system) and TES (solid waste treatment system) systems at Yangjiang units 3 and 4.

TEU System

The TEU system consists of EnergySolutions proprietary ALPS™/AIM™ and Thermex™ systems for the processing of liquid waste from the chemical drain, process drain, floor drain, and spare tanks. EnergySolutions systems will reduce the radionuclide liquid discharge concentrations to less than 37 Bq/liter. The system consists of two (2) GAC/IX column systems utilizing ES proprietary AIM system. Additionally, EnergySolutions is providing a Thermex reverse osmosis system to perform final polishing to meet the 37 Bq/liter discharge limit. As part of the equipment, EnergySolutions is providing local shielding and remote control capabilities of the equipment. Fig. 4 and Fig. 5 provide pictures of the main water treatment equipment during installation.



Fig. 4. ES ALPS system during installation

TES System

EnergySolutions is providing the equipment to fill the disposal containers with spent resin, filters, and the equipment necessary to safely handle and transport the waste to the QT building for 5-year storage.

Yangjiang Project Progress

Like the Haiyang project, as of early December 2014 installation is well underway. Commissioning will be beginning in the very near future.



Fig. 5. TES during installation

REGULATORY SUPPORT

EnergySolutions has actively participated in the regulatory reviews of the Haiyang and Yangjiang projects with the PRC nuclear regulatory authority, the NNSA. We have submitted five different license applications – the Preliminary and Final Safety Analysis Reports for the Haiyang and Yangjiang Projects, and a request for certification of the 8-120B cask under the Competent Authority provisions of the Chinese nuclear transport regulations.

HIC Standards

A HDPE HIC Standard has been drafted and submitted for public comment. Additionally, confirmatory testing of the *EnergySolutions* HIC containers has begun by the NNSA to ensure that the HIC standard requirements are being met. In addition to the HDPE HIC standard, standards for ductile cast iron and concrete HICs are under development. The progress of these two standards is less advanced; however, approval of these standards is expected in the near future.

Haiyang FSAR

The Haiyang FSAR is currently under review by the NNSA. The first two rounds of questions were received and responses have been submitted to the NNSA.

Yangjiang FSAR

Like Haiyang the Yangjiang 3&4 FSAR has undergone initial review by the NNSA. First round questions have been received and we are currently in the process of responding to these questions.

Waste Disposal Sites

Current PRC approach to low level waste disposal is to have 5 regional sites in key geographic locations to support the commercial nuclear power fleet. Currently, there is one disposal site located at Daya Bay (near Shenzhen China).

CONCLUSION

EnergySolutions has completed about 75% of the installation activities for both the Haiyang SRTF project and the Yangjiang TES/TEU project as of early December 2014. Commissioning and testing phases are planned to be completed in the first quarter of 2015.