United States
Environmental Protection
Agency

National Risk Management
Research Laboratory
Cincinnati, OH 45268

Research and Development

EPA/600/S-95/025 September 1995

ENVIRONMENTAL RESEARCH BRIEF

Pollution Prevention Assessment for a Manufacturer of Power Supplies

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Abstract

The U.S. Environmental Protection Agency (EPA) has funded a pilot project to assist small and medium-size manufacturers who want to minimize their generation of waste but who lack the expertise to do so. In an effort to assist these manufacturers Waste Minimization Assessment Centers (WMACs) were established at selected universities and procedures were adapted from the EPA *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003, July 1988). That document has been superseded by the *Facility Pollution Prevention Guide* (EPA/600/R-92/088, May 1992). The WMAC team at Colorado State University performed an assessment at a plant that manufactures power supplies from printed circuit boards and electronic components. Through-hole components are attached to the boards using a wave soldering machine. Surface-mounted components are mounted onto the boards which are then combined with cases, frames, and other prefabricated parts to form power supplies. The product is then tested and shipped. The assessment team's report, detailing findings and recommendations, indicated that waste cooling water is generated in large quantities in the testing and burn-in area, and that significant cost savings could be achieved through the installation of a closed-loop cooling system.

This Research Brief was developed by the principal investigators and EPA's National Risk Management Research Laboratory, Cincinnati, OH, to announce key findings of an ongoing research project that is fully documented in a separate report of the same title available from University City Science Center.

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Introduction

The amount of waste generated by industrial plants has become an increasingly costly problem for manufacturers and an additional stress on the environment. One solution to the problem of waste generation is to reduce or eliminate the waste at its source.

University City Science Center (Philadelphia, PA) has begun a pilot project to assist small and medium-size manufacturers who want to minimize their generation of waste but who lack the in-house expertise to do so. Under agreement with EPA's National Risk Management Research Laboratory, the Science Center has established three WMACs. This assessment was done by engineering faculty and students at Colorado State University's (Fort Collins) WMAC. The assessment teams have considerable direct experience with process operations in manufacturing plants and also have the knowledge and skills needed to minimize waste generation.

The pollution prevention opportunity assessments are done for small and medium-size manufacturers at no out-of-pocket cost to the client. To qualify for the assessment, each client must fall within Standard Industrial Classification Code 20-39, have gross annual sales not exceeding $75 million, employ no more than 500 persons, and lack in-house expertise in pollution prevention.

The potential benefits of the pilot project include minimization of the amount of waste generated by manufacturers, and reduction of waste treatment and disposal costs for participating plants. In addition, the project provides valuable experience for graduate and undergraduate students who participate in the program, and a cleaner environment without more regulations and higher costs for manufacturers.

Methodology of Assessments

The pollution prevention opportunity assessments require several site visits to each client served. In general, the WMACs follow the procedures outlined in the EPA *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003, July 1988). The WMAC staff locate the sources of waste in the plant and identify the current disposal or treatment methods and their associated costs. They then identify and analyze a variety of ways to reduce or eliminate the waste. Specific measures to achieve that goal are recommended and the essential supporting technological and economic information is developed. Finally, a confidential report that details the WMAC's findings and recommendations (including cost savings, implementation costs, and payback times) is prepared for each client.

Plant Background

This plant manufactures power supplies from printed circuit boards and electronic components. Approximately 50,000 units are produced annually during 2250 hr/yr of production time.

Manufacturing Process

The raw materials used by the plant—printed circuit boards and electronic components—are brought to the automated assembly area. Through-hole components are placed onto the boards manually, and the boards are passed through a wave soldering machine to secure the parts in place.

An ethanol-based flux is used by the wave solder machine to prepare the circuit board surface for soldering. Flux residue that remains on the boards after soldering is removed in a semi-automated board washer.

Surface-mounted components are added to the boards in another area of the plant. A flux that leaves no residue and solder paste are applied to the boards before the parts are put into place; the parts are then passed through an oven to secure the components to the board. Washing of the boards is not required after this operation.

The boards are combined with cases, frames, and other prefabricated parts and assembled into power supplies. Each unit is then load-tested in a test-area for about two hours. A longer burn-in test is also performed on each unit. After testing, the power supplies are packaged and stored to await shipment to customers.

An abbreviated process flow diagram for power supply manufacture is shown in Figure 1.

Existing Waste Management Practices

This plant already has implemented the following techniques to manage and minimize its wastes.

- A CFC reduction plan/policy has been implemented. All possible substitutions for CFCs in all plant operations are being explored; many substitutions already have been implemented.
- A flux that leaves no residue is used for surface-mounted parts. As a result the boards do not require cleaning after hand-soldering.

Pollution Prevention Opportunities

The type of waste currently generated by the plant, the source of the waste, the waste management method, the quantity of the waste, and the annual waste management cost for each waste stream identified are given in Table 1.

Table 2 shows the opportunity for pollution prevention that the WMAC team recommended for the plant. The opportunity, the type of waste, the possible waste reduction and associated savings, and the implementation cost along with the simple payback time are given in the table. The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. All values should be considered in that context.

It should be noted that the economic savings of the opportunity result from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health.

Additional Recommendations

In addition to the opportunity recommended and analyzed by the WMAC team, several other measures were considered. These measures were not analyzed completely because of insufficient data, implementation difficulty, or a projected lengthy payback. Since one or more of these approaches to pollution prevention may, however, increase in attractiveness with changing conditions in the plant, they were brought to the plant's attention for future consideration.

- Investigate the use of a no-clean wave solder machine in order to eliminate the need for cleaning following wave soldering. This technology is currently in the development stage.
- Install flow reducers on water lines in the test area to restrict the maximum flow rate available. This opportunity would not be viable should the plant implement the WMAC team's recommended waste minimization opportunity.
- Pipe the waste cooling water from the test area to the board washer in order to provide heated waste water as make-up to the washer. This opportunity would not be viable should the plant implement the WMAC team's recommended pollution prevention opportunity.

This research brief summarizes a part of the work done under Cooperative Agreement No. CR-819557 by the University City Science Center under the sponsorship of the U.S. Environmental Protection Agency. ßThe EPA Project Officer was **Emma Lou George**.

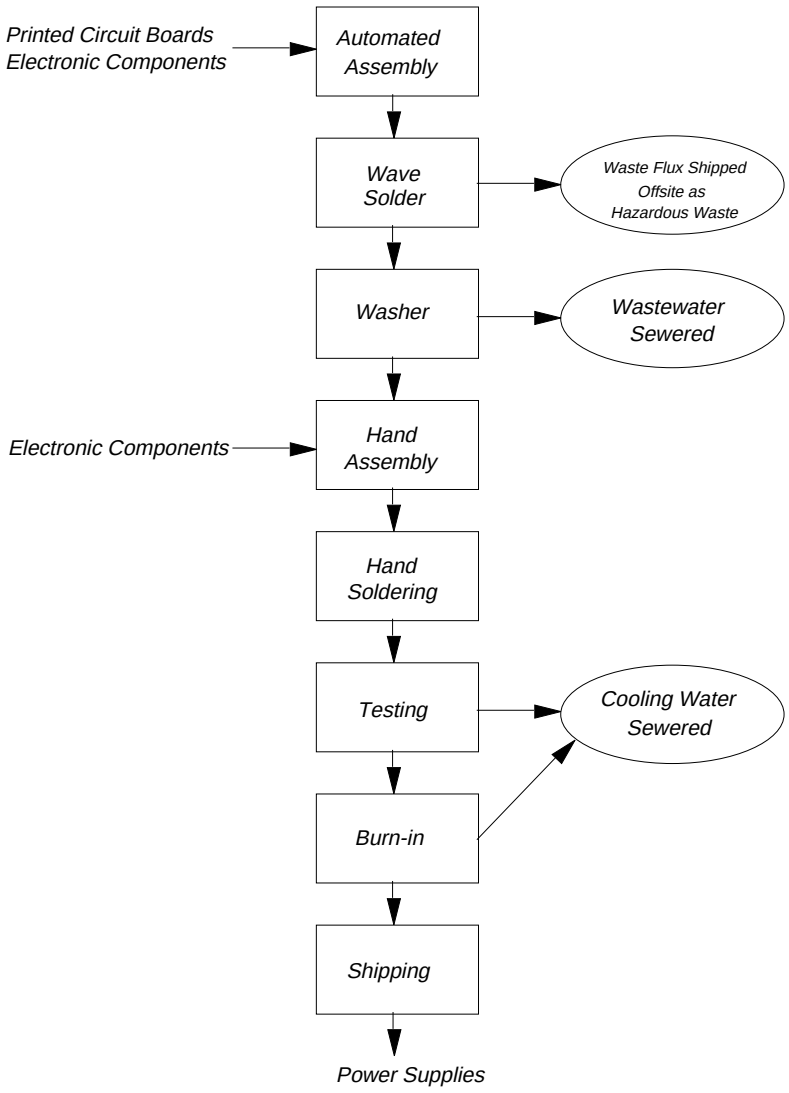

Figure 1. *Abbreviated process flow diagram for power supply manufacture.*

Table 1. *Summary of Current Waste Generation*

Waste Generated	*Source of Waste*	*Waste Management Method*	*Annual Quantity Generated (lb/yr)*	*Annual Waste Management Cost*[1]
Waste flux	*Periodic draining from wave soldering*	*Shipped offsite as hazardous waste; incinerated*	*2,690*	*$2,370*
Wastewater	*Printed circuit board washer*	*Discharged to sewer as industrial wastewater*	*1,999,200*	*670*
Cooling water	*Testing*	*Discharged to sewer as industrial wastewater*	*15,523,290*	*5,190*
Cooling water	*Burn-in*	*Discharged to sewer as industrial wastewater*	*12,571,640*	*4,210*

[1] *Includes waste treatment, disposal, and handling costs and applicable lost raw material value.*

Table 2. *Summary of Recommended Pollution Prevention Opportunity*

Pollution Prevention Opportunity	Waste Reduced	Annual Waste Reduction		Net Annual Savings	Implementation Cost	Simple Payback (yr)
		Quantity (lb/yr)	Percent			
Install a closed-loop cooling system for water used in the testing and burn-in areas in order to reduce water usage.	*Cooling water from testing* *Cooling water from burn-in*	*15,523,290* *12,571,640*	*100* *100*	*$9,550*	*$25,000*	*2.6*

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