D&D Update: Licensing, Tank Remediation, and APS™ Treatment for the Kozloduy, Bulgaria, Nuclear Power Plant

Jim Braun, Dennis Brunsell, Raja Beereddy, Mark Ping – AVANTech, Inc.
Raycho Yonchev – Risk Engineering Ltd.

AVANTech INCORPORATED
avantechinc.com

2050 American Italian Way
Columbia, SC 29209
803.407.7171

2680 Westcott Boulevard
Knoxville, TN 37931
865.539.9000

2155 Robertson Drive
Richland, WA 99354
509.943.6706

RISK ENGINEERING, Ltd.
Reliability - Safety - Management
Engineering Services - Software Development

10 Vihren Str., Sofia 1618 Bulgaria
Tel: +359 2 8089 518 • Fax: +359 2 9507 751

Kozloduy Nuclear Power Plant (KNPP)

KNPP is the only nuclear power plant in Bulgarian and the main electricity generating plant providing more than one third of the total annual electricity output of the country.

Waste Types

The project scope covers the safe retrieval, treatment, and processing of historical radioactive wet solid wastes in KNPP Units 1-4 to Category 2a product and secondary waste. The three wet solid radioactive waste types include:

- ✓ **Evaporator Concentrates** originating from the evaporators of contaminated water treatment systems, stored in ten evaporator concentrate tanks (ECTs) five each in Auxiliary Building 1 (AB-1) and Auxiliary Building 2 (AB-2)
- ✓ **Spent Ion Exchange Resins (SIER)** and other sorbents stored in three tanks each in AB-1 and AB-2
- ✓ **Sludges and sediments** originating from elutriation of resins and (chemically) activated carbon and also from precipitation of mechanical impurities captured with water flowing into floor drains, stored in several rooms and facilities within AB-1 and AB-2

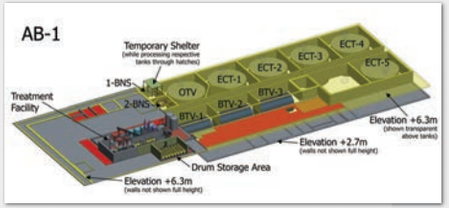
Project Approach

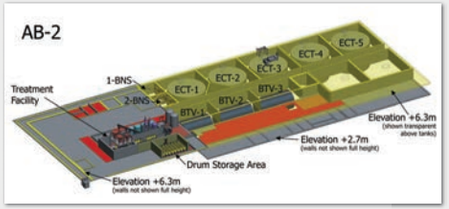
The primary focus is to achieve the following objectives:

1. Waste minimization to reduce the cost of final disposition
2. Minimization of material handling and the respective risks
3. Minimization of radiation exposure

The project will be implemented in three phases which include:

- ✓ **Retrieval –** A specialized retrieval method will be utilized for each waste stream.
- ✓ **Processing –** For the processing phase, there will be two different types of equipment: one set of equipment for the ECT and a second set for SIER/Sludge.
- ✓ **Stabilization –** AVANTech's Advanced Polymer Solidification (APS™) will be utilized for the stabilization phase for all three waste streams.

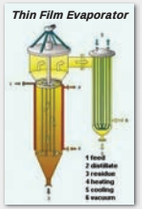




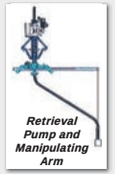
Retrieval and Processing

Retrieval UHP-Viper

ECT waste will be retrieved utilizing a hydrolasing process to remove the ECT waste from both the tanks and the bund area around the tanks. Hydrolasing will generate a slurry rather than dissolving the waste, so the drying step will utilize a minimum amount of energy. An Ultra High Pressure (UHP) Viper System will be utilized to break crystallized salts into a slurry. The slurry will then be pumped using a sump pump to the Hydrolasing Batch Tank (HBT). A Thin Film Evaporator (TFE) will be utilized to dry the ECT slurry to a material suitable for solidification.



Thin Film Evaporator



Retrieval Pump and Manipulating Arm

The **SIER** retrieval system will include a pumping and manipulating arm that will be installed in the round manhole situated on the top of each cylindrical storage tank containing stored waste. The arm carries the hose equipped with a suction head and manages all necessary movement inside the storage tank (vertical, horizontal, and rotary). All arm movements will be controlled via a remote control panel and monitored by a camera system installed on the manipulating arm. The SIER will then be transferred to the SIER/Sludge Batch Tank where resin will be mixed and sampled.

Remote Rover

Sludges will be removed from the tanks via the use of a Remotely Operated Rover. The crawler will be remotely maneuvered around the tank, slurrying the remaining solids. The slurry will then be removed by vacuum and pumped to the SIER/Sludge Batch Tank to await processing.

Both the SIER and Sludge will be transferred via slurry pump to a Decanting Centrifuge to dewater the waste by means of centrifugation. The solid waste will be discharged into one of two Loss-in-Weight (LIW) Feeders, and the clarified water will be returned to the SIER/Sludge Recycle Tank.

Decanting Centrifuge

Stabilization

The APS™ Continuous Mixer process was chosen because it has higher compressive strength, higher leach resistance, and longer life than the current cement process. Both borates and nitrates have very negative chemical interactions with the cement matrix which eventually cause failure and limit the waste loading into the matrix.

The dried solids will be collected in LIW Feeders and fed on a weight basis into the Continuous Mixer where the two APS™ polymer agents will be injected. The Continuous Mixer has two screw shafts that turn at close tolerances to thoroughly mix the solids and the two polymer agents, making a homogeneous mixture. This mixture is conveyed through the mixer where it is compressed into a paste-like material. The final product will ultimately be discharged from the mixer through a Fill-Head into waste drums.

The APS™ process is designed to begin gelation within 15-30 minutes and go to near completion in 2 hours. The polymerization will be monitored by two Exotherm Stations that use remote infrared sensors. Because the APS™ process has a short drying (or curing) time, it does not require any extensive storage area since by the time the exotherm is nearly complete, the hardness will be such to pass the Hardness Tester.

APS™ Continuous Mixing System

Containerization

Filling of the waste drums will be monitored with the Fill-Head through both continuous level sensing and a CCTV camera. Once a drum is filled, the Fill-Head will be automatically detached and the drum replaced. The filled drum will begin cure monitoring, hardness testing, remote capping, and gamma monitoring before it is conveyed to a storage area. The entire mixing, monitoring, and conveying process will be accomplished without direct human contact and will consist of the following equipment:

Fill-Head – Designed to fit waste container to provide environmental sealing, mounted using actuators that permit raising and lowering when drum changeout is required, mounted with both continuous and high-high level sensors to enable continuous level monitoring and prevent possibility of overflow.

Motorized Roller Conveyor with Stops – Enables remote movement of waste containers between stations (new container storage, fill, exotherm monitor, capper, gamma monitor, temporary storage), with each station having built-in stops and drum sensors.

Exotherm Monitors – Once an increase of >10°C is recognized, reaction has progressed to the point where completion is assured, as increased temperature causes reaction to proceed faster to completion, although final hardness may not be reached for more than an hour later.

Hardness Tester – Usually within 1-2 hours, polymer has reached minimum hardness required by the WAC, verification done by applying minimum required compression pressure on top surface of polymer matrix.

Remote Capper – Utilized to minimize personnel exposure, lid and ring manually loaded by operator behind shielding to transfer table, capper then transfers lid/ring to drum through remote manipulator and tightens to seal drum.

Gamma Monitor – Used to obtain final measurement to assure compliance with the Category 2b dose limits, provides assurance that previous calculations are correct, also aids in placement of drums in final waste container with highest dose drum placed in center position.

Removal Crane/Forklift – Either a crane or forklift will be used to remove capped drum from roller conveyor for transfer to longer-term storage area onsite.