

Automated Store Management For Drum Storage Facility - 8078

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ABSTRACT

This paper describes advanced system technology developed for a new Drum Storage Facility to be operated by Taiwan Power Company (TPC). A logistics management concept is applied for the storage of solid radwastes in terms of automated handling, transportation and storing as well as in terms of data management.

The individual equipments, such as automated Bridge Cranes, Automatic Guided Vehicles and auxiliary systems are introduced in this paper and the store management process is outlined.

The authors report furthermore on challenges during the design and engineering phase and review the project implementation from the equipment supplier's end.

INTRODUCTION

Taiwan is extending the use of nuclear energy for electricity production. TPC's Lungmen Project Fourth Nuclear Power Plant is currently under construction. The project involves a 2,700 MW plant consisting of two 1,350 MW BWR units located at the Yenliao site on the northeastern coast of the island.

On the plant's site a Drum Storage Facility (DSF) is built to accommodate processed solid radwastes which are transported from NPP's Radwaste Building for temporary storage before being shipped out. It is sized to store all packaged solid radwastes for the duration of the plant design life of 40 years. For handling and storage of radwaste drums an automated store management including highly demanding system technology will be applied.

DRUM STORAGE FACILITY

The On-Site Drum Storage Facility is a single reinforced concrete structure with one floor underground (for higher radiation drums, dose rate < 500 mSv/hr) and two floors above the ground (for low radiation drums, dose rate < 20 mSv/hr), see figure 1.

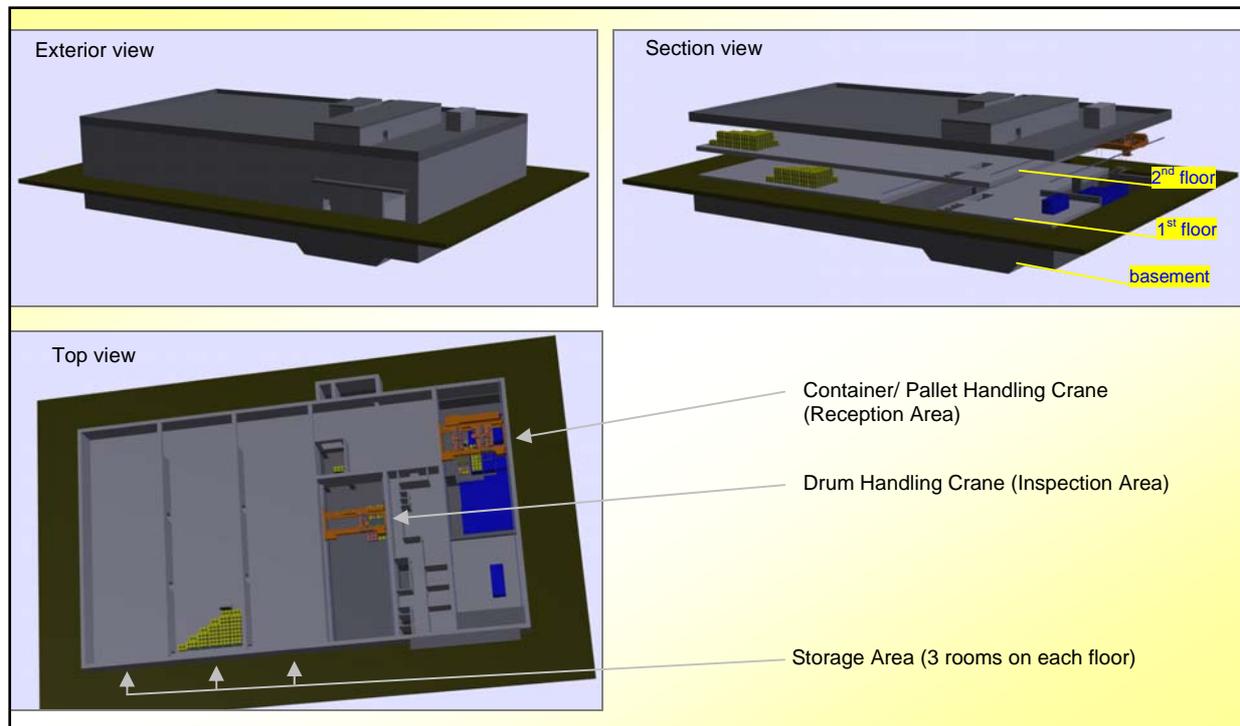


Fig. 1: 3D-Layout of the Drum Storage Facility

Processed, solid radioactive waste in 200 liter drums are here to be put into interim storage. The facility is planned to have a capacity for 20,000 drums in total. TPC has contracted Siempelkamp Nukleartechnik, Germany, for supplying all the required system technology for the automated storage of the drums. Such technology allows to control, administer and monitor conveniently from the central control room each of the stages involved in the process of putting the drums into the storage. Since the radioactive drums are handled by remote control, the amount of exposure to radiation of the plant personnel is reduced to an absolute minimum.

ADVANCED STORE MANAGEMENT

For shipping in and shipping out of the drums, automated systems for handling, transportation and observation are applied which are centralized controlled by the plant's operators. We will now describe in detail the involved systems which will be used to direct the radwaste drums through the store.

Bridge Cranes

Bridge Cranes are used to handle solid radwaste drums, pallets and containers remotely and manually inside the store. The radwaste drums are transported on stainless steel pallets, each can accommodate six drums. The Container Handling Crane which has a capacity of 30 mts will be required for unloading, loading and stacking containers. Sharing the same bridge, a Pallet

Handling Trolley (7.5 mts) will be required for pickup the drums/pallet assembly from the container. The pallet grab with a powered rotating block can move and rotate the pallet to unload it at the assigned position.



Fig.2: Container/Pallet Handling Crane during Shop Test Inspection

A Drum Handling Crane with a capacity of 2 mts is required to exchange the positions of the drums on the pallet or to pick single drums from pallet for visual inspection. This crane has attached a drum grab with a powered rotating block for 360 degree rotation of the drum and is equipped with load cell for measuring the drum weight. After sorting and balancing, a qualified drums/pallet assembly is ready for transportation to its assigned storage position.

Automatic Guided Vehicles

Remote and automatic transportation of a drums/pallet assembly inside the DSF will be accomplished by two Automatic Guided Vehicles (AGV). Both AGVs operate independently and can carry drum pallets to any allocated floor and storage point. For navigation, the AGVs use magnetic pins which are embedded in the floor. More than 500 magnets are in total distributed in DSF along predefined routes. Via so-called “access points”, the AGV can wireless communicate with its control system, i.e. control commands are transmitted to the AGV and in return the vehicle informs about its actual position taking the magnetic pins as reference. The control system continuously compares the actual AGV position with the related target position

and corrects the routing wherever necessary. So the vehicle is safely directed to the assigned storage point to unload its cargo. As three levels of drums/pallet assembly are stacked in the storage areas, the tolerance for deviation from the target position must be small. Therefore the positioning accuracy of the AGV needs to be within ± 5 mm which is a demanding requirement.

Both AGVs are powered by rechargeable batteries with a capacity of eight hours continuous operation. The vehicles are equipped with obstacle detectors to prevent any collisions when driving forwards or backwards. Figure 3 shows an Automatic Guided Vehicle during Shop Test execution.



Fig. 3: AGV loaded with drum/pallet assembly

To cover any possible failure malfunctions of the automatic system, a backup remote control system is available. For the case that an AGV has a complete breakdown, a Shielded Manually Operated Forklift (SMOF) is provided for intervention purposes. Electrical SMOF is equipped with a tow device for manually moving a failed AGV to the maintenance area. Furthermore, this radiation-shielded fork lift truck has an additional attachment and can thus be used for recovering a drum which may have tipped over, see fig. 4.



Fig. 4: Shielded Manually Operated Forklift (SMOF)

Control Systems

A Programmable Control System (PCS) is applied to control movements of the cranes, travelling of AGVs and interlocks with other systems (e.g. DSF freight elevator and shielded door) via data link. All transportation and storage movements are shown on dynamic (real-time) graphic displays in the central control unit. The operators therefore have a full overview and complete control of all automatic transportation operations in the plant at all times.

The intelligent control system also supports the operators in selecting and arranging drums to a qualified drums/pallet assembly and in generating automatic transportation orders for optimized storage, taking account of the specific radiology and weight of the drums. The operators can select between different operation modes which are automatic, semi-automatic and manual mode. Even for relocation of drum pallets in the store as well as for shipping out operations the PCS assists with logistics management and in calculating complex transportation orders.

The heart of DSF is the Computerized Inventory Control System (CICS) which saves the actual storage position of every radwaste drum, along with specific key data for each one (dose rate, weight, constituents, etc.). It is a complete automated system for the storage and retrieval of all information pertaining to the drums.

For additional visual monitoring of operation and security in DSF an efficient CCTV (Closed Circuit Television) system will be required. Controllable cameras are mounted on all Bridge Cranes, on both AGVs and in different areas of DSF that the operators can have a full visual observation of loading/ unloading processes and movements inside DSF besides the graphic displays.

PROJECT IMPLEMENTATION

SNT (Siempelkamp Nukleartechnik) received from TPC the order for the delivery of the above described system technology in June 2004. During the engineering and design phase, the main challenge was to elaborate proper technical solutions to fulfill all the specified functional requirements. Examples for difficulties which had to be smoothed out are:

- Sensitive electronic components of AGVs needed to be protected against harsh radiation environment. Conventional electronic sensors were replaced with radiation tolerant mechanical sensors and the on-board control electronics was housed in a protective shielding (20 mm steel housing). As result of such additional load the vehicle frame had to be reinforced.
- Conventional wireless transmission technology for analogous video signals would result in poor quality and transmission blackouts as reflections on the reinforced concrete walls would cause heavy interferences. Finally, digital COFDM (Coded Orthogonal Frequency Division Multiplex) technology was needed to be applied which is characterized with a high transmission stability in such reflective environments.

For manufacturing of components SNT worked together with specialised sub-suppliers. The overall control and visualization system and also the complete store management system (CICS) are in-house developments of SNT.

Design, engineering, fabrication and works acceptance tests could be successfully completed in accordance with the contractual schedule. Shipments of the components to Taiwan have been made in 2006.

OUTLOOK

Since TPC is making slower progress on the construction of the DSF store than originally planned, the components are currently stored on-site in (air-conditioned) warehouses, until installation can be started.

Installations of the equipments are scheduled for November 2008 to March 2009. The installations will be carried out by TPC and with supervision of SNT. Taiwan Power Company plans to put the Drum Storage Facility into commissioning/initial start-up from mid-2009.