

Westinghouse Cementation Facility of Solid Waste Treatment System – 13503

Torsten Jacobs* and Dr. Jörg Aign*

* Westinghouse Electric Germany GmbH, Global Waste Management, Tarpenring 6, D-22419 Hamburg, Germany, jacob1t@westinghouse.com, aignj@westinghouse.com

ABSTRACT

During NPP operation, several waste streams are generated, caused by different technical and physical processes. Besides others, liquid waste represents one of the major types of waste. Depending on national regulation for storage and disposal of radioactive waste, solidification can be one specific requirement. To accommodate the global request for waste treatment systems Westinghouse developed several specific treatment processes for the different types of waste. In the period of 2006 to 2008 Westinghouse awarded several contracts for the design and delivery of waste treatment systems related to the latest CPR-1000 nuclear power plants. One of these contracts contains the delivery of four Cementation Facilities for waste treatment, s.c. “Follow on Cementations” dedicated to three locations, HongYanHe, NingDe and YangJiang, of new CPR-1000 nuclear power stations in the People's Republic of China. Previously, Westinghouse delivered a similar cementation facility to the CPR-1000 plant LingAo II, in Daya Bay, PR China. This plant already passed the hot functioning tests successfully in June 2012 and is now ready and released for regular operation. The “Follow on plants” are designed to package three “typical” kind of radioactive waste: evaporator concentrates, spent resins and filter cartridges. The purpose of this paper is to provide an overview on the Westinghouse experience to design and execution of cementation facilities.

INTRODUCTION

The operation of nuclear power plants generates several waste streams caused by different technical and physical processes. Solidification of waste is one method to meet national regulatory requirements for storage and disposal of radioactive waste.

To accommodate the global request for waste treatment systems Westinghouse (W) developed several specific treatment processes for the different waste streams. Apart from integrated waste treatment facilities like “SRTF (AP1000)” and low level, solid waste treatment “Sorting & Compaction” Westinghouse established a cementation plant design based upon the actual state of the art and technology.

In the period of 2006 to 2008 Westinghouse was awarded several contracts for the delivery of waste treatment systems related to the latest CPR-1000, nuclear power plant generation in China. One of these contracts contains the delivery of four Cementation Facilities, s.c. “Follow on Cementations” dedicated to three locations, HongYanHe, NingDe and YangJiang, coastal sites

CPR-1000 nuclear power stations in China.

Previously W delivered a similar facility to the CPR-1000 plant LingAo II, in Daya Bay, China. This facility already completed the hot commissioning tests successfully in June 2012 and is now ready and released for regular operation.

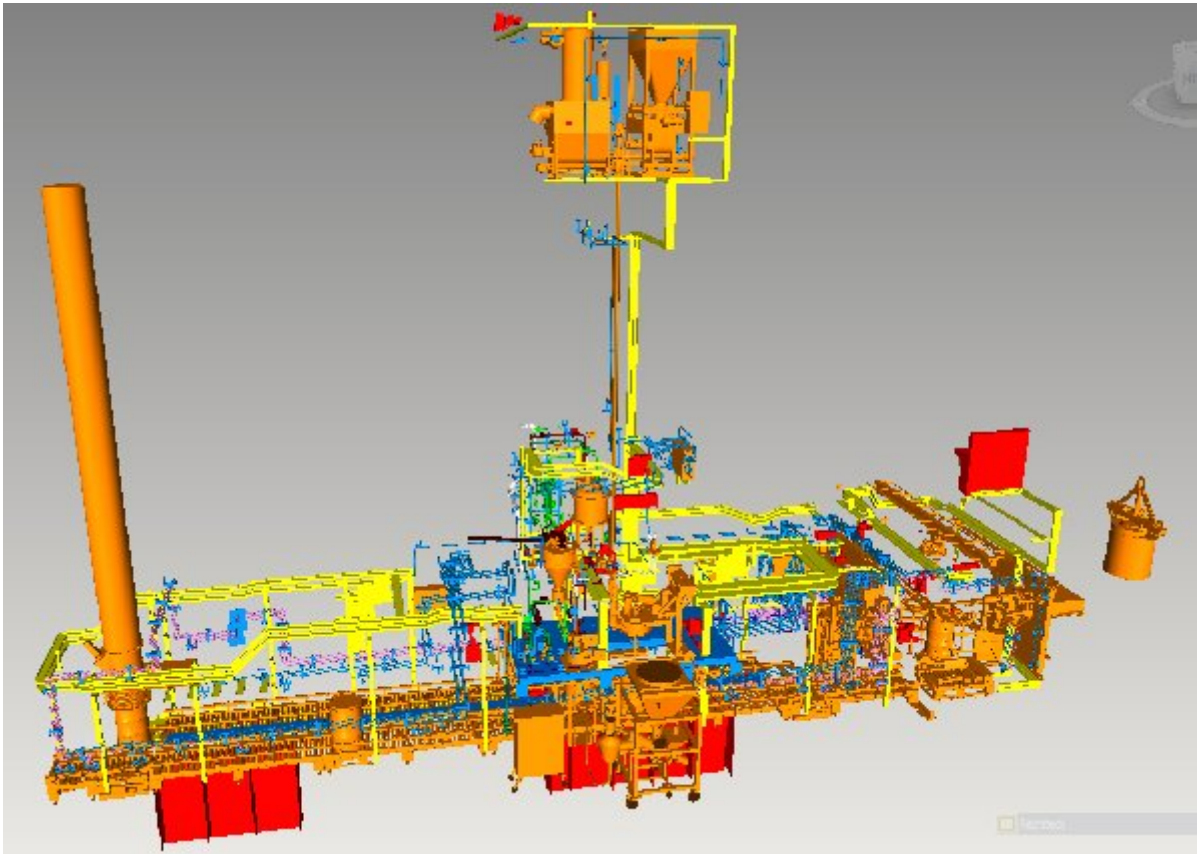


Fig. 1. 3D PDMS model of Westinghouse cementation facility (total view)

The plant scope covers all equipment required for a turnkey cementation system. Major equipment comprises transfer system consisting of roller conveyor, crane & applicable grapple for drums and shielded containers, automatic drum capping device, cement and waste filling system, filter loading unit and in drum mixing system. Furthermore, all required auxiliary equipment for hydraulic, pneumatic and electric / control system is part of the scope of supply. The control system is based on actual PLC technology which enables the operation personnel to ensure a reliable waste composition and related waste storage conditions. The equipment is designed to be remotely operated, under radioactive conditions.

Furthermore, W developed the waste/cement/additive/water recipe, in accordance to the Chinese

“GB” regulation.

PLANT DESIGN

Westinghouse waste plant projects utilizes actual technical planning tools for 3D design like PDMS® and Pro Engineer® and defined project management process to ensure a control planning and design process, scheduled project execution and reliable technical operation of the plant.

The following pictures provide an impression on the design method of the PDMS system. The related on-site pictures are shown in order to compare design and reality.

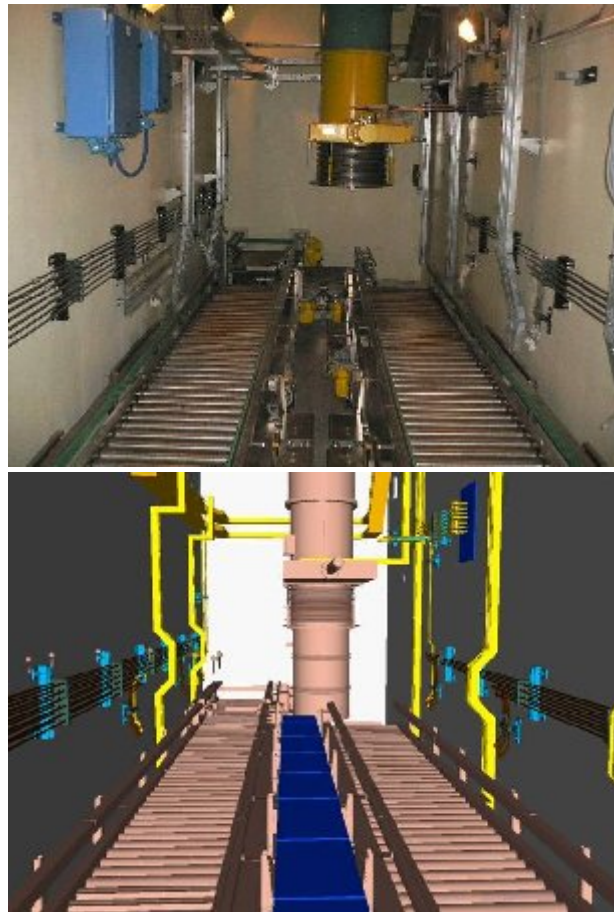


Fig. 2. View of filter loading station (on-site and 3D PDMS model)

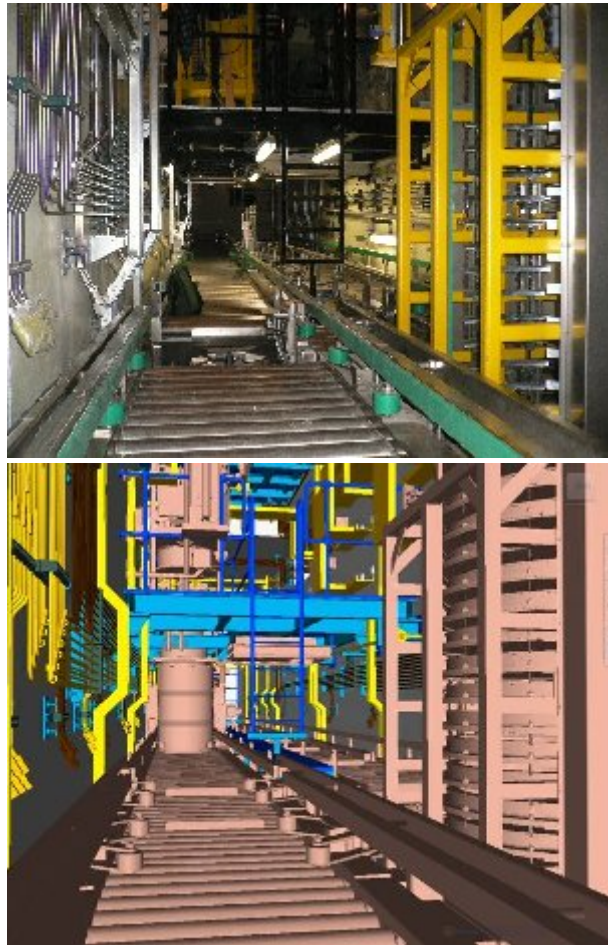


Fig. 3. View of steel platform (on-site and 3D PDMS model)

Type of waste

The “Follow on plants” are designed to package three “typical” waste as follows:

- Spent resin
- Evaporator concentrate
- Filter cartridges

Each type of waste requires its specific process equipment. The W cementation facility combines all required components into one integrated system.

Performance Data

The cementation facility is designed to maintain the following performance guarantees:

- Throughput: The plant is able to process up to eight (8) drums in eight (8) hours, depending on the detailed waste definition.
- Filling efficiency: The plant ensures a max. filling efficiency of 90 %.
- Waste load values: The waste load requirement in accordance to GB 14569.1 and EJ 1186 will be maintained.
- Shielding requirements: A maximum surface dose rate of 2 mSv/h will be provided by the shielding equipment related to the given activity content for the different types of waste, and will be in conformity with Chinese standard EJ 1186.
- Life time: All mechanical equipment is designed for a lifetime of 40 years.

MATERIAL FLOW

The following description shall provide a short introduction to the material flow and functioning of the main components.

Drum loading and unloading area

Fig. 4. shows the drum loading area of the cementation facility.

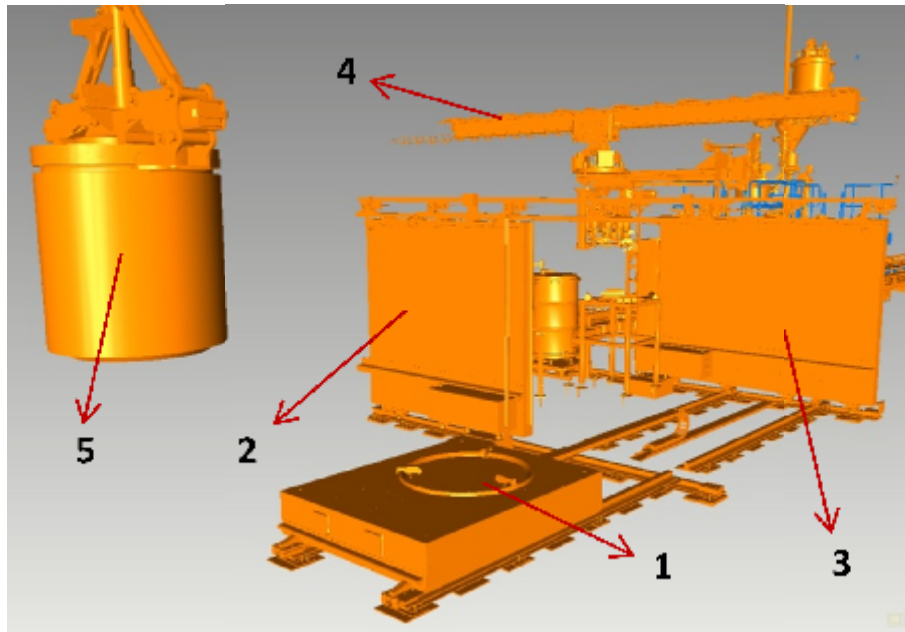


Fig. 4. View to Inner & Outer shielding door, Transfer cart, Drum shield and Grapple and Drum crane (3D PDMS model)

The transfer cart (1) conveys the drums, which are usually located within the shield container (5), through the entry opening into the process area. The process area is closed by the shielding doors, the inner shielding door (3) and the outer shielding door (2). The drum crane (4) equipped with the suitable drum grapple removes the drum out of the drum shield and conveys it onto the transfer system.

Process area

Fig. 5. shows the process area. Within this area the drum filling and mixing process will be performed.

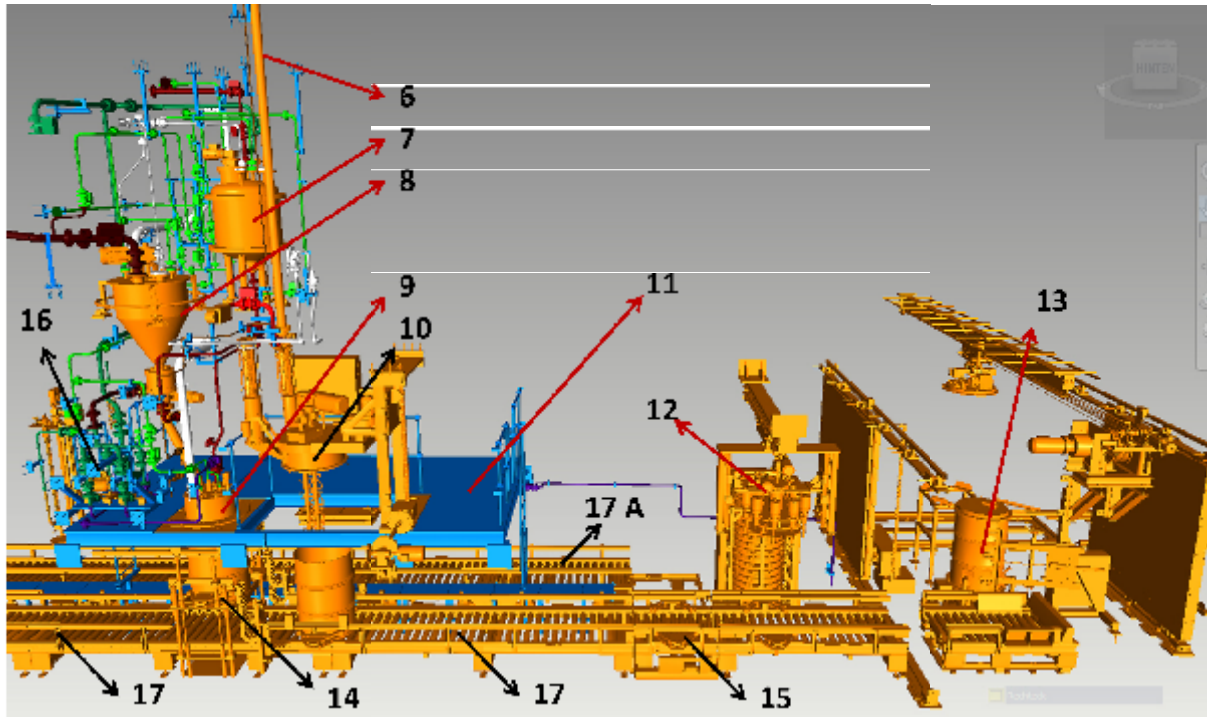


Fig. 5. Plant overview, process area (3D PDMS model)

For the further processing, the drum is opened by the drum capping (12) device. The closure screws are unscrewed and the lid is temporarily stored in a lid magazine. The transfer system (17) conveys the empty drum to the filling station (9). A drum docking device (14) lifts the drum to the filling seal. In this position the drum is filled with resin or concentrates and water by a given mixing ratio. The resins are stored within the spent resin tank (8) and the concentrate within the concentrate tank (7). The filling process will be gravimetrically controlled to ensure the best filling efficiency and the given ratio. After the filling process the drum is conveyed to the mixing device (10). The mixing device is lowered down onto the drum surface in order to close/seal the drum for the mixing process. In this condition cement is filled into the drum and the mixing process starts. The cement is filled through the cement filling pipe (6). The cement station at level 13.5 m provides the required cement, lime and additive. The filling process is gravimetrically controlled.

The cross conveyor (15) conveys the drum from one roller conveyor line to the other. The parallel conveyor line (17A) is used for intermediate storage of drums and/or the curing process. After the mixing process the drums are conveyed to the drum capping device (12) and closed with the appropriate lid.

The drum crane (4) places the filled, closed drum onto the inspection system (dose rate

measurement) (13). After monitoring of the dose rate, the drums are conveyed by the drum crane onto the transfer cart (1). The car conveys the drums out of the process area.

Cement station

Fig. 6. shows the cement station area. Within this area the cement, lime and additives will be filled into the process.

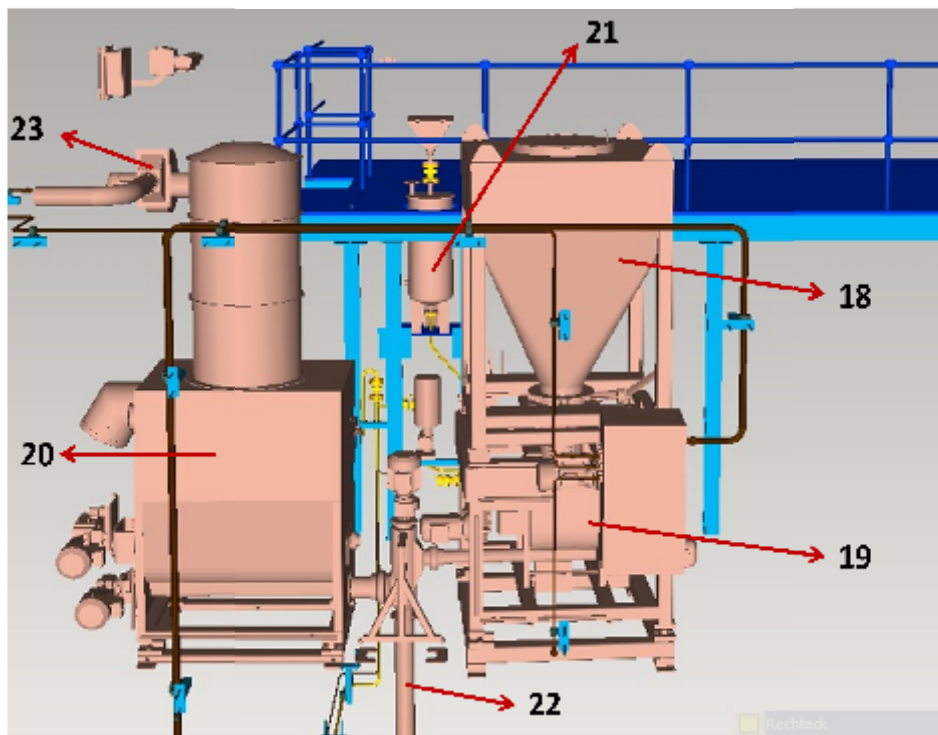


Fig. 6. View to cement station at level 13.5 m (3D PDMS model)

The cement station consists of the cement silos (18) which are filled outside of the plant area. The filled silos are loaded onto the cement device (19). Applicable lime can be loaded into the bag emptying device (20). Into this device, the applicable lime bags can be opened and discharged manually. Lime and cement are charged into the cement filling pipe (22). The filling is performed gravimetrically. The off gas fan (23) ensures that dust which can be generated by the emptying of the lime bags is routed into the off gas system. Applicable additives used for the process are stored in the additive tank (21). A metering pump will provide a defined filling volume.

Filter loading area

Fig. 7. shows the filter loading area. Within this area the filter cartridges will be loaded into the drums.

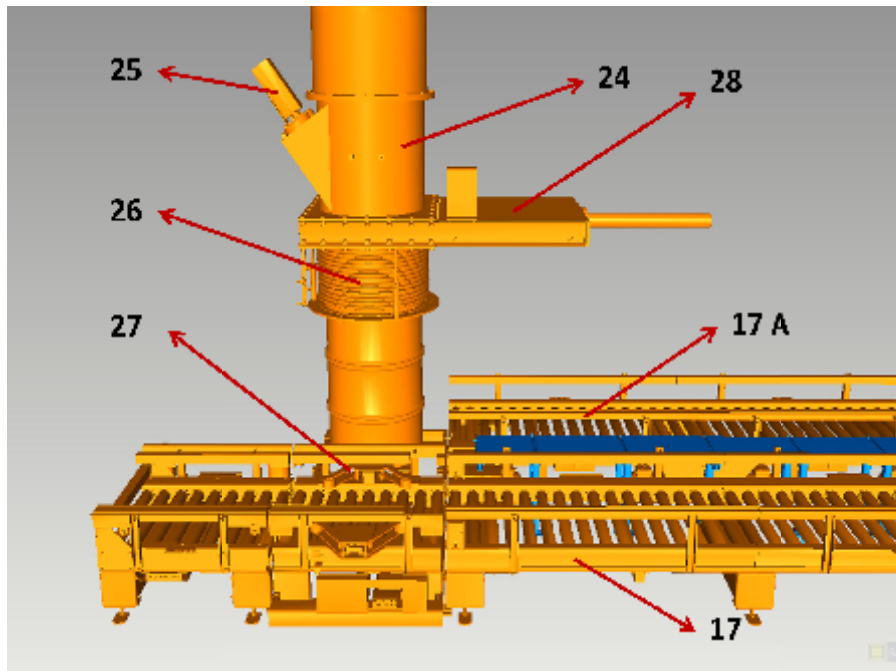


Fig. 7. View to Filter loading station at level 0 m (3D PDMS model)

Beside spent resins and concentrates, filter cartridges can be processed. Spent cartridge filter baskets are loaded manually into the drums before loaded to the cementation process. For the filter loading the drums are conveyed to the filter loading station by the transfer system (17) and are centered by the drum centering device (27) to a defined position. The filter baskets ensures that the filter cartridge has a defined position in the center of the drum in order to provide proper shielding and encapsulation of the surrounding cement. The docking device (26) is lower down onto the drum. The gate valve (28) is open and a filter cartridge can be lowered through the filter loading pipe (24) from the level 13.5 m. A CCTV camera (25) provides visual process control in order that the filter cartridge is loaded precisely into the filter basket. After the loading process the gate valve will close, the docking device lifts up and the drum is conveyed to the filling station. An external grouting device provides the required cement and water mixture which is filled at the filling station into the drum. The mixing device is not in use for filter cartridges.

PROCESS CONTROL

The type of waste and the related dose rates requires the cementation process to be fully controlled from outside the cementation area. All applicable process values are monitored. The cementation facility comprises a central control unit located in a separate control room.

Independent to the operation mode, the condition (status, position, etc.) of each component will be displayed. Furthermore any kind and location of failure will be displayed.

The process parameters are displayed (e.g. tank level, flow rate, etc.) and can be adjusted. Recipe values can be monitored, adjusted and stored in a related library.

The following main process areas can be monitored visually by a CCTV camera system:

- Drum loading area
- Drum crane area
- Mixing device
- Filling device
- Filter loading device

The related pictures are displayed on a screen located in the main control desk.

Automatic mode

The regular operation is performed automatically. Each single process step is operated by “start/stop”. The component statuses (open/close, up/down, etc.) are monitored.

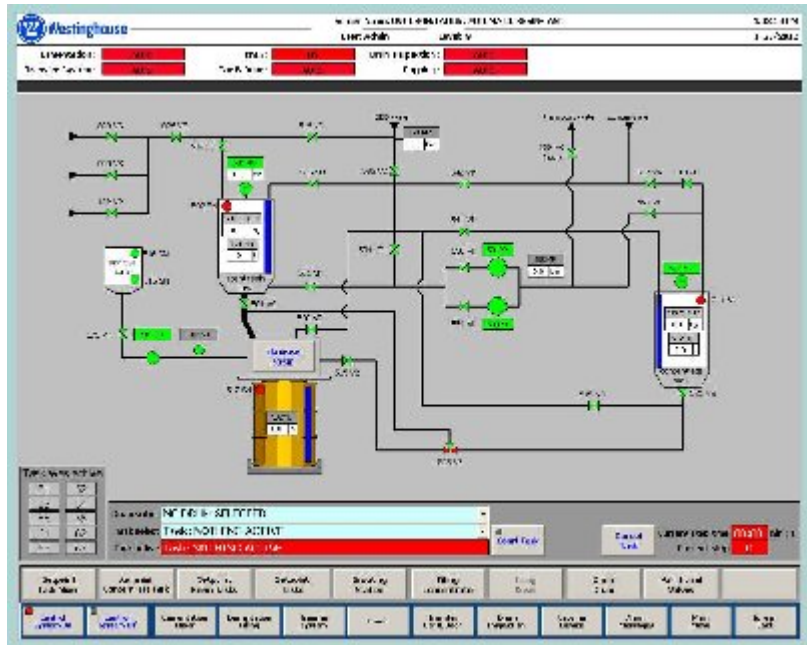


Fig. 8. Resin tank; automatic mode (Controller screen shot)

Manual mode

Beside the automatic mode each component can be operated in a manual mode. This mode enables the operator to control each single function like open/close of single valves, start/stop of single drives, etc. Related safety interlocks will ensure that no uncertain condition or even damages can occur.

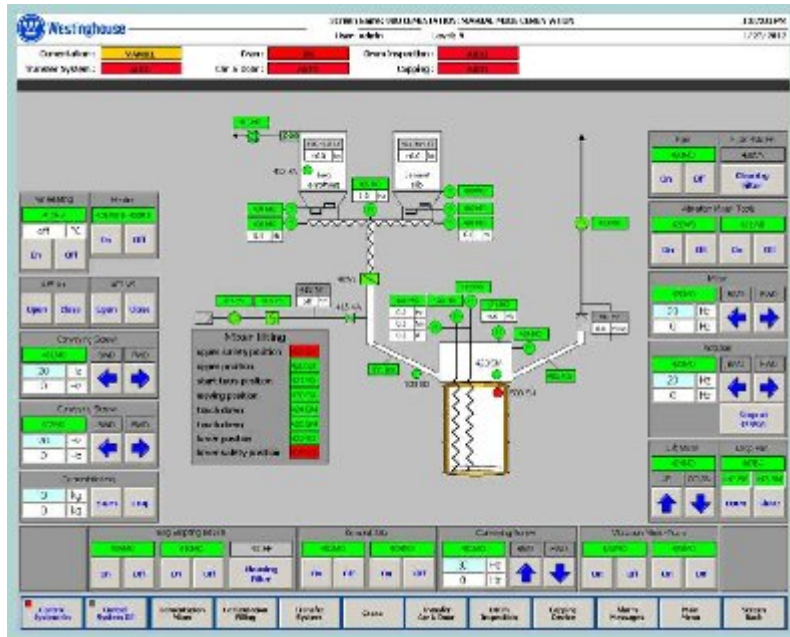


Fig. 9. Mixing device; manual mode (Controller screen shot)

CONCLUSION

The Westinghouse Cementation Facility described in this paper is an example for a typical standardized turnkey project in the area of waste management. The facility is able to handle NPP waste such as evaporator concentrates, spent resins and filter cartridges. While the Ling Ao II (Daya Bay) facility has already passed the hot functioning tests successfully in June 2012 and is now ready and released for regular operation, the other projects (HongYanHe, NingDe and YangJiang) are in the phase of installation and erection. All of them will be ready for hot function test in 2013.