AECL's Mixed Waste Management Program

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Abstract

Every nuclear facility has it, they wish that they didn't but they have generated and do possess "mixed waste", and until now there has been no permanent disposition option; it has been for the most been simply maintained in interim storage. The nuclear industry has been responsibly developing permanent solutions for solid radioactive waste for over fifty years and for non-radioactive, chemically hazardous waste, for the last twenty years. Mixed waste (radioactive and chemically hazardous waste) however, because of its special, duo-hazard nature, has been a continuing challenge.

The Hazardous Waste and Segregation Program (HW&SP) at AECL's CRL has, over the past ten years, been developing solutions to deal with their own in-house mixed waste and, as a result, have developed solutions that they would like to share with other generators within the nuclear industry. The main aim of this paper is to document and describe the early development of the solutions for both aqueous and organic liquid wastes and to advertise to other generators of this waste type how these solutions can be implemented to solve their mixed waste problems. Atomic Energy of Canada Limited (AECL) and in particular, CRL has been satisfactorily disposing of mixed waste for the last seven years. CRL has developed a program that not only disposes of mixed waste, but offers a full service mixed waste management program to customers within Canada (that could eventually include U.S. sites as well) that has developed the experience and expertise to evaluate and optimize current practices, dispose of legacy inventories, and set up an efficient segregation system to reduce and effectively manage, both the volumes and expense of, the ongoing generation of mixed waste for all generators of mixed waste.

Introduction

The nuclear industry in Canada began in the 1950's. The industry expanded as the possibilities and demand for nuclear products grew. Nuclear power, medical and industrial applications, food irradiations, and others were all areas where nuclear technology developed and the benefits of that technology were apparent and obvious. But along with these benefits came waste. Solid radioactive waste was, from the beginning, a key priority and managed in a responsible manner according to the acceptable practices of the day. From a safety perspective, the initial focus was to protect the worker with good radiation protection programs. Radioactive areas and materials were identified and labelled, and radioactive materials were segregated from non-radioactive materials. This initial segregation of active materials from non-active still remains as the most important component in any waste management program.

Along with radioactive solid waste, nuclear facilities were also generating chemical waste, both radioactive and non-radioactive. During the early years, this waste was

safely stored in isolated areas of the plant. The first type to be addressed, non-radioactive chemical waste was by far the most straightforward to solve.

The nuclear industry was not alone in the production of non-radioactive chemical waste. Most private industries generated chemical waste and often in larger volumes than nuclear sites. During this period, industry and government began to work together in trying to address and solve the accumulation of non-radioactive chemically hazardous wastes; however limited solutions were available. Incineration and spreading used oils on roads and other areas as a dust suppressant were approved options that were used for a short time. Throughout this period of time, public concern and environmental awareness grew significantly and some of the solutions were eventually recognized as unacceptable and stopped. Eventually at CRL, in co-operation with the regulatory agencies and private waste management companies, programs were established in the early 1990s to handle and manage the disposal of all types of non-radioactive chemical waste.

And then, there was the radioactive, chemically hazardous waste: mixed waste. Solutions for the management of this type of waste, because it contained both chemical and radiological hazards, presented a greater challenge. Organics such as oils, solvents, glycols and cleaning solutions become contaminated with radioactive material as they either passed through radioactive systems or were used to clean contaminated materials. This waste could not be managed by normal non-radiological methods, nor could it be treated by radioactive aqueous treatment systems because of the chemical hazard.

This waste contained enough radioactive material that it had to be dispositioned as radioactive, but it did not pose a significant radiation dose hazard to personnel. Gamma dose rates were not significant so that it could be stored in conventional storage facilities. Even though tritium was often the major contaminant, this beta radiation was sufficiently reduced by the shielding effect of the container and the liquids so that external dose rates were within low hazard storage limits. The end result was the slow accumulation of drums of mixed waste, in storage, awaiting a permanent resolution.

CRL's Hazardous Waste Program

In the late 1980s, with nuclear sites now well established and concentrating on their main business; i.e. research, power production, etc, hazardous waste management still essentially consisted of keeping the waste in storage. Around this time, AECL's Chalk River Laboratories took the initiative to begin addressing hazardous wastes more aggressively and hired qualified personnel to begin developing a program to manage this waste.

With dedicated personnel and a budget, the Hazardous Chemical Waste Management Program at CRL began in earnest. Once again, the starting point was the segregation of radioactive chemical from non-radioactive chemical waste. Non-radioactive waste was addressed immediately. The radioactive waste was safely stored until the non-radioactive chemical waste solution was established.

The first major hurdle for the non-radioactive chemical waste would be to establish, in conjunction with the regulator, a definition of non-radioactive. At the time, each nuclear site had their own approved and endorsed release references, but only for removing personal items or items to be returned to manufactures. These limits were not intended for releasing large volumes of waste materials.

It became obvious that, in practical terms, the only acceptable release activity level for the waste was "non-detectable", i.e. waste that did not exhibit any trace of radioactivity above natural levels. As a result, records of waste history became extremely important. By knowing where the material came from and in what process it was used, the sampling campaign and subsequent analysis could be streamlined towards focusing on the most likely contaminants. For the historical waste on site, accurate history records were difficult to obtain and radiological testing of all waste was necessary. Maintaining accurate waste history records has since become one of the most important tools for characterization when dealing with current waste inventories.

By the early 1990s, with the Program now well established, a major cleanup of CRL's hazardous chemical waste began. Over several years, about 200,000 Litres/kilograms of chemically hazardous waste was handled, monitored, packaged and shipped off-site for disposal with both Canadian Nuclear Safety Commission (CNSC) and Ministry of the Environment (MOE) approval.

CRL's Mixed Waste Program

A complete, accurate mixed waste inventory listed some thirteen hundred (1300) forty-five gallon drums of mixed waste stored at CRL in 1998. By this time, much of the historical waste inventory had been re-drummed into new plastic drums because of deterioration of the original carbon steel drums. The majority of the inventory of waste was stored in marine containers in the Waste Management Areas. As the marine containers themselves were aging, they needed continuing repairs. At around this time, the Solid Radioactive Waste Program officially ceded responsibility for the mixed waste to the Hazardous Chemical Waste Program.

The Hazardous Chemical Waste Program now had a clear mandate to deal with all mixed waste at Chalk River Laboratories. Timing was important due to the aging condition of the marine containers and the carbon steel drums that had not as yet been replaced. Also, with the inventories increasing, space was becoming limited, and the costs associated with the storage of this waste continued to increase.

Upon performing an initial history characterization of the contents based on available historical records and known CRL processes that generated mixed wastes, we were able to place the waste material into two general categories. There were approximately one thousand (1000) forty-five gallon drums of CRL historical liquid mixed waste and approximately three hundred (300) drums of commercial liquid scintillation solutions (cocktails).

First Disposition Success

The commercial liquid scintillation cocktail solutions became the first disposition success. As with any first-time project, problems were sure to arise. One of the problems was individual drum identification. All the required CRL characterization documentation was in place for the inventory as a whole, however, the information was not cross-referenced to the stored drums. Additionally, due to the large number of individual scintillation vials in each drum, a follow-up sampling campaign would be impractical, extremely time-consuming and costly. The CRL HW&SP staff were able to identify a Canadian waste disposal company that specialized in the disposal of scintillation solutions. The chemical and radiological characterization of the commercial solution was extensively reviewed and it was determined that the commercial waste was comparable in makeup and met the acceptance parameters of their license. With all regulatory restrictions met, the drums were shipped off the CRL site and the liquids were disposed of.

CRL Historic Liquid Waste

Approximately one thousand (1000) forty-five gallon drums of oils, solvents, chemical solutions or various combinations thereof that had been generated at CRL now remained on-site. The earlier portion (pre-1991) of this inventory, approximately 70%, did not have drum-by-drum identification or traceable history so that a radioactive classification was totally dependent on a comprehensive radiological characterization campaign. Up to this point, the major focus of the Hazardous Chemical Waste Program had been devoted to developing the protocols necessary to classify hazardous waste as non-radioactive and therefore make them eligible for off-site disposal. Since there was no Canadian receiver for this type of mixed waste, CRL continued with this philosophy, hoping to qualify as many drums as possible for unrestricted off-site disposal.

A sampling campaign was defined. Discussions were centred on whether the sampling and the analysis were to be performed in-house or to be contracted out. Several logistic issues emerged. Some of the logistical issues that had to be addressed were access to the Waste Management Areas, Radiation Protection support, training, weather and supplies. Contract waste disposal companies had proposed that they would collect the samples at no cost if they received the waste. It was decided to contract out the sampling campaign but to use CRL's in-house analytical chemistry laboratories for analyzing the samples. CRL's Radiation Protection Surveyors performed tritium assessments using a portable Sintrex tritium monitor and a beta/gamma contamination assessment using a portable GM tube. In addition, a gamma spec on all drums was performed in the lab. After these initial assessments, it was determined that four hundred drums could be tentatively classified as non-radioactive.

However, a more detailed analysis of these drums was necessary to verify that the material could be a candidate for unrestricted release. A rigorous waste history investigation was undertaken to verify the initial non-radioactive classification. Applying the then current production rates of mixed wastes from different CRL processes, it was

determined that only approximately ten drums of non-radioactive organic liquid waste were normally produced per year. Extrapolating this ratio over the last next twenty years, CRL should have produced only 200 drums of non-radioactive chemical waste. Another solution had to be found to assess actual 400 drums.

Mixed Waste Disposal Options

Program staff began an exhaustive search to find alternatives. Believing that it would be extremely difficult, if not impossible, to ship radioactively contaminated hazardous waste out of the country, the search initially focussed on Canada. However, no Canadian alternative could be found. While investigating the capabilities of the scintillation solution disposal company, we discovered that those solutions had been shipped to the United States for final disposition. Therefore, we expanded the search to the US. Several possible companies were contacted, but with little success. Finally a small mixed waste processing/disposal company was found and contacted. Initial discussions showed that there was potential for AECL to send the waste to Diversified Scientific Systems Incorporated (DSSI) in Tennessee. Based on the radiological and chemical characterizations of the waste in the earlier campaign, it appeared as though the analyses were complete enough for the waste to be acceptable for processing by DSSI.

CRL's Mixed Waste Program Management Begins

During 2000, the Hazardous Chemical Waste Manager began planning the changes that would be needed for the complete solution and management of CRL's mixed wastes. We were confident that the sampling techniques, laboratory characterizations and drum labelling/shipment manifesting were thorough enough and acceptable to successfully meet all of the regulatory requirements to ship the waste out of the country. At about the same time, CRL's Waste Treatment Centre (WTC) was in the process of upgrading its equipment and introducing a different processing method that would allow the facility to treat greater volumes of radioactively contaminated aqueous waste. Segregation of aqueous from organic material now became another priority, as in-house processing of the aqueous material would prove much more cost effective than exporting it for disposition. In-house protocols were initiated to ensure process consistency and efficiency in the segregation of aqueous from organic waste. Such changes in how mixed waste would be generated would effect cost savings, streamline operations and make CRL more efficient in the processing of mixed waste.

In order to initiate and implement these changes, buy-in from the generators themselves would be paramount. The necessary segregation changes were addressed first at the user level. Generators of mixed waste were cognizant of the potential for radioactive material to be inadvertently released offsite and so most often would default to the most cautious choice of classifying waste as "suspect". Placing all potentially radioactively chemical waste in "suspect active" streams, while safe, makes waste significantly more expensive to dispose of. Also, cross-contamination had to be addressed. If even a small sample of mixed waste was placed in a 45-gallon drum of non-active waste, the entire drum must now be treated as mixed waste. Non-radioactive hazardous waste is much cheaper to

dispose of than mixed waste. These actions mean that a large amount of unrestricted waste would now have to be exported for disposition, if the material was organic; or the entire drum would have to be processed in the WTC if it was aqueous waste.

Generators were also made responsible for sampling their waste prior to transferring ownership to the mixed waste program. If requested, mixed waste program personnel would take the samples for the generator and have them analyzed on-site. Sample collection and analysis was performed as early as possible in the process prior to any mixing of wastes. In addition, waste removal forms included a section for history of use in order to streamline the required analyses. An example of achievable savings would be a situation where a certain chemical is used in two processes in which different contaminants are present. Before the new measures, full radiological and chemical analyses would have been performed on samples from both processes. However, with stringent segregation methods, accurate and detailed histories of sample results, analyses would only be needed for the contaminants that were present in the process where the chemical was used. Full analyses would not be required. In other words, the new approach consisted of establishing a precise segregation system in the area, recording thorough analyses initially and then performing on-going tests for what was expected to be there.

Performing rigorous segregation of active from non-active and organic from aqueous wastes, knowledge of waste generating processes, early sampling of wastes for radioactive material prior to performing any mixing of wastes, evaluating an accurate history of use, and analysing only for the isotopes expected are all contributing to the generation of less mixed waste and huge cost savings. In one case over ten thousand dollars was saved in the disposal cost for only one drum.

CRL's Commercial Mixed Waste Disposal Project

With the initial changes in place and the management of the mixed waste program beginning to take shape, the issue of the legacy mixed waste inventories came up once again. However, DSSI, the small disposal company had since been bought out by Perma-Fix, a large hazardous waste management company, and treatment charges rose significantly. Even so, it was decided to proceed, and the process was started. Now it was time to obtain all of the necessary permits, approvals, agreements and other documentation that would be required to export mixed waste to a foreign country. CRL had never sent radioactive, let alone mixed waste, to a foreign country for disposition. With all of these hurdles still to be crossed, a waste representative from a Canadian Nuclear Generating Station approached AECL to ask if AECL could broker some of their mixed waste along with the CRL shipment. This was the beginning of AECL's Canadian commercial mixed waste brokerage initiative.

AECL applied to The Department of Foreign Affairs and International Trade Canada for an export permit that could only be granted with the permission of the CNSC for radioactive waste. The Ontario MOE was contacted, but declined involvement by deferring to the CNSC due to the radioactive component of the waste. There were many

external and internal concerns that had to be addressed, but finally the permit was approved with full permission to ship our waste to the United States. The contract or general service agreement negotiations, which consisted of many complicated discussions between DSSI, CRL waste management personnel, professional consultations associated with CRL legal, procurement and insurance experts, finally culminated in a signed agreement which CRL Purchasing then linked to a binding contractual purchase order.

The export licence stipulated that the waste must be shipped from the Chalk River site. CRL's site license was checked and it was confirmed that we could legally accept the waste from the utility site. Everything was in order and the waste was shipped from the utility to Chalk River. With all of the necessary components were in place and the utility waste on-site, the disposal could begin.

The CRL Hazardous Waste Manager began the project by selecting the waste to be disposed of in the first shipment. Lower activity wastes were chosen to go first. The radioactive contents of these drums fell within the "excepted" shipping category. Transport regulations for this level of activity dictated that no additional containment was needed and the primary containers did not have to meet increased integrity specifications. However, CRL did decide, for enhanced safety, to overpack all mixed waste drums before shipment. Once the material was ready for shipment, DSSI sent a US-certified Transport of Dangerous Goods (TDG) shipper to the CRL site and then shipped the waste.

Four hundred and fifty-nine (459) drums were successfully transported to DSSI and destroyed with official certificates of destruction issued to CRL. Each drum was sampled and retested by DSSI and there were no non-compliances, issues or reports of high concentrations, etc. Sixty percent (60 %) of our waste had now been successfully disposed of without incident. AECL was becoming DSSI's largest Canadian customer. The utility's waste was successfully brokered and soon other generators began to call. An educational institution requested that we handle their waste and we received and dispositioned four (4) drums from that facility. Waste generators across Canada began to express interest in having their waste brokered by CRL.

The remaining drums already at CRL had radioactive concentrations (by CRL analysis) higher than what could be shipped in normal salvage drums. We would have had to purchase special IP-2 certified drums, however it was decided by our Competent Authority that a DSSI LSA-2 certified tanker could be used. Four thousand gallons of mixed waste was pumped into the DSSI tanker and shipped to Tennessee. This tanker was used a total of three times. Each time, as with the drums, DSSI's TDG-certified broker arrived, the tank was loaded and the shipment sent after completing all necessary paperwork. In total 8000 gallons, or the equivalent of 178 45-gallon drums, were successfully shipped using the tanker.

Recent Projects

Although there was some initial excitement surrounding AECL's commercial mixed waste initiatives, no formal commercial contracts were entered into for some time. However, the trend reversed and the interest returned in 2004. The HW&SP completed a removal of mixed waste from another utility facility prior to an AECL decommissioning initiative. Mixed waste from the facility was identified, segregated, packaged, loaded into twenty shipping containers and shipped to CRL. A portion of the facility was temporarily transferred to AECL so that they could act as the consigner and consignee in order to meet Transport Canada TDG and CNSC Regulations.

Another Nuclear Generating Station contacted the HW&SP to discuss service and disposition options for approximately three hundred drums of legacy waste. The call was received on a Friday, and after receiving inventories by e-mail late in the day, the CRL HW&SP mixed waste team was on the generator's site by the following Monday morning with initial cost estimates for the packaging, removal and disposition of all legacy waste in question.

Further discussions ensued and a decision was made to break the project into three phases. Phase 1 was a characterization phase, Phase 2 was a preparation for ownership transfer and Phase 3 was final disposition. The utility management was not confident that an accurate characterization of their waste had been confirmed since a large percentage of the waste was legacy waste without a firmly established history. The AECL team supplied member resumes, prepared operating procedures for acceptance by utility management and discussed the operating methods and safety culture that the CRL mixed waste team would adhere to when performing the work. It should be noted that the first priority demonstrated by both organizations was safety - safety of the workers, safety of the station and safety of the environment. The Purchase Order was received on November 30. AECL's mixed waste team was on-site for training December 6. The fieldwork began on December 9 and was completed on December 18. The time frame was tight and the work intensive, but the project phase was successful in providing the Phase 1 deliverables.

Several discussions early in 2005 between AECL and the utility were necessary to resolve several logistic and regulatory issues for Phase 2. Key players from both organizations have exhibited great co-operation throughout these discussions. At the time of writing this paper, AECL has completed the Phase 1 deliverables and are awaiting a Request For Proposal to begin Phase 2, preparing for ownership transfer.

While completing the Pickering Phase 1 effort, an earlier waste generator again contacted AECL and twenty-four drums containing uranium-contaminated oils were received by AECL in 2004 December for disposition by DSSI.

Moving Forward - Disposition of Canada's Mixed Waste Legacy and Providing Mixed Waste Management to Generators of Mixed Waste in Canada

CRL's mixed waste management program is now well established. The framework for hazardous waste that began in the 1980's was the start. These initiatives have resulted in a program that has matured and born fruit: a commercial mixed waste business. The mixed waste management program that was initiated in late 1999, is now in its fifth year and has resulted in cost savings, increased efficiencies and consistencies in sampling, analyses and waste management protocols for both CRL and other Canadian companies.

While Phase 2 and 3 of the latest legacy waste initiative for a utility remains to be completed, CRL's Hazardous Waste and Segregation Program management have had additional discussions with the utility management to remove the mixed waste stored in twenty-four safety cabinets. This waste has greater chemical hazards associated with it than the earlier 300 drums of legacy waste. There are pending discussions with other nuclear facilities to discuss the on-going removal of mixed waste from their facilities. The CRL mixed waste team is a self-sufficient unit capable of performing all activities associated with the sampling, segregation, characterization, handling, packaging and shipping of mixed waste.

More proactive management of mixed waste has become a priority due to the amount of legacy material in Canada and the need for sites to put a mixed waste management program in place. Personnel in the mixed waste program are certified for work in the United States. Members of the team currently hold chemical waste handling, Radiation Protection, US TDG and DOT/NRC Transportation/Shipping certifications. The AECL team can also assist in the areas of non-radioactive waste removal and program management and could provide similar services for U.S. customers.

Summary

AECL's mixed waste initiatives have resulted in a team of dedicated and knowledgeable individuals. The team has dealt with many obstacles and has obtained a lot of valuable experience that enables the members to confidently discuss and deal with diverse, sensitive issues surrounding mixed waste. Seven years ago, AECL had more than 1000 drums of mixed waste on-site, plus ongoing routine generation. CRL has successfully disposed of more than seven hundred drums of its own legacy mixed waste over the last five years, as well as disposing of mixed wastes for other Canadian companies, thus reducing the Canadian mixed waste liability.

The CRL mixed waste team can now provide other related services to Canadian generators of mixed waste. These services include sampling, characterization, compliance packaging, transport and disposal options up to and including a complete waste management program for mixed waste or for all of their hazardous waste. We are now positioned to eliminate Canada's mixed waste legacy and effectively manage the ongoing generation of mixed waste for external customers, to prevent the re-accumulation of such a legacy. These initiatives have not only been good for AECL but

have also been extremely beneficial for the Canadian nuclear industry and for reducing the overall Canadian Nuclear Liability thereby making Canada a better and safer place to live.