United States
Environmental Protection
Agency

Risk Reduction
Engineering Laboratory
Cincinnati, OH 45268

Research and Development

EPA/600/SR-93/015 March 1993

EPA

Project Summary

Pollution Prevention Opportunity Assessment for Two Laboratories at Sandia National Laboratories

Science Applications International Corporation

The reports summarized here concern work conducted at the Geochemistry Laboratory (GL) and the Manufacturing and Fabrication Repair Laboratory (MFRL) at the Department of Energy's (DOE's) Sandia National Laboratories (SNL) facility in Albuquerque, NM, as part of the U.S. Environmental Protection Agency's (EPA's) Waste Reduction Evaluations at Federal Sites (WREAFS) Program. This project was funded by EPA and conducted in cooperation with DOE officials.

A pollution prevention opportunity assessment (PPOA) done in July 1992 identified areas for waste reduction at the GL. The assessment also examined opportunities for site-wide pollution prevention at SNL that were related to the GL. Preliminary evaluation of the GL revealed the greatest opportunity for pollution prevention is associated with research project design and implementation. The full report presents potential research project design and materials management initiatives, as well as recycling/reuse options to enhance current pollution prevention progress. Concurrently, a PPOA was performed that identified areas for waste reduction at the MFRL. The results of that study are published in a separate document. Although the MFRL has made substantial progress to date, opportunities were identified for further action. Potential personnel/procedural initiatives and recycling/reuse options to achieve further pollution prevention progress are presented in the full report.

This Project Summary was developed by EPA's Risk Reduction Engineering Laboratory (RREL), Cincinnati, OH, to announce key findings of the research project that are fully documented in two separate reports (see Project Report ordering information at back).

Introduction

The WREAFS program was developed to identify new technologies and techniques for reducing wastes from industrial processes at federal sites and to enhance the implementation of pollution prevention through technology transfer. New techniques and technologies for reducing waste generation are identified through PPOAs and may be further evaluated through joint research, development, and demonstration projects.

The United States Government, through legislative and executive actions, has mandated waste minimization as a national environmental policy. Federal statutes, such as the Resource Conservation and Recovery Act Amendments of 1984 and the Pollution Prevention Act of 1990, have emphasized the need for generators to reduce the volume and toxicity of their waste. These laws affect all waste generators, including federal facilities. To support pollution prevention activities at federal facilities, EPA has established the WREAFS program. WREAFS, administered by EPA-RREL, provides funding and technical assistance for pollution prevention efforts at a wide variety of federal facilities.

SNL is a federally owned DOE facility located in Albuquerque, NM. Under the

purview of the WREAFS program, SNL and EPA conducted PPOAs for two laboratories within the SNL complex. The PPOAs followed the general format of the *Facility Pollution Prevention Guide* (EPA/600/R-92/088). Portions of the PPOAs also used the *Guides to Pollution Prevention* and *The Fabricated Metal Products Industry* (EPA/625/7-90/006); additional guidance was obtained from the *Guides to Pollution Prevention, Research and Educational Institutions* (EPA/625/7-90/010).

SNL is owned by the U.S. Government and is operated by Sandia Corporation, a subsidiary of AT&T, under a prime operating contract with the DOE. Sandia, Albuquerque is located south of Albuquerque, NM, within the boundaries of Kirtland Air Force Base (KAFB), in Bernalillo County. Sandia, Albuquerque consists of five technical areas and several remote test areas. Sandia's primary mission is national security, with principle emphasis on nuclear weapons development and engineering. In the process of carrying out this mission, Sandia has evolved into a multiprogram laboratory pursuing broad aspects of national security issues. As by-products of production, research and development, and environmental restoration activities, Sandia generates a variety of waste materials that are carefully controlled during operations and regulated by the federal government and state and local agencies.

SNL has developed a written waste minimization plan in compliance with DOE Order 5400.1. As part of this plan, the Waste Minimization Network (MinNet) has been created to carry out the Waste Minimization and Pollution Prevention Awareness Program. MinNet representatives assist the line organizations in planning, organizing, and directing those activities related to pollution prevention (e.g., conducting Process Waste Assessments as described in the Pollution Prevention Awareness Plan).

Procedure

Geochemistry Laboratory

The GL, located in Building 823, was chosen for one of the two WREAFS PPOAs. The lab performs analysis of earth materials (primarily physical and composition analysis) and simulates earth conditions (e.g. subjecting rock samples to extreme temperatures and pressures). The types of research performed by the GL fall into three major categories differing in researcher control over project design. For the purposes of this PPOA, these project types are considered the three types of processes performed by the lab.

Type 1 projects are those where the GL prepares an unsolicited proposal and submits it to one of several DOE sponsors for approval and funding. The DOE sponsors include Basic Energy Sciences, Energy Services, and DOE groups funding military/intelligence projects. The proposals are developed from the researcher's interests in areas of geochemistry that could further DOE's research objectives. The general approach for these projects is preparation and submission of proposal, acceptance by a sponsor, implementation of the project, and shutdown/closeout. Type 1 projects are the largest in scope and budget, typically generating funding for 1 or 2 people for several years ($100,000 to $300,000/yr). Although funding is renewable, the funding is approved on a 1-yr basis. Typically less than 10% of these projects are terminated before the anticipated project end; this would only happen if there were major changes in DOE policy/funding. This type of project accounts for approximately 40% of the lab's workload.

Type 2 projects are those where a proposal is being implemented by another group and the GL is asked to assist because of their capabilities and expertise. These projects are the most likely to be prematurely terminated and, consequently, are the largest producers of waste. Bench top wet chemistry research in this type of project also contributes to GL waste production. Type 2 projects are usually of medium duration and funding. This type of project typically does not have a formal statement of work (SOW) or similar instructions. An example of this type of project is the examination of brine inclusions in salt formations at DOE's Waste Isolation Pilot Plant (WIPP) site. Funding for this project was withdrawn before completion, leaving the GL with 50 lb of rock salt that reportedly must be disposed of as chemical waste. The project did not generate any unique chemicals that could not be used in ongoing or future projects. These projects account for approximately 50% of the GL workload.

Type 3 projects are those where the GL is requested by other SNL researchers to do a specific task. An example of this type of project is where the GL is asked to determine the types of chromium compounds in a soil sample. For these projects neither a formal SOW, nor a work request is generated. These projects are commonly done as "freebies" that, if successful, can turn into type 2 projects. They are of short duration, usually requiring one to three days of laboratory work. These projects account for approximately 10% of the GL workload.

The GL has established at least two "libraries" where materials accumulate. The sample library is where rock and soil samples are archived. Samples are usually archived to allow retesting, should the validity of previous results be questioned. Other samples are archived because of their uniqueness of origin or composition. Samples continue to accumulate until there is no more space. They are then disposed of, usually as chemical waste. Unique samples are either retained indefinitely or archived at sites where they were collected. The chemical library, the second collection, consists of chemicals that were not consumed during projects.

The GL uses a variety of analytical instruments in performing research: an atomic emission spectrophotometer; scanning electron microscope (SEM); x-ray diffraction analyzer; a scintillation counter; and an ion chromatograph. Various wet chemistry techniques are also used. Sample preparation employs grinding, sieving, and polishing equipment. Additionally, a drill press, lathe and grinder, comprise a small machine shop in the lab.

The largest waste stream, by volume, generated by the GL is Polaroid[1] film backs from SEM photography. The estimated annual production of this waste is 14 kg. The largest waste stream, by weight, is discarded, unused samples (e.g. cement cores, rocks, soils). As discussed above, this waste stream is generated on an infrequent basis; consequently, annual generation data is not available. The remaining wastes are mostly spent solutions and solids from various analytical techniques employed in the GL. The estimated annual production of these wastes is 77 kg. Because of the varied nature of research performed in the GL, waste generation is not consistent between projects and/or years. The use of prior waste generation data, therefore, is not an optimal indicator of future waste generation or a sufficient "yardstick" for measuring the success of pollution prevention projects.

Manufacturing and Fabrication Repair Laboratory

The MFRL typically repairs printed circuit board assemblies, wiring, and box assemblies (mother boards) for use in satellite systems. Repairs usually involve changing and modifying design by adding or replacing electrical components. Occasionally, repairs involve replacing faulty electrical components. Of approximately 1100 repair requests processed from Oc-

[1] Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

tober 1990 to September 1991, 80% involved boards; the remainder was roughly divided between boxes and cables. These repairs usually involve soldering of new resistors, capacitors, transistors, etc. MFRL also repairs similar assemblies for ground equipment.

A work repair request is submitted for each electronic assembly needing repair. MFRL staff log in the board and give it an initial inspection. The part is given to the technicians for repair. After the repair, the board is again inspected to assure that all work was adequately completed. Currently, about 70% of the electronic boards are destined for satellite applications, and the remainder are used in miscellaneous ground equipment. Satellite systems cannot be repaired once deployed (except by an expensive space shuttle mission); the final product must be of superior quality.

Approximately 683 lb/yr of waste are generated from the MFRL. Bulk solvent accounts for approximately 88% (603 lb) of the waste generated. Other waste streams include solvent contaminated lab trash, rinse water, conformal coating waste, isopropanol, solder and lead scraps, potting compound waste, isopropanol contaminated lab trash, adhesive contaminated lab trash, and flux contaminated lab trash. These other wastes are generated at an annual combined rate of approximately 80 lb/yr. Wastes and input materials are primarily related to board repair, but a portion of these result from repair of box assemblies and cables. The total waste generation on a per unit basis is approximately 0.62 lb (0.07 lb excluding bulk solvent). Waste generation can vary significantly from one repair to another.

Results and Discussion

Geochemistry Laboratory

The nature of waste generation at SNL presents certain obstacles to pollution prevention initiatives. The number of laboratories at SNL and the nature of laboratory work result in a large number of small quantity waste streams being generated. Conducting quantitative analysis of the feasibility of pollution prevention opportunities may not be cost effective, given the small amounts of waste generated by individual labs.

The need for generating reproducible lab results and the strong reliance on standard methods hinder implementation of pollution prevention initiatives that could call into question a researcher's findings. The complexity of federal and state hazardous waste regulations also makes scientists reluctant to carry out many pollution prevention activities. The feasibility of pollution prevention opportunities discussed in this report, therefore, is largely dependent on the attitude and confidence of SNL's researchers. If, through education and training, the importance of pollution prevention is elevated to the level of other crucial scientific principles, significant reductions in waste generation within SNL's labs can be achieved.

Many of the pollution prevention opportunities discussed in this report are feasible and readily implementable through researcher and administration initiatives. Tables 1 and 2 present qualitative ratings of pollution prevention options for GL projects and site-wide, respectively. Each option was subjected to the same eight criteria and rated. Options affording the greatest benefit or least detrimental effect for a criterion were assigned a "5" for that criterion. Options affording the least benefit, or most detrimental effect were assigned a "1". The ratings were summed and a total score given for each option. While the totals indicate that implementation of certain options would be more feasible than others, the range of totals is sufficiently narrow to require SNL discretion in prioritizing the options.

Given DOE's stated commitment to pollution prevention, proposals that include waste minimization components should be favored over similar research that does not address waste generation. Submission of these types of proposals would require researchers to invest additional time in proposal preparation. The increased chances of DOE funding the proposal (because of its pollution prevention aspects) and the potential savings in disposal cost, however, justify the increased effort. Building pollution prevention into research proposals, consequently, is one of the most feasible initiatives.

Site-wide pollution prevention opportunities offer the greatest potential for waste reduction. The site-wide options identified in this report are technically feasible. Many of the options are already being developed and implemented at SNL. With the recommended modifications, implementation of these options will be even more effective. Although increased costs would be incurred, the increase would be offset by savings in disposal costs. Although researchers would have to modify procurement habits and may have to spend increased time in tracking materials, the program may assist researchers in preparing for future projects by being aware of intra- and inter-laboratory resources.

Manufacturing and Fabrication Repair Laboratory

The assessment team visited the two rooms (repair room and vapor degreasing room) and the storage room for the MFRL. During the assessment phase of the PPOA, several options were identified for each waste stream. The pollution prevention options evaluated in detail during the feasibility analysis are summarized in Table 3.

Test/Reuse Rinse Water—

Testing of the rinse water would probably reveal that it is not an actual D008 waste. Once this waste stream is determined to be non-hazardous, it could be used for other non-potable purposes.

The cost of testing is estimated to be $50 assuming purchase of two test kits. MFRL personnel would send samples to a certified laboratory that employed an appropriate analytical method such as SW-846 Method 6010, 7420, or 7421. This price may be reduced if analysis can be performed onsite by another organization within SNL. The change in disposal and transportation costs results in a net annual savings of $139.50. The payback period for this option is 0.36 years.

Eliminate Ziplock Bags—

Nonflammable contaminated laboratory trash is placed in Ziplock bags so it can be carried to a 30-gal container in the storage room. Each Ziplock bag is labelled with a bar code for tracking purposes. The 30-gal waste container is lined with a plastic bag, which is removed when full and transported to the waste disposal area. At this point the bag is combined in special containers with other wastes. The Ziplock bags contain mostly air. By keeping a lined 20-gal polyethylene container in the vapor degreasing room, the use of Ziplock bags could be eliminated. The disposal people already pick up similar 20-gal containers at SNL.

The cost of the 20-gal container was priced at $31.20. The change in disposal and transportation costs is estimated to be $28.40. The raw material costs savings from not having to purchase Ziplock bags for this purpose is estimated at $100. With a net annual savings of $128.40, the payback period for this option is 0.24 years. These savings do not include reductions in waste management costs produced by no longer bar coding and tracking each individual Ziplock bag. When considering these savings, the payback period will be much shorter.

Table 1. *Rating of Pollution Prevention Options for GL Projects*

Pollution Prevention Option	Media Impact	Pollution Prevention Hierarchy Factor	Potential Economic Recovery	Ease of Implementing	Crossfeed Potential	Mission Impact	Material Control	Increased Staff Required	Total
Type 1 Projects									
Design pollution prevention into proposals for research activities	5	5	5	4	5	5	5	5	39
Build in funding for proper waste management	4	3	5	4	1	5	5	5	32
Return unused, contaminated samples to point of collection or SNL grounds	5	3	4	3	1	5	5	4	30
Type 2 Projects									
Escrow a portion of available funds to cover the cost of project closeout	4	2	4	2	1	3	5	5	26
Contact other labs within SNL before ordering chemicals to determine their local availability	5	5	5	3	3	4	5	5	35
Encourage chemical suppliers to accept returned, unopened chemicals and issue refund or credit	5	4	4	3	3	4	4	5	32
Exert tighter controls on sample sizes sent to GL	5	5	3	3	3	4	4	5	32
Type 3 Projects									
Determine sample quantities needed and alternatives to sample analyses	5	5	4	4	3	5	5	4	35
Expand use of microanalytical techniques	4	5	4	3	3	5	4	3	31
Retain or return to requester unused portions of samples	5	3	4	2	1	5	5	5	30

* *Pollution prevention options rated with 5 signify most favorable effect and 1, least favorable effect.*

Break Off Swabs—

By breaking off the contaminated ends of swab sticks, the amount of hazardous waste generated can be reduced. As long as the uncontaminated end is long enough, it could be reused by the technician. It is estimated that the amount of laboratory waste resulting from swab use could be reduced by 80%. In addition, approximately 100 swabs/yr could be eliminated by reusing the clean ends of broken swab sticks.

No capital costs are associated with this option. The estimated disposal and transportation cost savings are estimated at $20.55. The change in raw material cost from purchasing less swabs is $1.73. The net annual savings would be $22.28. Since there are no capital costs, the savings would be realized immediately.

Eliminate Bench Cleaning—

Lab trash is generated when bench cleaning is performed to deflux soldered connections. After the boards are repaired they are cleaned in the vapor degreaser, regardless of whether they were bench cleaned or not. Elimination of the bench cleaning step would reduce the amount of solvent- and flux-contaminated lab trash generated. In addition the number of wipes and swabs expended would be less.

There are no capital costs associated with this option. The disposal and transportation cost savings from this option are estimated to be $63.11. Raw material cost savings are $26.15. The expected net annual savings is $89.26 with a payback period of zero years.

Conclusions and Recommendations

Geochemistry Laboratory

SNL continues to expand its pollution prevention efforts. Implementation of concepts identified during this WREAFS project would further enhance SNL's pollution prevention program. To that end, EPA recommends that DOE and SNL investigate the following topics:

- Research Proposals—Build pollution prevention into research projects from the start. Researchers should share their ideas in this area, possibly through the MinNet. An onsite compendium of pollution prevention ideas could be generated to assist researchers in this area.

Table 2. *Rating of Pollution Prevention Options: Site-Wide Projects*[*]

Site-Wide Options	Media Impact	Pollution Prevention Hierarchy Factor	Potential Economic Recovery	Ease of Implementing	Crossfeed Potential	Mission Impact	Material Control	Increased Staff Required	Total
Chemical Material Management System									
Provide a life cycling and control mechanism for chemical materials	4	3	3	3	4	5	5	4	31
Central Purchasing									
Educate procurement personnel to spot material substitution opportunities	5	5	4	3	5	5	5	3	35
Central Distribution									
Determine usage patterns of operations that commonly use and dispose of certain chemicals	5	4	4	3	4	5	5	4	34
Order specialty chemicals through the site-wide stockroom	5	4	4	3	4	5	5	4	34
Identify other potential users	5	3	5	3	1	5	5	4	31
Checkout System									
Require employees retiring or leaving the lab to report the status of chemicals and samples present in their labs	4	4	4	4	4	5	5	5	35
Chemical Exchange									
Require supplying researcher to certify contents of an opened container have not been altered by the addition of contaminants or improper storage	5	3	4	3	1	4	5	5	30
Explore ways to use expired chemicals for other applications	5	5	4	3	5	5	5	4	36
Chargeback System									
Use chargeback money for site-wide pollution prevention options	5	5	4	4	5	5	5	4	37

[*] *Pollution prevention options rated with 5 signify most favorable effect and 1, least favorable effect.*

- Central Purchasing/Central Distribution—Implementation and refinement of these systems could reduce waste generation. When combined with an expanded chemical exchange system, disposal of expired chemicals could be virtually eliminated.
- Escrowed Closeout Money—By setting aside this money at the beginning of a project, potential reuse, proper characterization, and appropriate management of chemicals can be maximized.
- Checkout System—As with the escrowed closeout money, potential reuse, proper characterization, and appropriate management of chemicals can be built into the procedures for researchers leaving SNL employment.
- Chargeback System—Modifications to the system that promote funding of site-wide projects would make the system more effective.

The recommendation with the largest potential for pollution prevention gains is to continue SNL's education and training efforts. Through these efforts, pollution prevention can become an integral part of research design, implementation, and conclusion. As researchers modify their perceptions toward waste generation, new concepts and approaches that extend beyond individual labs will emerge and be assimilated into site-wide pollution prevention efforts.

Manufacturing and Fabrication Repair Laboratory

Of the four options evaluated in detail, eliminating Ziplock bags appears to be the most promising. All of the options had payback periods of less than 6 months. The waste reduction achieved from any of the options evaluated is small, but they are easy to implement and savings could be realized quickly.

These options are for extremely small waste streams, and they are presented here only as examples of the types of activities that could be identified using EPA's systematic approach to pollution prevention for the individual organizations within SNL. The cost effectiveness of con-

Table 3. Summary of MFRL Pollution Prevention Options

Pollution Prevention Options	Waste Streams Affected	Nature of Pollution Prevention Option	Capital Investment $	Net Operating Cost Savings $/yr	Payback Period (yr)	Rank Low to High (1-4)
Test/Reuse rinse water	*Rinse water*	*Recycling/Reuse*	*50.00*	*139.50*	*0.36*	*3*
Eliminate Ziplock bags	*Solvent lab trash, adhesive lab trash, conformal coating waste, potting compound waste, solder and lead scraps*	*Personnel/Procedure-Related*	*31.20*	*128.40*	*0.24*	*4*
Break off swabs	*Solvent lab trash, adhesive lab trash, conformal coating waste, potting compound waste, and isopropanol lab trash*	*Personnel/Procedure-Related Recycling/Reuse*	*0*	*22.28*	*0*	*1*
Eliminate Bench Cleaning	*Solvent contaminated lab trash*	*Personnel/Procedure-Related*	*0*	*89.26*	*0*	*2*

ducting PPOAs for other SNL organizations should be examined. An ongoing effort at SNL is to prioritize waste generators based on quantity and/or type of waste generated. Implementation of options at SNL should be done according to a prioritization ranking; those with the greatest potential for pollution prevention should be done first.

The full reports were submitted in fulfillment of Contract 68-C8-0062, WA 3-51, by Science Applications International Corporation under the sponsorship of the U.S. Environmental Protection Agency.

*U.S. Government Printing Office: 1993 — 750-071/60214

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***James S. Bridges** is the EPA Project Officer (see below).*
The complete report consists of two volumes, entitled "Pollution Prevention Opportunity Assessment for Two Laboratories at Sandia National Laboratories:"
Volume 1. "Pollution Prevention Opportunity Assessment: Geochemistry Laboratory at Sandia National Laboratories," (Order No. PB93-146868; Cost: $17.50, subject to change)
Volume 2. "Pollution Prevention Opportunity Assessment: Manufacturing and Fabrication Repair Laboratory at Sandia National Laboratories," (Order No. PB93-146900; Cost: $17.50, subject to change)
The above reports will be available only from:
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