APPLICATION OF IMPROVED RADIATION MONITORING AND DECONTAMINATION TECHNIQUES TO SIGNIFICANTLY REDUCE THE COST AND VOLUME OF RADIOACTIVE WASTE VIA RECYCLING

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Abstract

UniTech Services Group has been designing, manufacturing, and using custom radiation monitoring equipment to efficiently survey materials for recycling or reuse while significantly reducing the risk associated with traditional hand frisking. Additionally, they have developed and used custom decontamination processes that have allowed several million pounds of scaffolding and tooling to be released for unrestricted use back to the owners, or recycled as non-radioactive scrap metal. The combined effect of custom monitoring and decontamination processes has reduced significant volumes of radioactive waste in a low risk, cost effective, manner. This paper and presentation will highlight the processes and showcase the types of materials decontaminated. The intent is to make waste generators aware of new processes that could be applied to the waste materials stored in their vaults, project waste, or obsolete equipment and tooling.These processes could also help major projects control materials and equipment at reduced cost and risk.

1. Introduction

UniTech Services Group has been designing, manufacturing, and using custom radiation monitoring equipment to efficiently survey materials for recycling or reuse while significantly reducing the risk associated with traditional hand frisking. The primary focus is to reduce risk and cost associated with post decontamination monitoring or while verifying the absence of radioactivity to allow the cost effective reuse of tools and equipment in unregulated environments.

Financial pressure on the sale price of electricity is driving cost reductions for both the operating and project based maintenance evolutions. Add to this a lack of clear regulation, unstable background levels at the site, and typically outdated, non-production equipment and processes that use expensive labor inefficiently, and there has never been a better time to look at off-site monitoring/survey services.Additionally, decommissioning and refurbishment projects generate a disproportionate amount of radioactive waste compared to normal operations. The long-term cost and liability could be significantly reduced at the point of generation.

In addition to custom radiation monitoring equipment, UniTech has developed and used custom decontamination processes that have allowed several million pounds of scaffolding and tooling to be released for unrestricted use back to the owners, or recycled as non-radioactive scrap metal.

The combined effect of custom monitoring and decontamination processes has reduced significant volumes of radioactive waste in a low risk, cost effective, manner. This paper and presentation will highlight the processes and showcase the types of materials decontaminated. The intent is to make waste generators aware of new processes that could be applied to the waste materials stored in their vaults or generated during a refurbishment/decommissioning project.

2. UniTech Services Group

UniTech Services Group has been providing decontamination services for Personal Protective Equipment (PPE) since 1961. We have 9 licensed facilities in North America and 2 licensed facilities in Europe. Our primary focus is the decontamination and survey of launderable PPE, respirators, and tools and equipment to minimize the generation of radioactive waste, reduce long term liabilities and reduce overall cost for our customers. To optimizeour services, we design and build our own radiation monitoring equipment; design and sell/lease launderable items to replace single use items that produce volumes of radioactive waste (cart covers, bags of all types, fire retardant clothing and covers, FME covers, tents, etc.); manage transportation and as required the Canadian/US border; maintain a CNSC Waste Nuclear Substance License (WNSL) and an approved Emergency Response Assistance Plan (ERAP) to manage the radioactivity and transport risk from Canadian customer sites to the US licensed processing facilities.

UniTech is a ISO 9001 and ISO 14001 certified company. We have maintained these certifications since 1996. All our monitoring activities are controlled by procedures within our quality program. Our parent company, UniFirst Corporation, is publically traded on the New York Stock Exchange, with annual revenues exceeding $1.5B/year. We have recently purchased a facility with a Bulk Survey For Release (BSFR) license and are revising key licenses to allow waste processing in addition to decontamination services. For Canada, the BSFR license allows UniTech to sort Canadian low level radioactive waste and offer a cost effective, permanent disposal option for all materials with a dose rate of <50 μR/hr. This service opens up another avenue to help customers understand what waste is being generated and what can be done to reduce overall volume and cost.

3. Monitoring Criteria and Risk

Surveying materials for unrestricted release typically includes hand frisking using a Geiger-Mueller GM pancake detector hooked up to a rate meter. There are many different types of hand held equipment. However, the process of direct frisking typically shares the same set of human factors adding significant risk into the process. These human factors include: inconsistent detector to item distance, inconsistent scan speeds, fluctuating background levels, long instrument response time, and difficulty with monitoring 100% of each item's surface area.

Automated monitors, designed and manufactured by UniTech, eliminate human factors by: having fixed detector to item distance using a conveyor and two banks of detectors, one below and one above the belt; a staggered detector array to ensure 100% monitoring over the active area of the conveyor without any dead zones; and computer controlled belt speeds, limit set-points, false alarm rates, and programmable confidence levels taking into account background levels and isotopes being monitored. This greatly reduces risk, however not all items have the proper shape for automated monitoring.

A widely accepted technique for releasing radioactive material for unrestricted use is described in NRC IE Circular 81-07 entitled "Control of Radioactively Contaminated Material." The Circular, issued by the NRC in 1981, contains a procedure that can be used to survey materials for unrestricted use. It specifies survey of any object being released by a qualified individual conducting a direct frisk using a GM pancake probe, and a smear test for removable contamination. It approves the use of equivalent procedures. It should be noted that NRC IE Circular 81-07 continues to be routinely referenced by the NRC today. A search conducted while developing and issuing UniTech's Process Procedure: RP-062 "Unrestricted Release of Materials" (available upon request), revealed nearly 360 references in the NRC electronic ADAMS database including three in the first six weeks of 2015 and thirty-six references in 2014. Many references are embedded in nuclear power plant inspection reports where NRC IE Circular 81-07 is referenced as an inspection standard for Control of Radioactive Materials.

When surveying materials for unrestricted release from US DOE facilities the limits of NRC Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors (1974) shall apply. UniTech performed a detailed comparison of both documents, NRC IE Circular 81-07 and NRC Regulatory Guide 1.86, and determined that from a practical standpoint the requirements are equivalent. Based on this, UniTech's Process Procedure: RP-062 "Unrestricted Release of Materials" (available upon request), sets out the types of instruments and the techniques UniTech uses to release materials for unrestricted use and demonstrates how they are equivalent to the requirements in NRC IE Circular 81-07. It should be noted that in most cases the automated methods used by UniTech will find and reject contaminated objects more readily than using the manual direct frisk technique specified in NRC IE Circular 81-07, thus significantly reducing radiological risk.

UniTech's automated methods are more reliable because automated surveys check every square centimeter of the objects being surveyed (100% of the item) and do not rely on the surveyor to ensure that no area is missed. In addition, the automatic instruments precisely control scanning speed and the distance between the detector and the object being surveyed. Furthermore, they do not rely on the subjective evaluation of audible click rate. Instead, they use computer controlled alarm points, counting statistics, and programmable confidence levels and false alarm rates. UniTech automated monitors remove all of the human factors as compared to hand frisking with a GM pancake detector. The instrumentation used is as sensitive as, or more sensitive than a pancake GM detector.

4. Evolution of Automated Monitoring Equipment

Automated monitors at UniTech have been evolving for the last 30 years. The first flat item conveyor monitor had 100cm2 detectors connected to individual rate meters with a single row of detectors above the conveyor belt. Today, the Alpha Beta Automated Laundry Monitor (ABALM), pictured in Figure 1, has an active width of 72" and is supported with 62 each 100cm2 beta/gamma detectors and 24 each 1200 cm2 Alpha detectors. The detector array is both above and below the belt. Detectors are staggered to ensure even efficiency across the active width of the machine. The computer, with input from operators regarding set-point, confidence level and false alarm rates, calculates the belt speed in the production low background environment. The machine stops if a detector stops working or high counts are detected.

Figure 1 ABALM, 24 each 1200cm2 Alpha Detectors, and 62 each 100cm2 Beta/Gamma detectors

This machine operates at the unconditional release limit of 2,500 dpm, Cs-137, point source geometry, 95% confidence level for Beta/Gamma and 600 dpm Am-241, point source geometry, 95% confidence level for alpha (typically expressed as 100dpm/100cm2 alpha). Efficiency is about 17% for Am-241 and 21% for Cs-137. Figure 2 highlights the layout of the detector array.

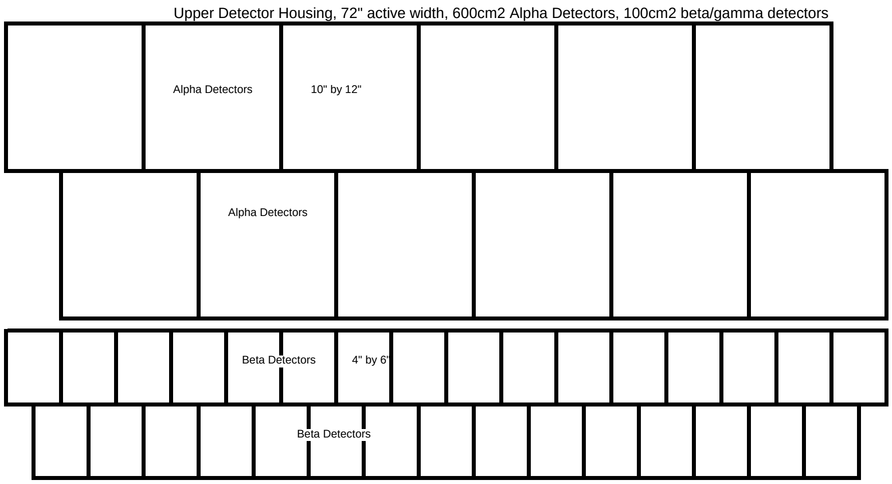

Figure 2 – ABALM detector layout. This array is both above and below the conveyor.

Pipe monitoring has gone through the largest evolution. The first generation of pipe monitoring, see figure 3, included putting individual detectors and rate meters on jig, in a train track configuration which fixed the detector to item distance, but did not fix the scan speed. Generation 2 automation, see figure 4, consisted of a staggered detector housing and the materials were moved through the detector array on a conveyor belt. This was a significant improvement in detector to item coverage compared to the first generation automation.

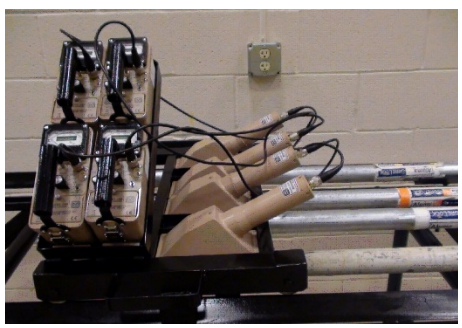

Figure 3 First Generation Pipe Automation

However, there was room for improvement in that the detector was square and item being monitored was round. Because of this, certain parts of the pipe we not as well monitored as others.

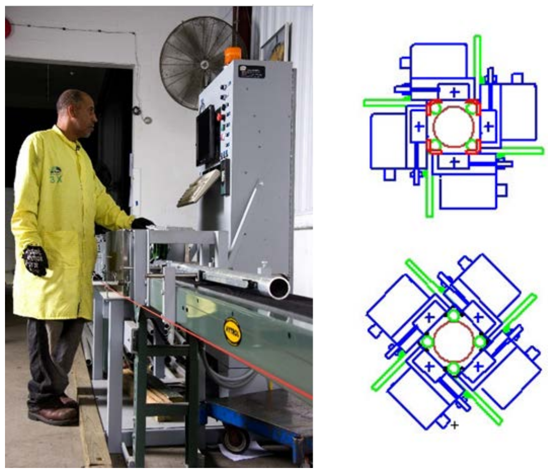

Figure 4 Second Generation Pipe Automation

To improve the measurement, see Figure 5, the conveyor was removed and the pipe was rotated at a specified speed in front of a fixed detector bank.

Figure 5, Third Generation – pipe is rotatedin front of detector

The final generation of monitoring, in use today, see figure 6, includes rotating the pipe in front of the detector, collecting counts every 5 degree of arc, and then box car averaging 16 data points over an 80-degree arc. The end result is a very accurate measurement that cannot be duplicated with a hand held detector. This machine operates at the unconditional release limit of 2,500 dpm, Cs-137, point source geometry, 95% confidence level for Beta/Gamma. Efficiency is about 22% for Cs-137.

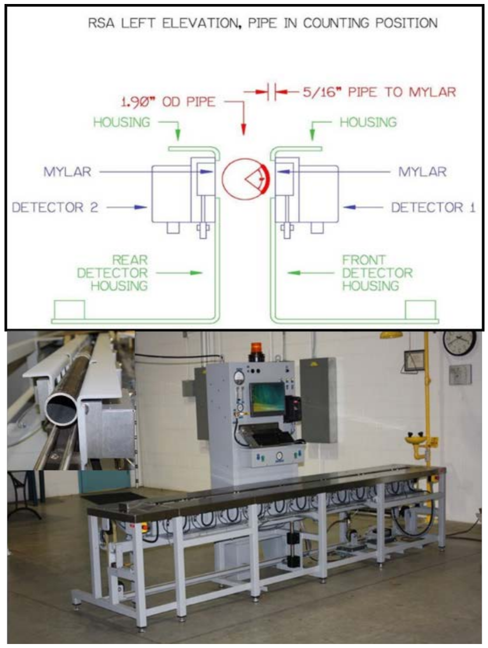

Figure 6 RSA Pipe Monitor

With flat item and round item monitoring optimized, we shifted focus to specialty items. One such item was the Versa-Light Aluminum planks, a standard Canadian scaffolding system, see Figure 7.For this machine we manufactured alpha detectors that were long and narrow to fit into the support system allowing alpha measurement on 90% of all surfaces and beta measurement on 95%. If we ran these materials on a flat item monitor, we would only be monitoring about 35% of the surface area.

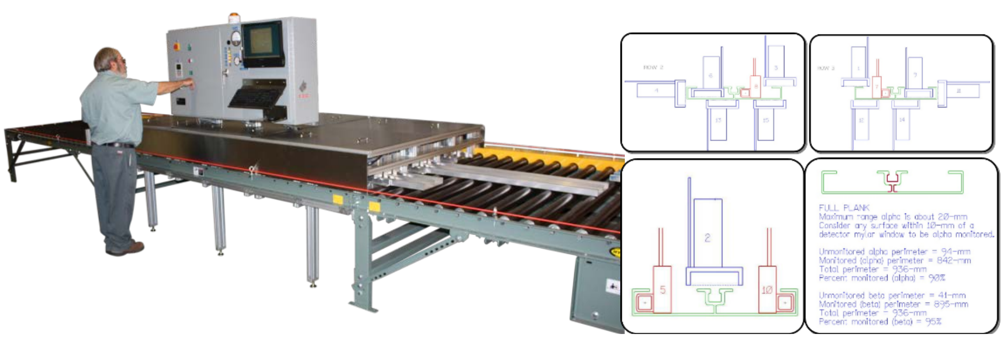

Figure 7 Versa Light Plank Monitor with detector configuration

The Versa Light Plank monitor operates at the unconditional release limit of 2,500 dpm, Cs-137, point source geometry, 95% confidence level for Beta/Gamma and 500 dpm Am-241, point source geometry, 95% confidence level for alpha.

Additional monitors have been designed and are in use. The development of new monitors is ongoing to support operational and customer needs. Please review the presentation for additional monitors. There simply isn't enough room to describe all the monitors. That being said, one final instrument has been built to optimize the survey process for large items that are too heavy or irregularly shaped to fit on or in an automated monitor. The MJM, see figure 8, operates a host of jigs/detector arrays to allow optimum hand monitoring. The MJM uses computer controlled alarm points and confidence levels. The computer tells the worker what is required for scan speed. All other human factors have been eliminated. Each jig operates at the unconditional release limit of 2,500 dpm, Cs-137, point source geometry, 95% confidence level for Beta/Gamma.

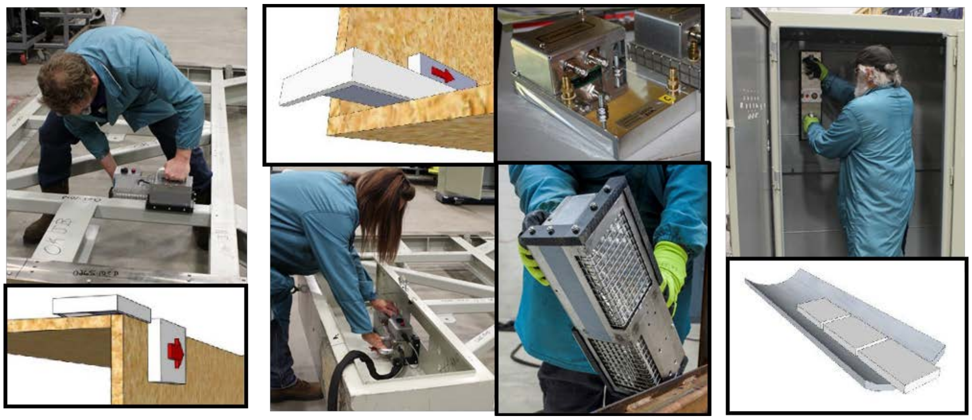

Figure 8 MJM Jigs, from left to right, outside corner, inside corner, 3 detector flat

In addition to the three jigs above, we have designed specialty turning equipment, see figure 9, that further reduces or eliminates the human factors associated with hand frisking. The lattice guide sleeve monitor pictured below is made up of 2 each, 500cm2 detectors (2" by 42"), and operates at the unconditional release limit of 2,500 dpm, Cs-137, point source geometry, 95% confidence level for Beta/Gamma.

Figure 9 Lattice Guide Sleeve Monitor

5. Improvements with Decontamination Processes

UniTech's primary business is the cleaning/decontamination of launderable PPE. Because of this, water and chemistry are our cheapest feed stock. For every 1 M gallons of water used, we typically see a 55gallon drum of radioactive waste from our wastewater system. We can also use CO_2, grit blasting, and other multi-media processes. However, they are restricted to very specific processes. Our day to day decontamination process for tools and equipment is high pressure water and low pressure steam, see figure 10 (negative ventilated room, worker wearing wetsuit, face shield and goggles). Combined with this is a blend of surfactants and chemicals that aid the decontamination process. This process typically cleans about 85% of the materials to unrestricted release levels.

Figure 10 High Pressure water/Low pressure steam with chemistry, a basic decontamination process.

For the remaining materials, which is typically stainless steel, UniTech designed and built the ChemClean Process, see Figure 11.

Figure 11ChemClean Process

For our Launderable PPE, we use a pH cycling formula that removes significant amounts of radioactivity without damaging the clothing. Generally, radioactivity is removed during the pH change from low to high or high to low. Adapting this process for tool and equipment decontamination has allowed us to release metals that were contaminated and reading several hundred mr/hr on contact. This process is destructive and materials decontaminated with this will not be used for their intended purpose. The ChemClean system is made from specialtyplastics that are impervious to the various chemicals used. This process has not failed to allow stainless steel to be monitored and released for unrestricted use. All old tooling and stainless components stored as radioactive waste could likely be released with this process for about half the price of metal melt.The tank can hold pieces up to 1500 pounds and fit within the dimensions of 10’long by 2’ wide by 2’ tall. We have ongoing R&D to continue to optimize the process and adapt it for other materials. All acid solutions are neutralized and processed in our wastewater treatment systems.

6. Materials/Projects Completed – Waste Saved/Avoided

UniTech has completed or has ongoing projects that significantly reduced the volume of radioactive waste generated through the use of launderable items replacing single use throwaway PPE/covers/bags and with our decontamination services for tools and equipment. Some key projects are highlighted below.

Refurbishment, Units 1 and 2, Ontario Canada: For this project, 2006 – 2012, 11.5M items (PPE, bags, covers, respirators, plastic suits, etc.) were decontaminated by UniTech. This included 18 new launderable items that replaced the single use throw away items. These items were tracked throughout the project and over the 5-year period avoided generating 5,600 M3 of radioactive waste (about 77 each, 40' sealands). These items were leased and laundered and the cost was $5.2M cheaper than just purchasing the single use throw away clothing and covers/bags. During this project we surveyed for unrestricted release 1M pounds of leased scaffolding. This was 42 each 40' sealand containers that were picked up, surveyed, released and delivered back to the owner of the scaffolding. We also decontaminated about 200,000 pounds of scrap metal/construction debris.

8 Unit Candu nuclear power station (only 6 are running), Ontario Canada: In 2004 we started looking at ways to help reduce the generation of radioactive waste. Figure 12 highlights the tracking program put in place to track the cubic meters of waste avoided by item. The items were implemented over several years, and identified via the supply system, a waste sorting pilot project, and ongoingreview of the waste stream. There are more opportunities to reduce waste,and the

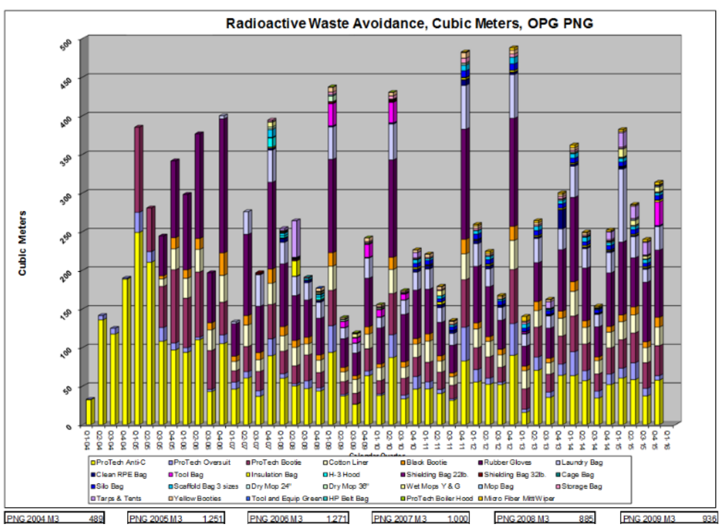

Figure 12 Waste Avoidance Tracking

process is ongoing. The items depicted in Figure 12 eliminate on average 1,000 cubic meters of radioactive waste each year.

Large Steam Generator Crane Decontamination: A large crane was constructed within containment of a US power plant. The evolution required that the crane remove the old steam generators from where they were installed, then lay the steam generator on its side and push it out the equipment hatch. In addition, this crane installed the new steam generators. While this process was ongoing, someone used a non-HEPA vacuum to clean up radioactivity and inadvertently contaminated upper containment as well as this crane, see figure 13. The crane was shipped toUniTech for disassembly, decontamination, reassembly and survey for unrestricted release.

Figure 13 SG Replacement Crane

Part of this process involved manufacturing a monitor that would pull the 2 miles of 1” cable through a detector housing to complete the survey on the actual cable. It is recommended that HEPA vacuums be used to perform future decontamination processes. The customer was very happy they did not have to purchase this $30M crane.

Candu 6 Refurbishment Tool Set Demobilization: Refurbishment tool sets for the Candu 6 reactor were manufactured and designed to be used twice. When Hydro Quebec cancelled their refurbishment and went into decommissioning instead, there existed a 2.5M pound tool set that already rebuilt one reactor and was contaminated. There was no prospect in the future to need this tool set so it was classified as a radioactive waste liability. UniTech was contracted and we used our Waste Nuclear Substance License and shipped 72 trucks of contaminated tooling to our decontamination facility in Morris IL. Over a one-year period we opened up 677 packages, about 100 of those packages were Type A or IP2 shipped as UN2915, assessed the radiological condition of the material, disassembled as requiredand decontaminated.

Figure 14 Parts of Candu Tool Set Demobilization Project

Significant disassembly was required, see figure 14. This was one of the few projects where we actually had no idea what we were looking at and no idea what the tool did for a living, so additional precautions were put in place to ensure radiological safety. To date, 2.2M pounds of the 2.5M pounds have been released for unrestricted use (scrap metal). The remaining material, stainless steel guide sleeves and shield plugs, are staged to be decontaminated with the ChemClean Process when production time is available.

Miscellaneous Materials: UniTech has decontaminated, surveyed and released for unrestricted use, millions of pounds of equipment and tools. Specific items include: ladders, hand tools, electric tools, extension cords, welders, drill presses, fork lifts, PHT motors, scissor lifts, scaffolding, chain falls, computers, heat exchanger plates, machine tools, transformers, air hoses, pipe hangers,electrical cables, structural steel, refuel drive motors, instrument cables, vent fans, power panels, rad boots, and frack tanks.

Figure 15 Frack Tank Decon and release for unrestricted use

7. Ways to Reduce Radioactive Waste Generation

A waste reduction strategy should be in effect for all day to day operations as well as all project based work such as refurbishments. A good strategy reduces the volume of radioactive waste generated, reduces long term liability, and in many cases overall cost. Key elements that should be considered include: 1) Waste Avoidance through launderables: A Continuous Improvement Process, 2) Tool/Scaffold/Equipment Decon/Verify Absence of Activity: clean and return tools and equipment to contractors to eliminate or reduce back end project liability using state of the art monitoring equipment. 3) Ongoing demobilization of construction debris (structural steel, cabling, motors, etc.) using off-site decontamination/monitoring services, 4) Off-site Waste Sorting: a) BSFR, b) reusable items, c) recyclable materials, d) incinerable above BSFR, e) volume reduce solid materials, f) identify new launderable item opportunities, 4) Contaminated material storage until reuse is needed and finally, 5) Refurbishment of contaminated tooling/equipment for continued reuse.

8. Summary.

Major opportunities exist to significantly improve the reduction of radioactive waste volumes and the associated long-term liability and costs via reuse, recycling and waste prevention strategies. Typically, during refurbishment/decommissioning projects (and even routine maintenance), the resources, capacity and expertise required to create and reliably deliver an effective tool & metal radiation survey and decontamination program are not readily available onsite. There are companies that have the tools in place to support this effort from off-site.

The increased volume of reusable/recyclable materials can be achieved by employing: a) a proven combination of advanced, cost effective, accurate, reliable and precise monitoring techniques/ technologies which reduce/eliminate risks associated with inefficient, sub-optimal, manual techniques; b) new, improved decontamination processes which are applicable to an extremely wide range of items; c) prevention of item/tool contamination at source via the use of launderable, multi-use protective strategies, and finally d) a comprehensive QA/QC methodology that captures the necessary information and process data in a full documentation package for Regulatory Compliance.

References: A copy of this paper, the power point presentation, or our Unrestricted Release Procedure RP-62 is available by request. Please contact Kent Anderson, Dir. Canadian Operations, UniTech Services Group, (413) 348-3826 or email: kanderson@unitechcdn.com