Another DOE Small Business Success Story – "Closing the Loop"

In 1999, two chemical engineers, Jim Braun and Tracy Barker, had a dream to start a wastewater processing company. Previously, they each worked in the nuclear industry at US commercial nuclear power plants and later worked for nuclear waste service companies. They pooled their money and incorporated AVANTech, Inc., as a South Carolina small business headquartered in Columbia, SC. Jim Braun, with his MBA, would be the President, and Tracy Barker the VP and Chief Technical Officer.

For over 10 years, they grew the company by providing specialized products and services for waste water treatment. They provided an integrated client service of testing, engineering design, fabrication, and installation of modular water treatment systems. Their systems ranged from treating non-radioactive water to highly radioactive waste water. They served many overseas clients, the US commercial reactors, and the U.S. DOE and DOD.

In 2011, AVANTech was part of a team that received an award for the DOE Savannah River Site (SRS) Small Column Ion Exchange (SCIX) program. The SCIX program was to provide additional salt processing capability to accelerate closure of SRS High-Level Waste (HLW) tanks. The SCIX program was to use two ion exchange columns operating in series to remove cesium-137 from the salt solution waste stream. Cesium-137 is the predominant material causing an external radiation hazard. AVANTech's role was the design, manufacture, and testing of a full-scale prototype small column ion exchange column that was used for evaluating Crystalline SilicoTitanate (CST) ion exchange media. Savanah River Remediation, LLC, lead the project along with expertise from Savannah River National Laboratory. The SCIX ion exchange prototype that was designed and built by AVANTech is shown to the right.

CST was a specialty resin developed in the 90s by DOE Sandia National Laboratories and Texas A&M University. It was later licensed by DOE for commercialization to Honeywell UOP. CST exchange media is a single-use material that cannot be regenerated, but it is very selective for the cesium isotope in a salt environment and has an extremely high loading capacity. Once fully loaded with cesium-137, the spent CST resin is removed and the vessel is replaced or replenished with fresh resin.

Jim Braun (left) and Tracy Barker are the co-founders of AVANTech, Inc. The two were given the challenge to design, test, build, and deliver a unit to remove radioisotopes from highly radioactive wastewater following the earthquake and tsunami that ravaged the Fukushima Daiichi Nuclear Power Station.

In April 2011, a few weeks after a massive earthquake and tsunami ravaged the Fukushima Daiichi Nuclear Power Station, AVANTech got a call. The Japanese nuclear plant was out of commission. Backup systems had failed, and emergency workers were pumping water out of the ocean to cool reactors at the Tokyo Electric Power Co. facility. While TEPCO was attempting to avoid a total meltdown, another potential environmental disaster was in the offering. Fortunately, they discovered AVANTech and their success with the DOE SRS program.

For Jim Braun and Tracy Barker, the challenge was to design, test, build, and deliver a unit to remove radioisotopes from the wastewater. The Fukushima waste had many similarities to the SRS HLW tank waste they experienced with SCIX.

They had twelve weeks to get it done. "If we didn't deliver it on time, they ran the risk of overflowing contaminated reactor cooling water right into the

ocean," said Jim Braun. "That stuff was so contaminated it would have caused an environmental and health disaster along Japan's Pacific coast." For the Fukushima task, AVANTech had to come up with a system to treat the radioactive water that was effective and simple to operate.

"Tracy Barker knew from his experience with SCIX and other systems they built that we could put the system together," Braun said. "We had the foundation based on other work we had done for the U.S. DOE and our other customers." Just days after they were asked to design the system, Barker presented a plan to TEPCO. By May, they got approval and proceeded with the project. They manufactured and delivered the system within 12 weeks. Seven days a week, twenty four hours a day, this team worked to make this happen.

AVANTech chose the DOE/CST media because of the stability and high cesium sorption capacity for the removal of cesium in a simple once-through process. This was a result of the DOE SCIX development program. AVANTech and UOP worked extensively to ensure the ion exchanger design provided the optimal design conditions for effective removal of cesium in a safe manner. By removing the cesium, the radiation dose of the cleaned water was dramatically reduced, increasing worker safety, expediting recovery, and enabling the use of above ground tanks for water storage.

In developing the overall process, it was quickly understood that the capacity of the CST media far exceeded the ability to safely shield and cool the ion exchanger. Therefore, the ion exchanger was limited to less than 200,000 curies of cesium. The goal was to enable the working staff to be able to maintain the equipment in a work environment of less than 200 millirem per hour. As a result, AVANTech Engineers integrated the ion exchanger into a shielded vessel much like a transportation cask. The integral shielding was designed for a six-inch lead equivalent and resulted in the overall vessel weighing approximately twenty-three metric tons, or fifty thousand pounds. Lead shot was utilized because it expedited the product development and eliminated several transportation issues associated with shipping significant weights between the United States and Japan.

Nearly five years later, the AVANTech system is still operating at the Fukushima Daiichi Nuclear Power Station. AVANTech has also partnered with Hitachi-GE Nuclear Energy, Ltd. (HGNE), in providing additional systems to Fukushima. The original system has been upgraded several times and has processed nearly 300 million gallons of water similar to the salty HLW in the DOE tanks. AVANTech is also on the second generation of the large single-use shielded ion exchange modules after manufacturing and delivering over 175 to Japan and is currently working on the third generation of ion selective, shielded canisters.

AVANTech has grown to over 130 employees and now operates two manufacturing facilities: a 120,000 ft² facility in Columbia, SC, and a 30,000 ft² facility in Knoxville, TN. They have provided systems to 14 different countries and currently own and operate 12 wastewater treatment facilities at numerous nuclear and industrial facilities.

The lessons learned from Fukushima are now being utilized by the U.S. DOE. AVANTech was recently awarded with AECOM to provide ion-exchange design and test demonstration expertise for maturing HLW pre-treatment technology to be used at DOE-Hanford. This is through the Hanford tank management contractor, Washington River Protection Solutions (WRPS). AVANTech is also actively involved in the pursuit of other DOE work that is an excellent fit for this technology. The goal is to expedite U.S. DOE tank closures while reducing costs and personnel radiation hazards by using the systems used and proven in Japan by AVANTech.

From the start of the CST resin development in the late 90s, nearly 20 years later, DOE is "Closing the Loop" with the assistance of small businesses like AVANTech and the experiences gained from our US and Japanese partners.