Custom Engineered Remotely Controlled Waste Sorting and Packaging System Retrofit-11355

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ABSTRACT

ROBATEL was contracted to design and build a customized radioactive waste sorting, treating and packaging facility to be retrofit into an existing building at the EDF/AMI site in Chinon, France. The completed facility allows sorting of radioactive waste thanks to a shielded leak-tight hot cell equipped with remote-controlled handling equipment. Wastes are sorted according to their physical and chemical properties and then radiologically characterized. Afterward, the waste is packaged for shipment to a designated facility.

This paper will explore the initial project scope and limitations as defined by EDF/AMI, the identified challenges and the engineered solution. Additional discussion will be provided on the post-commissioning experience.

1. Background

The Chinon nuclear power reactor site is located near the town of Avoine, France on the Loire west of Tours. There have been 7 reactors on site; 3 Magnox and 4 PWR all operated by Electricite de France (EDF).

Operations served dual purposes of electricity generation and plutonium production utilizing natural uranium metal, LEU, mixed uranium and plutonium oxides.

The first three reactors A-1, A-2 and A-3 were shut down between the mid-1970s and late 1980s into 1990. These reactors were subsequently dismantled with two placed in safe store for full decommissioning in approximately 30 to 40 years.

A-1 was partially dismantled with the reactor vessel confined in a steel/concrete envelope and its metallic sphere containment turned into a museum open to the public.

A-2 was partially dismantled in 1992. The reactor graphite is stored on-site as are the steam generators and the dismantled primary circuit. These are stored in four buildings on-site.

A-3 was partially dismantled beginning in 1997.

While some decommissioning wastes were transferred off site to Champteusse-sur-Baconne (Maine-et-Loire), the bulk of the decommissioning and former operations waste remained on-site in thousands of drums held in storage cells.

After years of storage, it was during routine monitoring that EDF determined the original waste packages were deteriorating at an unacceptable rate resulting in radiological conditions in the storage cells that were tripping monitoring alarms. In addition, it was determined that as a result of regulatory changes, the original waste packages would not meet current regulations.

As a result of these enhanced regulations, changes to the waste site acceptance criteria and the deteriorating conditions of the original drums, it was determined that it would be necessary to repackage the wastes to comply with current standards and disposal site criteria. Included in the repackaging requirements would be volume reduction and sorting according to radiological and chemical characterization.

Robatel was awarded a contract by EDF for the design engineering and fabrication of a waste retrieval and repackaging system that would automat much of the process while minimizing worker contact with the wastes.

2. Waste Storage

Chinon on-site storage is achieved in the Atelier des Materiaux Irradies, or Irradiated Materials Workshop, commonly referred to as “AMI”.

The AMI building entered service in 1965 for the assessment and examination of irradiated fuel elements and radioactive materials. The facility includes high activity storage cells or bays.

In the mid-1990s, an incident in the AMI facility resulted in a top down safety review concluding the facility had become out of date and undergone so many modifications its safety related systems were unreliable and out of compliance with current regulations.

EDF undertook a comprehensive engineering analysis culminating with the implementation of temporary and permanent modifications intended to keep AMI a viable operating facility until the 2030 timeframe.

As part of the engineering assessment, a waste inventory was conducted cataloguing the presence of highly radioactive and long lived wastes, moderate and low activity wastes; and very low activity wastes. Waste forms included control rods, absorbents, concrete blocks, graphite and magnesium, rags, contaminated clothing, trash and tools.

3. Technical Situation/Status

EDF performed an assessment of building AMI as well as its waste contents. It was concluded 1) that the building required significant renovation, 2) there were uncertainties as to the radiological and/or chemical composition and/or contents of waste containers, and 3) waste characterization uncertainties limited the ability to transfer the waste off-site. Accordingly, the AMI building was renovated and 56 internal waste storage pits were deemed unacceptable for long-term or permanent storage. Removal of the wastes would require extensive sorting and repackaging.

The 56 storage pits averaged 1.6m L x 1.6m W x 7.7m H in size. Inventoried contents included 200L drums arranged on frames and stacked on each other; 30L drums arranged on frames and stacked on each other; metallic baskets stacked on each other; bulk wastes; containers stored horizontally on pallets; and control rods arranged vertically in steel pits.

Pre-existing equipment available for waste sorting and repacking included a 20 metric ton overhead crane remotely operated and multiple 3-axis robotic arms; a vertical robotic arm secured to the hook of the 20 MT crane; tools and yokes adapted for the recovery of waste packages; control rod removal and dismantling tools.

Nevertheless, sufficient wastes were not properly accessible to the existing robotics and EDF decided to solicit tenders for a waste sorting, characterization and conditioning unit

(ETC).

3.1. Robatel Technical Approach

EDF ultimately contracted with Robatel for the design and fabrication of the new system. Robatel's technical approach incorporated:

- A sorting cell made of concrete lined with stainless steel and equipped with manipulators, an overhead crane, cutting press and spectrometry station. This cell was designed to function as a fire barrier and all work within is performed remotely by an operator.
- A loading/sealing chamber located below the sorting cell. This chamber includes conveyors and elevators for transporting new drums under two tight traps communicating with the sorting cell and two drum sealing machines. A custom designed and engineered double door transfer system was required.
- A discharge chamber equipped with autonomous smear testing equipment.

Figure 1 – Control Station with Waste Sorting Manipulators In Background

Loading, sealing and the discharge chamber are controlled from a central station that includes remote video monitoring and displays waste characterization data and system status parameters.

Figure 2 – Building Cross Section Illustrating Installed System

The entire system is airtight and isolated from the surrounding room with high density concrete for biological shielding. All components were required to fit within the limited space available in the existing AMI waste storage building.

Waste to be sorted and repackaged is transported from the storage bays by a transfer system that positions the waste package onto the interface of the sorting cell.

Figure 3 – Drum Transfer System

With assistance from an overhead crane with a heavy lift arm located inside the cell, the waste package is drawn into the cell, opened and its contents emptied onto a work surface. The empty waste container is compressed and segmented using a cutting press. Lightweight telemanipulators sort the remaining waste according to their chemical and radiological properties. Sorted and segregated waste is placed into new 200 L or 60 L drums compatible with ANDRA or CEDRA waste disposal criteria. The newly packaged drums are sealed and conveyed to an automatic smearable contamination monitoring system before being transferred to a temporary storage area equipped with 10 m^3 shielded holding cells, a staging area to permit decay of short-lived nuclides, and a mechanism for cementing/grouting the drums in an overpack.

4. System Components

4.1. Screening Analysis

Prior to entry into the system, drums to be repackaged are screened by gamma spectral analysis. This screening provides a preliminary assessment of the presence of any "hard" radionuclides as well an estimate of the total activity for comparison to repackage disposal limits.

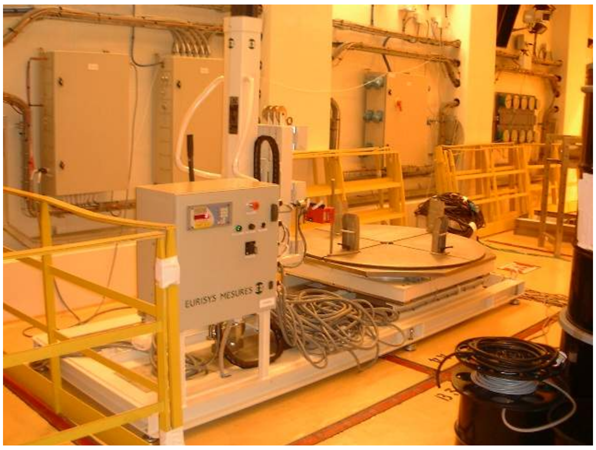

Figure 4 – Drum Screening Station

The system consists of a turntable with integral scale for weighing the waste packages.

Turntable specifications are: RPM ~3; maximum weight 150 kg with accuracy of +/- 1 kg; motorized; and capable of accepting waste packages ranging in diameter from 350 mm to 550 mm and a height of 550 mm to 775 mm. This equates to 50 liter and 200 liter drums.

Additional features of the screening equipment include a sleeve for mounting of the gamma spectrometry detector and a special pass through for the probe cabling that maintains leak tight integrity of the cell. The gamma detector has a very broad range from low to very high dose rates to avoid frequent exchanges of the detector probe. The gamma spectrometer is equipped with in cell collimation to control the attenuation and solid angle. Collimation is adjusted using the manipulators.

To ensure an accurate drum measurement prior to opening and minimize contributions from waste table contamination and/or unpackaged wastes on the sorting table, a sliding shielding wall is installed between the sorting table and turntable.

4.2 Waste Analysis

Once the drum to be repackaged has been opened and dumped onto the sorting table, a detailed radiological survey is performed using detectors handled by the telemanipulators. Waste is first segregated by predetermined dose rates based on threshold values set by the final disposal site. Alpha measurements and gamma levels are obtained including gamma spectral analysis for peak energies.

The waste table surveys are rather simplistic in that they are performed using the manipulators to pass a cabled probe over the waste. The detection probe is a GM counter or Si diode. The only in cell detector equipment is the probe and associated cable. All other electronics are outside the cell. Alpha measurements are taken with a dedicated alpha detector. Similar to the screening analysis, the gamma detector has a very wide range from low to high with an accuracy of approximately 20%.

4.3 Discharge Analysis

Prior to a repackaged drum being discharged from the system, it undergoes another gamma survey to verify that external dose rates are within stated limits. The drum rotates on a turntable while the detector moves on the vertical axis.

5. Operations

5.1. Screening Station

Provides initial screening of drum radiological characteristics before opening and sorting. The drum platter rotation is synchronized with the detector probe. Weight is obtained and displayed at the operator station as well as electronically recorded.

5.2. Waste Analysis

Radiological characterization of the waste after removal from drum. Sorting according to type and level of radiation. Spectral analysis. Continuous data logging electronically as well as displayed at operator station.

5.3. Discharge Analysis

Measurement of repackaged dose rates to verify average dose rate below administrative limits and absence of hot spots. Automatic remote smear testing of the drum lid periphery

6. Maintenance

6.1. Screening Station

Assembly, disassembly and maintenance on the drum platter, motor and integrated weight scale have all been engineered to be performed by manipulator. Limit switches have all been standardized to allow for change out by manipulator and to avoid modifications and down time. The radiation probe is maintained and calibrated from the exterior. In the event of the need to replace the probe head, it can be exchanged by passing a new probe through a transfer port.

6.2. Waste Analysis

Detector probes are exchanged through a transfer port and swapped out by manipulator. All other maintenance and calibration is performed outside the cell.

6.3. Discharge Analysis

Detector probes are exchanged directly through the transfer chamber. All other maintenance and calibration is performed outside the cell. The smear counter is maintained by personnel entry into the transfer chamber.

7. Conclusion

Following fabrication and initial testing at the Robatel shop, the unit was transferred to the EDF site and installed. Despite the tight space limitation and presence of contamination, the installation and cold commissioning were uneventful. The unit was placed into service and, to the best our knowledge, has operated uneventfully. The custom engineered double door transfer system has proven reliable and is under consideration by other facilities.