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Pollution Prevention Cost Savings Potential

John Celeste

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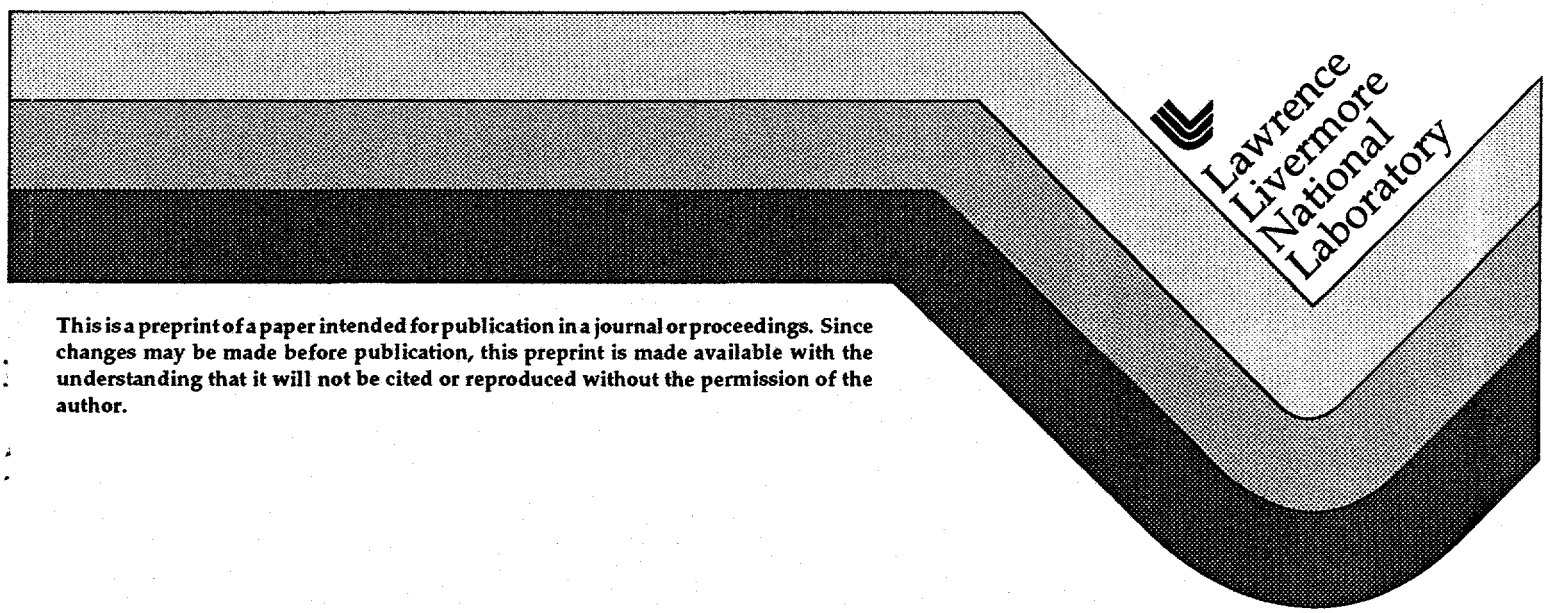

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Abstract

The waste generated by DOE facilities is a serious problem that significantly impacts current operations, increases future waste management costs, and creates future environmental liabilities. Pollution Prevention (P2) emphasizes source reduction through improved manufacturing and process control technologies. This concept must be incorporated into DOE's overall operating philosophy and should be an integral part of Total Quality Management (TQM) program. P2 reduces the amount of waste generated, the cost of environmental compliance and future liabilities, waste treatment, and transportation and disposal costs. To be effective, P2 must contribute to the bottom line in reducing the cost of work performed.

P2 activities at LLNL include: researching and developing innovative manufacturing; evaluating new technologies, products, and chemistries; using alternative cleaning and sensor technologies; performing Pollution Prevention Opportunity Assessments (PPOAs); and developing outreach programs with small business. Examples of industrial outreach are: innovative electroplating operations, printed circuit board manufacturing, and painting operations. LLNL can provide the infrastructure and technical expertise to address a wide variety of industrial concerns.

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I. Introduction

Waste currently generated by DOE facilities along with the legacy waste create serious financial problems. At LLNL they impact our current operations and annually cost millions of dollars to manage. Even with Pollution Prevention (P2), waste management costs continue to increase because of to increasingly strict regulations, compliance tracking and reporting, and the lack of adequate treatment capacity. Our groundwater remediation projects are clean up contamination that is decades old while mortgaging future budgets for the next generations. Future decontamination work will have the same effect. These expenses are diverting funding which could be used for new programs in other areas such as energy, transportation, and improvement of the nation's manufacturing competitiveness.

The total live cycle cost of waste generation is extremely high compared with the investment in P2 today. P2 cost savings are compounded daily by avoiding treatment and disposal costs and minimizing future environmental liabilities.

P2 attempts to reduce waste generation at its source. Currently, the system does not charge the generator for the clean up but EM pays the cost and thus the overall clean up costs skyrocket. End-of-the-pipe solutions are never as cost effective as source reduction. Effective P2 programs in the field are required to maximize the return on investment using source reduction as the preferred option, not only to the DOE but to the American taxpayers as well.

We need to view any waste generation as an unacceptable inefficiency in resource utilization. Buying recycled materials from the beginning and finding an alternative use for the by products are ways of incorporating P2 into the daily operations of the DOE and its contractors.

The current budgets for P2 are very limited especially when compared with the total budget for waste management, treatment, storage, and disposal. At LLNL, we are prioritizing waste streams and processes for PPOAs. Unfortunately, the current waste management database provides mostly end-of-the-pipe information and very little data regarding the responsible processes or source

terms. We are working to incorporate the source terms into the database to complete the profiles on waste generation at LLNL

II. Recent P2 accomplishments at LLNL

A significant waste reduction effort has been focused on reducing hazardous organic solvents, which are disposed of as liquid hazardous waste or which may evaporate into the air. LLNL is undertaking an alternative solvent and coolants research project to minimize the use of ozone-depleting chemicals, halogenated hydrocarbons, and material with volatile organic compounds. Substituting less toxic cleaning materials minimizes environmental and waste management costs, minimizes employee health risk exposures, reduces potential impact to the environment, and correlates well with guidance and objectives from the USEPA.

Several alternative solvents have proved to be not only less hazardous but also better cleaners than the more toxic materials previously used. LLNL has evaluated the effectiveness of more than 70 alternative solvents for cleaning grease, oil, and dirt from commonly used substrates such as optical glass, aluminum, other machined metals, printed wiring boards, and plastic. Overall, permitted solvents use was reduced from 5700 liters to fewer than 570 liters per year by switching to alternative cleaning products that do not require permits.

Several parts degreasers have been eliminated and/or changed to citrus-based solvents and an aqueous-based detergent solution. Dry film developing reduced its use of 1,1,1 Trichloroethane by switching to nonchlorinated, nonpetroleum-based solvents, and a printed circuit board cleaning unit was purchased that eliminated Freon degreasing of the boards.

The metal plating shop converted to alternative chemistries that eliminate chrome from many of its waste streams. By consolidating similar metal finishing processes in two facilities, it eliminated 900 gallons per year of spent chemical waste. We initiated several pollution prevention technology evaluation and development projects . These included analyzing carbon dioxide snow and pellet cleaning, using no-clean flux for electronic assemblies, evaluating alternative electroplating chemistries for the elimination of hexavalent chromium and the

recycling of nickel, and improving parts-cleaning process controls through development of real-time contamination analysis sensors.

Transportable Treatment Units (TTUs) are used to process hazardous wastewater from retention tanks. Since mid-1992, TTUs have treated approximately 200,000 liters of metal-contaminated wastewater. This treated wastewater is discharged to the sewer system instead of being hauled off site for disposal. This procedure has already resulted in a cost savings of more than $100,000.

The Hazardous Waste Management Division of EPD established a Chemical Exchange Warehouse (CHEW) to receive, temporarily store, and track excess, usable chemicals in order to make them available to other users. By reusing chemicals, the hazardous waste stream is lessened, thereby reducing chemical procurement as well as disposal costs. The program was established in October 1993 and savings from reduced disposal expenses are expected to break even with operational costs in 1994. If LLNL personnel cannot use the chemicals, we try to find other DOE or federal agencies or contractors who can reuse them. The chemicals are ultimately sold if no one picks them up for reuse.

The Chemistry and Materials Science Department recycled approximately 426 liters of acetone that were used in a process to displace water from aerogel. The acetone is driven from the aerogel, captured, and distilled for reuse. The reuse of acetone is of great interest in industry and is an added selling point regarding for aerogel manufacturing technology transfer.

The Lasers Directorate modified procedures for refurbishing Freon in equipment, reducing the potential for Freon emissions during maintenance by 5700 liters per year. Installing a biodegradable, water-based dye penetrant inspection station for radioactive contaminated parts assured that mixed waste was not generated during the inspection process. This also eliminated the production of deionized water and reduced the volume of wastewater sent to the hazardous waste retention system by 31,000 liters. New laser designs are being investigated that will eliminate the use of Freon coolants with a non-hazardous oil-based material.

Site 300 staff have developed and implemented procedures for controlling the generation of energetic materials and wastes and have a recycling system for

those that are generated. TCE was removed from an environmental testing facility and sent to an off-site resource recovery operation, and surplus insulating oil (sixteen 55-gallon drums) was transferred for use in another facility.

The Automotive Fleet Division of Business Services at Site 300 have substituted aerosol cans with reusable stainless steel containers that use pressurized air, providing an 80% reduction in generated waste. Also, compressor and generator lubricating oils are now changed only when analyses show high metal content; previously, oil changes followed a time schedule. The Motor Pool started using recapped tires instead of buying new ones for certain vehicles.

Biology and Biotechnology Research reduced its radioactive waste by using fewer long half-life radioisotopes, eliminated the use of hazardous solvents for disinfectanting cleaning bench tops and biosafety cabinets, and now use a non-hazardous scintillation cocktail, when applicable, thus eliminating the generation of mixed waste

Overall, during 1993 hazardous waste generation declined by 303,000 kilograms, or 32%, at the Livermore site and by 18,800 kilograms, or 21%, at Site 300. Mixed waste generation decreased by about 46,400 kilograms, or 41%, at the Livermore site, while Site 300 had a 100% reduction from 172 kilograms to none. Mixed transuranic waste decreased by 254 kilograms, or 88%, at the Livermore site.

In 1991, LLNL implemented a site-wide white paper recycling program that collected 267 tons of paper in its first year. In 1993, 392 tons were collected and recycled. This number includes destroyed classified as well as nonclassified paper wastes.

The Pollution Prevention Group (PPG) completed the second of two nonhazardous waste stream assessments in which solid wastes from over one hundred dumpsters were sampled and categorized according to their types. Cardboard comprised the largest single solid-waste stream category. LLNL has implemented a pilot program for cardboard recycling and is in the process of implementing a sitewide program that will go on-line in FY95.

Plastics, comprised largely of polystyrene from food service wastes, constituted another major group of wastes. PPG is studying the feasibility of recycling polystyrene at LLNL's three cafeterias. Glass and aluminum cans represented a very small portion of the waste stream, indicating that individual employee efforts to collect and recycle these materials are successful. Other new or continuing programs include wood recycling, which diverted 419 tons from the LLNL solid-waste stream, plant trimmings composting by the LLNL gardeners , a pilot program to recycle single-use batteries, holiday tree recycling, a cafeteria food donation program to a local food bank, and donation of over $1,000,000 worth of excess equipment to area schools. PPG has developed and implemented a comprehensive database for tracking and analyzing nonhazardous waste generation and P2 efforts site wide.

LLNL has established a Buy Recycle Committee in response to Executive Order 12873, which mandates federal facilities to increase use of recycled materials. LLNL Stores now carries white photocopier and printer paper containing 50% recycled fiber content (with 10% to 25% post-consumer waste), refillable bottles that replace aerosol cans, aqueous-based correction fluid, low alkalinity dishwashing compound, rechargeable batteries, and refurbished laser printer toner cartridges. The Technical Information Department demonstrated that recycled paper could be used in most copiers and laser printers, stimulating acceptance by many other departments.

Property Management's Donation, Utilization, and Sales (DUS) Group has a project to divert scrap material from being dumped into landfills and make it available for LLNL reuse at no cost to the programs. The most common types of reuse items are moving boxes, wooden pallets, box pallets, office supplies, and general hardware such as nuts, bolts, and screws. Scrap metals that are not picked up for reuse are sold under term contracts, as are tires, cardboard, telephone books, electronic scrap, and baled paper. Pilot programs have been implemented to recycle magazines and newspapers. During CY 1993 , DUS recycled over 1200 metric tons of scrap material. DUS is working closely with the PPG to explore new avenues of recycling.

In 1993, LLNL received a national award from the Department of Energy commending the Laboratory's nonhazardous waste stream assessment and its outstanding contribution to solid-waste recycling.

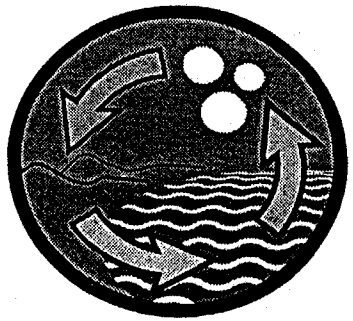
III. Future P2 program development goals at LLNL

The previous section on P2 accomplishments documents waste minimization and pollution prevention at LLNL. After the "low hanging" fruit is picked, the program must develop a system for ranking PPOAs and P2 project implementation. This work is now in process using a decision matrix approach. In order for the projects to be ranked by ROI we need a reasonable estimate of the total waste management costs from the point of generation to final disposal.

We are currently evaluating waste management costs by using our Hazardous Waste Management Division's (HWM) budget. We are evaluating and assigning a percent for each work breakdown structure element that which contributes to each the waste's management cost. The costs will then be correlated to the number of waste requisitions or the quantity of waste that is managed by HWM so that we can develop the unit cost information. We are planning to use these numbers as the baseline unit costs to perform life cycle cost assessments (LCA).

Even though it is difficult to assign total costs to waste management, we believe that our system will be a consistent, defendable, and useful baseline for LCA comparisons. As long as we apply a consistent set of criteria, the relative comparisons of the total LCAs will be useful in identifying the ROI and therefore in prioritizing P2 opportunities.

Pollution Prevention Cost Savings Potential



John Celeste
Pollution Prevention Group Leader
Lawrence Livermore National Lab

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Waste generation impacts current operations, future costs and creates future environmental liabilities

- Annual waste management costs at LLNL are in the millions of dollars and are continually increasing.
- The groundwater remediation projects are mortgaging budgets for the next generation.
- The lack of adequate treatment capacity for mixed waste creates storage and disposal liability problems.
- The immediate needs for treatment and remediation diverts DOE resources for other program development.
- Future decontamination and decommissioning work may dwarf the current waste treatment budgets.

A Proactive Pollution Prevention (P2) program addresses waste generation at the source

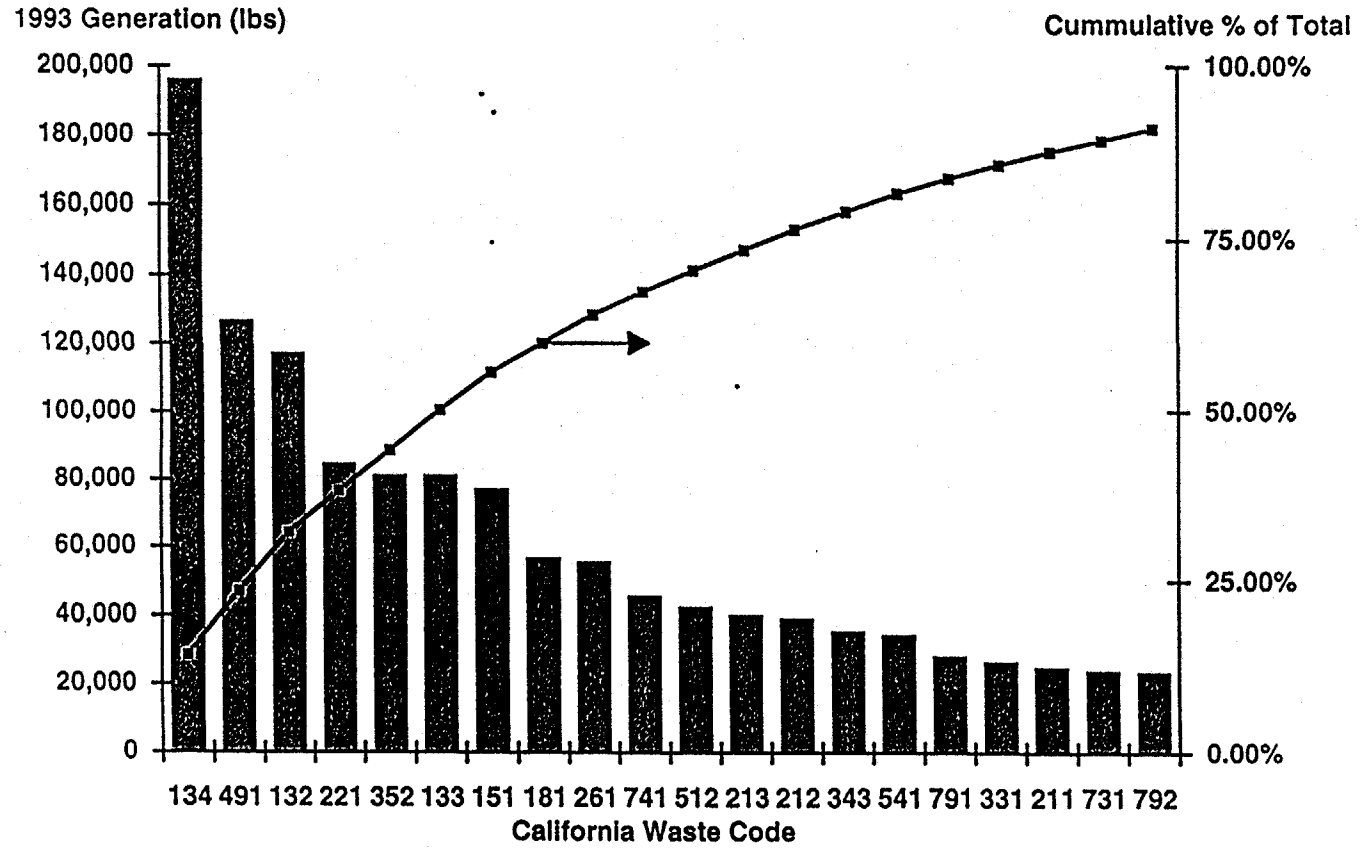
- Source reduction
- Recycle Reuse
- Waste minimization
- Treatment

Source reduction is achieved by process improvement control systems and material substitution. We must shift paradigms and view "waste" as an unacceptable inefficiency.

We are developing criteria to identify major waste streams and to prioritize P2 implementation projects

	Weight	Score	Totals
Quantity			
Cost			
Toxicity			
Risks			
Politics			
Implementability			
Stability			

Evaluating the hazardous waste by type is useful to identify the source of generation



Our database is useful for end-of-pipe information, however the source is not adequately identified.

There are several examples of cost savings from source reduction and recycle at LLNL

- Explosives testing
- Metal plating
- Chemical Exchange Warehouse
- Donation, Utilization and Sales
- Paint Shop
- Machine shop coolant recovery
- Alternative solvent substitution

The alternative solvent substitution program reduces toxic air emissions using environmentally benign cleaners

- The incremental cost of air emissions is high
  - May increase LLNL's classification level
  - Risk evaluation studies would be required
  - Public notification and reaction would be negative
  - Would increase the cost of compliance

- Clean Air Act requires no net increase in site emission
  - Restrictive for new experiments
  - Buying emission credits can result in bad publicity

The Donation, Utilization and Sales (DUS) efforts have recycled over 1200 metric tons in FY94

- Recycled scrap metal, tires, cardboard
- Donated over $1M in excess equipment to schools
- Donated over 6,700 gallons of transformer oil for fuel and avoided hazardous waste generation
- Recycled contaminated diesel fuel for reuse

The Chemical Exchange Warehouse (CHEW) program "brokers" unused chemicals at LLNL and has saved over $120K in FY94

- CHEW picks up, stores and delivers unused chemicals onsite at no charge.
- Maintains a database on a computer server which can be accessed sitewide.
- Utilizes storage space in a hazardous waste management building.
- Chemicals are made available to other agencies if there is no interest at LLNL.

The metal plating shop has recycled over 40,000 gallons and is working at being a zero discharge facility

- Eliminated vapor decreaser
- Eliminating cyanides in metal plating
- Evaluating a replacement for hexavalent chrome
- Combined operations from two facilities into one facility
- Is a "model shop" where others can evaluate new technologies

Examples of P2 Cost Savings

	Amt (lbs)	Savings
• Donation Utilization and Sales	> 3 million	$500K
• CHEW	N/A	120K
• Reduction of aqueous photochemical waste (moving into a filmless, digital system)	6,000	225K
• Eliminated the use of lead as a barrier (mixed waste stream was eliminated)	125,000	280K
• Redesigned a test screening system for explosives testing	26,400	281K
• Segregated energetic materials	20,000	300K
• Developed an energetic materials recycle database program	10,000	170K
• Separated gravel from other debris (mixed waste stream was minimized)	43,000	262K

Currently the cost savings only reflect the treatment and disposal costs

We are developing a unit cost for each waste type using the Hazardous Waste Management's work breakdown structure.

This includes the following:

- Documentation / Information System
- Inspection / Certification
- Training / Quality Assurance / Compliance
- Storage, Transportation and Disposal
- Management/Administration
- Processing / Engineering / Analysis

Barriers to Pollution Prevention Implementation

- Lack of financial incentive to reduce
- Lack of funding for new projects
- Fear of reallocation of existing funding for P2 projects
- Fear that changes to existing processes may impact cost, quality, and production
- Not my job, too much work

Conclusion

- LLNL is pursuing P2 to meet University of California contract Performance Measures.
- We have successfully implemented P2 at LLNL.
- A recharge program that would provide funding for P2 projects could ensure continuous improvement.
- P2 benefits are continuously compounded.
- LLNL has the expertise and infrastructure to help industries reduce their cost of operation and increase competitiveness.