[Form 2 (to be reported to Committee on Countermeasures for Contaminated Water Treatment and to be disclosed to public)

Technology Information	
Area	1-(4) Facilitating Removal of the Bolted Type of Tanks
Title	Long Reach Arm for Tank Cleaning
Submitted by	Vista EngineeringTechnologies

1. Overview of Technologies (features, specification, functions, owners, etc.)

Retrieval and processing of nuclear waste inside tanks is a common challenge in decommissioning projects around the world. Millions of gallons of legacy waste are contained in waste storage tanks. As it stands today, the methods and processes used to remove bulk nuclear waste from waste tanks are well understood, and have been implemented at many nuclear facilities around the world. However, after the bulk volume of the waste is removed from accessible tanks, a significant amount of residual highly radioactive waste can remain leading to additional issues. This dilemma presents a significant waste removal problem for a variety of reasons; among which two issues have become prominent: obstructions to tank access and waste forms which are varied and complex in constituents.

Figure 1 - Remote Manipulator Retrieving Tank Waste

Storage tanks with access obstructions encompass a myriad of installation or operation interferences including: plant equipment interferences, in-tank obstructions, overhead lifting limitations, access door sizes, floor loading, tank penetration size and location, and tank size and geometry. Complicating matters even further, the presence and project impact of each of these obstacles varies not only from site to site, but also from tank to tank. The space restrictions resulting from these tank access obstructions, and the lack of commonality between waste tanks, contributes greatly to the difficult deployment of equipment for final tank waste retrieval.

Another challenge for final waste removal is that much of the legacy waste currently remaining in nuclear material storage tanks is not homogeneous. Various fluid and solid waste forms are often present within a single tank, and the presence of varying waste forms requires a versatile and fit-for-purpose solution when dealing with tank waste. Differing waste forms require separate means of retrieval in the form of new tools or systems, each with added complexity and costs.

Figure 2 - Manipulator Retrieving Liquid and Solid Tank Waste

In recent years, advanced waste retrieval systems have been proven to be advantageous in that they can often be designed and built to work within the existing facility constraints. With these systems, modifications to the facility are often very minimal, if required at all. One type of advanced waste retrieval system that has seen increased visibility and usage for these types of waste problems is the use of remote manipulators. There are a number of off-the-shelf manipulators available in the marketplace, but most of these manipulators are built to address the need of production environments and are limited in comparison to the capabilities and versatility required from a multidimensional tank retrieval manipulator system. These advanced systems allow personnel to manipulate and utilize tools within a hazardous environment from a remote location via cameras and virtual feedback systems.

Figure 3 - Example of Tank Manipulator

Specifically, manipulator system technology combines the form factor and versatility required for successful deployment and operations for tank waste retrieval. The latest waste retrieval manipulator systems have been designed to be easily moved from tank to tank, through existing plant rooms and doors, and to accommodate a multitude of plant room constraints including limited head room, access in and out of doorways, existing plant room equipment, and penetration locations. The ability for these systems to be installed and operate in extremely tight quarters without impacting the infrastructure is very advantageous when considering the cost, scope, and safety concerns associated with modifying existing tank structures. Until recent years, most manipulator deployments have required heavy machinery and open areas to operate and install the equipment. With advances in composite structural materials and micro-hydraulic systems, similar systems can be pushed through small doorways and around obstructions that would otherwise prevent a remote manipulator installation or deployment.

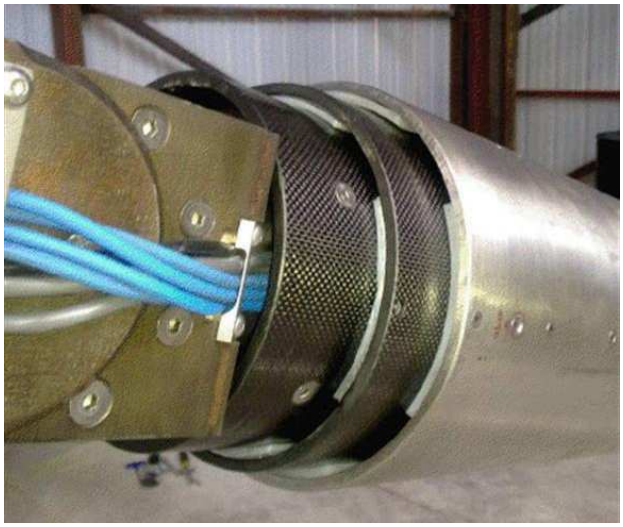

Figure 4 - Compact and Lightweight Manipulator Using Composite Materials

In addition to advantages in installation and deployment, waste retrieval manipulator systems are extremely versatile in operation. These systems are capable of deploying a multitude of tools to remove tank waste. The flexibility of tool deployment in a tank retrieval manipulator system is invaluable for removing non-homogeneous waste, and is much more efficient and cost effective than the use of a number of separate systems to complete various operations. Waste retrieval manipulator control and visualization options are also widely customizable, and can be suited to the needs of a specific tank or group of tanks. For example, manipulator control systems can include a full three dimensional visual model of the deployed system on the interface screen to allow operators to instantly understand the configuration of the manipulator relative to the surrounding environment. This is extremely advantageous in applications with reduced visibility such as waste tanks flooded with water. In these applications the water is normally very opaque due to the entrained waste particles. All of these capabilities make a seemingly impossible and expensive project into one that can be feasible and affordable.

An example of successfully deploying this technology can be seen at the Trawsfynydd nuclear power station in North Wales, UK. Vista's Remote Systems and Solutions has been working in partnership with EnergySolutions-owned Magnox Ltd and ACTUS to design and build two long reach manipulators for retrieval of waste from three separate storage tanks.

The 'Rotary Deployment Arm' (RDA1 and RDA2) is a highly capable and versatile solution for the site's tank cleaning dilemma. The RDA is designed to complete a variety of clean up tasks within four main areas on site including the Resin Vaults (RV2 and RV3), Main Sludge Vault (MSV), and

Pond North Void (PNV). All of these tanks have different size and technical constraints making it difficult to design a single solution that could meet each of the tanks requirements.

The RDA is capable of being deployed through penetrations of 10 inches and larger in diameter; has a vertical reach of 32 feet and a horizontal reach of 15 feet when fully extended. The RDA consists of mast and forearm assemblies, which are constructed from carbon fiber and stainless steel components, as well as electromechanical and hydraulic components to provide actuation. These mast and forearm assemblies reside inside the tanks during operations. At the plant room floor level, the RDA is mounted inside a stationary support frame, which allows the RDA to be deployed into and retrieved from the various tanks and provides cable management for the variety of required services. The RDA support frame also provides containment for operation, wash down capability for contamination control, and wheeled transportation for the RDA. The frame itself is mounted to each of the plant room floors during operations.

Figure 5 - Example of Long Reach Manipulator in Shipping Configuration

In its retrieved state, the RDA fits completely within the support frame, which is about the size of a large refrigerator. The RDA system includes a hydraulic power unit, electrical enclosure and

integrated control system to provide motive power and control. Tooling for the RDA is designed to meet a variety of operational requirements for each tank and void. Examples of some of the tools that will be deployed include the following:

Figure 6 - Examples of Tank Cleaning Tools including Scoops, Scrapers, Sprayers, and Grabs

The nuclear environment presents many risks and thus a safe working environment is always paramount. In an attempt to mitigate risk and maintain safety, new and custom equipment is cautiously used in nuclear decommissioning activities. The nuclear industry has begun to embrace remote manipulators as a viable solution to previously difficult decommissioning projects. While nuclear site decommissioning remains challenging, new technologies and methods continue to simplify the decommissioning process, and worker safety continues to be

improved by the use of remotely operated systems. Using remote manipulator technologies will help make the future of decommissioning facilities safer, more reliable, quicker, and economical. Examples like the RDA offer many benefits by providing a highly capable and versatile solution for very difficult tank retrieval problems throughout the nuclear industry.

2. Notes (Please provide following information if possible.)

- Technology readiness level (including cases of application, not limited to nuclear industry, time line for application)

  TRL-9 – Commercially Available based on previous deployments such as:

  -Hanford Tank Cleaning Prototype:

- Savannah River Tank Cleaning Arm

- Trawsfynydd Tank Cleaning Manipulator (RDA)

- Challenges

  Size and location of tank penetrations will affect design of manipulator.

3.

【Areas of Technologies Requested】

(1) Accumulation of contaminated water (Storage Tanks, etc.)
(2) Treatment of contaminated water (Tritium, etc.)
(3) Removal of radioactive materials from the seawater in the harbor
(4) Management of contaminated water inside the buildings
(5) Management measures to block groundwater from flowing into the site
(6) Understanding the groundwater flow