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IMPLEMENTATION OF WASTE MINIMIZATION AT A COMPLEX R&D SITE

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ABSTRACT:

Under the 1994 Waste Minimization/Pollution Prevention Crosscut Plan, the Department of Energy (DOE) has set a goal of 50% reduction in waste at its facilities by the end of 1999. Each DOE site is required to set site-specific goals to reduce generation of all types of waste including hazardous, radioactive, and mixed. To meet these goals, Argonne National Laboratory (ANL), Argonne, IL, has developed and implemented a comprehensive Pollution Prevention/Waste Minimization (PP/WMin) Program.

The facilities and activities at the site vary from research into basic sciences and research into nuclear fuel cycle to high energy physics and decontamination and decommissioning projects. As a multidisciplinary R&D facility and a multiactivity site, ANL generates waste streams that are varied, in physical form as well as in chemical constituents. This in turn presents a significant challenge to put a cohesive site-wide PP/WMin Program into action.

In this paper, we will describe ANL's key activities and waste streams, the regulatory drivers for waste minimization, and the DOE goals in this area, and we will discuss ANL's strategy for waste minimization and it's implementation across the site.

INTRODUCTION

Pollution Prevention and Waste Minimization implementation at a large research and development facility can be a difficult process. The key steps to implementation are pollution prevention awareness and training, knowledge of waste streams and practices, and a judicious approach to committing resources. Cultural change and buy-in on the part of the user community are critical steps in program implementation. Argonne has developed an approach that has begun with employee awareness and training and source reduction and recycling. A Waste Minimization Advisory Committee selected from a cross section of internal stakeholders has also been formed. The next step in the process is the development of interlinks between ANL's data management systems to identify areas of concern. All of these steps have demonstrated success in their initial phase.

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DISCLAIMER

ARGONNE R&D AND WASTE GENERATION

Argonne National Laboratory (ANL) is a multiprogram national laboratory with sites near Chicago, Illinois, (ANL-East) and Idaho Falls, Idaho, (ANL-West). ANL was established by the Atomic Energy Act of 1946 as the successor to the Metallurgical Laboratory of the Manhattan Project. Its initial mission was the development of fission reactor technology for power generation and the supporting science and technology; Argonne conceived most of the reactor systems in use today. The Laboratory's focus expanded to include high-energy physics research in the mid-1960s and environmental R&D in the 1970s.

ANL's major national research facilities include: Advanced Photon Source, Structural Biology Center, Intense Pulsed Neutron Source, Argonne Tandem Beam Linear Accelerator System (ATLAS), and High-Voltage Microscope/Tandem Accelerator. In addition, there are a host of other facilities such as the Fuel Cycle Facility, Hot Fuel Examination Facility, Transient Reactor Test Facility, and the National Battery Test Laboratory. The Integral Fast Reactor (IFR) Program, including the Experimental Breeder Reactor-II, are based at Argonne West (ANL-W) near Idaho Falls.

ANL's areas of supporting and basic research include: materials science, chemical sciences, computing and information sciences, mechanistic biology, environmental research, nuclear physics, and high energy physics. Technology development activities are focused in the areas of energy and industrial technologies and advanced reactors. Even though in January 1994 the DOE announced the termination of the IFR program, the DOE is proposing to redirect Argonne's advanced technology capabilities to the areas of nonproliferation, spent nuclear fuel and waste treatment, reactor and fuel cycle safety, and decontamination and decommissioning programs. The Laboratory's Institutional Plan (FY1995- FY2000) recognizes the major mission areas to be energy and environmental technologies, national research facilities, basic research, industrial and manufacturing technologies, technical evaluation, and education. ANL's core competencies include fission and other advanced energy systems; accelerator-based research, facilities, and technologies; industrial and transportation technologies; modeling, simulation, and advanced computing, environmental R&D, partnership R&D with industries and universities; education and training. ANL has a total staff of 5,210 over 1,100 of which represent the scientific and engineering staff. The Laboratory budget for FY94 was in excess of 450 million dollars.

The diversity of mission activities, the facilities, the R&D programs, and D&D projects generates a wide variety of radioactive and hazardous waste streams. Table 1 summarizes the recent ANL waste generation data (in this paper, we focus on ANL-E, referred to as ANL, unless otherwise noted, and the data presented are for ANL-E, even though a similar waste minimization program is in place at ANL-W). The R&D waste generation accounts for approximately 40-60% of the low level, hazardous, and special waste streams. This waste is generated by many different projects and the quantities may vary from negligible to liters or drums per year. Approximately 90% of the radioactive waste generated at ANL

can be classified as low level. Hazardous wastes represent the largest segment of the waste inventory. In Table 1, the increases from 1992 to 1993 reflect increased project activities particularly in the D&D area and an increased knowledge of the waste in the legacy waste area. The 1994 data are currently being compiled and are likely to reflect mild increases in the two areas mentioned above.

Table 1. Summary Waste Stream Data

	1991	1992	1993
Transuranic	1.53 m^3 11.0 L	5.07 m^3 170 L	3.66 m^3 680 L
Low Level Mixed	.11 m^3 148 L	.47 m^3 18.9 L	67 m^3 19 L
Low Level	37.6 m^3 836 L	47.0 m^3 134.6 L	169 m^3 135 L
Hazardous	103,142 kg	97,855 kg	113,000 kg
Toxic Release Inventory H_2SO_4 Methanol Benzene Toluene Mixed Xylene 1,2,4 Trimethyl benzene tert-methyl butyl ether	NA	NA	 1,183 kg 666 kg 220 kg 350 kg 110 kg 13 kg 39 kg
TSCA	4,975 kg	3,211 kg	0
Recycled Materials Paper Lead Metal Radioactive Metal	 85 t 459 t	 108 t 383.7 t	 106 t 502.6 t

REGULATORY DRIVERS AND DOE DIRECTIVES

Waste Minimization and Pollution Prevention are driven by a complex set of regulatory drivers, in ANL's case, administered by the EPA, state laws, disposal site criteria, Presidential Executive Orders, and the DOE Orders. The list of regulatory drivers is summarized in Table 2.

Table 2. Regulatory Drivers for PP/WMin

Federal Laws

- Clean Air Act (CAA)
- Clean Water Act (CWA)
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- Emergency Planning and Community Right to Know Act (EPCRA)
- Energy Policy Act of 1992
- Federal Facility Policy Act of 1992
- Federal Nonnuclear Research and Development Act of 1974 (as amended)
- National Environmental policy Act (NEPA)
- Occupational Safety and Health Act (OSHA)
- Pollution Prevention Act (PPA) of 1990
- Resource Conservation and Recovery Act (RCRA)

EXECUTIVE ORDERS

- Executive Order 12088, Pollution Prevention at Federal Facilities
- Executive Order 12843, Procurement Requirements and Policies for Federal Agencies for Ozone depleting Substances
- Executive Order 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements
- Executive Order 12873, Federal Acquisition, Recycling, and Waste Prevention

DOE ORDERS

- DOE Order 5400.1, General Environmental Protection Program
- DOE Order 5400.3, Hazardous and Radioactive Waste Program
- DOE Order 5820.2A, Radioactive Waste Management

DISPOSAL SITE CRITERIA

- Hanford Radioactive Waste Acceptance Criteria
- WIPP Waste Acceptance Criteria
- INEL/RWMC Disposal Site Criteria

STATE

State of Illinois has authority to administer portions of the Federal Laws and may apply additional requirements.

By far, the PPA and the FFCA had the most impact on DOE facilities including ANL. The FFCA waived the sovereign immunity for federal facilities, and it also amends the RCRA by requiring

DOE to prepare facility plans that provide for the development of treatment capacities for mixed wastes. The PPA establishes a hierarchy of pollution prevention activities that must be followed.

The Department of Energy (DOE) is committed to waste minimization and pollution prevention at its facilities. The first Waste Minimization/Pollution Prevention Crosscut Plan, published in 1992, introduced waste minimization strategies and key objectives. Under its 1994 Waste Minimization/Pollution Prevention Crosscut Plan, the DOE has set a goal of 50% reduction in waste by the end of 1999, and each DOE site is required to set site-specific goals to reduce generation of all types of waste including hazardous, radioactive, and mixed. To meet these goals, ANL has developed a comprehensive PP/WMin Program Plan that is applicable to all activities and all waste generators at the site.

WASTE MINIMIZATION PLANNING AND IMPLEMENTATION

In compliance with the Pollution Prevention Act hierarchy, waste source reduction is a main element of waste minimization strategy at Argonne. The pollution prevention hierarchy can be briefly summarized as the following order: source reduction, recycling, waste treatment, and disposal.

A PP/WMin Program Plan and a PP/WMin Awareness Plan have been prepared. The purpose of the two ANL plans is to attain for this site the goals of the DOE's 1994 Crosscut Plan and to ensure compliance with the federal and DOE requirements discussed earlier. The strategies outlined in these plans are now being implemented.

To meet the challenge of PP/WMin at Argonne, several major initiatives have been taken:

1. Implementation of source reduction and recycling practices.
2. Employee awareness and training programs.
3. Tracking of waste through Waste Management Data System (WMDS)
4. Implementation of a Chemical Management Systems (CMS).

The program is being expanded to include: 1) linking the CMS with the WMDS to provide information and reporting capability, 2) development of training videos, and 3) implementation of site-wide waste reduction goals.

ANL has also formed a Waste Minimization Advisory Committee that includes representatives of the research and development areas, operations, and compliance. It also includes representatives of DOE's Argonne Area Office as well as the DOE Chicago Operations Office. A representative of the New Brunswick Laboratory, which is also located at the ANL site, is also on the committee. The purpose of the committee is to review pollution prevention program implementation, waste generation practices, and provide direction and integration of the program into the laboratory culture.

Waste source reduction and recycling have become the principal elements of waste minimization strategy at ANL. The Laboratory has committed to specific waste reduction goals of 50 % for Toxic Release Inventory (TRI) wastes and 25% for other waste streams over a five-year period. The baseline for these reductions is the 1993. Concerted efforts are being made for source reduction through materials exchange and recycle of excess materials such as metals. Initiatives in this area include the use of nonhazardous scintillation fluors, alternative solvents, and chemicals. A Chemical Exchange Program is also in effect at ANL to exchange chemicals not being used by generators. Technical expertise is provided to waste generators and several technologies are being evaluated to further reduce the volumes of waste generated.

Separation technologies developed by ANL researchers have allowed the extraction of radionuclides such as Pu, Am, Np, and U out of certain waste solutions. For stored and operational liquid waste from site-wide activities, another ANL-developed ion-exchange process can allow the separation of actinides.

ANL's waste minimization strategy features awareness and training of the employees as a first step. The waste generators are also being trained on proper techniques for readying waste for pick up by waste handling specialists. A bar code computer system allows waste management personnel to retrieve information about individual waste containers from a central data base with a hand-held, battery-operated bar code reader. This information determines the waste handling requirements. After employee awareness and training, the next important step is the general waste stream analysis and review and identification of priority areas. The final step is to work directly with D&D and environmental restoration projects to identify opportunities at the outset. The D&D and restoration projects are the single largest generator of hazardous and radioactive waste.

The ANL Awareness Program began in 1993 with a poster program similar to the safety posters presented in many locations. The program started with developing a character that people could identify with the recycling program, individuals could suggest a name for the character, and receive a recycling container for their work place. They voluntarily emptied this into common collection bins. As an immediate result of this program, white paper recycling increased by 62% (over 1993), which represents approximately 40% of the available paper on site. In 1994, ANL recycled 190 tons of white paper, which as standard sheets laid end to end could stretch 6,500 miles. This program achieved a plateau of recycling that was limited by the number of people willing to bring their paper to a central receptacle. This hurdle is being overcome by instigating a custodial collection once per week in lieu of garbage collection. This is being tried in several buildings to identify problems before going laboratory wide. The principal problems identified so far include inadequate collection equipment and the need for a container that can be transported up and down stairways. One building generates so much general trash that a trash pick-up cannot be avoided. The problem is being addressed by conducting a second sort of facility waste to identify particular problems. The awareness program is being expanded to feature metal recycling and sharing of materials in the near future.

Training efforts are starting with a simple video to be used in all employee training sessions. The theme will be to identify the problem and focus on simple solutions that individuals can use every day to impact pollution prevention. Topics will feature housekeeping, documentation, control of quantities, and sharing of materials. Specific training of waste generators is also planned.

Awareness and training will only take the program to a certain stage. The next major hurdle is to identify specific waste streams for review and action. The collection of data is the first major step. With over 1100 technical staff generating very small to large quantities of waste, the problem is in identifying priority targets. For instance, methylene chloride may be a very high priority pollutant, but if it is generated in very small quantities, scarce review resources may be dedicated elsewhere.

ANL currently has three data bases that are relevant to the pollution prevention effort. The procurement system processes purchase requests and is currently based on the military code system. It is relatively easy to review purchase orders for cost or quantity but not for specific material or user. Fortunately, this system is currently being phased out. The new system is ORACLE-based and will have capabilities more friendly to the pollution prevention effort. The second data base is the Chemical Management System (CMS). This system was created in 1992 to serve as a repository for material safety data sheets (MSDSs)and inventory control. It is ORACLE-based and also contains all of the regulatory tables plus a capability to identify surplus material for exchange. The final data base is the Waste Management Data System (WMDS). This system is currently CLIPPER-Based and manipulates all of the waste data from the time of documentation. The present data system interlinks are shown in Figure 1.

The initial steps in the data management process occurred in FY93 when data were developed for the DOE Annual Waste Reduction report and the (TRI) Report. This process was only partially effective because the first data only reflected waste as shipped. A second review of data was necessary to identify specific sources and quantities of TRI chemicals. This effort brought several problems to the forefront: 1) the data did not necessarily reflect material entering the system; 2) data quality was unreliable; for instance some data did not reflect concentrations but only the absolute container size; 3) access to the data was extremely limited, and 4) the waste management data base did not directly access either the regulatory lists or the MSDSs contained in the CMS data base; and 5) units of measure were not always consistent.

The need to link pollution prevention to WMDS was immediately apparent. The limited data available from the 1993 TRI report indicated that the largest H_2SO_4 generator contributed 1000 L of waste. A review with the generator indicated that half of this was dilute rinse water that could be neutralized.

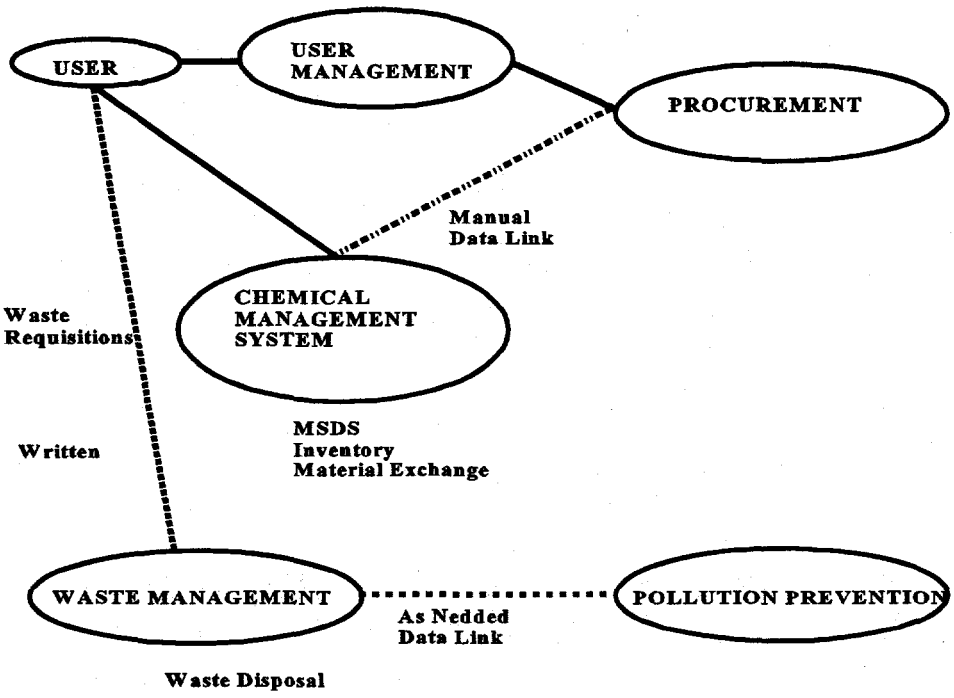

Figure 1. Present Data System Interlinks

The planned data linkages will provide for real-time data availability to the pollution prevention staff. Because waste data can provide a powerful driver for managers to incorporate pollution prevention in their programs, the second step in the data management process will be to generate two reports for laboratory managers to use. The first will be a simple report summarizing individual division waste generation. This report will be provided to division management. The second will be a detailed report of specific waste generation practices and will be available electronically to the researchers. Linking of the data bases is currently underway.

The user community, requests chemicals through the procurement chain. The original systems had the user independently ordering materials. With the establishment of the CMS, the first step was for an individual to prepare a purchase requisition and a data sheet for chemical management and inventory control. Procurement is developing new software for its system and as a part of that effort, the link between the user, purchaser and the inventory control by chemical management will be electronic and automatic. The next step in this process will be to prompt a user to determine if they can use materials from inventory and provide them with the link to inventory. A user that cannot use inventory will not be required to do so. Finally, quantity approval limits will be applied to limit excess purchase.

The final links will be between the waste management system, chemical management system, and the pollution prevention group. The final data management configuration will resemble Figure 2.

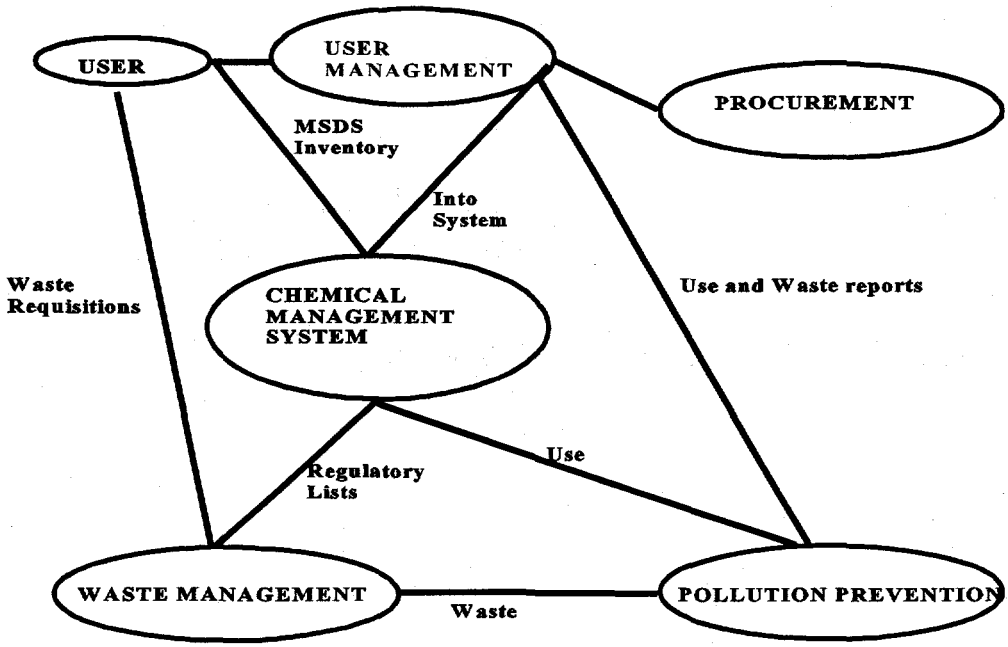

Figure 2. Planned Linked Data Management System

The advantages offered by the linked system are many:

- Users will have access to CMS including MSDS and regulatory information at the outset of a project or experiment.
- Procurement and inventory information will be fed to CMS and subsequently to pollution prevention and waste management in a real time frame resulting in knowledge of future activities.
- Users will be able to generate waste requisitions electronically and transmit the information to waste management resulting in a more detailed knowledge of waste and its timely disposal.

This planned linkage will provide use of regulatory tables, inventory trends, procurement and waste documentation. This information will be used by pollution prevention group to determine target waste generators, waste generation trends, and documentation of successful source reduction efforts. The current schedule calls for the initial links between waste management and pollution prevention to be completed the spring of 1995. The final links will, however, be determined by the budget availability
for these activities.

CONCLUSION

Argonne has implemented a comprehensive waste minimization program with significant initial success. We have found that institutional buy-in at a complex R&D site, such as Argonne, is essential to implementation of a consistent waste minimization effort. Awareness and training are also essential components and are in fact responsible for source reduction in major part but they have limitations that are impacted by buy-in and commitment on the part of the user community as well as, both the physical and financial commitment. Awareness and training have been effective at identifying and capturing the "low hanging fruit" but have limitations at prioritizing waste streams. A detailed knowledge of waste generating practices is essential at a large research facility because of the varied nature of the materials. Overall, it is anticipated that Argonne will be able to meet its waste minimization goals through a multi-faceted but consistent approach applied to all facilities and activities at the site.