WASTE REDUCTION ACTIVITIES AT OAK RIDGE NATIONAL LABORATORY

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ABSTRACT

Oak Ridge National Laboratory is a multipurpose research and development facility which generates numerous small waste streams including radioactive liquid low-level waste, liquid process waste, solid radioactive waste, hazardous waste, industrial waste, and mixed waste (containing both hazardous and radioactive constituents). The wide diversity of waste complicates management, compliance with reporting requirements and traditional waste minimization approaches.

In 1992 ORNL generated 18,200 yd^3 of sanitary waste. Through the cardboard and paper recycling programs, 22% of this waste stream was recycled. Hazardous and mixed waste generation has been reduced by 20% in the past four years. Most of this reduction was achieved through affirmative procurement, controlling inventories and the identification of non-hazardous substitutes. Solvent wastes were reduced in the paint department by developing a gravity filtered system to facilitate the reuse of paint thinner. Solvents have further been reduced by replacing some solvent degreasing operations with aqueous washers and by switching to non-hazardous scintillation cocktails.

Radioactive waste is comprised of liquid low-level, solid low-level and transuranic waste. The whole liquid low-level system is undergoing a long-term thorough evaluation to determine which combination of generator reduction activities and wastewater treatment facility upgrades will most efficiently and cost effectively reduce overall waste generation. Solid and transuranic waste generation rates have fluctuated over that past few years. Much of this is due to the varying level of activities in the programs that generate these types of waste. Efforts to reduce these wastes have been primarily through segregation and limiting materials that enter radioactive areas.

ORNL's Waste Management division performed a strategic planning exercise process to help identify real issues and roadblocks (11) to waste minimization. In an effort to cope with these issues, ORNL is forming a waste reduction strategic planning committee. With leadership from Waste Management and significant participation from research and support divisions, the committee will develop an approach to waste reduction activities. Using this site-wide approach, it is anticipated the ORNL can achieve widespread support of waste reduction efforts and ensure the benefits from waste reduction are shared equally.

INTRODUCTION

Oak Ridge National Laboratory (ORNL) is a multipurpose research and development (R&D) facility owned and operated by the Department of Energy (DOE) and managed under subcontract by Martin Marietta Energy Systems, Inc. (MMES). ORNL's primary mission is the support of energy technology through applied research and engineering development, and scientific research in basic and physical sciences. These activities are conducted predominantly on small scales in over 900 individual R&D laboratories. Activities are diverse, variable, and frequently generate some type of waste material. In contrast to the typical production facility's few large-volume waste "streams", ORNL has numerous small ones, including radioactive liquid low-level waste (LLLW), solid radioactive waste, hazardous waste, industrial waste, and mixed waste (containing both hazardous and radioactive constituents). The wide diversity of waste complicates management, compliance with reporting requirements, and traditional waste minimization approaches.

Since the early 1980s, increased effort has been devoted to the minimization of hazardous and radioactive wastes at ORNL. Policy statements supporting such efforts have been issued by both DOE and ORNL management. Motivation for waste reduction is found in federal (1,2) and state regulations (3), U.S. DOE policies (4,5,6) and guidelines, increased operating costs and liabilities associated with the management of wastes, and limited disposal options and storage facility capacities.

Although sporadic, ORNL's waste minimization efforts have been successful. Since the ORNL waste generators are primarily numerous small laboratory or research programs, lowering the volume of waste being generated often involves reductions which, taken by themselves, are apparently small changes in the total volume. However, in terms of the quantity of waste produced from that particular program, the savings in waste volumes can be substantial.

Most reduction success were made through the efforts of a few interested staff members. Hence, the reductions have been random and the waste streams that have received attention may or may not be the most important to reduce in terms of overall cost savings or improved waste management. With the development of a centralized Waste Reduction Program and strategic planning, ORNL will be able to focus the limited funding and staffing efforts on the highest priority waste streams.

HIGHLIGHTS OF SUCCESSES

Sanitary/Industrial Waste

Waste categorized as sanitary/industrial includes solid waste generated from sanitary sewage treatment, steam plant operations, coal yard runoff, general refuse, and construction debris. As these wastes are generated, segregation of these waste streams from radioactivity and hazardous waste is important. Steam plant ash, sludge from the ORNL Sewage Treatment Plant, filter cake from treatment of coal yard runoff, general office refuse, and wastes from construction and demolition activities are landfilled on the Oak Ridge Reservation.

Waste reduction accomplishments have primarily been in the area of reducing and recycling general office refuse. The paper, cardboard, and aluminum beverage can program recycling programs were fully implemented in 1991. In 1992, 306,172 lbs. of white, high-grade paper and 312,740 lbs. of cardboard were collected for recycling. This represents 22% of the total amount of sanitary/industrial waste generated at ORNL. Furthermore, the amount of white paper collected is equal to 47% of the amount of copy paper and bond purchased. Office paper, generated in non-radioactive areas, is collected by each employee and carried to a central location in each building. A subcontractor collects these centralized containers, transports and markets the paper. In 1991, the market value of the white office paper covered the cost of collection and transportation. Due to a drop in the value of paper, ORNL is providing $4,000 to cover costs incurred by the subcontractor that are not off-set by selling the paper. The cardboard is sold for 50 percent of the official board price.

Aluminum beverage containers are also collected from non-radioactive areas. Employees deposit empty cans in specially marked drums. Volunteers then transfer these cans to a central location where they are accumulated for transportation. Seven thousand pounds of aluminum was collected in 1991 and an additional 7,700 lbs. in 1992. The proceeds from the sale are donated to a local charity.

Until recently, waste reduction had not been as important a factor for conventional waste as it had been for radioactive and hazardous waste because the cost for disposal per unit volume is significantly less. However, sanitary waste disposal costs are increasing significantly as a result of transportation, emplacement, monitoring, and new site development costs. Therefore, economic incentives to reduce sanitary waste volume will continue to grow rapidly, especially in the area of bulky general refuse. At ORNL, the primary value of the paper, cardboard and aluminum recycling program is not the income from the sale of the recyclable material, but the unused landfill space. The operation of the Y-12 Centralized Sanitary Landfill is approximately $\$20/yd^3$.

To complete the recycling loop, recycled-content paper is already used to some extent by many divisions throughout the Laboratory. A study was conducted to investigate the substitution of 100 percent recycled paper instead of virgin paper for computer output. For three months (November 1989 to February 1990), recycled paper was used to ensure that it performed to the same level as the virgin paper. The recycled paper performed with minimal difficulties, and has improved in the past couple of years. Initially, the cost of recycled paper was prohibitive to most programs. Now, the cost is coming down and the rate of purchase is increasing. To further support the struggling recycled paper market, Executive Order 12780 (7) requires all U.S. Government offices and their contractors to use recycled paper products, when possible, in order to create a market for recycled paper, conserve natural resources, and protect the environment.

ORNL's scrap metal has previously been recycled through scrap metal vendors. Metal is collected in designated dumpsters and sold the contents through property sales. Vendors would then sort the accumulated metal for recycling. This effort resulted in the recycling of 825 tons of scrap metal in 1988, 1,004 tons in 1989, and 487 tons in 1990. Due to an increased effort to ensure radioactive contamination is not transported off-site, only a small portion of the scrap metal is now released for recycling.

Hazardous and Chemical Waste

Hazardous wastes are considered to include 1) those wastes regulated under RCRA and 2) chemical wastes not regulated under RCRA, but which could present a hazard if improperly managed. Mixed wastes, which are either RCRA or non-RCRA hazardous waste combined with radioactive waste, are managed as hazardous radioactive wastes.

ORNL has reduced its hazardous and mixed waste generation by 20% in the past four years (8) through affirmative procurement, controlling inventories and the identification of non-hazardous substitutes. This reduction indicates that while ORNL is headed in the right direction, the nature of the work done at a laboratory does not lend itself to dramatic reductions in waste generation. This also emphasizes the importance of sharing information about reduction techniques with other generators in order to make a more significant impact on the reduction of total wastes generated.

ORNL instituted the Accelerated Vendor Inventory Delivery (AVID) system for the acquisition of materials and chemicals. This system operates on a "just-in-time" basis which discourages the stockpiling of excess chemicals. Control of hazardous materials procurement can prevent excessive inventories, which, if their shelf lives are exceeded, will require disposal. Substitution of less hazardous chemicals is also encouraged by the procurement control system. One of the most important elements of procurement control is limiting the size of units being ordered. Often chemicals are less expensive to buy in bulk quantities. However, the initial cost advantage in purchasing larger sizes is dwarfed by the higher cost incurred in disposing of the unneeded volume. Researchers and purchasers have been advised to purchase only the necessary quantities of chemicals and to procure them in the smallest units practical.

ORNL is participating in the development of a multi-plant procedure for hazardous material inventory, which includes improved procurement practices. The lab-wide inventory of chemicals in research laboratories, process areas, and storage areas will be reviewed annually, and should result in fewer unwanted and expired chemicals requiring disposal.

To further reduce the disposal of unwanted chemicals, the Swap Shop has been organized to identify users for unwanted chemicals. This informal exchange system advertises unwanted chemicals which are available at no cost to another user. During the brief existence of this system, a number of chemicals have been exchanged. An interactive computerized system is being investigated as this program expands.

Photochemical waste is by far ORNL's largest hazardous waste stream. Photochemical processing activities generate an average of 32,000 kg of liquid photochemical waste per year. In the past, the photochemicals were sold to silver recovery firms for reclamation. In 1990, the material's low silver concentration and the drop in the value of silver proved to make the recovery process of ORNL's waste uneconomical for commercial firms. Therefore, it was disposed of as RCRA hazardous waste. In the last quarter of 1991, a cold evaporator was purchased to treat the photochemical waste stream generated by the Photography Department (Photography generates 60 percent of ORNL's total annual generation). By evaporating the water, the concentration of silver is greatly increased. This concentrated sludge will be marketable to commercial recyclers. Furthermore, after the completion of a formal process waste assessment (9) in 1992, ORNL will be implementing a cartridge filtration system at all processing areas. This will eliminate the handling of any photochemicals as hazardous waste.

The reduction of solvent waste is important both from a cost and compliance standpoint. In 1989, the ORNL Paint Shop put into place a gravity filtered system to facilitate the reuse of paint thinner. While they reduced their waste generation by 900 gallons annually, a similar system was put into place at four other Energy System's sites, thereby increasing the total reduction.

A process waste assessment (10) was performed last summer on the degreasing operations. Parts cleaners at ORNL typically use a hazardous solvent to clean grease and oil off soiled parts. In 1992, one operation switched to an aqueous parts washer, similar in design to a large industrial dishwasher which uses a citric-acid based detergent. Parts are placed in a tray and the machine is set to run a five to thirty minute cycle. The aqueous solution is recycled within the machine and oily residue is skimmed off the top of the solution. Only small amounts of oil and grease have to been handled as waste. In addition, this operation presents the workers with a significantly lower health risk and allows them to be working on other operations while the machine is degreasing. ORNL has twelve degreasing operations that use a variety of solvents and can technically be replaced by the aqueous parts washer. Interestingly, because these are minimal use activities generating only a few drums of solvent waste each year, the assessment indicated that based on capital equipment and waste disposal costs alone, it is not cost effective to modify these waste generating processes. However, ORNL is still making an effort to phase in new equipment over the next five years to replace solvent degreasing tanks based on compliance with the Land Disposal Restrictions regulations and to significantly reduce chemical exposures to maintenance workers.

Another process waste assessment was completed last year for methylene chloride use in the analytical laboratories for organic extraction procedures. Methylene chloride is of particular interest as it is required for regulatory sample analysis, but is scheduled to be phased out under the requirements of the Clean Air Act. In the sampling procedure, methylene chloride is added to each soil or water sample to extract any organic or polychlorinated biphenyl constituents. More than 90% of the methylene chloride is captured for reuse when it is evaporated to concentrate to extracted solution. Previously, the methylene chloride had been allowed to evaporate.

Wastewater Treatment

Radioactively and chemically contaminated liquid wastes are generated by various activities including R&D functions, decontamination activities, reactor operations, and waste treatment facilities operations. ORNL operates two wastewater plants that treat radioactively- and chemically-contaminated wastewaters. The Process Waste Treatment Plant (PWTP) treats wastewaters that are contaminated with radionuclides by softening, filtration, and ion exchange. The PWTP effluent and the nonradioactive process waste are treated at the Nonradiological Wastewater Treatment Plant (NRWTP) to remove organic and metal contaminants prior to discharge to the watershed through a National Pollutant Discharge Elimination System permitted point.

Because of the complexity of the LLLW system, a multiyear study is addressing both the major contributors and the actual treatment system. Through a combination of efforts at the generator level and upgrades to the treatment system, the generation of low-level waste concentrate requiring disposal will be reduced. While many previous waste reduction projects have reduced the volume of waste entering a given phase of the liquid waste treatment system, they often have little impact on volumes or compositions of the final waste steams which must be treated for permanent disposal. The systems analysis approach is assuring that waste reduction projects are implemented which will be cost effective and significantly reduce the amount of waste being stored for ultimate disposal.

Maximum efficiency can be achieved at both plants by ensuring wastewaters are treated only at the appropriate plant. To this end, on-line radiation monitors have been implemented since 1989 to help segregate radioactive from nonradioactive waste streams. If a waste stream is found to be free of contaminants or within acceptable limits, it can bypass the PWTP and be treated at the NRWTP, thus reducing the load on the PWTP and enabling more effective removal.

In another segregation project, a pH-based system was also developed to segregate metal-containing waste water from nonmetals waste water. Using the pH segregation system, the amount of waste water which must be treated for metals removal is reduced by approximately 5700 m^3/week. This quantity of waste water would have produced an additional 50 m^3 of sludge per year for disposal, if not segregated.

Generator input reductions have been achieved through the installation of equipment for recycling water used in the garage's steam cleaning operations. Water is recirculated, oil and grease are skimmed off the surface and the water is reused in the cleaning operations. This completely eliminated an oil and grease laden input to the treatment plant.

Cooling water systems have also been evaluated. Often, cooling waters require only chlorine removal before discharge. Several activities have provided either source treatment or recycling systems for cooling water to reduce the input to the wastewater treatment plants. Additionally, equipment systems and buildings are being upgraded to eliminate once-through cooling water systems. A generator survey of the inputs to the treatment plant identified several once-through cooling water streams which are being fed to the PWTP. These streams account for 35 percent of the PWTP feed and a corresponding percentage of the secondary waste generated at the plant. Minor piping modifications are being made to segregate these waste streams which will reduce the SLLW production 33 percent of the present generation rate. The cost savings for this project alone are estimated to be $120,000/year.

Solid-Low Level Waste

The majority of solid low-level waste at ORNL is generated as contact-handled (CH) LLW. This waste has a radiation dose rate at the surface of the container of ≤200 millirem/h and is typically slightly contaminated debris or sludges from the Process Waste Treatment Plant. CH-LLW is divided into three categories: 1) compactable CH-LLW, 2) noncompactable CH-LLW, and 3) sludges. Most compactable waste has a surface dose rate less than 10 millirem/hr and consists of slightly contaminated plastic bags, blotter paper, glassware, etc. Noncompactable CH-LLW consists of heavy gauge metals items, wood and other debris that cannot be compacted by conventional methods.

Due to health physics procedures, this waste stream is particularly difficult to reduce. Therefore, segregation of SLLW from other waste is the most important step in the minimization process. Generators have implemented programs to reduce SLLW generation through improved segregation from uncontaminated waste. Energy Systems has implemented a policy to prohibit packaging materials from entering radiological areas. This allows them to be handled in the recycling program instead of potentially radioactive waste. Careful segregation and handling procedures have reduced SLLW generation by approximately 20% (8) in the past five years.

Transuranic Waste

Transuranic (TRU) wastes are defined as radioactive waste without regard to source or form that is contaminated with alpha-emitting radionuclides that have an atomic number greater than 92, half-lives greater than twenty years, and an assay concentration greater than 100 nCi/g. ORNL also handles waste contaminated with ^{233}U, ^{244}Cm, and ^{252}Cf as TRU waste, although they have not yet been formally declared as such by DOE.

The generation rate of TRU waste decreased steadily from 1985 to 1987 followed by a slight increase in 1988 and 1989 due to clean-up efforts in the Radiochemical Processing Pilot Plant. Generation in 1990 fell dramatically due to reduced processing activities in the REDC, the shut down of the isotopes programs in Bethel Valley, and the continued shutdown of the High Flux Isotope Reactor for most of 1990 (8). The increases in TRU production in 1991 and 1992 are largely due to the restart of HFIR. Because of the dramatic changes in activity level, it is very difficult to say if any reductions of TRU waste are attributable to waste reduction techniques or simply reduced activity level. Much like solid low-level waste, segregation of other waste types from TRU is the most effective waste minimization tool.

Strategic Planning

In 1992, ORNL's Waste Management division performed a strategic planning exercise process to help identify real issues and roadblocks (11) to waste minimization. Once the significant issues are identified, efforts can be focused on eliminating or accommodating them so as to reduce their impact on programmatic activities. For waste reduction, several issues were identified. Among these issues were:

- The lack of defined roles and responsibilities for waste reduction results in 1) poor communication of needs and expectations and 2) lessened commitment to implementation, (e.g., lack of ownership and accountability) and
- Historical absence of formal regulatory "hammers" and technically defensible goals results in a lower relative priority and a reluctance for generators to allocate limited resources to waste reduction.

In an effort to cope with these issues, ORNL is forming a waste reduction strategic planning committee. With leadership from Waste Management, but significant participation from research and support divisions, the committee will develop a technically-defensible approach to waste reduction activities. Using this site-wide approach, it is anticipated the ORNL can achieve widespread support of waste reduction efforts and ensure the benefits from waste reduction are shared equally. This working group will also participate in the development of a prioritization scheme to ensure that limited resources and staff efforts are focus on waste streams whose reduction will provide the Laboratory with the greatest overall benefit.

Additional strategies that will be pursued by the Waste Reduction Program include

- The pursuit of alternative funding both through established sources (e.g., Office of Energy Research, ORNL Executive Committee, etc.) and innovative concepts such as the development of a waste reduction investment fund (source of funds or matching funds for division level projects, to be repaid either in the form of ORNL overhead reduction or direct cost savings from waste reduction);
- The identification of effective, innovative programs and cost savings realized as added justification for additional resources needed to effectively adopt "best management practices" for waste reduction programs and improve funding levels;
- The innovative incentives programs to provide tangible rewards (cash awards, vacation, etc.) to individuals or organizations that make major contributions to achievement of ORNL's waste reduction goals;
- The use of Total Quality Management empowerment concept to enhance commitment at the working level and progress toward waste reduction and;
- Develop a working relationship with other existing programs, such as National Environmental Protection Act, energy conservation research groups or technology transfer organizations.

As it is everywhere, the reduction of all ORNL waste generation is an economically logical response to the rising costs and liabilities of waste management and the best use of limited resources. Human health and the environment are best protected from all types of waste by prevention of their generation from the start. Real progress has been achieved. As generators become increasingly aware of the advantages of reduced waste generation, strategic planning helps focus attention on the most beneficial reductions, and successes are shared among all waste generators, ORNL will be able to demonstrate significant reductions in waste generation.

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