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MEASURING POLLUTION PREVENTION PROGRESS

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Project Officers:

Harry M. Freeman
U.S. Environmental Protection Agency
Risk Reduction Engineering Laboratory
Cincinnati, OH 45268

and

Ann Rappaport
Center for Environmental Management
Tufts University
Medford, MA 02115

RISK REDUCTION ENGINEERING LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OH 45268

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NOTICE

The papers in these Proceedings were presented at the workshop, "Measuring Pollution Prevention", sponsored by Tufts University, Center for Environmental Management and U.S. Environmental Protection Agency, on March 31, April 1 and 2, 1993, in Salem, MA. This publication has been reviewed in accordance with the U.S. Environmental Protection Agency's review policies and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the EPA, nor does mention of trade names or commercial products constitute endorsement or recommendations for use.

FOREWORD

The growing importance of pollution prevention as an environmental strategy has increased pressure to develop systems for measuring achievements. The Pollution Prevention Act of 1990 charges U.S. Environmental Protection Agency with responsibility for developing national pollution prevention goals, and for devising a scheme for measuring national progress. Individual firms are under increasing pressure, in part from the public disclosure of toxic release information required under SARA Title III, to practice pollution prevention and to communicate successes to the public. All of these activities must occur within a recognized frame of reference or measurement scheme to be meaningful.

U.S. EPA's Risk Reduction Engineering Laboratory has identified pollution prevention measurement as a high priority for research, and as a result has provided support for this project, "Management Tools to Support Pollution Prevention", to be undertaken cooperatively between the Pollution Prevention Research Branch and the Center for Environmental Management of Tufts University.

These Proceedings from a 1993 Workshop provide the results of current information on projects presently underway. Those wishing additional information on these projects are urged to contact the authors or the EPA Project Officer.

E. Timothy Oppelt, Director
Risk Reduction Engineering Laboratory

ABSTRACT

The workshop, "Measuring Pollution Prevention Progress", was held in Salem, MA, March 31, April 1-2, 1993. The purpose of this Workshop was to present the latest significant research and practical findings related to pollution prevention measurement from ongoing and recently completed projects in industry, research and development institutions, and governmental organizations.

These proceedings are organized into two sections, contain complete paper presentations in the first section and brief and extended contributions in the second. Subjects include the application of system analysis, system input and output definitions, data handling, pollution prevention measurement types, financial aspects, management practice, and participants' discussions and recommendations.

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This workshop, "Measuring Pollution Prevention Progress", was planned in partial fulfillment of the project, Management Tools to Support Pollution Prevention, by the Center for Environmental Management of Tufts University under sponsorship of the U.S. Environmental Protection Agency. Dr. Ann Rappaport of the Center for Environmental Management is Project Leader responsible for coordinating this project. The workshop program and activities were planned by a committee consisting of the following individuals: Harry M. Freeman of U.S. EPA, RREL, Ann Rappaport, Margaret Flaherty and Maureen Hart of CEM. This Proceedings was compiled by Dr. Rada Olbina, a Tufts postdoctorate fellow at the RREL.

Section A

PRESENTATIONS OF PARTICIPANTS

POLLUTION PREVENTION: THE IMPORTANCE OF MEASURING PROGRESS

Jim Craig
US EPA, Office of Pollution Prevention and Toxics
(PM 222B)
401 M Street, SW
Washington, D.C. 20460
PHONE: (202) 260-4168

INTRODUCTION

Many of us at EPA feel strongly that the Agency has a responsibility to work cooperatively with industry, states, and academia whenever possible, to achieve environmental results, just as we have a corresponding obligation to regulate and enforce our Nation's environmental laws. We want to accomplish our work in a manner which helps keep American industry prosperous and competitive, and I hope some of the activities I mention today will indicate our commitment to that approach.

Before talking about measuring progress in working to achieve results, let me briefly describe the key components of EPA's program for pollution prevention. I want to emphasize the fact that this is not the Division's program, nor the office's, but rather is an Agency-wide program that even includes activities at other federal Agencies.

EPA's POLLUTION PREVENTION ACTIVITIES

Five themes characterize and guide our pollution prevention efforts and they may be useful in designing other programs.

(1) Incorporate prevention principles into the mainstream work of EPA and the Federal government.

(2) Help build and facilitate a network of prevention programs, particularly among states and local governments.

(3) Identify and pioneer new environmental programs which:

- Emphasize cross-media prevention
- Reinforce the mutual goals of economic and environmental well being, and
- Represent new models for government/industry interaction.

(4) Generate and share information to promote prevention and track its progress.

(5) Develop partnerships in technological innovation with the private sector.

Let me briefly outline a few highlights of our programs in each of these five areas.

Incorporating Prevention into the Mainstream

One of our goals has been to include pollution prevention (P2) principles in all facets of EPA's ongoing regulatory and program agenda. The EPA Pollution Prevention Strategy, formally announced in February 1991, sets forth guidance and direction for this effort. Both organizationally and programmatically, EPA has been working hard to ensure that prevention becomes a routine part of the way we do business.

How is this done? One initiative underway is the Source Reduction Review Project, a cross-program effort within the Agency to incorporate P2 into the process of developing statutorily mandated regulations for 17 industrial categories. The goal of the project is to ensure that each EPA office considers source reduction measures as a primary means of obtaining compliance with the desired standard and pushes as far up the environmental protection hierarchy as possible.

In addition, EPA's Office of Enforcement has a policy of including pollution prevention conditions in enforcement settlements when appropriate. Through supplemental environmental projects, violators can mitigate their fines and penalties by applying P2 practices in their operations.

In modifying our programs, it is clear that developing a P2 orientation even among our own staff is a difficult undertaking and one that will not happen overnight. For this reason, we have developed an Agency P2 training program which includes both general prevention training and orientation for all new employees, as well as specific training for permit writers and other EPA Regional staff. We're just now expanding our efforts to work with Agency programs to help them help themselves in promoting prevention. The idea is to enable them to take promising ideas and move them forward by obtaining management commitment at all levels, ensuring that training is available, and finally, providing guidance and oversight where needed to help them in their efforts.

EPA is also devoting attention to putting the federal government's P2 house in order -- developing a pollution prevention approach for the federal sector. The goal is to promote source reduction among federal agencies in their various capacities: as generators of hazardous and solid waste, in their ability to influence the marketplace as major purchasers of goods and services, and as policy-makers, regulators, and educators.

Network of State and Local Governments

It is critical for EPA to develop and strengthen state and local government P2 programs, and facilitate their coordination. It appears that the face of government on environmental issues, especially source reduction and toxic use reduction, is increasingly at the state level. EPA's assistance comes in several forms, including technical assistance and grant funding.

On the technical front, EPA is developing a pollution prevention information clearinghouse (PPIC) to provide assistance to targeted customers through the repository of prevention information and a database of industrial cases.

In 1993, EPA will provide about $6.8 million to states for P2 program activities -- an amount comparable to the last several years. This supplemental funding has helped state toxic use reduction and other similar programs take root and expand their prevention activities.

Pioneer New Programs

We will continue to identify and pioneer new environmental approaches and programs which emphasize cross-media prevention, reinforce the mutual goals of economic and environmental well-being, and offer imaginative new models for government/industry interaction.

EPA has launched a series of innovative programs designed to capture industry's attention and interest while engaging business in projects that will achieve real environmental benefits. The programs have mostly involved industry in voluntary pollution prevention projects that feature collaboration rather than confrontation.

An example? The voluntary 33/50 Program initiative to reduce toxic waste generation from industrial sources is expected to achieve real P2 results in a relatively short time frame. Under this program EPA has targeted 17 chemicals for reductions of *33 percent* by the end of this year and *50 percent* by the end of 1995.

Another exciting initiative is the "Green Lights" program, an aggressive, non-regulatory effort to reach corporate decision-makers with information on new energy-efficient lighting technologies.

Finally, we believe our new Design for the Environment, or DfE, program will encourage the design of safer products and processes and will, accordingly, eliminate or minimize the generation of pollution. Improved technologies lie at the heart of DfE -- we at EPA want to help make available information and help promote new analytic tools in ways which are most meaningful to the needs of those professional groups which guide industrial design decisions.

There are two areas that we're pursuing DfE: industry, and professions who have an influence on practices, decision making and activities that generate pollution. Initial industry efforts involve the printing and dry cleaning industries.

I'd also like to advise you of four projects which have longer run implications.

- We've recently provided grants to six university research groups exploring alternative synthetic pathways -- ways to design safer chemicals. Safer chemicals generally lead to safer products.

- We're working with property and casualty underwriters to develop an insurance incentive for P2 -- and they seem very interested. Our first focus is on the curriculum they use to train their profession.

- We're also considering a national accounting workshop to promote total cost assessments which allocate overhead to processes and material decisions which fail to prevent pollution.

Sharing Information and Tracking Progress

Sharing information is key to promoting prevention. We need to "keep book" on P2 progress and document real achievements to build public credibility. Here, we feel EPA must serve as an honest broker which recognizes genuine success but also sorts out false claims of public health and environmental protection.

TRI data is one of the most powerful changes that has occurred in the U.S. environmental sphere. In response to the Pollution Prevention Act of 1990, EPA has devoted considerable attention to additional types of information that should be collected and how the information should be used to measure progress in pollution prevention. EPA will soon be releasing TRI data from reporting year 1991 which will contain the new pollution prevention data for the first time. Over the next few years, we will be improving methods for measuring progress as data are received and analyzed.

EPA is also using information to achieve change in the consumer sector through environmental or eco-labelling. We are working closely with the U.S. Federal Trade Commission and the U.S. Office of Consumer Affairs to provide a coordinated and cohesive national response to the issue of environmental labeling and marketing claims. This past summer, the FTC announced new guidelines for environmental marketing claims in advertising and labeling of consumer products. The guidelines are intended to help reduce consumer confusion and prevent the false or misleading use of terms such as "recyclable," "degradable," and "recycled".

We expect that this will be an area of increasing interest and attention in the coming years as consumers seek more reliable information in the marketplace in order to act effectively on their concerns for the environment.

In this area, we are paying close attention to the experience of other countries with labeling and environmental marketing claims programs.

More on information and measuring progress in a moment.

Develop Partnerships in Technological Innovation

A truly effective pollution prevention program must look beyond its own resources to cooperative efforts with other organizations. Developing partnerships with other agencies and private groups can have a multiplier effect in bringing about greater awareness of P2 and in bringing to bear the resources and technological capabilities of other organizations, many of which are greater than the Agency's.

WHY DO WE MEASURE PROGRESS?

I can offer three important reasons for measuring progress and evaluating pollution prevention initiatives. I'm sure there are others, but let me start with these.

First - Measuring progress helps us figure out what works and what doesn't so we can modify programs over time. If you don't know what works, you can waste time and money on efforts that are launched with the best of intentions.

Second - Credibility - If we're not willing to open our programs (and I mean both the public and private sector) to outside scrutiny and measurement of progress, how can we expect the public to believe us when we say what we're doing is protecting them and the environment?

Third - (for the altruistic) Measuring progress lets us know if we're having any impact on the environment.

TYPES OF MEASUREMENT

1) Level of Program Activity - Counting the number of:
   - inspectors and inspections,
   - enforcement actions,
   - FTEs' (how many bodies),
   - dollars in budget,

I could go on, but I won't

2) Environmental Improvement - Tools like TRI can provide trends in environmental loadings over time. We're a ways away from where we'd like to be due to uncertainties in reporting. However, environmental measurement is a relatively new field. In a much more mature field, economic measurement, the Commerce and Labor Departments have developed a series of economic indicators that we anxiously await each month to see how we're doing. Consumer Price Index, Unemployment level, Housing starts, to name a few.

3) Cause of Environmental Improvements - This is very difficult and expensive to do. I'm not sure even the sophisticated economic measures attribute changes to specific causes; however, there seems to be much discussion of what are the effects of various measures.

A CONSTRAINT ON MEASURING PROGRESS

I'll just mention one constraint on developing ways to measure progress - RESOURCES. We don't want to spend more on measuring progress of our programs than we spend on the programs themselves.

WHAT ARE WE DOING TO SHARE INFORMATION AND MEASURE PROGRESS?

The Agency spends a lot of time collecting and using information to assess progress. Traditionally, measurement has meant counting - how many of you name it are there. This bean counting has never been a great way of measuring progress, but it was what we had.

This traditional role has evolved over time to the point where EPA's major contribution is simply providing public information, TRI being the best example. The profound effect of the TRI data happened simply because information was made available to the public.

While there has been a pronounced downward trend in releases reported in TRI since its inception, we are not quite ready to declare victory and go home. Prior to the Pollution Prevention Act data, there has been no indication of the reasons for reductions and admittedly, much of the reductions are due to paper changes - changes in the way the same quantities are reported, rather than actual changes in quantity. I don't want to minimize the effect of these paper changes; however, real changes are also occurring. A soon to be released study comparing 1989 and 1990 releases indicates that source reduction is occurring and is responsible for a reduction of approximately 7% of the total 1989 releases and transfers.

Fortunately, with the advent of TRI, we can use it as a major source of information for measuring the effect of our programs. In addition, as we develop more innovative programs, we have more and better ways of measuring progress. TRI and some of the measures of the new and innovative programs have the capability of becoming much more focused on the effect we're having on the environment. However, I should caution that we're not ready yet to state with certainty what is the true effect on the environment, and we're farther away from stating the cause for the effects.

Some examples of how we measure progress:

33/50 Program: Since the Program's inception in February 1991, EPA has received commitments from over 1,000 U.S. companies. These commitments translate into a minimum of 340 million pounds of toxic emissions reduction by 1995. EPA is almost halfway to reaching its goal of commitments for a reduction of 700 million pounds. EPA is planning to use TRI data and supplemental information submitted by companies

Green Lights Program: Over 270 corporate partners plus 12 states have signed on so far, committing themselves to use energy efficient technologies to light some 2.65 billion square feet of space. EPA estimates that every time an ordinary incandescent light bulb is replaced with an energy-efficient compact fluorescent bulb, carbon dioxide emissions are reduced by 300 pounds a year.

The above measures are the ones that have been identified to date for these programs and we ask your help in identifying others as the programs mature. These programs are ones that seem to lend themselves to tracking progress; however, there are many others for which measures of progress are not readily available. This is why counting (bean counting) has been used as a measure of progress. Earlier in my talk, I slipped in some counts as measures of progress for the state grants program. Remember - In 1993, EPA will provide about $6.8 million to states for P2 program activities. The challenge is to develop measures of progress for the state grants program. Another example I'll leave you with is our Design For Environment Accounting Project - How do we track its progress without devoting more resources to tracking than to the project itself? I hope you all will give some consideration to these questions as the conference gets underway.

SUMMARY

In summary, EPA's pollution prevention program has gone through a period of rapid development and growth over the last few years. The five themes discussed here point to a continuing dynamic effort, one that seeks institutional change, innovative programs, expanding P2 partnerships, improved tools to measure and encourage progress, and greater state and local P2 infrastructure.

Pollution prevention, as we see it, is as much your mission as ours. Sharing information and jointly measuring our progress is a key component of the program and we look forward very much to a strong partnership with you in accomplishing it.

MEASURING STATE POLLUTION PREVENTION PROGRAM EFFECTIVENESS IN THE NORTHEAST: A WORKING PAPER

Terri Goldberg
Pollution Prevention Program Manager
NEWMOA
85 Merrimac Street
Boston, MA 02114
PHONE: (617) 367-8558

The New England states, New Jersey and New York (Northeastern states) pollution prevention programs have begun to develop methods for measuring the effectiveness of their activities. To assist the states in this effort, the Northeast States Pollution Prevention Round table (NE Round table), a program of the Northeast Waste Management Officials' Association (NEWMOA), has developed this working paper. NEWMOA and the states anticipate that we will update and revise this paper in the future as we develop better methods of measuring state pollution prevention program effectiveness.

The challenge to states and others in evaluating the effectiveness of pollution prevention programs is that the overall goal of these programs is to reorient the behavior of manufacturers and commercial institutions toward prevention or source reduction. This requires a change in organizational attitudes as well as possible changes in organizational culture and structure. These changes can also require an investment in new technology and in some cases research and development of new products and manufacturing techniques. All of these types of changes take time. Tracking or measuring such changes is difficult and challenging at best. The tools available for evaluating the impact of state PP efforts on manufacturers are crude and not well developed. Furthermore, if states are successful and companies begin to integrate pollution prevention concepts into the design of new manufacturing processes or new products, states would have great difficulty in determining how much waste and pollution was avoided because there would be no baseline. The purpose of this paper is to discuss these and other measurement issues facing the Northeast state programs and the status of their efforts to address them.

This paper reviews the various pollution prevention (PP) activities in the northeast states and how the states evaluate them[1]. The paper summarizes key

[1] This paper is based on a survey of how the northeast states evaluate the effectiveness of their pollution prevention program (see Appendix) and discussions at several NE Round table meetings. Other sources of information are the Massachusetts Office of Technical Assistance, the New Hampshire Department of Environmental Services Waste Management Division staff, the Massachusetts Department of Public Health, EPA Headquarters project on measuring program effectiveness, the National Round table of State Pollution Prevention Programs, and the Department of Social Science at Boston University.

issues facing the state pollution prevention programs and describes several ideas on how EPA and others should approach measuring state program effectiveness.

The NE Roundtable and the National Roundtable of State Pollution Prevention Programs have identified measuring program effectiveness as a priority issue for a variety of reasons. First, program evaluation enables states to make choices among the components of its PP program so that resources can be allocated to those activities that are the most effective. Second, states can share their successes with each other and encourage each other to initiate similar successful activities. Third, evaluation can help states justify appropriations of funds from the state legislature or through EPA grants. Finally, the Pollution Prevention Act of 1990 mandates that EPA evaluate pollution prevention program effectiveness.

State Pollution Prevention Activities

All of the states in the northeast provide non-regulatory technical assistance on pollution prevention to commercial facilities and manufacturers. The services provided by these technical assistance programs (TAPs) include: (1) on-site technical assistance to business through assessments of pollution prevention opportunities; (2) financial assistance to businesses in the form of matching grants or low interest loans; (3) research on pollution prevention methods for specific industrial processes or wastes; (4) outreach to business through newsletters, fact sheets, manuals, surveys and case studies; (5) telephone assistance and referrals to businesses; (6) workshops and conferences on pollution prevention techniques targeted toward specific businesses; (7) training for state agency staff and others on pollution prevention methods and concepts; (8) clearinghouses of literature and vendor lists; and (9) analysis of data on changes in hazardous waste generation, toxics use reduction and other pollution prevention trends in the states.

Maine, Massachusetts, New Jersey, New York, Rhode Island, and Vermont also have initiated pollution prevention programs in their regulatory agencies. For most of these states, the programs include requirements for certain facilities to conduct toxics use or hazardous waste reduction plans and report on their progress. Several states, including Massachusetts, New Jersey and New York are also piloting various approaches toward integrating pollution prevention into their air, water and waste regulatory programs. These states have initiated multi-media source reduction-biased compliance, permitting or enforcement programs.

Each state has developed a different functional relationship between their regulatory and non-regulatory programs[2]. For instance, in some states the programs are housed separately within one agency, while in others they are part of different agencies. States have organized these programs into different offices or agencies because they have different goals and objectives. Each state has developed a unique

[2] For the purposes of this discussion, we will refer to these varied types of programs as "pollution prevention programs".

PP program and evaluation of their program must be conducted with sensitivity to their specific context. However, there are some common issues facing all of the state PP programs and some common methods of evaluation that they can utilize.

Current Methods of Program Evaluation

Most of the northeastern state PP programs evaluate their effectiveness. In their evaluations, they distinguish between measuring the outputs and quality of the activities of their state programs from actual reductions in pollutants and wastes in the environment. These two types of measurements should be related, but the measurement tools available to the states make linking them difficult. They currently qualitatively evaluate the effectiveness of their services, use some quantitative measures of the level of their activities, and analyze the available data on emissions and wastes generated by manufacturers. These methods of program evaluation are described below.

Surveying the Users of State PP TAP Services

Surveying users usually involves sending out a written questionnaire to firms that have contacted the state (TAP) programs for information or asking attendees at workshops and conferences to complete an evaluation form. This method allows the state to evaluate the level of activity in a program and provides a sense of whether the state is expending its funds on the services it promises to offer. The benefit of this approach is that some amount of information can be obtained about the program's quality or effectiveness. However, the drawbacks of this method are that it is primarily non-quantitative, survey respondents may have biases (that the surveys cannot correct), and surveys are impersonal and may violate a sense of trust in a new state program. Furthermore, most companies do not want to fill out another government form.

Personally Contacting Firms to Document Their Pollution Prevention Achievements

This type of tracking system is widely used in the northeast states to document the toxics use or waste reductions by the firms served by the states' TAPs. The method involves personal contacts with the firms either by a site visit or a phone call to gather information on a firm's accomplishments and to request comments and suggestions. The benefit of this tracking system is that it can show what types of outreach and promotional programs work in various industrial settings. Personal interviews with users of the program's services may be the best method of obtaining qualitative information on the users' impressions of the state program. In addition, anecdotal information gathered during personal contacts can be useful in justifying a program's funding from the state legislature or EPA. However, a drawback of this method is the extensive time required.

Many state TAPs have published case studies or success stories of firms that they have assisted using the information collected during follow-up visits and phone calls. These reports are written with the permission of the facility and provide useful

anecdotal information on the value of the state's programs to particular companies. By publishing case studies on how firms have overcome barriers to pollution prevention, state TAP programs help others who are confronting similar challenges. However, not all successful facilities want the TAPs to publicize their successes or information on how they achieved toxics use or waste reduction. Furthermore, the case studies generally publicize only the successful firms and do not cover those that were unsuccessful in using the state's PP services. Therefore, case studies have limited value in providing a measure of the overall effectiveness of a state program.

Tracking the Number of Attendees at Workshops, Information Requests, Telephone Calls, Onsite-Assistance Visits and/or Other State Activities

By tracking the number of contacts with industry and variety of services offered, the pollution prevention TAP and regulatory programs can provide some measure of how aggressive its outreach activities have been. This approach provides quantitative information and tends to provide positive feedback. However, the approach affords no measure of the success of the transfer of information during the activities or the quality of the services offered.

Reviewing Data Provided by Industry

The northeast state TAP and regulatory programs currently analyze biennial report data; manifest data; permit information; generator estimates of waste reduction; Right-to-Know data; TRI data; reports on toxics use or hazardous waste under the states' PP planning requirements; process-specific data; or data on industry type and size, waste type, the number of businesses in that industry, and technology transfer potential. This data typically provides a numerical representation of a company's emissions, waste or toxics use reduction (TUR). It can help states determine whether firms are reducing their use of toxic chemicals, air emissions, wastewater discharges, or waste generation. This type of data is utilized by regulatory programs to track the progress of their compliance and enforcement efforts and by state toxics use and hazardous waste reduction programs to track the progress of firms in reducing or eliminating their use of toxic chemicals and wastes.

Industry data has many drawbacks as a means of measuring state program effectiveness. First, some of this data, such as manifest data and permit information, does not account for changes in production levels at manufacturers. Second, much of this data is not able to distinguish between reductions due to treatment techniques versus pollution prevention. Third, industry has not been accustomed to reporting waste or toxics use reduction data and accurate information can be difficult to obtain from them. Fourth, many industries simply collect the wrong data or cannot effectively collect the information needed to report correctly. Often, baseline waste generation and toxics use information is difficult to get from industry due to the nature of many corporate materials accounting systems (or the lack thereof). Finally, the data may indicate whether reductions are taking place overall in a particular state, SIC code or facility, but the data may not indicate whether these reductions are associated with particular services provided by the state agencies or requirements in the state

planning laws. As a result this data may not provide a direct indication of the effectiveness of particular outreach or regulatory activities of the state programs.

States are interested in improving the indices that relate toxics use and waste generation to product produced or some other factor that can be tracked from one year to the next. Massachusetts and New Jersey have begun to require firms to report on toxics use reduction within individual production processes or on a facility-wide throughput basis. They are currently analyzing this data to develop a baseline of information for future analyses and to assess its quality. The Massachusetts and New Jersey experience indicates that depending on the reporting criteria, it may be possible to track actual toxics use and release reductions. However, many states do not have mandates that allow them to require industries to report this reduction information.

Measurement Issues

There are a number of issues concerning the evaluation of state pollution prevention program's effectiveness that need to be resolved before states can develop effective measurement methods. The National Roundtable of State Pollution Prevention Programs' position on evaluating state program effectiveness argues that there is a lack of agreed upon methods and adequate data for evaluating program effectiveness. The position also expresses the concerns of the states that pollution prevention changes take place over a long period of time, and as such, real changes that may be associated with a state programs activities may not be detectable for a long time. State TAPs have different goals and objectives from regulatory pollution prevention programs. Therefore, different evaluation approaches may be necessary to analyze their respective effectiveness. The northeast states concur with the National Round table's position. Other issues identified by the NE Roundtable are described below.

Recognize the Inherent Value of PP Activities

The position of the NE Roundtable is that pollution prevention programs are inherently valuable; this must be recognized, not measured. Technology transfer and training need more support than does measurement of state program effectiveness. There is a great deal of anecdotal information collected by state pollution prevention programs that indicates that the programs are working. Pollution prevention programs are getting an excellent reception from the regulated community. Therefore, states place a higher priority on expanding the services that they currently offer than on measuring past accomplishments.

Define "Effectiveness"

A major problem with measuring state pollution prevention program effectiveness is that the issue has not been framed accurately. "Effectiveness" has not been defined. Some believe that effectiveness must be evaluated quantitatively or in reference to numerical reductions in waste generated/toxics used. Others argue that a

qualitative measure is necessary to assess whether users value the services provided by the state. Each state should define effectiveness according to its pollution prevention mandate and program components.

The assumption behind using a quantity of waste or toxics use reduction to demonstrate the effectiveness of state pollution prevention programs is that this assumes that the relationship between these variables is a causal one. These two variables may not be related. A state program may be highly effective in communicating the benefits of pollution prevention and may have convinced firms to invest in pollution prevention changes, however, these changes may not appear in data reported to the state for a number of years after the firm has been in contact with the state program. For example, a state program might be able to change the attitudes within a firm toward pollution prevention, but such a change may not be measurable until the firm implements a PP process change several years later. Similarly, a state program may not be effectively promoting pollution prevention, but the quantitative data indicates that firms have reduced their emissions. Such reductions could be related to economic or technical factors that are not controlled by the state.

Some quantitative results may be necessary to justify state program funding from EPA and/or the state legislature and to provide accountability to the general public. For example, reductions in hazardous waste generation could be used as measures of the achievement of state waste reduction goals within their hazardous waste capacity assurance plans. However, evaluation of the achievement of specific goals should not be used as a measure of the overall effectiveness of a state's pollution prevention program. Furthermore, the delayed effects of pollution prevention efforts make it difficult to use quantitative measures exclusively to justify a program's funding.

The participants in the NE Roundtable believe that a qualitative evaluation of a program's effectiveness and the quality of its services should be documented to report on a state program's effectiveness and improve its functions.

Define the Program's Audience

Another important concern of the NE Roundtable participants is how to define the audiences of the various types of state PP programs. These audiences can vary widely from one state to the next. Some state programs have mandates to "perform" primarily for industry, while others are required to report success to state environmental agency heads. These audiences must be defined before methods of measurement of program effectiveness can be developed by states in a consistent manner. In addition, non-regulatory TAPs have different goals and objectives from toxics use reduction and pollution prevention programs in regulatory agencies. The TAPs may need to use different methods of evaluation from the regulatory programs.

Develop a Baseline

If states use quantitative measures of pollution prevented or services provided to evaluate their programs effectiveness, they will have to develop a baseline of data for purposes of comparison from year to year. Establishing a baseline is important because state programs must justify their funding. However, identifying the baseline is difficult because the data may change from one year to the next. For example, the regulated community under EPA's TRI data has changed since 1989 when the Agency first started collecting information. In addition, the regulated community has become more knowledgeable about filling out the TRI forms, so the quality or accuracy of the information may have improved over the past few years. These and other factors may make selection of a baseline year of information a crucial issue in conducting any quantitative analysis of toxics use or waste reduction.

Proposed Methods of Evaluation to Investigate Further

States should develop their own criteria for evaluating the effectiveness of their programs and build an effectiveness evaluation around the criteria. States could use a combination of qualitative and quantitative criteria and methods as described above.

The participants in the NE Roundtable believe that any evaluation of the quality and impact of state programs must be integrated into the program from the outset. This requires that state programs clearly define the goals and objectives of their overall program and specific activities. In addition, the state programs should consider criteria for evaluating their efforts during the design of the activity rather than after the activity has been completed.

The participants in the NE Roundtable believe that EPA and others should not put pressure on state pollution prevention programs to justify their existence. Rather, they should place a priority on facilitating the establishment of up-front quality assurance procedures that are built into the operation of state PP programs. The NE Round table views this as a more effective strategic use of scarce state resources than requiring states to produce lengthy reports evaluating their fledgling pollution prevention programs.

The northeast states recognize that they must constantly improve the quality of the technical assistance and other services they provide to industry and increase the reliability and effectiveness of the advice they provide. This can be done by systematically organizing technical information in state information clearinghouses and encouraging TAP staff to work in teams. Furthermore, the states encourage interstate collaboration of the state pilot programs on integrating PP in the air, water and waste regulatory programs to facilitate comparisons of their effectiveness.

A possible quality assurance mechanism would be to establish a network of state PP programs in each region of the country to help states build upon each other's successes, discuss technical applications, and gauge program effectiveness relative to other programs. Though not an empirical tool, this would help address some of the

issues raised above.

Linking Cost Reductions to Pollution Prevention

By encouraging companies to link the wastes they generate and cost increases and process inefficiencies, a state program can motivate them to implement pollution prevention programs at their facilities. This could be the goal of all state pollution prevention programs. Therefore, states could qualitatively analyze whether it has changed the view of corporations toward the costs associated with pollutants and wastes. This could be measured by (1) examining how much firms have invested in pollution prevention equipment or other capital expenditures in certain well defined sectors in particular industries, (2) by collecting anecdotal information on whether companies are reviewing the costs associated with wastes and pollutants, or (3) by documenting the number of firms that have established teams or committees to investigate pollution prevention opportunities and options. Another similar measure could be to document the success of the state in convincing companies to track their use of materials, particularly toxic substances.

Analyzing Pollutants Generated Per Unit of Product or as Throughput

State progress in achieving pollution prevention goals (as distinguished from evaluating program effectiveness) can be measured through tracking changes in the generation of industrial byproducts per unit of product as reported under various state laws. Tracking progress may provide an indirect indicator of the effectiveness of a state program, and is only one of many measures of its effectiveness.

The TUR data collected by Massachusetts and New Jersey may provide models for other states on measuring reductions on a per unit of product or a throughput basis. The northeast states believe that these quantitative measures incorporate indirect measures of risk reduction associated with pollution prevention.

Using Anecdotal Information

A great deal of information on state program effectiveness is anecdotal. Letters of thanks, good responses during on-site visits and presentations, and indications of support by colleagues can be used as indicators, not measures, of program effectiveness. States could also collect some quantitative information from firms that have received onsite technical assistance on their reductions. The combination of anecdotal information and reports on the quantity of toxics use and waste reduction at facilities receiving on-site technical assistance would provide useful information on the effectiveness of these programs.

Furthermore, firms sometimes comment on whether they understand how to comply with state regulations to pollution prevention technical assistance staff. These general comments could be provided to regulatory officials as a way of enhancing the effectiveness of state regulatory programs. Similarly, firms may provide comments to state inspectors on the effectiveness of the services provided by the technical

assistance staff, and these could be communicated to the TAP programs as a way to help them improve their services.

Summary

State PP programs have delayed, long term and indirect effects for which they should be credited, but there are no widely accepted methods to quantify them. The participants in the NE Round table believe that states should not be required to use quantitative measures alone to evaluate their program's effectiveness. The Northeast states are pursuing development of qualitative measures of the effectiveness of their PP activities and quantitative measures of overall toxics use and waste reduction statewide. The states also plan to focus on building quality assurance into the design of their programs and activities in addition to measuring program effectiveness after the activity has been conducted.

Next Steps

Participants in the NE Round table propose to undertake the following steps to follow up on this position paper:

- Investigate methods of program evaluation available in human service and public health programs. Some of these methods may be applicable to PP since both are attempting to measure changes in behavior. NE Round table participants have begun such discussions with social scientists, public health experts and others in New Hampshire and Massachusetts.

- Contact state programs in other parts of the country to identify how they are approaching evaluation of their programs. The Northeast states plan to participate in the measuring program effectiveness activities of the National Round table of State Pollution Prevention Programs.

- Work with EPA on several pilot measurement projects to be conducted by the various types of state PP programs in the Northeast. Such a program would enable the states to more formally test various measurement techniques and data sets. This program would also enable the states and EPA to test the various evaluation methods that may be appropriate for the different types of state service. EPA Headquarters Waste Minimization Program has initiated a PP measurement work group and is planning several pilot measurement projects in selected states. The NE Roundtable plans to participate in this initiative as members of the work group as potential pilot states.

Appendix

NORTHEAST STATES POLLUTION PREVENTION PROGRAM EFFECTIVENESS ASSESSMENT SURVEY RESPONSES

What type(s) of program(s) do you currently operate? What activities do you conduct under each program?

ConnTAP operates a non-regulatory program based in a quasi-public state agency. Conducts technical assistance (on-site and off-site), financial assistance, and research.

Erie County OPP operates a non-regulatory technical assistance program for small to medium-sized businesses. Conducts on-site and telephone technical assistance, research, workshops, training, publishes newsletters, and provides compliance info as needed.

Maine DEP operates a regulatory TUR program based on a statute, and conducts nonregulatory work. Conducts outreach, education, and technical assistance.

New Hampshire DES operates a non-regulatory technical assistance program. Conducts onsite waste reduction assessments, process and product research, and informational outreach. New Jersey Institute of Technology operates a non-regulatory program at a university. Conducts technical assistance, seminars, literature research, contracts with state agencies and counties, and training.

New Jersey DEPE operates a regulatory program to implement the Pollution Prevention Act of August 1991. Conducts research on data contained in industry progress reports (required under the Act) to develop trends in pollution prevention achievements; also conducts a pilot program in facility-wide permitting.

New York DEC operates regulatory and non-regulatory technical assistance programs with strong enforcement requirements and university R&D. Conducts hazardous waste reduction planning, technical assistance, conferences, Waste Min Assessment reviews, workshops, annual report, clearinghouse, BRS data management, CAP, siting requirements, grants management, publishes fact sheets and bulletins, and household hazardous waste research.

Rhode Island DEM operates a non-regulatory state government/university chemical engineering pollution prevention program. Conducts on-site assessments, R&D grants to university/industry, information clearinghouse, conferences/workshops, data analysis, P2 & POTW industrial pretreatment compliance program.

Toxics Use Reduction Institute, UMass at Lowell operates a university-based program. Conducts research activities such as funding research fellows, developing lab resources for small and medium sized companies, and providing industry matching

grants. Education and training projects include a TUR planners course, developing educational materials for schools, and conferences.

Vermont DEC operates the WasteCAP program for industry, and non-regulatory and regulatory programs. Conducts hazardous waste reduction and TUR plans under the regulatory program, and non-regulatory program conducts limited on-site technical assistance, workshops and conferences, publishes a newsletter, and is member of waste exchange. WasteCAP conducts primarily on-site audits.

US EPA, Region I operates a non-regulatory program with some regulatory program influence. Conducts P2-promoting activities, resource identification, project organization and initiation, training, transportation committee, strategic planning.

How do you evaluate each program? What are the benefits/drawbacks associated with each method of evaluation? What types of data do you use in evaluating your program(s)? How do you collect these data?

ConnTAP evaluates programs through tracking number and type of request, and one-time survey of users of programs. Benefit is that some useful info was obtained. Drawbacks are inability to quantify effects of services and lack of an overall assessment of satisfaction. Biennial report data is used to track waste reductions.

Erie County OPP evaluates programs by number of companies requesting assistance, number of individuals that attend seminars, and overall number of individuals who become aware of pollution prevention through its efforts. Uses manifest data, SPEDES permit requirements, air permit info, and estimates made during inspections of baseline waste generation.

Maine DEP does not evaluate programs at this time. Other programs are measured primarily by the number of programs offered and interest by the regulated community. Benefits are that it's a more positive program (positive interaction with public) and is easily tracked. Drawbacks are that it's not effective in measuring success of transfer of information.

New Hampshire DES does not evaluate programs at this time. For grant reporting purposes, it tracks number of contacts, information packages sent, and workshops attended. Drawback is that it does not provide quantitative information. Uses manifest data, biennial reports, and questionnaires to conduct assessments.

New Jersey Institute of Technology evaluates programs through follow-up surveys to users. Drawbacks are response rates and built-in bias of responders. Uses data on type of industry and wastes, business and industry size, number of businesses in an industry, and potential for technology transfer.

New Jersey DEPE evaluates chemical use through data provided by industries under NJ Right-to-Know law. Benefit is that source reduction achievements can be separated

from release reduction. Uses TRI data and other data including use, quantity in product, consumed in process, beginning and ending inventory, and quantity brought on site. No formal evaluation reports are prepared.

New York DEC evaluates programs through reports to EPA, evaluation of hazardous waste reduction plans (HWRPs), generator annual reports, HWRP annual reports, and biennial updates of HWRPs. There are penalties for non-compliance with HWRP law requirements. Drawbacks are need to improve indices that relate waste generated to product produced or another value that can be documented from year to year. Looking only at waste quantities will not quantify if changes resulted from actual waste reduction activities or from changes in production levels.

Rhode Island DEM evaluates programs with a computer tracking system of all technical assistance recommendations, does follow-up plant visits, and tabulates and quantifies waste and toxics use reduction as the direct result of TA program efforts. Benefits are that it allows one to understand what works and what doesn't work in a variety of settings, and allows program staff to gage effectiveness. Drawback is that it takes time. Uses process specific data on a case-by-case basis, collected in the field through follow-up visits and phone calls.

Vermont DEC evaluates programs through industrial surveys to determine needs and rates results of technical assistance. Uses TRI, biennial reports, hazardous waste and TUR plans, manifest data, and air and water permits.

US EPA, Region I evaluates programs through qualitative progress reports from programs. Drawbacks are that reporting is irregular and qualitative, and that without it programs may go unnoticed.

If you do not currently evaluate your program, what types of program evaluation methods have you considered using? What is your assessment of these method(s)? What future plans do you have for an evaluation system? If you have no plans, what type of evaluation system do you envision or have you considered?

ConnTAP will computerize a technical assistance request tracking system.

Erie County OPP has considered evaluating programs through measuring actual toxics use reduction and generation records. Drawbacks are inability to force companies to implement recommendations, companies' lack of capital resources to implement recommendations, absence of adequate company records to establish baseline data and conduct analysis, lack of upper management support necessary to implement recommendations. No other evaluation plans at this time.

Maine DEP plans to use annual report data with reduction information from TRI data, SARA 312 & 313 reporting data. Will implement a system allowing quick comparison of percentage reductions from an annual reporting system. Will most likely evolve from a facility database now under development.

New Hampshire DES will set up a database to track and collect data, and will use some form of adjusted quantity change method in order to generate numbers.

New Jersey DEPE will be performing a trend analysis of pollution prevention data from similar industries (e.g., by SIC), to help determine what accomplishments should be expected in certain industrial categories and which specific facilities are above and below the industry wide trend.

New York DEC: HWRPs will identify details on waste to be reduced and programs to be implemented. Annual status reports will be used to evaluate progress and biennial updates will result in re-evaluation of reduction methods and their economic feasibility.

Vermont DEC will try to quantify reduction and provide qualitative information, depending on hazardous waste and TUR plans received.

US EPA, Region I has attempted increased communication with Agency leaders on this issue. Future plans for evaluation will be detailed in Strategic Planning documents now under development.

How can states work together to develop methods for measuring and evaluating P2 program effectiveness? Other comments or suggestions?

ConnTAP: States should look at what EPA OSW and Region X are doing on measurement.

Erie County OPP: States should network with each other to determine ongoing activities and effectiveness. States with programs that target priority pollutants or large quantity generators should base effectiveness on generator reductions. Effectiveness depends on your program goals and who you have to answer to.

New Hampshire DES: States should compare notes and try to come up with some ideas that work. There should be a workshop on this subject that state folks should be invited to by EPA and/or NEWMOA to explain an evaluation system that has been developed.

New Jersey Institute of Technology: States should compare existing survey/evaluation results. P2 programs are inherently valuable; this needs to be taken into account, but not measured. Technology transfer and training need more attention than measurement.

New Jersey DEPE: States should collect the same data so comparisons can be made.

New York DEC: An evaluation method that is applicable to all states could be developed from HW generator and TRI data, because this info is required of all states by EPA, regardless of individual state PP, TUR or source reduction program elements. An effective pollution prevention program must be multi-disciplinary with strong

regulatory and enforcement components as well as traditional technical assistance.

Toxics Use Reduction Institute. UMass at Lowell: States should develop a standard methodology for normalizing use or emission quantities to account for changes in production.

Vermont DEC: States should establish a data work group, assure that federal reporting contains information we need, and develop methods to assess program effectiveness for CAP purposes.

US EPA Region I: States should use the Roundtable's recommendations as a basis for discussion, select one method that they will use, and at NEMPP meetings discuss how each state is succeeding (or not) in using its chosen evaluation method. EPA Headquarters is very interested in this issue and would look favorably on any state that demonstrates how various evaluation methods work. Although future PPIS Grant awards criteria are yet to be determined, methodology analysis may be featured prominently.

NOTE: A letter is available from Rick Reibstein, MA OTA, on this subject.

POLAROID'S TOXIC USE AND WASTE REDUCTION PROGRAM "50% IN 5"

Robert T. Hawes
Corporate Chemical Compliance Manager
Polaroid Corporation
1265 Main Street
Waltham, MA 02254
PHONE: (617) 684-5337

Pollution Prevention is not a new concept. I can recall some of Polaroid's early Toxic Use and Waste Reduction (TUWR) efforts as far back as the mid-70's. My old division, the Chemical Operations group, began working with people in the process development laboratories to prioritize and work on key candidate waste streams for recycling and waste reduction efforts. The problem was that this was an adjunct to the primary job of developing chemical synthesis processes which made better and cheaper film products rather than better waste streams.

Waste minimization didn't become an important concept until the mid '80's nationally with efforts such as a study by the Office of Technology Assessment in Washington, a project Polaroid participated in. Using the O.T.A. work as a model, we began coalescing our program in early 1987. I was fortunate to participate as a member of the team which developed the framework for the TUWR Program, working with our CEO Mac Booth towards the planned announcement of the program at the 1987 Annual Meeting.

We developed an early version of the reporting format based upon the following concepts:

1. The reporting system should serve as an overall chemical material balance around the reporting unit.

2. It should include all chemicals, regardless of toxicity or their inclusion on any Federal or State lists (remember this predated SARA Title III).

3. It should track all waste streams in extreme detail (drum vs.bulk, physical state, TSDF destination and ultimate treatment technique).

The team then began the task of setting appropriate goals and began addressing such questions as:

1. Should we aim for reductions of 100 per year or 50% over 5 years? More? Less?

2. Do we reduce usage or wastes?

These and other questions resulted in compromise whereby chemicals would be slotted into four categories by a team of experts and recycle/reuse counted as waste reduction depending upon category. It was easy to agree that the reduction index be calculated on a per unit basis to account for changes in production schedule.

Finally, it was decided that the reduction goal would be corporate-wide and the accounting system developed to afford tracking of progress at all levels of the corporation.

The accounting system, dubbed EARS (Environmental Accounting and Reporting System), was developed for reporting quarterly via the corporate-wide VAX system already in place to allow data entry at the divisions and data base administration at the corporate level.

Chemical categories were assigned initially to approx. 1300 chemicals and approx. 200 more have been assigned since. Those chemicals having the highest environmental risk were placed into Category 1 and include substances such as acrylonitrile and Freon 11. Category 2 contains dichloromethane, ammonia and silver nitrate among others while Category 3 contains such materials as toluene, ethylene glycol and hydrochloric acid. Category 4 includes most alcohols, ketones and zinc dust and is the largest chemical category. A Category 5 was later added to track solid, non-chemical wastes such as paper, plastics and molded metal products.

The final product, announced in 1987, set a 5 year goal of 10% reduction per year in usage of Category 1 and 2 Chemicals and 10% per year reduction of waste by-products of Category 3,4 and 5 materials. The Category 3 reduction allows credit for on-site recycle (off-site for Categories 4 and 5) providing the generating division actually reuses the recycled materials. The program also established a waste management hierarchy with preference shown to recycle over disposal and internal disposition over external handling. At the bottom of the hierarchy are emissions and land disposal.

The final goal established was a "virtual" elimination of emissions of Category 1 chemicals at the end of 5 years.

The program was initiated with 1988 as the baseline year and was to be voluntary in nature with corporate-wide (international) scope and local autonomy over accountability. I was among the early skeptics and there did not seem to be much going on well into 1989 in many areas until a Polaroid "Earth Day" was established in the Fall of 1989. It was hosted by Polaroid's Vice President of Worldwide Manufacturing and attended by the CEO and approx. 200 officers and other operations, research, engineering and environmental types. Plant Managers had to present their TUWR progress reports to this corporate-wide forum. In my opinion, this was the first time many of them thought much about their waste minimization efforts. I think we turned the corner that day.

Now, Polaroid has made an annual event of this "Earth Day" process and has instituted several other waste reduction forums such as Waste Reduction University (an all day exchange of ideas held at Bentley College), a waste reduction newsletter issued periodically to all employees, a grassroots Waste Reduction Now program and an annual awards program where approx. 20 employees are awarded plaques by the CEO or another senior Officer at a luncheon he or she hosts.

In order to achieve successful waste reduction, a cooperative effort was needed involving operations, R&D and engineering representatives. The company is now committing significant capital spending to the program, encouraging toxic use reduction via process changes and funding installation of solvent recovery systems. It has been recognized that different T.U.R. techniques are required in the varied divisions with such diverse products as chemicals (dyes and polymers), photographic negative, cameras, film (assembly), coated sheet and the film pack battery. Thus, each division is encouraged to manage its own program while drawing on the resources of the corporation as needed.

Today, I'm going to summarize five case studies which illustrate the diversity of the projects encountered.

The Camera Division replaced degreasing equipment which resulted in increased condensing/recycling capability and an 80% reduction in Freon. Meanwhile, the Battery Division completely eliminated the small quantity of mercury in our battery, giving up a small amount of energy for a major environmental benefit. The Chemical Operations Division has, among its many successes, managed to replace the chemical sodium chromate which was used as an oxidizing agent in a synthesis with air as the oxidant. One can be sure air is lower on Polaroid's list of toxics than sodium chromate!

The Industrial Coatings group has already converted one solvent based coating mix to an aqueous system and has committed to the same for its primary product, a coating fluid containing a four solvent system which is virtually impossible to recycle.

Finally, two groups have instituted an interdivisional waste reduction program where a methanol-caustic waste from one division is sent to another who separates the two components and reuses the caustic as a neutralizing agent in the plant. By the end of 1991, the methanol was also being reused, in this case by the generator.

At this point, we are trying to fit the TUWR Program into other on-going initiatives such as SARA Title III (TRI), EPA's Industrial Toxics Program, Clean Air Act Amendment reductions and Massachusetts' Toxics Use Reduction Act (TURA).

Polaroid is now targeting SARA TRI reductions in our EARS reports and will attempt to modify the data base to allow us to cull the SARA Form R reports directly out of EARS. In addition, we have "signed up" for EPA's voluntary Industrial Toxics Program (ITP), recommending to the EPA that we use our existing program to generate the data. Of course, the EPA's program is emissions reduction oriented while

ours measures reductions in total "toxics" used or generated as wastes, depending upon the category.

With regards to CAA Amendment compliance, we are currently looking at the potential for utilizing our TUWR Program to achieve Air Toxics reductions of at least 90% in order to achieve M.A.C.T. early reduction credits.

Finally, we are now in the midst of preparing our third annual TURA reports (Form S's which complement Form Rs), using EARS data as much as possible to generate the data. It will require considerable modifications and reprogramming of EARS to allow data reporting as required by the Form Ss and for appropriate Production Units. This may be accomplished in time for the reports due July 1, 1994.

The main thing our program will do for TURA will be to help us achieve its goals since we are aiming for 50% reduction by 1993 using 1988 as the baseline year. Conversely, TURA will help us achieve the TUWR Program goals by forcing us to report (and evaluate) each production unit annually. In addition, it will probably spur a second generation TUWR Program when T.U.R. Plans are required biennially beginning in 1994.

At this point we have achieved an approx. 27% reduction corporate-wide after the first four years but have been experiencing some difficulty in the third and fourth years. The "low hanging fruit" has now been picked and some of the substantial process changes (use reduction) and new solvent recovery systems will take a year or more to implement, putting the company somewhat behind its expectation to achieve its goals by the end of 1993. Discussions have begun regarding development of the next phase of the program once the first stage is completed at the end of 1993. Expectations are the program will broaden in scope into such areas as post-consumer waste.

SUMMARY OF MATERIALS ACCOUNTING AS A TOOL FOR MEASURING PROGRESS IN POLLUTION PREVENTION

Shelley A. Hearne,
Bureau Chief,
Office of Pollution Prevention
New Jersey Department of Environmental Protection and Energy
CN 423
Trenton, NJ 08625-0423
PHONE: (609) 777-0518

While it is critical for an industrial facility to have a means of gauging pollution prevention progress within their operations, there is also a public need for reliable and uniform reporting on source reduction achievements. The Toxic Release Inventory (EPCRA Form R) has been modified to include pollution prevention data elements that will help the public better understand industry source reduction activities. Yet because pollution prevention occurs at the production source -- not at the end-of-pipe where TRI measurements occur -- this database may offer a limited perspective on pollution prevention progress.

The New Jersey Department of Environmental Protection and Energy is using materials accounting data as a means of augmenting TRI release information for pollution prevention purposes. Since pollution prevention focuses on changes in production inputs and production efficiency, along with innovative production technologies, it is also useful to measure production inputs as a means of tracking pollution prevention progress. Materials accounting data can provide information on the amount of chemicals used at a facility level and allow efficiency calculations to be made, such as use: release, or amount of chemicals used normalized to production. This is important, particularly since use may change due to pollution prevention activities, but releases may remain constant.

Material accounting determines the quantity of the chemical at key junctures in its progression through a production plant by quantifying the amount of chemical brought on-site, consumed in-process, shipped off-site as or in product, starting and ending inventory, and released into the environment. Materials accounting is a simplified mass balance of what comes in and what goes out of a plant and thus provides a critical facility wide perspective of toxics use. Below are the specific throughput reported under the NJ Community Right to Know law.

	QUANTITY (lbs)
7. Maximum Inventory of Substance	
8. Starting Inventory of Substance	
9. Quantity Produced on Site	
10. Quantity Brought on Site	
11. Quantity Consumed on Site (used, not emitted)	
12. Quantity Shipped off Site as (or in) Product	
13. Ending Inventory of Substance	

Figure 1: Materials Accounting Data Elements

Theoretically, throughput data, in combination with TRI release data, could make possible some important pollution prevention analysis. For instance, yearly chemical use comparisons can be determined which would provide insight into the magnitude of chemical use and be quantitative indicator of actual toxics use reduction. Production-to-use ratios, use-to-release, and consumption-to-use can also be calculated along with chemical use efficiency. In addition, materials accounting data not only provides a potential mechanism for direct pollution prevention measurements, but also offer a broader and more meaningful perspective on a facility's operations than TRI release data alone.

New Jersey has required materials accounting information to be reported by manufacturing facilities since 1987. Several different versions of the RCRA reauthorization bills have included provisions for expanding TRI to have materials accounting data elements. While concern have been raised nationally about confidentially of this information, a minimal number for NJ facilities have made trade secret claims for materials accounting data. On the average, between 3-6 trade secret claims are made per year for more than 1,000 materials accounting forms submitted.

Though this information was not originally collected for pollution prevention reporting purposes, it is anticipated that this information can be used to evaluate pollution prevention progress that has been achieved by NJ industries prior to passage of mandatory pollution prevention planning law. A research project, partially funded through EPA's Office of Pollution Prevention, has recently been initiated to test effectiveness of throughput data for measuring pollution prevention progress at industrial operations at a facility wide perspective. In addition, this materials accounting information will be the cornerstone of the state's pollution prevention tracking and reporting.

WASTE REDUCTION MEASUREMENT PROJECT AT IBM

Joel S. Hirschhorn
President
Hirschhorn & Associates, Inc.
4221 Forbes Blvd., Suite 240
Lanham, MD 20706
PHONE: (301) 731-4095

Several years ago it became clear to various IBM managers that there were several needs for obtaining data which accurately reflected the progress from many pollution prevention/waste reduction actions being taken at IBM plants. In addition to reporting and planning regulatory requirements under state and federal laws, corporate headquarters wanted to be able to have comparable data for different plants. However, various efforts by some plant personnel had not proven effective enough. Indeed, to some extent some efforts yielded disappointing results, because data did not seem to capture various improvements in manufacturing.

A major complexity facing the measurement issue at IBM was that within any one facility many different "products" were being manufactured. Moreover, the mix of products and the products themselves typically changed very frequently.

The goal of this project was to design a measurement approach which would make maximum use of existing plant data, be relatively simple to use in many different plants, and produce data which could both satisfy regulatory requirements and also allow aggregation of plant data to create accurate company-wide data on waste reduction progress.

From the beginning, it was clear that changes in waste generation (or chemical use) has to be correlated with changes in production output. The major issue which became clear after initial examination of data and extensive examination of several major plant facilities was the need to rethink and reconceptualize the meaning of production output.

The key concept which was used in development of the new measurement approach was to redefine products in terms of their technology content rather than to use conventional metrics which described products in terms of physical attributes. All previous efforts had used traditional measures of production output, including, for example, number of products produced and total area of a product or some intermediate item in the production process. However, many products were routinely being redesigned and improved so as to produce higher value and greater performance without necessarily changing conventional measures of output.

The new approach sought ways of describing production output in terms of what customers purchased and valued, which is not a physical object (in terms of size or weight), but rather some technological performance capability. Use of the right technology metric would reflect changes in materials usage and manufacturing practices. It would also allow aggregation of data across many different products, as seen from a manufacturing or sales perspective, but which really are essentially the same generic type of product in terms of technological performance capability. Data for one major facility were used to show how the new method yielded very improved results as compared to conventional measurements, using the same basic waste and production data for several years.

The approach and methods developed have been implemented by a number of IBM facilities.

TEXTRON EFFORTS TO ENSURE INTEGRITY OF NUMBERS

Patricia Iezzi
Supervisor
Textron, Inc.
40 Westminster Street
Providence, RI 02905
PHONE: (401) 457-2215

Textron is a multi-industry company with operations in three major business sectors: Aerospace Technology, Commercial Products, and Financial Services. Textron consists of about 35 Divisions, 135 manufacturing locations, 54,000 employees and has revenues of $8.3 billion.

What follows is a broad overview of Textron and its pollution prevention program and a description of the means we are using to help ensure that our numbers are reliable.

Textron policy requires each manufacturing facility to reduce or eliminate the generation of hazardous and nonhazardous waste and emissions of toxic chemicals through implementation of a plan. Other program elements are as follows:

- 1988 is the base year (for hazardous waste and toxic chemicals);
- 1991 is the base year for nonhazardous waste;
- each facility must show a 5% annual aggregate reduction;
- each Division must submit a plan that identifies its goals for the year and report numbers which reflect the previous years activity.

The numbers for hazardous waste are based on biennial reports and on manifests; the numbers for toxic chemicals are based on Form Rs. The numbers are adjusted due to changes in regulations and production levels.

Below is a list of some of the factors that complicate the number crunching.

Acquisitions

- may result in need to recreate figures for base year,
- how will acquisition impact Textron.

Overlapping reporting requirements may result in confusion caused by reporting same data in different ways. Different reporting requirements and formats result in different numbers.

Detection of errors in **Form Rs** by auditors, Textron, regulatory authorities - using 1988 as base year presented problems because the Form R was new; people were not familiar with the form and thus made errors.

Employee turnover may result in inability to recreate same number twice.

Downsizing - Ability to determine aggressiveness of program and rely on data depends on ability to view entire picture (true waste minimization v. changes in production). These factors may result in need to revise figures continually.

Textron has not joined the 33/50 program, we canceled an award program Also, communications to the public are limited to the extent that we do not translate data into cost savings. A standard method for calculating costs has not been developed and applied corporate wide.

In 1991 Textron started a program to audit the chemical accounting and control programs at each facility, Essentially, auditors have been asked to track chemicals through the plant as they would dollars. Chemical Accounting and Control Programs are evaluated based on their ability to perform the following functions:

- Identify all regulated chemicals;
- Compare chemical amounts and activities at the facility against those that trigger reporting;
- Provide a signal when reporting is required;
- Assist in effort to eliminate/reduce used of regulated chemicals;
- Help prepare for and predict future reporting requirements; and
- Produce and summarize current and accurate data.

The focus in 1993 is to continue the effort to ensure the integrity of our numbers through use of our compliance assurance program and by ensuring the development of effective chemical accounting and control programs at each facility.

FINANCIAL PLANNING AND POLLUTION PREVENTION

Raymond P. Lizotte, Jr.
Senior Environmental Engineer
Texas Instruments Incorporated
34 Forest Street Ms 10-04
Attleboro, MA 02703
PHONE: (508) 699-3016

The costs of complying with environmental requirements through pollution control is expected to increase dramatically over the next decade. Companies do not have sufficient resources to pay these costs and remain competitive in the world economy. One of the major selling points of Pollution Prevention/Toxics Use Reduction (PP/TUR) is that it offers a method of reducing these costs without forfeiting environmental imperatives.

Common practice within industry has been to place environmental costs into a separate account (i.e. "overhead") and allocate the costs back to the manufacturing areas based on a formula. When environmental costs were only a small percentage of a company's total budget, this arrangement worked fine. However, as environmental costs have increased, they are beginning to be a significant percentage of the cost of doing business. The financial practices presently employed by industry often do not adequately describe environmental costs.

The lack of description of environmental costs results in management making major strategic decisions with insufficient information. To correct this, the corporate cost accounting system needs to be modified to comprehend all environmental costs. Once these costs are fully described, the financial tools that are being used by the company can be applied on this data. In this way, the impact of environmental issues are integrated into the routine procedures used by the company to analyze financial information.

Besides identifying the actual costs that a company is expending for environmental compliance, a cost accounting system such as this allows a company to proactively pursue PP/TUR as a method of achieving cost reductions. By integrating environmental costs into the cost accounting system, they become another line item in a company's financial assessment procedure. The expenditures related to operating a new manufacturing line may be compared with an existing line and a decision to install the new manufacturing line may be justified. With environmental costs, a significant part of the total cost of doing business, manufacturing options which reduce the environmental costs, such as options based upon PP/TUR, may be implemented to produce a savings.

Tracking environmental costs may also provide a powerful tool for optimizing the amount of resources a company expends towards environmental compliance. For example, as environmental regulation becomes more stringent over time, the cost of compliance via pollution control/abatement methods also increases. Performing an analysis, which compares the cost of an existing operation under tighter emission controls with a estimate of the costs of an alternative operation that employs PP/TUR to reduce emissions, may demonstrate that it is more cost effective to implement PP/TUR option that reduces emissions below a regulatory threshold rather than attempt to abate the emissions with emission control technology. In this way, expensive regulatory requirements may be avoided and the cost of complying with environmental regulations reduced.

At Texas Instruments (TI) a team has been formed to meet these challenges. TI is evaluating its existing cost accounting system to determine if modifications are necessary to ensure that environmental costs are being completely tracked and auditable back to the area responsible for the cost. In addition, the existing financial tools are being modified to allow them to manipulate the added environmental costs data. In this way, TI intends to include this data as an additional variable within all its routine financial planning procedures.

SOURCE REDUCTION THROUGH TOTAL QUALITY ENVIRONMENTAL MANAGEMENT

Richard F. Mannion
Manager
Environmental Services
Foxboro Company
33 Commercial Street (MS NO52A)
Foxboro, MA 02035
PHONE: (508) 549-3620

Beyond Compliance: Total Quality Environmental Management

Due to increasing governmental regulation, environmental compliance has come to represent a significant percentage of total production costs for many U.S. manufacturers. In most cases, source reduction remains the single most cost-effective means to achieve compliance. Not only does source reduction result in a direct reduction in tangible compliance costs (licensing fees, disposal costs, lab fees, waste treatment, and so on), it simultaneously reduces costly waste in the production process. Additional benefits include improved employee safety, enhanced community relations, and -- more and more -- the approval of end-user customers.

Instituting an effective, ongoing source reduction program in a manufacturing environment involves total management commitment and often, a culture change in operations. At The Foxboro Company, a manufacturer of instruments and automation systems for industrial process control, source reduction efforts were integrated within an ongoing Total Quality Management (TQM) Program. The resulting process is known as Total Quality Environmental Management (TQEM).

The Foxboro Company's three major manufacturing facilities are located in Southeastern Massachusetts. Specific manufacturing operations at these facilities include electronic assembly, cleaning, plating, painting, degreasing, and machine shop operations.

Foxboro has been actively involved in source reduction since the late 1970s. Previous to instituting TQEM, the most significant accomplishment had been a reduction in VOC emissions (Fig. 1). This reduction was achieved by modifying the existing solvent paint process to a powder coating process, and by implementing product design changes that eliminated the need for painting altogether. Other source reduction programs reduced wastewater discharge and eliminated a number of degreasing operations. These programs, which had been informally managed by the environmental department, were focused primarily on compliance issues.

In 1992, TQEM was implemented to enable Foxboro to progress to a level of environmental responsibility that went above and beyond regulatory compliance.

A structured approach to source reduction

Foxboro instituted its Total Quality Management program (TQM) in 1989. The goal of this ongoing program is to meet or exceed customer expectations. This is achieved through continuous improvement of our work processes and by reducing variability in our individual efforts. "Customers," in this context, can be external (i.e. other companies that purchase our products and services), internal (other Foxboro departments or downstream manufacturing operations), or in the case of environmental management, local, state, and federal regulatory agencies, the neighboring communities, and the environment itself.

At Foxboro, TQM encompasses three interrelated elements: quality planning, quality teams, and quality operations.

The purpose of quality planning is to focus the entire company on strategic quality targets and provide the means to accomplish them. Quality planning is performed primarily at the staff-level Quality Council and by lead quality teams.

The team element includes formal teams composed of individuals from corporate, operations, technology, manufacturing, and marketing departments that are trained and empowered to solve specific problems through the 7-step Quality Improvement Process (QIP) shown in Table 1. Training covers the five principles of QIP: customer satisfaction, respect for people, structured problem solving techniques, management by fact, and continuous improvement (Fig. 2).

Quality operations extends the problem-solving training and mentality established in the team efforts to the day-to-day activities of the company. In this manner, Foxboro is working toward making customer sensitivity an embedded characteristic in the culture of the company.

In this kind of quality-process-focused environment, implementing a Total Quality Environment Management program was simply a matter of isolating strategic environmental targets by stratifying the manufacturing process (Fig. 3) to indicate where emissions or waste were being generated and forming QIP-type problem-solving teams to address the specific environmental issues. Ultimately, specific team themes were selected on the basis of the relative impact to the customer, the urgency of a solution, and the practicality of finding a solution.

Individual teams are composed of five to seven individuals representing a variety of different departments (environmental management, production, engineering, purchasing, quality control, facilities, inventory control, and so on). TQEM teams meet once a week to develop a strategy and a plan to solve their assigned environmental objective. Once again, this process involves stratifying the manufacturing process to identify the root cause of the problem. The teams develop effective, easy-to-understand measures of improvement -- or "indicators" -- and then apply structured problem solving

techniques to attain continuous improvement in these indicators with the ultimate goal being the total elimination of the hazardous component in question.

Each team is directly supported by a senior operations sponsor manager. The Foxboro Environmental Manager serves as a technical consultant to all TQEM teams and as a team member on more than one of the teams. A full-time Foxboro quality consultant serves as a quality system consultant (facilitator) to the teams and a corporate Foxboro vice president sponsors the TQEM teams and serves as the link to the Quality Council.

As a whole, the TQEM teams represent an environmentally focused organization matrixed within the entire Foxboro quality organization. TQEM teams frequently get together as a single group to update each team's progress and share approaches to addressing environmental issues.

TQEM in action

Six Foxboro TQEM teams -- each with a different environmental objective -- were established in January 1992 (Fig. 4). One year later, all six teams were already in Step 4 of the 7-step QIP problem-solving process, developing effective counter measures. Most teams are confident that they will be through all seven steps by the end of 1993, and sooner in some cases.

Let's examine the results achieved by two of the teams empowered to reduce CFCs and heavy metals usage, respectively.

The goal of the "CFC" team (which stands for Changing Foxboro's Cleaning systems) goal was to eliminate the use of ozone-depleting chlorofluorocarbons (CFC) from the manufacturing process. Their first step was to analyze the situation by determining the current usage at the three manufacturing plants (Fig. 5). The problem was then stratified by chemical, by application, and by process (Fig. 6) to allow the team to determine actual cleaning requirements. This data made it possible to investigate and promote alternatives. The team subsequently implemented several alternative CFC-free processes, such as the use of no-clean fluxes. The team also received authorization to purchase the new equipment required to implement a semi-aqueous process that will totally eliminate the use of all CFCs in manufacturing operations at Foxboro.

Another team, the "Cad Cutters," was initially charged with reducing heavy metals from manufacturing operations effluent. After studying the problem, they chose to specifically target the cadmium used in some plating operations with the ultimate goal of eliminating its use altogether. The first task was to stratify the operation to isolate those manufactured parts requiring cadmium plating (Fig. 7). From this data, the team developed a dendrogram (Fig. 8). This is a series of questions and answers concerning the need for cadmium.

This investigation resulted in the elimination of many parts having to go though the cadmium bath. The team is also investigating and evaluating alternatives to cadmium plating to eliminate its use altogether.

Conclusions

TQEM certainly isn't the only way for manufacturers to achieve source reduction. But since TQEM focuses on continuous performance improvements (rather than the incremental improvements achievable with other methods), TQEM is clearly an ideal process to enable a company to go beyond strict regulatory compliance and achieve, as Foxboro has in several cases, the total elimination of the hazardous materials in question.

At Foxboro, witnessing the TQEM "buy in" on the part of senior management has been gratifying. But it has been even more gratifying to share with the team members themselves the satisfaction in seeing significant reductions in the use of materials that have proven to be detrimental to the environment.

Table 1:

The 7-step problem-solving process utilized by Foxboro QIP teams:

1. Reason for Improvement
2. Current Situation
3. Analysis
4. Counter Measures
5. Results
6. Standardization
7. Future Plans

Fig. 1

THE FOXBORO CO.

VOC REDUCTIONS from PAINT LINE

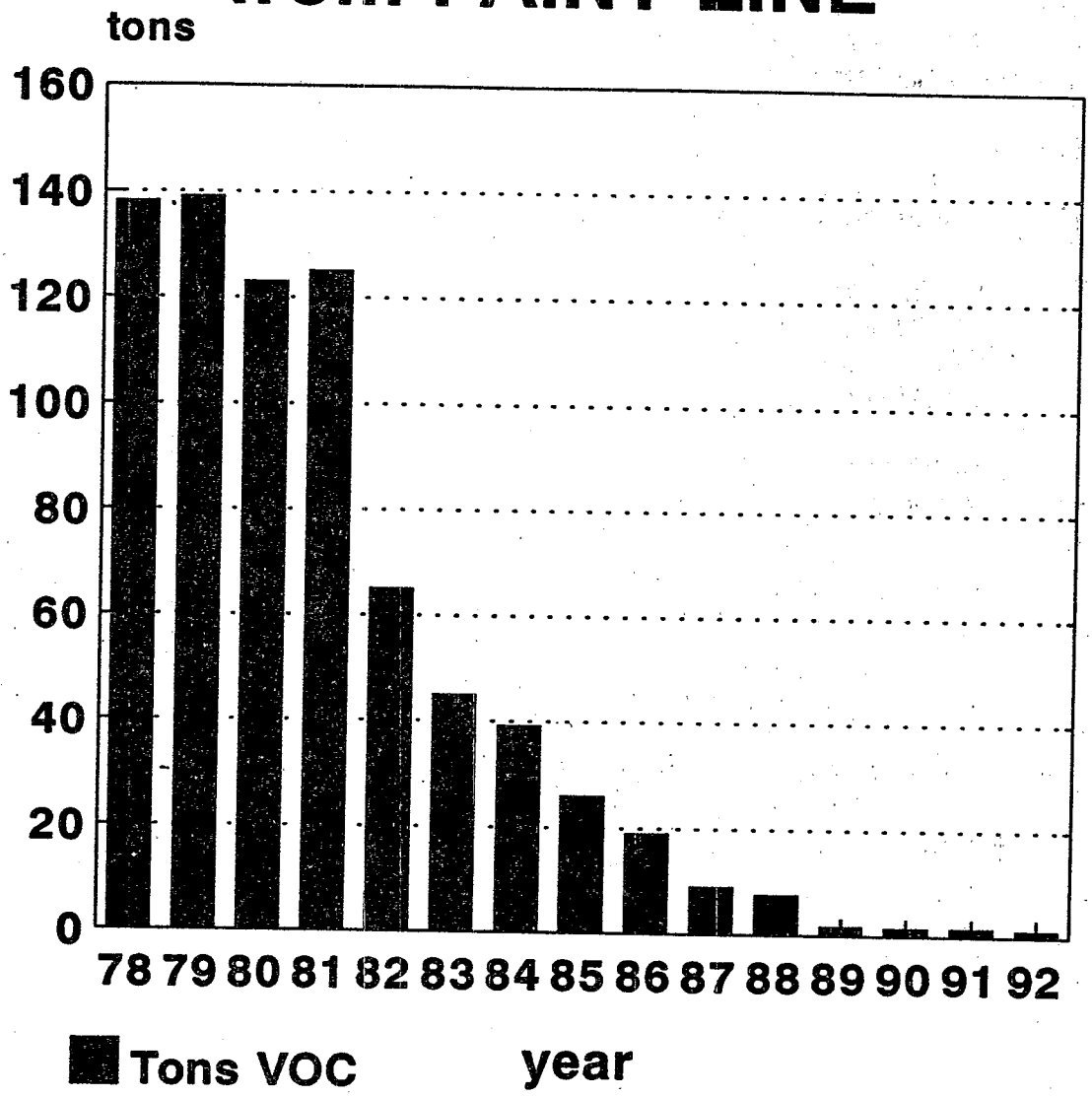
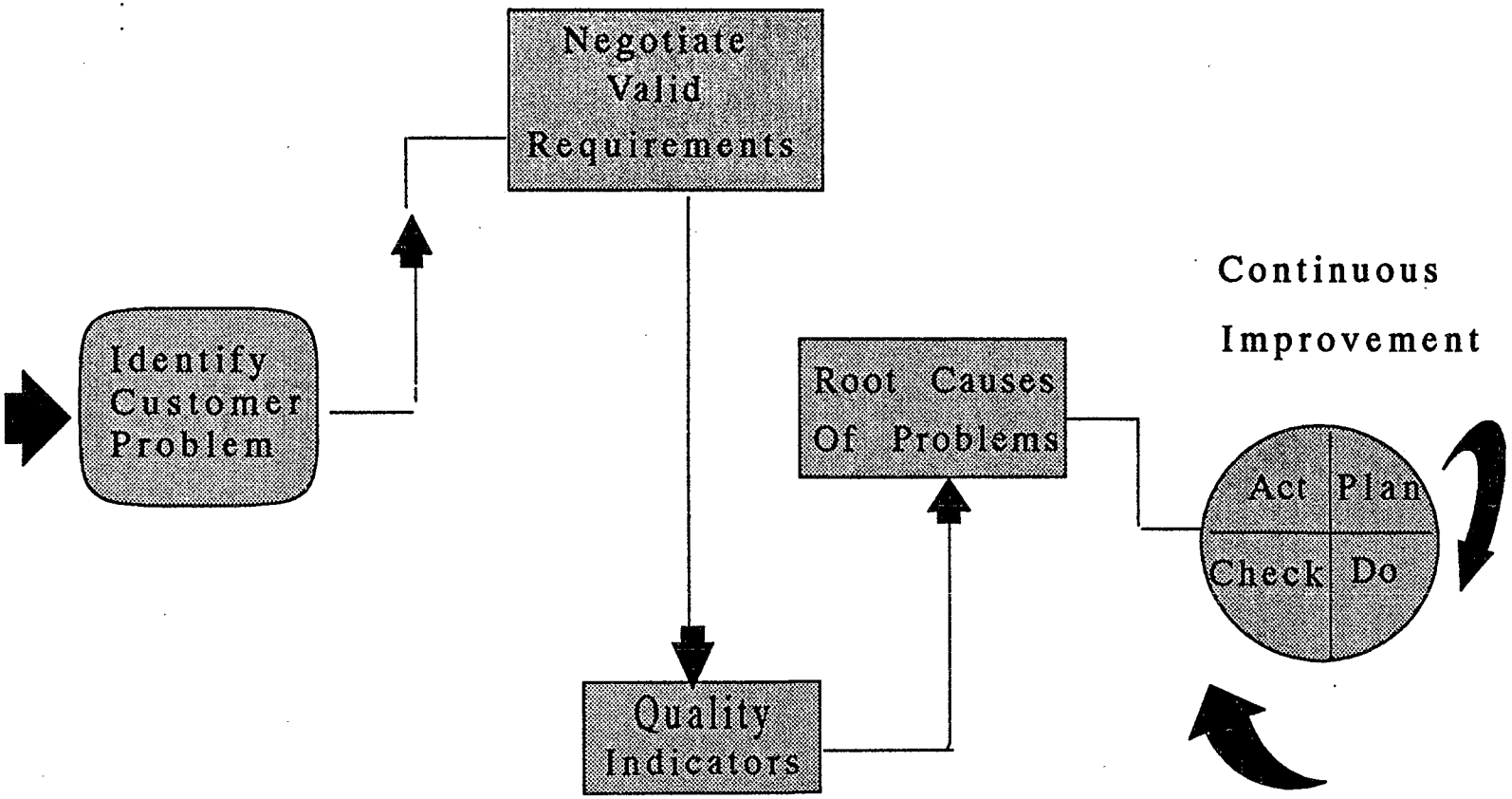


Fig. 2

QUALITY IMPROVEMENT PROCESS



Process Stratification

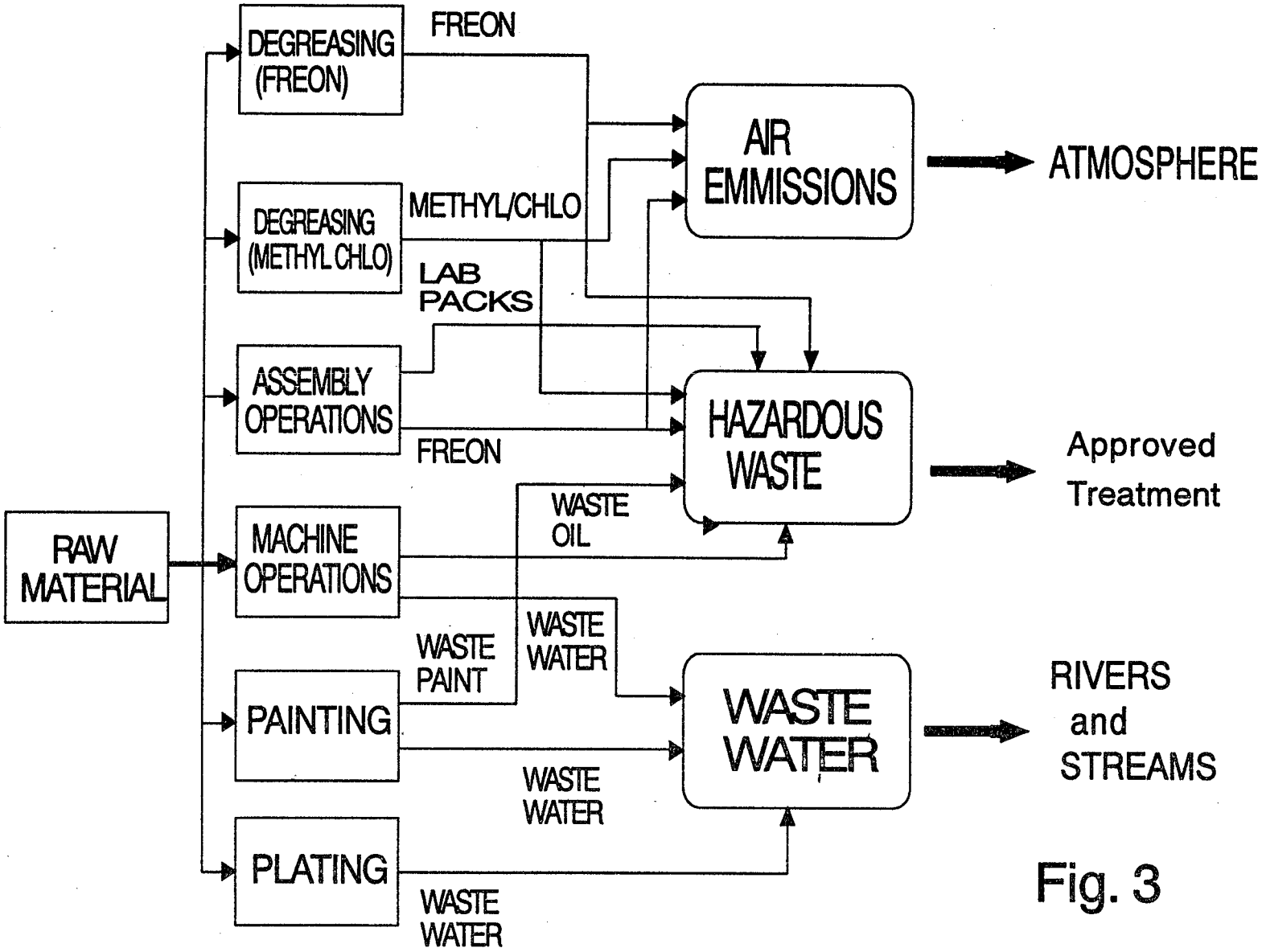


Fig. 3

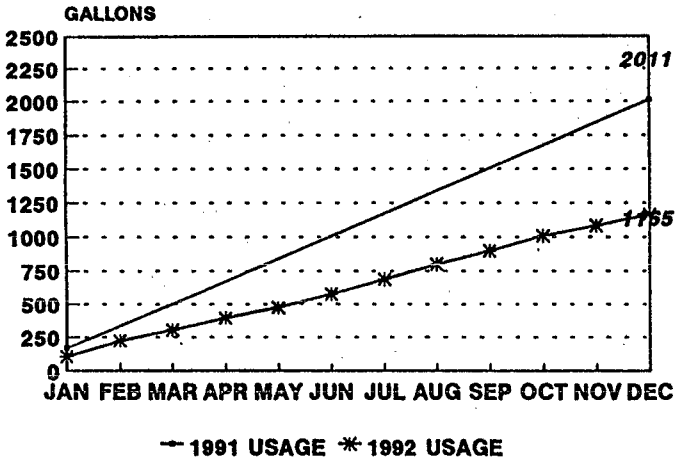
Fig 4

ENVIRONMENTAL TQEM TEAM PROFILE

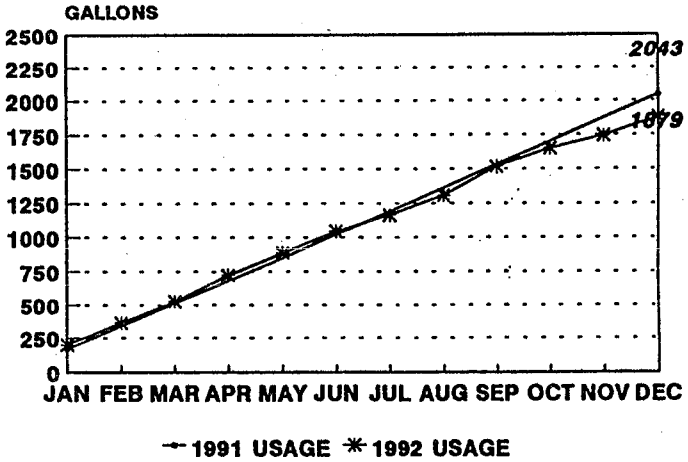
TEAM THEME	INDICATOR	Team name
1 Reduce or eliminate the use of Freon in degreasing processes	Tons of Freon	CFC's
2 Reduce or eliminate Methylene Chloride in degreasing procsses	Tons of Me/Cl Gal of waste oil	Dukes of Haz.
3 Reduce waste paint from painting operations	Gallons of waste paint Tons of VOC	SMOG HOGS
4 Reduce "Lab Packs" in assembly operations	Lbs of waste	"Pak Rats"
5 Reduce waste water contaminants	MGD of H20 Conc of Metals	Cad Cutters
6 Improve material tracking accuracy	Chemical usage	GiGo

Fig 5

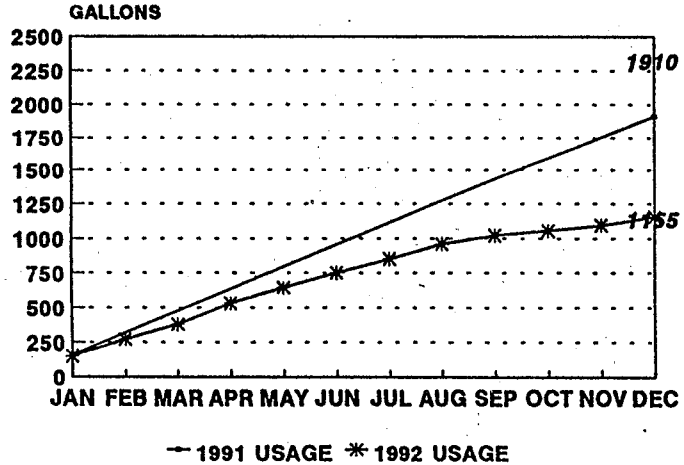
CFC USAGE
HIGHLAND



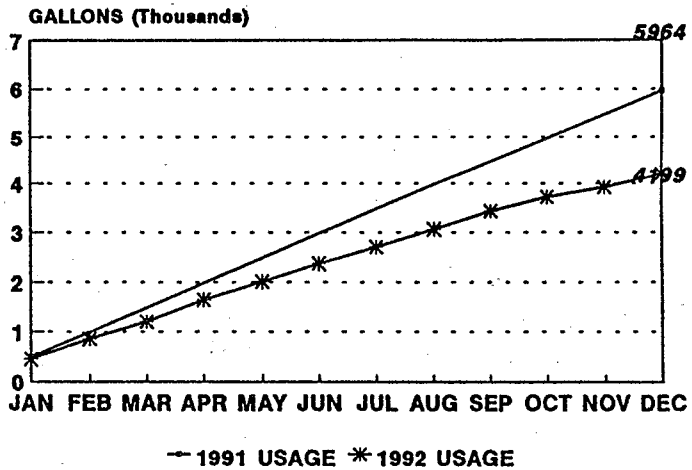
CFC USAGE
I/A



CFC USAGE
NEPONSET



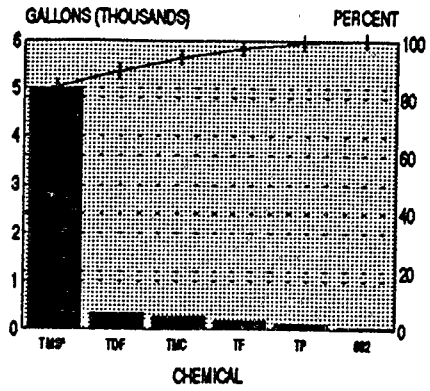
CFC USAGE
CORPORATE TOTAL



Previous existing situtation for CFC usage

CFC USAGE

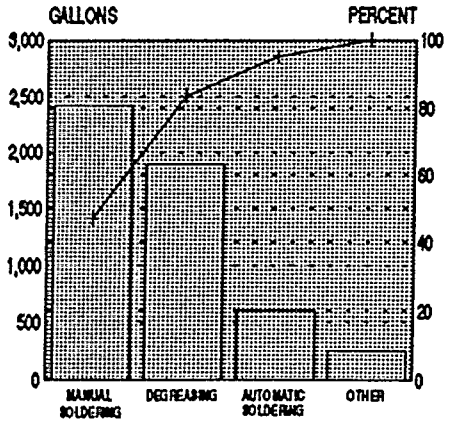
1991 BY CHEMICAL



* INCLUDES DMS

CFC USAGE

1991 BY APPLICATION



CFC USAGE

1991 BY PROCESS

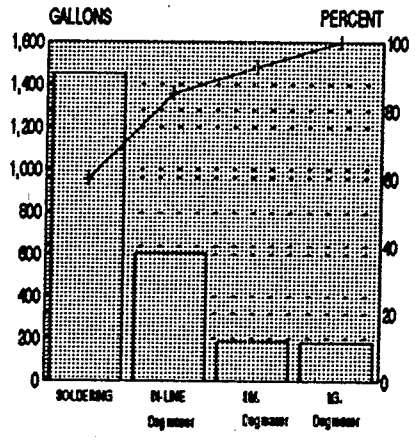


Fig. 6

Fig 7

Cad Cutters

PART SIGNIFICANCE
For Cd usage

Part	Number Run	Rank	Percent Pluses	Significant
Housings	1	14	0	?
Manifolds	4	2	75	?
Bonnets	2	1	99	?
Bases	13	3	62	Yes
Rings	2	12	0	?
Yokes	1	13	0	?
Connectors	7	4	60	?
Jackscrews	3	11	33	No
Flanges	11	10	33	No
Covers	30	7	42	No
Brackets	12	9	33	No
Bodys	20	6	50	Yes
Flowtubes	5	5	60	?
Plates	20	8	40	No
Flexures	1	15	0	No

DENDROGRAM

Fig. 8

Cad Cutters

Question	Answer	How do you know
Why do we Cad plate Bodies and Bases.	Corrision Protection	Salt Spray Tests Agency Req Applications

Question	Answer	How do you know
Why do we need Corrosion Protection.	Increase life Asthetics Base metal	History

Question	Answer	How do you know
Why do we use these Base Metals.	Cost Effective Inexpensive	History

Question	Answer	How do you know
Why do we use only Cad, are there alter-natives to Cad Plate that will provide adequate protection.	Determine in Step 4	

VOLUNTARY POLLUTION PREVENTION AND OPPORTUNITY ASSESSMENT

David McEntee
Environmental Manager
Simpson Tacoma Kraft Company
P.O.Box 2133
Tacoma, WA 98401-2133
PHONE: (206) 596-0257

ABSTRACT

Simpson Tacoma Kraft Company, in voluntary cooperation with EPA Region X and the Washington Department of Ecology, developed a mill specific pollution prevention plan. Using funds provided from EPA's Industrial Pollution Prevention Project, EPA Region X was tasked with the development of a model pollution prevention plan for the pulp and paper industry, one of the largest industries in the Region. As a part of that project, a specific pollution prevention opportunity assessment and voluntary implementation plan was developed for the Simpson Tacoma Kraft Mill in Tacoma, Washington.

An EPA contractor conducted the opportunity assessment and developed the implementation plan for Simpson Tacoma. Representatives of Simpson, EPA, and the Washington Department of Ecology participated in the mill observations and discussions that helped shape the study. By reviewing the major process areas and equipment within the Simpson Mill, interviewing plant personnel, noting recent equipment upgrades, and evaluating emission and discharge estimates from the Toxics Release Inventory (TRI) data, feasible procedures were identified and evaluated for potential implementation by Simpson.

The study identified a number of pollution prevention measures currently in place at Simpson Tacoma and presented recommendations to develop an ongoing pollution prevention program. The report included recommendations for implementation of short-term and long-term process modifications to attain pollution prevention benefits.

Looking beyond the study, a key issue is the implementation process. Industry and Regulators alike recognize the merit of short and long-term planning aimed at multi-media environmental benefits. However, even with this common interest, moving a project from a plan to implementation can be a significant challenge.

With the multitude of regulatory jurisdictions (local, state and federal) and the array of interconnected programs within individual agencies, good intentions can quickly turn to frustration and disappointment for regulators and industry alike.

However, the process of multi-media management and pollution prevention planning provides promise for regulators and businesses when considering project implementation. Just as good pollution prevention planning weighs total environmental benefits in a single framework, the implementation process should also be integrated and coordinated, and reside with a single entity. A coordinated process would stimulate more aggressive pollution prevention planning, but more importantly, it would result in implementing more pollution prevention products.

The implementation dilemma, as well as its solution, is recognized by both the regulators and the regulated community. From this awareness has come hopeful signs, such as the cooperative pollution prevention effort of EPA, Washington Department of Ecology and Simpson, and development of the cross-media assessment program by Oregon DEQ.

While the regulators, regulated community, and public can easily point to the merits of cross-media environmental management, to realize these benefits, these same entities must work together.

MEASURING PROGRESS IN POLLUTION PREVENTION

George Nagle
Director
Environmental, Health and Safety Services
Bristol-Myers Squibb Co.
5 Research Parkway, P.O.Box 5100
Wallingford, CT 06492
PHONE: (203) 284-6120

ABSTRACT

Bristol-Myers Squibb Company is a large, decentralized organization supplying pharmaceutical, nutritional, medical devices and consumer products worldwide. Our environmental, health and safety program has historically addressed pollution prevention activities in a variety of ways.

Current programs include waste minimization procedures, packaging guidelines, capital appropriation request reviews and purchasing guidelines. Pollution prevention performance measurement has been facility-focused and anecdotal in nature.

In 1992 we embarked on a company-wide pollution prevention program entitled ENVIRONMENT 2000 which is based on integrating product life cycle management into the core of our businesses. Our goal is to conduct product life cycle reviews of both new and existing products.

The preparation of an initial Company environmental report to our stakeholders has caused us to focus our efforts on developing company-wide pollution prevention performance metrics. Such metrics must be clear, precise and relevant to both our stakeholders and businesses. This need has been recognized as a priority and initial elements should be identified later this year.

POLLUTION PREVENTION

Robert B. Pojasek, Ph.D.
Corporate Vice President
GEI Consultants, Inc.
1021 Main Street
Winchester, MA 01890
PHONE: (617) 721-4097

Manufacturing is defined as the mechanical or chemical transformation of substances or materials into new products. The assembly of component parts of products is also considered to be manufacturing if the resulting product is neither a structure nor other fixed improvement. Any loss of materials, energy or other resource whatsoever, represents an inefficiency in manufacturing. A company needs to utilize a variety of proven management tools, together with effective process re-engineering, to minimize the losses (i.e., wastes). As much material and energy as possible must be recovered from process wastes and from post-use products to enhance the gains in efficiency. Management tools, which include Total Quality Management (TQM), Just-in-Time (JIT) and Computer Integrated Manufacturing (CIM), are the pillars upon which the competitive enterprise is built.

What we are calling "pollution prevention" is not a special field but is concentrated on improving efficiency in all manufacturing activities. Every loss from the process is an opportunity not to have the loss. A "pragmatic" pollution prevention program is attained when a process is operated efficiently by an enlightened management with employee participation in that management. Pollution prevention comes about in practice through continuous improvement of manufacturing efficiency and not through the imposition of a prescriptive or opportunistic program. By practicing pollution prevention, industry can obtain increased industrial efficiency, profitability, and competitiveness.

Management's skills and attention must be continuously devoted to decreasing its total costs over time. This can be accomplished through the use of Activity-Based Costing (ABC) techniques. ABC methods recognize that activities associated with certain unit operations and their resultant products cause costs. These ABC systems allocate overhead (i.e., indirect costs) in proportion to the activities associated with a product or product family. For instance, if one product by its nature has losses of regulated chemicals to the workplace and environment associated with it, it must bear a significantly higher cost burden than another product made without significant regulated chemical loss. ABC methods really form a basis for value-added and business process analyses and redesign that fosters global competitiveness. The use of ABC provides a company with a wonderful tool to identify and reduce resource consumption by increasing both efficiency (productivity) and effectiveness.

Two measurements of production efficiency are as follows:

$$\text{Material Use Efficiency (\%)} = \frac{\text{(Amount of Material Used - Amount of Products)}}{\text{Amount of Material Used}} \times 100\%$$

$$\text{Economic Efficiency (\%)} = \frac{\text{(Production Unit ABC - Cost of Loss)}}{\text{Production Unit ABC}} \times 100\%$$

How does this measurement meet the criteria posed by this workshop?

1. How do you measure waste that is not created? Waste (i.e., losses) which is not created improves production efficiency. Therefore, it is counted in this method.

2. How can you compare results from differing companies or industries? Efficiency is universal to all manufacturing processes. However, some are inherently more efficient than others thus making cross-industry comparisons difficult.

3. How do you account for changes in production? Production efficiency is a normalized unit less measurement. Remember that some processes may become less efficient at lower production rates!

4. Is it meaningful to compare a company with a history of successful pollution prevention with another company that is just beginning? In the best practice of TQM and JIT, a firm strives for maximum efficiency. The goals are always zero losses or 100% efficiency.

5. To what extent does accounting for "hidden" costs, such as recordkeeping and reporting, get factored into environmental decision making? Indirect costs must be factored into all manufacturing decision making. The use of total costing methods, which include intangible costs, will not receive favorable management acceptance. ABC takes real costs normally attributed to overhead and reassigns them to the units responsible for them. Wasteful unit operations appear a lot more costly in this accounting practice.

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IMPLEMENTING AND TRACKING WASTE REDUCTION PROGRESS AT DUPONT

Randy Price
Manager
Waste Programs
E.I. DuPont De Nemours & Co.
P.O.Box 80721, MR 2024
Wilmington, DE 19880-0721
PHONE: (302) 999-4128

The DuPont company has an active waste reduction program. This program consists of a three-tiered approach. The first tier focuses on present activities and facilities. At this tier we look for immediate results typically requiring a relatively low investment and results in a relatively high rate of return (these are the so-called "low hanging fruit").

The second tier focuses on near-term changes by upgrading existing processes using existing technology. These initiatives tend to take from 1-5 years to complete.

The third tier focuses on developing new technology and requires basic research and development. These initiatives tend to take more than 5 years to complete. This tier usually results in major capital investment through either major process modification or construction of new facilities. The rate of return for these initiatives tend to be lower than the other two tiers as well as having a lower probability of success.

DuPont has several waste reduction goals for such categories as air toxics, air carcinogens and hazardous waste. To properly plan for the successful achievement of the goals as well as to track our progress, the company has developed a Corporate Environmental Plan (CEP). The CEP integrates environmental planning with business planning as well as identifies the initiatives required to achieve our environmental commitments.

The company also maintains or is in the process of developing several data bases to enable the company to track progress more accurately and on a more frequent basis. Currently, the company operates the Corporate Solid Waste Information System (CSWIS). This system tracks our generation of hazardous and non-hazardous waste and is updated annually. The company also has a corporate TRI data base which tracks our TRI numbers, both "as generated" and "releases and transfers". We are currently developing systems which will help our sites track their air emissions and manage their waste management programs.

In addition, the company has implemented the Chemical Manufacturers Association's Responsible Care® program whose purpose is to promote the continuous improvement in environmental performance of member companies. Responsible Care® tracks improvement in management systems. Programs like TRI track progress in waste reduction. Both systems aid a company to understand its performance and helps to identify where progress is needed the most.

NORMALIZED MEASURES OF POLLUTION PREVENTION

Nasrin Behmanesh
Julie Roque, PhD
Associate Professor
and
David T. Allen

UCLA
Graduate School of Architecture & Planning
405 Hilgard Avenue
Los Angeles, CA 90024-1467
PHONE: (310) 825-0577

ABSTRACT

Releases and off-site transfers reported in the 1987 Toxic Release Inventory (TRI) were normalized by a variety of economic indicators reported through the 1987 Census of Manufactures (employment, payroll, sales, value added and others). Industrial sectors, identified by two digit Standard Industrial Classification (SIC) codes, were ranked according to total TRI releases and transfers and by the normalized measures. The normalized measures yielded industry rankings that were different than the rankings based on total releases and transfers. Among the normalized measures, however, the rankings were largely independent of the choice of economic indicator despite the fact that both labor and capital intensive industry sectors were included.

INTRODUCTION

Initiatives to promote pollution prevention have been undertaken at the federal, state and local level across the United States. One of the greatest challenges to strengthening and expanding these efforts, however, is developing measures to assess progress toward reducing or minimizing industrial discharges. Measures of pollution, normalized to levels of industrial activity (i.e., emissions/production), would enable decision-makers to track emissions over time and identify facilities that are making great, little or no progress in pollution prevention, despite changes in economic conditions. The concept of normalizing pollutant releases and discharges to production levels has been widely discussed, with significant debate centering on the choice of appropriate production indices[1,2]. The general perception is that the choice of production index may influence the apparent environmental performance of a facility or an industry sector. The goal of this paper is to assess the validity of the perception by normalizing releases and transfers reported through the Toxic Release Inventory (TRI)[3] by economic indicators available through the Census of Manufactures[4].

The TRI is the single most comprehensive source of multimedia data available on releases and transfers of hazardous materials to the environment. Mandated by Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA), the TRI reports quantities of hazardous materials, on a facility by facility basis, that are released into the air or surface waters, managed on land on-site, or shipped off-site for treatment and disposal. It is compiled from annual reports submitted to the U.S. Environmental Protection Agency by manufacturing facilities that use and store any of the approximately 320 chemicals (or classes of chemical compounds) listed in the inventory.

In 1992, the TRI reporting requirements were revised to include a production or activity index that would enable waste generation to be normalized to levels of production[5]. The production index is a facility specific ratio of some measure of production in the current year to the same measure for the previous year. The addition of a production index to TRI reports will enable pollution prevention trends to be evaluated for single facilities, taking into account increases or decreases in activity. As currently reported, however, the productivity indices used by different reporting facilities will be vastly different and cannot be compared or aggregated. For comparisons and aggregations to be made, activity must be expressed in a common set of units such as number of employees, or value added by manufacture. It is uncertain, however, whether the development of such as index would significantly supplement the information already in the Toxic Release Inventory. To explore this issue, we normalized TRI reports using indicators of economic activity such as employees, payroll, value added by manufacture and total sales. The measures are available from the Census of Manufactures[4], which is collected every 5 years and is reported by the U.S. Department of Commerce. Economic indicators such as employment and value added, measure different characteristics of economic activity. Therefore, we expected that labor intensive industrial sectors might appear "greener" if emissions were normalized by employees, while capital intensive industries might benefit from a production index based on value added. We found, however, that with only a few exceptions, the choice of economic indicator had little bearing on the overall ranking of industrial sectors. These are very preliminary results, however, and must be confirmed by more detailed analysis, particularly an examination of individual facilities. The details of our methodology and results are described below.

METHODOLOGY

Measures of environmental performance used in this work are the ratios of a numerator, the total mass of TRI chemicals released to the environment or transferred from a manufacturing facility, to several different denominators. The denominators considered were: total payroll of all employees, wages of production employees, value added by manufacture, value of shipments, total number of employees, and number of production employees. The total amounts of chemical releases and transfers by each industry category were derived from the 1987 Toxic Release Inventory (TRI) using on-line and published TRI data. The denominator data were all obtained from the 1987 Census of Manufacturers for the same industry categories.

Both sources of data are national in scope, and both contain data on general manufacturers identified by Standard Industrial Classification (SIC) codes 20-39. The TRI is collected from all facilities with ten or more full-time employees which produce, import, or process more than a threshold amount of any of the TRI listed chemicals. These facilities are required to report the amounts of toxic chemicals that are released to air, water, land or injected underground. In addition, manufacturers must report the amount of chemicals that are transferred off-site to other facilities. The threshold value of TRI chemicals for triggering a report was set as 50,000 lb/year for the year 1987 and 1988 but it was reduced to 25,000 lb/year for 1989 and 1990. Approximately 20,000 facilities report through the TRI[3].

The Census of Manufacturers, on the other hand, covers all establishments that had one paid employee or more at any time during the census year, primarily engaged in manufacturing. In the 1987 Census, approximately 150,000 small single-establishments (from the total of 350,000 establishments) were excused from filing reports. This included all single-establishment companies with less than five employees[4]. Thus, the data from many facilities with less than five employees were not included in the 1987 Census of Manufactures.

These differences in the scope of the data sources introduce uncertainty into the evaluation of measures of pollution prevention. The number of facilities used in establishing economic indicators was significantly larger than those reporting under the TRI, and the fraction of TRI reporting facilities varied from sector to sector. Additional uncertainties were imposed by differences in SIC codes. Specifically, the Census data were reported on the basis of the newly revised SIC system (1987 revisions)[4]. In this system some 4-digit and some 3-digit codes were either substituted by new codes or were categorized under other existing code(s). For example, since 1987, the SIC codes 2793 (photoengraving) and 2795 (lithographic plate-making and related services) are both classified under a single code, 2796 (plate making services). A similar example is 3-digit SIC 264 which is included with SIC 267. In other cases, one industry code is split into two separate new industry codes. For example, the 1972 SIC-based industry 2831 (diagnostic substances) has been divided into two distinct industry codes: 2835 (diagnostic substances) and 2836 (biological products, except diagnostic substances). The revisions, however, were not considered in TRI database.

Another complication involves an individual facility reporting under more than one SIC code. In some cases, where emissions from a facility are categorized under more than one SIC, the amount of releases might be counted more than one. For instance, a detailed examination of data corresponding to industries represented by 3-digit SIC codes of 261 (pulp mills) and 262 (paper mills) reveals 557 double counts of SIC codes as follows:

1. There are 21 streams which are identified by both SICs of 2610 and 2620. The sum of total releases and transfers of these streams is equal to 78,569,695 lb/yr.

2. There are 536 chemical streams which are reported to be released from the industries identified by both SICs of 2611 and 2621. Total rate of releases and transfers for these streams adds up to 1,019,666,506 lb/yr (1987 data).

Therefore, a total amount of 1,098,236,201 lb/yr could be double counted when the releases and transfers of SIC codes 261 and 262 are determined. Examples of multiple counts are not rare at the 3-digit SIC code level. In some cases three or four SIC codes per chemical release are reported that all belong to the same 2-digit SIC code. For instance, 114 streams were identified by four 3-digit SICs of 281, 282, 286 and 287 that had total releases and transfers of 203,175,218 lb/yr. In other cases, only a 2-digit SIC code is reported by the manufacturer. An as example, there are 14 streams within SIC 21 which are identified by only the 2-digit code. The sum of releases and transfers of these chemicals is 14,528,072 lb/yr, which is large than the sum of releases for all 3-digit SICs within 2-digit code of 21. In contrast to the confusion at the 3- and 4- digit SIC code levels, there is relatively little multiple counting at the 2-digit SIC code level. (Thus, the results of the analysis presented below focus on the 2-digit level.)

RESULTS

As shown in Table 1, the Chemical and Allied Products Industry (SIC 28) is the major contributor to the total releases and transfers reported through the TRI in 1987. More than 47 percent of the total annual releases of industrial toxic chemicals is from chemical industries. Primary metals (SIC 33), paper and allied products (SIC 26), and transportation (SIC 37) are the other major contributors to total releases of TRI chemicals with 13.7 percent, 5.6 percent, and 4.3 percent of the total annual release, respectively. It must be noted here that including the "multiple 2-digit codes" category, with a contribution of 8.4 percent to the total TRI releases and transfers[3], introduces uncertainty.

Table 1 also lists the rankings of industry sectors based on emissions normalized by production indicators. The rankings of TRI releases and transfers, normalized by economic measures are roughly similar to the ranking by total mass of TRI releases and transfers for all but five 2-digit SICs. The exceptions are the SICs 21, 25, 29, 31, and 35. Four of these five SICs rank higher using normalized indices than when the rankings are based on total releases and transfers. Only SIC 35 appears substantially greener when normalized indices are used.

Although the renkings of these five industry sectors vary when normalized indices are used instead of total releases and transfers, the rankings based on the normalized economic indicators (ratios 1 through 6) are relatively consistent, with one notable exception. Tobacco manufacturing (SIC 21) ranks how based on normalized TRI

Table I. Ranking of the Manufacturing Industries (SIC 20-39) Based on Different Environmental Indices Using 1987 TRI Data

2-digit SIC	Major Industry Group	Total Release (lb/year)	Rank	Ratio 1a	Rank	Ratio 2b	Rank	Ratio 3c	Rank	Ratio 4d	Rank	Ratio 5e	Rank	Ratio 6f	Rank
28	Chemical and allied products	3,319,477,595	1	4,078	1	132,693	1	7,171	1	269,602	1	27,484	1	114,461	1
33	Primary metal industries	958,272,396	2	1,367	2	48,453	2	1,770	3	67,661	3	20,777	2	7,969	2
Mg	Multiple SIC codes 20-39	582,812,531	3												
26	Paper and allied products	395,148,751	4	646	4	23,437	4	849	4	33,555	4	7,826	4	3,626	3
37	Transportation equipment	300,889,604	5	166	8	5,118	12	249	7	8,640	11	2,195	11	904	13
34	Fabricated metal products	241,406,904	6	166	7	6,897	8	224	8	10,597	8	3,221	7	1,638	7
36	Electronic and other electric equipment	222,529,336	7	142	10	5,744	10	223	9	11,286	7	2,322	10	1,299	9
30	Rubber and miscellaneous plastics products	194,437,019	8	234	6	11,059	6	302	5	16,623	6	4,376	6	2,244	5
29	Petroleum and coal products	176,693,200	9	1,525	2	44,215	3	2,313	2	71,864	2	9,542	3	1,355	8
38	Instruments	78,795,702	10	80	15	2,738	15	157	12	6,833	14	1,110	15	734	14
35	Machinery except electrical	77,831,560	11	42	19	1,540	19	68	17	2,983	19	659	17	358	17
27	Printing and publishing	71,200,630	12	48	16	2,129	18	89	16	4,547	16	790	16	523	15
22	Textile mill products	67,965,969	13	101	13	5,957	9	118	15	7,787	12	2,649	9	1,082	11
20	Food and kindred products	66,500,670	14	46	18	2,197	17	65	18	3,519	17	547	18	202	19
25	Furniture and fixtures	65,166,552	15	128	11	7,175	7	159	11	10,421	9	3,209	8	1,739	6
32	Stone, clay and glass products	59,055,730	16	113	12	4,782	14	146	13	6,715	15	1,769	13	961	12
39	Miscellaneous manufacturing industries	37,006,141	17	99	14	5,376	11	137	14	9,187	10	2,120	12	1,156	10
31	Leather and leather products	32,577,268	18	253	5	17,796	5	299	6	25,031	6	7,441	5	3,587	4
24	Lumber and wood products	32,342,544	19	46	17	2,545	16	56	19	3,396	18	1,128	14	464	16
Nh	No SIC codes 20-39	23,931,871	20												
21	Tobacco manufactures	7,268,625	21	163	9	4,893	13	222	10	7,193	13	510	19	350	18
23	Apparel and other fabricated textile products	2,709,835	22	3	20	195	20	3	20	274	20	83	20	42	20

a - (Total Release)/(Total no. of employees)
b - (Total Release)/(Payroll)
c - (Total Release)/(Number of production employees)
d - (Total Release)/(Wages of production employees)
e - (Total Release)/(Values added by manufacturer)
f - (Total Release)/(Value of shipments)
g - Data for companies reporting under multiple codes 20-39
h - Data for codes other than 20-39

emissions and also based on emissions per value added and value of shipment. Its rank according to the emissions normalized by number of employees is relatively high, however.

CONCLUSIONS

The primary goal of this preliminary research report has been to assess the effect that the use of different measures of production may have on normalized measures of pollution prevention. This limited analysis shows that the choice of a particular production index for normalizing TRI releases and transfers does not substantially change the rankings of major industrial sectors. The findings described in this article demonstrate that the choice of a particular normalized index, consistently applied , will not substantially influence the perceived environmental performance of major industry categories. Nevertheless, the normalized rankings are different in a number of cases from the rankings based on the mass of TRI releases and transfers. Because facility-specific economic data were not available for this research (such data are treated as proprietary by the Bureau of the Census), the utility of production normalized data for the comparison of individual facilities cannot yet be comprehensively evaluated. Work is currently underway by the Department of Energy and the Bureau of the Census researchers to couple the Census of Manufactures to environmental databases at the facility level[6]. Their effort should provide a more better foundation on which to judge pollution prevention performance.

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U.S. EPA, REGION I POLLUTION PREVENTION MEASUREMENT ISSUES

Abby Swaine
Coordinator
Pollution Prevention Program
U.S. EPA, Region I
JFK Federal Building, Mail Code - PAS
Boston, MA 02203
PHONE: (617) 565-4523

The following is an overview of the two major measurement topics I will cover in my short panel presentation. I will address these topics from the point of view of a regional EPA office, rather than attempting to characterize national EPA thinking. Although regional offices sometimes pilot test national measurement techniques (for example, Region I's work in Comparative Risk and Region 10's work on Environmental Indicators), they generally rely upon national programs to develop analytic and assessment techniques and policy. The regional perspective is useful, however, in that way we see how effective these tools are in guiding implementation of programs and in convincing others that the programs are worthwhile.

Strategic Planning in Region I

Region I was one of the first EPA regional offices to undertake strategic planning, and from the beginning established pollution prevention as a top priority. Our "long-term objective" for pollution prevention sets the following ambitious and admittedly arbitrary goal: to reduce the quantity of pollution produced by all sources in New England by 30% by 1996 and to avert all future pollution of the Region's resources." Short-term objectives set for fiscal years 93 and 94 target more easily-measured goals, expressed in terms of EPA resources expended, that are not really intended for function as surrogates for the long-term goal.

Our senior managers see a need to justify shifting our staff time and dollars away from lower-priority traditional activities toward pollution prevention, but are of at least two minds on how to accomplish this -- whether to undertake a major measurement experiment that attempts to get as close to true environmental indicators as possible, or to develop and track more modest surrogates. Holistic environmental assessment appeals to our identities as scientists and protectors of a specific geographic area (end ecosystems), but the task is boggling. Surrogates are easier and more familiar, but are also suspect: we are familiar with the artificial and inflexible aspects of the "bean-counting" we have done for years to show our management in Washington that we are fulfilling our statutory and programmatic responsibilities.

Pollution prevention is bearing perhaps an unfair measurement burden: it needs to "prove itself" more, and earlier, than our command-and-control programs had to. We must develop new pollution prevention "beans" to count without much guidance from law or Washington, and risk that they will be superficial, or embrace the even more consuming challenge of measuring actual environmental impacts.

The 33/50 Program and the Toxics Release Inventory

One of the crown jewels of the national EPA pollution prevention program, and one that Region I has taken quite seriously, is the 33/50 program. Here again, EPA has set admittedly crude percentage reduction goals: a 33% nationwide reduction in releases and transfers of 17 toxic chemicals by 1992, and 50% by 1995. Based on tallies of commitments made thus far by companies who have volunteered for the program, EPA feels the 1995 target will be met. However, measuring actual reductions is a confusing and touchy prospect, one that is likely to be shouldered mainly by the Regions.

Region I's questions on the subject are too numerous and complex to characterize well in brief. Among them are the following:

Can the 1988 TRI data -- an early, spotty reporting year -- function at all adequately as a baseline? Will the new TRI Form R yield any meaningful information on production changes and pollution prevention (versus control and treatment) techniques used, to help us assess if reported changes really signify pollution prevention gains? Has the downturn in New England industry already hopelessly confounded the data? To what extent is it appropriate to use more close-up assessment techniques (such as site visits) to verify Toxics Release Inventory data and progress on commitments, given that the 33/50 program is voluntary, and that EPA is offering only recognition in return for commitments?

Notwithstanding our trepidations regarding data quality and measurement techniques, and the looming task of assessing progress with these imperfect tools, Region I is convinced that the 33/50 program is a very useful outreach tool and has played at least a part in achieving substantial pollution prevention.

THE USE OF SYSTEMS ANALYSIS FOR MEASURING POLLUTION PREVENTION PROGRESS IN THE MANUFACTURE OF ELECTRONIC COMPONENTS

Dr. Manjini Saminathan
Dr. Janine C. Sekutowski
and
George Williams, PhD, P. E.
Environmental Technology Department
AT&T Bell Laboratories
Engineering Research Center
P.O. Box 900
Princeton, NJ 08542-0900
PHONE: (609) 639-2473

ABSTRACT

Environmental concerns over waste disposal and efficient utilization of manufacturing process materials, together with evolving state and federal government policy on these issues, have led to the development of an on-line Factory Systems Environmental Advisor for tracking process materials consumption, and the generation of waste or byproduct (per unit of manufactured product), at each step in the manufacturing process. Of particular interest to the authors is the manufacture of electronic components which involves many process intensive, semi-continuous, and repetitive wet chemical and physical operations, that define circuit patterns on polymer, ceramic, or silicon substrates. These manufacturing operations typically involve numerous product codes (having unique processing sequences) and many processing operations. The value of the application of systems analysis concepts for environmental considerations to complex sequential manufacturing operations, lies in its capability to ascertain materials consumption and waste generation at all times, at the individual process step, manufacturing line, or factory levels, and to provide process optimization and control from an environmental perspective.

This paper describes the formulation, concepts, and automation of the systems analysis for electronic components manufacturing. The first step in the analysis is the identification and quantification of all the input (raw materials) and output streams (product and byproduct) in the manufacturing process. A proposed scheme is illustrated to quantify process materials streams through the use of typically available information residing in incoming and outgoing material data bases supporting the manufacturing operation. Typical data bases may include: Chemical Tracking Systems, Bill of Materials data base, and shop production and product routing data bases. The waste streams will be categorized and quantified using information from the above data bases coupled with engineering inputs, energy consumption data, shop records, detailed process audits, physical property data, on-line sensor data from process streams, the results of laboratory analysis, and stoichiometric calculations.

A proposed architecture for the application of the Factory Systems Environmental Advisor to a typical manufacturing process line in a UNIX~ (UNIX is a registered trademark of UNIX Computer System Laboratories) System environment is illustrated. The major elements of the system are: acquisition of data from available sources at periodic intervals, a menu-driven interface for engineering input, automatic and on-demand report generation, and a user interface to query the system. A major element for future incorporation in the Systems Advisor Platform is the "Smart" Analysis Module which provides intelligent manufacturing systems assessments having environmental impact at both the micro- and macro- manufacturing levels, and recommends process alternatives or control using knowledge of best available process technology.

As environmental regulations and reporting criteria evolve relative to manufacturing waste and materials utilization, the authors anticipate a trend towards the application of "Smart" Systems Advisor concepts to manufacturing operations. The proactive development of these systems today will serve to prevent pollution and reduce manufacturing costs.

MEASURING ENVIRONMENTAL PERFORMANCE

Thomas W. Zosel
Manager
Pollution Prevention Programs
3M Company
900 Bush Avenue
St. Paul, MN 55144
PHONE: (612) 778-4805

How to measure the success of a company's or a facility's environmental performance has been a question that has significantly increased in importance as environmental issues have become the concern of top corporate management. Many corporations are spending a significant portion of their capital and operating expenditures on environmental issues. Top management wants to have ways of measuring the results of these efforts.

As environmental managers within a corporation, we need to determine what measurements need to be taken and reported to top management. We also need to remember that there are many others that are interested in our company's or our facility's environmental performance.

The communities in which our plants are located may be extremely interested in what we are releasing into the environment. The customers of our products have an interest and potentially a legal requirement in knowing what materials are in our products or are used in their manufacture. Of particular legal interest today is if CFC's are used in a product's manufacture.

And of course the environmental agencies have a distinct interest in tracking environmental performance. However, in this case, we do not have much choice in conducting the measurements. Our permits, our plant's operations, and as the criminal aspects of many laws are implemented, our personal freedom may depend on these measurements.

When all of these stakeholders are taken into consideration it becomes obvious that there is no single environmental metric or one single measurement system that meets everyone's needs.

Let's just look at some of the advantages and disadvantages of some of the metrics that are currently in use. Perhaps the data that has been given the most publicity in the last few years has been the SARA Toxic Release Inventory (TRI) reports. This information is the actual measurement of the releases into the environment of a selected list of "toxic" chemicals.

This is the measurement system that is generally focused upon by the local community, by environmental groups, and by the media. It gives them a single number which has some degree of reference to a facility's environmental performance. However, the SARA TRI numbers do not take into consideration the risk associated with these releases. A very small quantity of a potent carcinogen may pose a significantly greater health risk than a large quantity of a mild irritant. The SARA numbers do not make this differentiation.

Even with that inherent flaw, the SARA releases have become the focal point for environmental groups, the local communities, and the media. The primary reason for this is that the numbers are very easy to understand. This is of particular value to the media. This is a single "pounds per year" number and this can easily be compared to past performance. In addition, since all major manufacturing facilities are required to file this report on a yearly basis, there is the ability to compare a specific facility's releases to other similar plants in other locations.

This comparison is being used by many of the environmental organizations to push plants with high releases to meet the lower levels of comparable facilities. There has even been suggestions that this could be the foundation for legislation. Today in the air regulation area, new sources in non-attainment areas are required to meet Lowest Achievable Emission Rate standards. This is the lowest emission rate that is achieved in practice or is required by any state law or regulation.

In a similar vein, new plants could be required to meet a "Lowest Achievable Release Rate". This would be the release rate to all media that is achieved by the best performing similar manufacturing facility. This type of regulation could be extremely burdensome and raises some very disturbing issues regarding proprietary information.

The basic concern is that the best performing plants may be achieving these exceptional results through the use of proprietary technology. Could this type of legislation result in a mandate that the superior yet proprietary technology be shared with one's competitors? Even if a licensing fee was offered, the mandatory release of this technology would create a significant monetary and competitive loss for the company which developed it.

While there are many ways in which the SARA TRI information can be utilized, the development and reporting of the data is determined through published requirements. A plant or a company does not have much leeway in how this is done. Consequently, the company does not really have the ability to modify the data to best suit its individual needs. This means that facilities and companies must develop the SARA data but may also want to consider the development of other metrics that are more utilizable for internal environmental performance measurements.

At 3M, we have been quantitatively measuring environmental performance since 1975. The initial measurement system which we have kept in place since its inception, has been the measurement of the pollution that has been prevented under

3M's Pollution Prevention Pays (3P) program and the monetary savings that have been accomplished through these efforts. While this metric does not indicate total environmental performance, it does apply to an extremely important issue for top corporate management. This metric tracks the amount of pollution that has been prevented through cost effective projects.

It emphasizes to all employees that there are actions which they can take to reduce both the actual volume of pollution which is being generated and the monetary savings that are accomplished through these actions. However, this metric did not address the reductions that were being achieved on a basis that was indexed to production, nor did the system include reductions that were achieved that were not reported as specific projects.

In the late 1980's 3M began looking at ways in which we could measure and report waste and waste reductions that would better fit into a Total Quality Management program. The criteria which we established for this system was that it needed to be simple yet be accurate and reproducible. It needed to be indexed to production so that the waste was viewed in relationship to the total plant output. The system needed to measure the reduction in waste through pollution prevention which 3M defines as source reduction and environmentally sound reuse and recycling. It also needed to accomplish this measurement before the waste was subjected to treatment, control, or disposal. And finally, the system needed to be amenable to the establishment of goals on both a total corporate and on an individual division basis.

After considerable discussion and pilot projects on different measurement schemes, a system was implemented in 1990. This system classifies the outputs from a production facility into one of three categories:

Product - this is the intended output from the manufacturing facility.

By-product - this is the residual from the operations that is then productively used through some form of recycling or reuse.

Waste - this is the material that is subjected to waste treatment, pollution control, or is directly imposed upon the environment.

Together these items add up to be the total output from the manufacturing facility. The metric that is then reported is the waste ratio which we define as:

$$\frac{\text{Waste}}{\text{Waste + Byproduct + Product}} = \frac{\text{Waste}}{\text{Total Output}}$$

This metric is, in a manner of speaking, a measurement of manufacturing efficiency. If the waste ratio is zero then all raw materials are being productively used. This does not mean that the plant's processes are 100% efficient, that all raw materials are being converted to product. We all know that for the majority of

operations, this is a total impossibility. However, to say that all materials are going into product QL are being reused or recycled makes the attainment of zero waste within the realm of feasibility.

At 3M, this waste ratio is reported on a divisional basis. It is not solely a plant issue. The manufacturing people can make significant contributions but there are many others that are also necessary to the full implementation of waste reduction and pollution prevention. The Research and Development scientists need to develop new products and new processes that generate less waste. The Engineers need to design equipment that is more efficient and will accept recycled or reused materials. And let's not forget marketing. They need to know which products generate the least amount of waste and sell them in preference to the high waste generating products. In short, waste reduction and pollution prevention is everyone's job. If our objective is to change the corporate culture and the way that we view environmental waste, then each and every employee must see that they can participate and play an integral part in the program.

Now, let's take a more detailed look at exactly how 3M facilities are measuring our wastes. The objective is to have a single number for each division, therefore we do not need to actually measure each specific waste stream, but we need to find ways of accurately measuring all of the wastes that are generated by that division or facility.

What we have found is that currently there is an extensive amount of information in various databases that, if properly integrated, can be used to calculate the waste that is generated. In doing this, we at 3M have divided the waste measurement into five specific categories.

1. Chemical Waste

2. Trash

3. Organic Waste (air and water)

4. Particulate Waste (air)

5. Water Waste (excluding the water)

If we look at these categories, we find that the measurement of each is relatively simple.

If we define this category as all of the material which is included on a RCRA required manifest, then finding out how much is generated is as simple as tapping into the database that contains the manifested information, since the quantities are required on the manifest. If this information is not in a database it may be necessary to calculate by hand, but there is no question that the information is available. If it is not, the facility and the company's management personally has a much greater problem than measuring waste.

Trash

Many people do not realize it but most of the major landfills in the United States already weigh the amount of trash which is sent to their facilities. They normally have a truck scale that weighs the truck on the way in and on the way out. The difference is the amount of waste that was dumped. It is generally fairly easy to make arrangements with the landfill operator to obtain this information.

If the local landfill does not weigh the trucks, we have found that it is relatively simple and inexpensive to find a truck scale in the local area that can accomplish this weighing procedure.

Many people have said that because of the extreme difficulty in measuring organic releases into the air, particularly from fugitive sources, that obtaining a value for organic wastes is next to impossible. That is probably correct if you attempt to measure each air stream. However, If you measure by difference using a material balance, things become much simpler.

If you look at how we have formulated the definitions, the organic waste would be the total amount that is brought into the plant minus that which goes out as product, that which is shipped off-site as chemical waste, that which is shipped off-site for recycling, and that which is consumed or reacted in a chemical process. Each of these individual items are relatively easy to calculate. The amount of total volatile organics brought into the plant should be available from purchasing records. The amount shipped in the chemical waste should be available from the manifests. The amount that is shipped for recycling should be available from shipping record. The amount which is reacted or consumed should be available from production or process engineering yield or production data. The remaining amount is the volatile organic material that is waste before it is subjected to treatment or pollution control. Granted, you may not know exactly where it went but for the purposes of this metric to show management the progress that is being accomplished, this detailed information is not necessary.

The majority of particulate waste will actually be measured in the other categories. Material that is collected from dry control systems such as bag houses, will either be in the chemical waste measurement if the material is hazardous, or in the trash measurement if the material in non-hazardous. If a wet control system is used, the material will end up in the water waste measurement. With this in mind, the actual particulate waste that is in an air stream is very small and in most cases, can be neglected. In those few cases where it is relevant, an actual measurement system may be needed.

Since the objective is to get a measurement of the total waste and not of the individual components, the amount of waste in the water can be determined by a simple total solids analysis. This also takes into consideration the fact that any organics in the water have previously been accounted for in the organics categories.

Establishment of Goals

This metric and measurement system was implemented throughout 3M in 1990, with that as a base year. 3M management then established a waste reduction goal of 35% by 1995 -- we called it Challenge 95 and asked each division to accomplish a 7% per year reduction in the rate of waste generation in each of the next five years.

In 1991 3M accomplished an 8.3% reduction in the rate of waste generation and it appears that our accomplishments for 1992 will also be ahead of schedule.

Summary

The metrics that are required by laws and regulations can be useful to indicate environmental performance but are not suited for internal corporate purposes. Using existing databases that are currently available 3M has developed a waste metric that conforms to a Total Quality Management structure, is simple yet accurate, is a good employee motivator, can be utilized to establish goals, and after three years of experience has proven to be effective in accomplishing waste reductions and pollution prevention.

Section B

CONTRIBUTIONS BY PARTICIPANTS

BUILDING THE INFRASTRUCTURE FOR POLLUTION PREVENTION

Dana Berkley
Environmental Consultant
Arizona Public Service Company
P.O.Box 53999, Mail Station 9308
Phoenix, AZ 85072-3999
PHONE: (602) 250-3838

Arizona Public Service Company (APS) is an investor-owned electric utility serving over 200 communities in Arizona. Our mission is to be one of the top five investor-owned electric utilities in America. Our success in achieving this goal will be measured, in part, by our environmental performance.

APS operates a nuclear power plant, two coal-fired plants, four gas and oil plants, and a hydro plant. Service centers are located throughout our territory. Aside from our primary function of electricity generation and distribution, the utility business includes activities such as vehicle maintenance, instrument repair, and the operation of paint shop, a photo shop, a transformer shop, a meter shop, and a carpenter shop. Field work is also essential to the daily operation of our business.

As indicated by diversity of our operations, APS has many small waste streams. These waste streams necessitate a dramatic change in environmental culture if APS is to succeed in focusing its efforts on proactive prevention, rather than on pollution control engineering and compliance issues as has been done in the past.

Initial evaluation of company-wide pollution prevention efforts revealed that many different pollutants were being reduced or eliminated throughout the company. These efforts were not, however, being measured or coordinated with others. From a corporate perspective, our goal is to educate our employees on the concept of pollution prevention, reinforce the message that everyone's commitment is necessary, and create the infrastructure to support current and future pollution prevention efforts. A common corporate focus will act as surrogate to accomplish these goals.

APS initiated a pollution prevention pilot with a corporate critical success indicator to reduce the use of chlorinated solvents by 100% as of January 1, 1995. The solvents targeted are 1,1,1-trichloroethane (methyl chloroform), carbon tetrachloride, methylene chloride, trichloroethylene and tetrachloroethylene. Though the volume of products containing these chemicals is relatively low, they are used throughout the company in a diverse range of applications.

By establishing a narrowly-focused indicator, APS now has a specific issue to rally around. We are able to raise the general level of awareness around chlorinated solvents and educate our employees as to what types of products may contain the targeted chemicals. Everyone in the company is asked to look at their products since

these chemicals can be found in products ranging from degreasers to adhesives to insecticides. This will assist in changing the culture by making employees more comfortable with chemical names. We hope to raise our employees' comfort level in the same way that, as a society, we have become familiar with computers over the past two decades.

As products containing these chemicals are identified, we will begin to share information on potential substitutes. This will encourage teamwork and enhance our communication efforts. In parallel, APS is working to interface our purchasing system with our chemical tracking system, allowing the product to be reviewed and approved and the chemical composition recorded before it is brought on-site. A system that is integrated in this manner will enable APS to identify, measure and track chemicals. This capability will allow us to implement additional proactive environmental programs with measurable results.

STATEMENT OF PROFESSIONAL INTERESTS

Barbara L. Bush
Senior Regulatory Analyst
American Petroleum Institute
1220 L Street NW
Washington D.C. 20005
PHONE: (202) 682-8325

Five years as Senior Regulatory Analyst with the American Petroleum Institute (API) with duties that involve the management and implementation of key health and environmental programs related to pollution prevention and waste minimization for the petroleum industry. This includes management of research activities to develop tools to assist member companies in the development and implementation of pollution prevention programs within their operations. Specific on-going research activities include: (1) an annual survey of wastes and residuals generated and managed at petroleum refineries that captures quantitative information on source reduction activities underway within refineries, (2) an engineering design and construction study of a refinery process unit that suggests ideas for how environmental release can be minimized while maximizing energy efficiency, and (3) an case study at a refinery that demonstrates how existing accounting systems are used to fully identify the costs of waste generation and management.

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MEASURING PROGRESS IN POLLUTION PREVENTION

Barry F. Dambach
Senior Environmental Engineer
AT&T
131 Morristown Road, Rm B2237
Basking Ridge, NJ 07920
PHONE: (908) 204-8237

My current work area is to implement Pollution Prevention (PP) throughout AT&T. We are presently working on implementing the results of a PP Benchmarking project that included interviews with 3M, Dow, DuPont, Xerox, H.B. Fuller, Intel and AT&T.

The data from the interviews was analyzed and grouped into elements critical to the success of a corporate wide PP program. Two of these critical elements were "monitoring progress/metrics" and "reward/recognition", which ties into the metrics issue also. It was recognized that there must be some methodology to evaluate how well the program is succeeding for both environmental and business reasons.

At this point in time, AT&T has corporate environmental goals for which we are tracking progress, but it is mostly "end-of-pipe" type metrics. We still need to develop new metrics that will track and promote pollution prevention and tie into the business performance of the company. This is the type of information that I hope to get help on from this seminar.

MEASURING POLLUTION PREVENTION EFFECTIVENESS

Lisa Dufresne
Toxic Use Reduction Engineer
and
Paul Richard
Massachusetts Office of Technical Assistance
100 Cambridge Street, Suite 1904
Boston, MA 02202
PHONE: (617) 727-3260

OTA has seen industry measure its own effectiveness in pollution prevention. Some of the key results common to a successful pollution prevention program include:

- reduced use of toxic chemicals,
- elimination of toxic chemicals through substitution, process modification, product reformulation,
- improved end of pipe compliance,
- improved business economics,
- more efficient process,
- defined procedure for applying pollution prevention concepts (like implementing a pollution prevention of toxics use reduction team and policies),
- clear accounting system for money spent and actual product costs,
- clear inventory system for chemicals,
- clear environmental auditing system.

Case studies show how all of the above benefits were measured in different companies, and other benefits derived from the measurement system itself that are not readily apparent. These include:

1. The ability to locate a non-compliance situation quickly.

EXAMPLE

- A company had a copper discharge issue and because they had such a good handle on their process, they immediately could locate the operation and piece of equipment that caused the problem.

- A company had a discharge issue with a metal, and was able to trace it back to a particular process and determine that the metal was in a product but was not listed on the MSDS. Contacting the supplier confirmed the metal was in the product, and they were able to rectify the non-compliance situation.

2. The ability to determine whether a process line is making or losing money.

EXAMPLE

- A company thought one of its process lines was marginally profitable. After implementing a measurement system for TUR, they were able to better quantify the cost of running the line, determined it was losing money, and dropped it.

In addition to added benefits, OTA has found some impediments to effective measurement of pollution prevention. Sometimes OTA works with state schools and gets graduate students involved in assisting companies, however it was difficult to transfer money from the state to the State school.

There are levels of effectiveness for measurement. Again, case studies illustrate examples of how companies can implement and measure pollution prevention in stages.

- Pollution prevention measure (actual reduction in pollution and TUR) right in the facility,

- measure of reduced loadings at local POTW due to TUR at facility,

- more efficient use of chemicals without changing them, etc.

MEASUREMENT TOOLS TO SUPPORT POLLUTION PREVENTION

Margaret Flaherty
Environmental Research Analyst
and
Ann Rappaport, PhD
Center for Environmental Management
Tufts University
Medford, MA 02155
PHONE: (617) 627-8558

Since 1988, Margaret and Ann have been collaborating on projects that seek to advance understanding of corporate decision making with respect to the environment. They explored the complex process in which multinational companies make decisions on how to implement environmental programs in the different legal, social and economic regimes in which their disparate operations are located. In the course of that research, it became clear that corporate decision makers were very interested in knowing how their environmental programs compared to those of their corporate peers. It was possible to compare types of activities, but few companies had established measurement systems that would enable managers inside or people outside the organization to draw conclusions about the effectiveness of programs that had been implemented.

In research on the development and transfer of pollution prevention technology within a multinational corporation, Ann found that extensive formal and informal communication was associated with more effective transfer of technology. One element of communication is describing in quantitative terms the reductions that resulted from pollution prevention projects.

The current project builds on earlier work, and focuses on Management Tolls to Support Pollution Prevention. Outlined below are components of the two-year effort:

I. Benchmarking Seminar Convene corporate leaders, government decision makers, academics and interested others to exchange information on analysis systems and measurement schemes for pollution prevention. Identify leadership firms, and chart directions for future research. A seminar was chosen as the most effective approach to encouraging: mutual learning; exchange of know-how among corporate participants as well as across sectors; and serious reflection that will advance the state of knowledge as in the field.

II. Case Studies Following the benchmarking seminar, researchers will identify companies where pollution prevention measurement is in place, or being implemented, and will undertake selected case studies. Attributes of measurement systems, and strategies for their implementation will be explored. In at least one case, field research will be conducted to examine pollution prevention practice in developed and developing country facilities of the same multinational corporation. Key questions to be addressed include: What role

does pollution prevention measurement play in observed outcomes? How is measurement technology transferred? Is the technology adapted to fit requirements of multiple locations? If so, why and how?

Seminar participants are encouraged to discuss with Margaret and Ann their interest in participating as case companies.

III. Simulation Modeling The project supports a post doctoral research fellow based in the Pollution Prevention Research Branch of the Environmental Protection Agency's Risk Reduction Engineering Laboratory. Dr. Rada Olbina, who was previously with the International Centre for Chemical Informatics at the University of Ljubljana in Slovenia, has an established record in research on waste management, information sciences applied to environmental issues, and computer simulation to identify pollution prevention opportunities. Dr. Olbina is building on her experience by developing several computer supported methods to enhance the prediction capability of simulation models, thus making them more useful to decision makers.

IV. International Seminar Proposed for the end of the second year (May/June, 1994), an international seminar on pollution prevention will enhance opportunities for mutual learning and dissemination of research results. Case study results will be presented and discussed, and leaders from industry, a variety of governments, non-government organizations and academia will be convened to examine opportunities for developing innovative policy and management initiatives within government, corporations and other institutions to promote pollution prevention.

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MEASURING TOXICS USE REDUCTION AT THE PRODUCTION-UNIT LEVEL

Timothy J.Greiner
and
Joseph Paluzzi
Massachusetts Office of Technical Assistance
100 Cambridge Street
Boston, MA 02202
PHONE: (617) 727-3260

Lori Columbo
Sandra Wyman
Chris Witchard
The Environmental Careers Organization
Boston, MA

ABSTRACT

In a study to assess toxics use reduction among a subgroup of Massachusetts manufacturers, 110 firms were studied from a stratified random sample of metal intensive producers (SIC 34-39). Seven percent of the mostly small and medium sized firms documented and measured their toxics use reduction changes on their own unless required by state law. Of those that did measure their progress, roughly half did so accurately. To address one of the predominant toxics use reduction measurement problems, normalizing toxics use reduction changes for production level, we experiment with linear regression techniques. Linear regression is used to determine whether normalization factors correlate to toxics use. The study documents over 2.4 million pounds of toxics use reduction, mainly acids and solvents, from 28 firms.

ENHANCING ENVIRONMENTAL RETURN ON INVESTMENT

John Paul Kusz
Manager of Product Development
Safety-Kleen Corporation
Elgin, Il 60123
PHONE: (708) 697-8460

The work being pursued currently at Safety-Kleen Corporation has focused largely on pollution prevention through the application of life cycle concepts to the development of new products and the redesign of existing products. Measuring progress has been accomplished by assessing actual material reductions in products, waste reduction associated with product use, and product life extension. We are also implementing systems for the recovery of the materials embodied in the products subsequent to their use.

Applying this closed-loop stewardship approach to the products provided by the Company is an extension of the recycling philosophy on which Safety-Kleen's core business was established.

An example of redesign resulting in pollution prevention can be exemplified in the redesign of a hazardous waste container in 1985. The Company used open head steel drums to recover still bottom waste from dry cleaning plants. The drums were used an average of only 1.5 times before disposal was necessary as a result of denting, rusting, and potential corrosion. The cost of drum replacement was approximately 1.3 million dollars per year.

A redesign of an open-headed container made of rotationally molded medium density polyethylene with high stress crack and impact resistance has proven to be a viable solution that significantly increases product life, reduces risk associated with product transport and allows for controlled and cost-effective destruction of the container when its utility has been exhausted. The container is easier to maintain and handle and has exceeded its projected life of four to five times that of the original steel drum.

The environmental benefits of the product have been augmented by turning what was an annual loss of 1.3 million dollars in product to a profit of 500,000 dollars. The annual economic value of the redesign is 1.8 million dollars. In this concurrent project, the Company was able to improve a product technically, operationally, economically, and environmentally with quantifiable results through comparative analysis.

The product was designed in 1985 and was recognized as a "Design of the Decade" by the Industrial Designers Society of America, for innovative solutions in 1989. The product is made of a material which contains a high energy value (17,000

to 19,000 BTU's per pound). It therefore can be recovered after its useful life for energy -- a choice more appropriate than recycling in light of the potential for contamination with hazardous materials over its lifetime.

A number of the Company's products have been redressed in order to minimize materials and maximize material recovery. Using the simple hierarchy of reduce, reuse, and recycle has had a significant impact on resources used, reused and recovered in the equipment manufactured by the Company. A conscious effort to retain the product in order that it might be managed has been an underlying philosophy which allows for this form of stewardship.

The implementation of these footprint-reduction strategies has proven both environmentally and economically beneficial.

Realizing that all products are components of larger product delivery systems has resulted in an essential shift in the concept phase of our product development efforts.

We have begun to look much more closely at the utility needed by the end user and how we might provide the result desired with the lowest possible environmental burden.

By using the conventional comparative analysis that allows for examining the potential economic return on any given investment, such as a product improvement, and including the real or perceived environmental benefits or costs related to those product improvements, what might be called an "environmental return on the investment" can be assessed. Our experience has shown that in many cases these environmental benefits can be quantified economically and result in an economic improvement as well. Implementing product improvements that fall into this "win-win" category becomes the first order of business in reducing the environmental footprint related to any product and/or product system.

DEVELOPMENT OF A COMPUTERIZED INTEGRATED INFORMATION SYSTEM FOR POLLUTION PREVENTION

Rada Olbina, PhD
Visiting Scientist
US EPA, RREL
Pollution Prevention Research Branch
26 W. Martin Luther King Avenue, Mail Stop 466
Cincinnati, OH 45268
PHONE: (513) 569-7526

The Pollution Prevention Research Branch of the US EPA's Risk Reduction Engineering Laboratory in Cincinnati, OH, has shown interest in the development of an integrated information system for pollution prevention (P2). Following is an abbreviated description of the project:

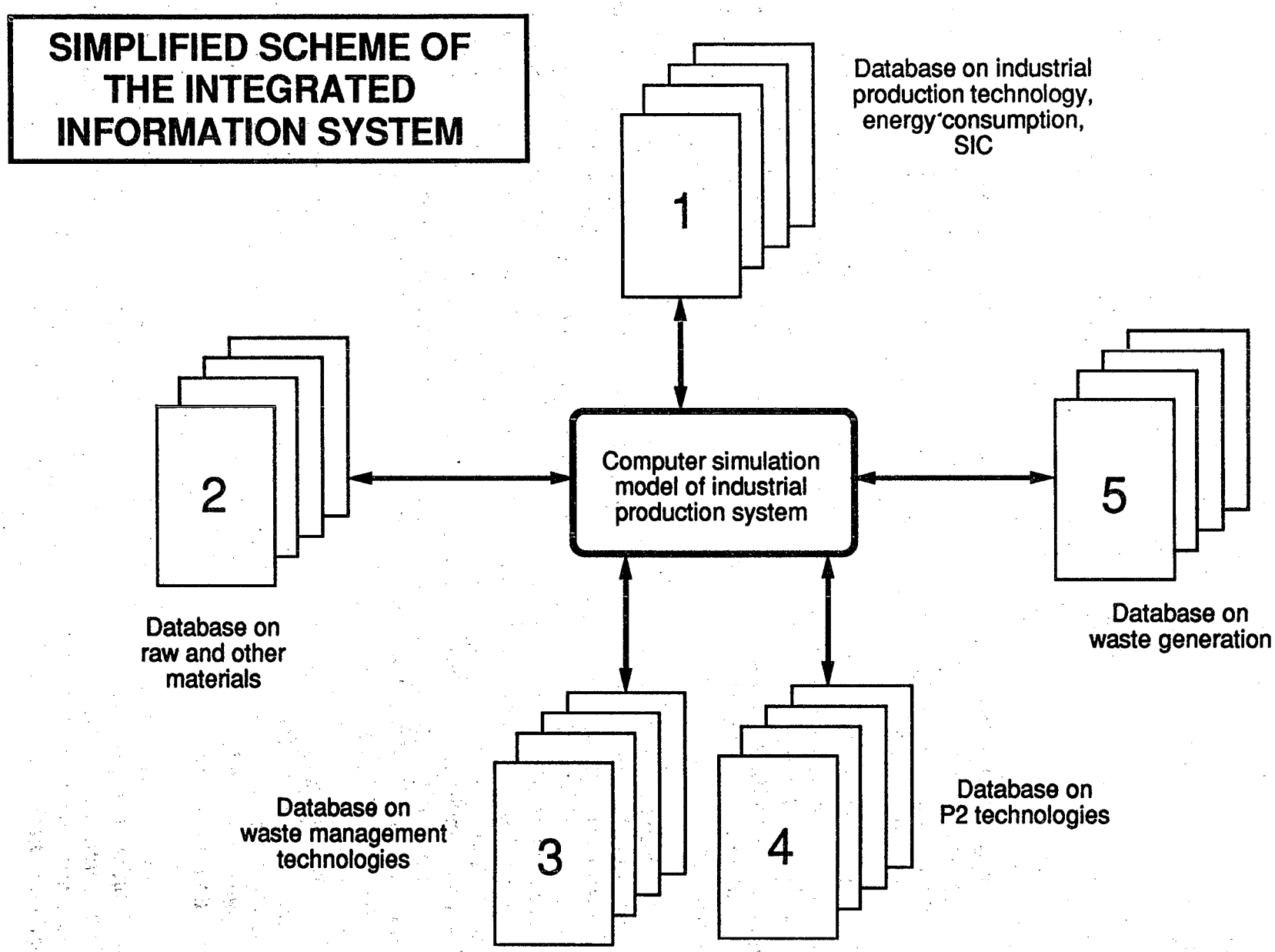
Available on-line, CD-ROM and conventional sources of information are being searched to acquire relevant data on P2 measurement concepts, methodologies and applications. Comparative analysis of over 30 papers has shown that many different approaches to P2 measurement in industrial production have been used, and that the majority of the approaches deal with measurement of P2 quantity, while very few deal with toxicity.

Criteria for selection of the most appropriate P2 measurement concept will be developed. Furthermore, parameters of a model of an industrial production and waste generation system will be defined and the boundaries of such a system will be determined. Computer simulation will be applied to study the system capability and behavior under a variety of conditions. The model for measuring of P2 in an industrial sector will then be a basic part of an information system. The information system will include quantitative and qualitative data on industrial production processes, including Standard Industrial Classification (SIC) number, raw and other materials, production technology types, products, energy consumption, waste and wastewater generation. Databases on P2 strategies as well as waste management technologies will also be incorporated into the system (Fig. 1).

Taking into consideration that there are numerous types of waste and numerous data for their proper identification as well as constant updating in legislation and regulations, it is more than obvious that information on waste management systems needs to be integrated into a computer supported information system for pollution prevention.

The functions of such an information system are to select pertinent data from the infinite variety of available sources, to create information by applying the appropriate tools to data selected; and to communicate the information to the user. In short, information systems deal with collection, storage, processing, transmission, retrieval, distribution and utilization of information.

Fig. 1


SIMPLIFIED SCHEME OF THE INTEGRATED INFORMATION SYSTEM
1
Database on industrial production technology, energy consumption, SIC
2
Database on raw and other materials
Computer simulation model of industrial production system
5
Database on waste generation
3
Database on waste management technologies
4
Database on P2 technologies

An integrated information system for P2 could provide governmental institutions with a powerful tool for implementation of P2 strategies and introduction of efficient waste minimization practices by:

1. prediction of waste and/or wastewater generation in industrial sectors,
2. introduction of process optimization while minimizing waste in production processes,
3. suggestion for application of P2 strategies,
4. measuring achievement in P2.

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5) Industrial Pollution Prevention Opportunities for the 1990s, EPA 600/8-91/052, U.S. EPA Office of Research and Development, Washington, D.C. 20460, pp. 60 (August 1991)

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9) Facility Pollution Prevention Guide, EPA/600/R-92/088, U.S. EPA, Office of Research and Development, Washington, D.C. 20460, pp.143 (May 1992)

POLLUTION PREVENTION INTEREST

David Panco
Program Manager
Weyerhaeuser Company
Environmental Sciences and Technology
Corporate Research and Development
WTC 292
Tacoma, WA 98477
PHONE: (206) 924-4441

Weyerhaeuser Company is principally engaged in growing and harvesting timber; the manufacture, distribution, and sale of forest products; and real estate development and construction. Its principal business segments include timber lands, wood products, and pulp and paper.

The Environmental Sciences and Technology group provides specialized scientific and engineering support, primarily, to Weyerhaeuser's manufacturing operations. Our staff of about 40 works directly with facilities across the U.S. and Canada - including 12 primary pulp and paper manufacturing sites, sawmills, plywood and composite panel plants, and a growing network of recycling facilities. We also provide technical support to the Office of the Environment and the corporate level, and execute research programs with sponsorship from both Weyerhaeuser Paper Company (mid-term targets) and corporate (longer-term targets).

Pollution prevention and product life cycle analysis are among the topics we have decided warrant particular attention. Specific topics of interest include:

Measuring economic results - accounting and financial analysis methodologies;

Integration of pollution prevention options into business planning processes and investment decisions; and

Current best practices in pollution prevention measurement.

INTEREST IN THE FUGITIVE EMISSION REDUCTION

Elizabeth Pfeiffer
Manager
Environmental Services
Givaudan-Roure Corporation
P.O.Box 560
East Hanover, NJ 07936
PHONE: (201) 386-9800

My major interest in the area of pollution prevention is the reduction of volatile organic emissions primarily from fugitive sources.

Givaudan-Roure is currently integrating several separate operating facilities into a single operating facility, and will be installing a biofiltration unit to capture most of its process emissions; however, we are still faced with significant fugitive emission releases.

Due to the complex nature of our distillation and extraction processes, we are faced with the issue of having many portable pumps as well as many flanges and valves. Our process engineering department have been investigating alternative controls including new seals for pumps and welding flanges wherever possible; however, it is not feasible to use certain types of seals in our facility.

I am, therefore, interested in learning how other facilities are controlling fugitive emissions and the cost of doing so.

TURA COMPLIANCE AT MERRIMACK VALLEY WORKS

Anne Reynolds
Environmental Engineer
AT&T
1600 Osgood Street, Department 209100
N. Andover, MA 01845
PHONE: (508) 960-4475

Merrimack Valley Works is AT&T's largest single manufacturing plant. Two business units have manufacturing operations at the facility. About 6,000 people are employed at the plant which operates three shifts. A large part of the facility is devoted to the assembly of telecommunications equipment. The Transmissions Systems Business Unit was a 1992 Winner of the Malcolm Baldridge Quality Award. Two-thirds of Transmission System Business Unit's 7,500 US employees work at this North Andover Massachusetts facility.

The Microelectronics Business Unit manufactures integrated circuits at the plant and this is the most chemically intensive manufacturing at the plant. Under the Massachusetts Toxics Use Reduction Act, the facility is required to report chemical usage on a unit of product basis. Electronic circuit manufacturing consists of a selective addition and removal of layers of conductive and non-conductive material. Some of these layers are added or removed by chemically intensive processes. The number of layers varies on different products. Production units at this factory produce as many as 500 different types of circuits. To accurately calculate the chemical usage per unit of product it is necessary to know the area of the circuit and the number of layers or passes through a chemical process the circuit requires. It became apparent that this could be accomplished very accurately using a manual system. The plant contracted the Bell Laboratories Engineering Research Group to design a computerized system for measuring chemical use by unit of product. The system developed is described in a paper delivered by Dr. George Williams, one of the principle designers of the system.

COMPUTER SIMULATION OF FUGITIVE EMISSION MEASUREMENT

Jordan M. Spooner
Process Engineer
US EPA, RREL
Pollution Prevention Research Branch
26 W. Martin Luther King Avenue, Mail Stop 466
Cincinnati, OH 45268
PHONE: (513) 569-7422

Since May of last year, I have been involved in various technical research and project management efforts as a process engineer for the EPA's Pollution Prevention Research Branch. This research position is part of a two-year Masters degree program with Tufts University in Environmental Science and Management. My research activities have primarily been in the areas of computer process simulation and pollution prevention (P2) measurement.

The predominant research and project management activity has been in computer process simulation, as this is the subject of my Tufts University Masters Report. The objective of this research project is to evaluate the ability of existing process simulation computer software to be used for industrial process pollution prevention, and in particular fugitive emissions prediction and estimation. Computer process simulation involves modeling on a computer any process that can be described as a compilation of discrete unit operations and flow streams. Developed and used primarily by the chemical process industries, process simulation has rapidly emerged as a design and analysis tool that is now used by many different process industries.

For this project, I began by searching the technical literature for all prior applications of process simulation for P2. I then gathered information on several leading commercially available simulation packages in order to examine their basic features. Presently, I am examining how some of these specific features are currently applied for P2 and fugitive emissions prediction, and how they might be applied in the future. I plan to finish with conclusions on the overall P2 and fugitive emissions prediction capabilities of process simulation software, and also recommendations for future features and/or applications.

My work in P2 measurement has focused on exploring the development of a measurement methodology that industry can use on a project-by-project basis. This type of methodology would allow industry to quantify the P2 accomplishment or potential of each individual project. The project measurement might then be added with those from other projects in order to quantify P2 at varying levels, such as a process or facility level. I am interested in somehow applying process simulation in this effort.

WORKSHOP RESULTS

WORKSHOP QUESTIONS FOR WORK GROUPS

Each workgroup should address the following set of questions around the three main issues:

1. Best Practices in Pollution Prevention Measurement

-What are the practices?

-Who is doing it?

-What industry/product/process lines is it done for?

-What are the advantages and disadvantages?

-Is a method transferable to other companies/industries?

-How can the method be aggregated to the corporate / industry /regional/national level?

2. Normalizing Production

- When is normalizing production worthwhile?
- What are effective approaches to normalizing production?
- For each approach, what industries does it work for? Which industries does it not work for?
- How do you establish a meaningful track record -- with rapid product change (e.g. high tech); with change in product mix (e.g. job shops)?

3. Integrated Pollution Prevention Measurement into Corporate Culture

- How do you overcome the barriers to measuring pollution prevention?
- How do financial/accounting methods need to be changed to reflect or encourage pollution prevention?
- When are different types of measurement useful or not useful?

Each workgroup should **develop recommendations** for industry, government and academia on the following topics:

1. What action should industry pursue to improve pollution prevention measurement?

2. What additional analysis or research needs to be done to assist industry?

3. How should the EPA and state agencies proceed on setting pollution prevention measurement policy?

WORKGROUPS

Group 1

Facilitator: Pojasek

Recorder: Dufresne

Barkley
Coob
Hearne
Mannion
Olbina
Panco
Rappaport
Williams, G.

Group 2

Facilitator: Griffon

Recorder: Goldberg

Craig
Dambach
Flaherty
Greiner
McEntee
Pfeiffer
Reynolds
Williams, T.

Group 3

Facilitator: Hart

Recorder: Spooner

Bizzozero
Hirschhorn
Iezzi
Moore
Noble
Roque
Ross
Zosel

Group 4

Facilitator: Freeman

Recorder: Allen

Bush
Cullen
Hawes
Lizotte
Nagle
Price
Swaine

CLOSING REMARKS

Jim Craig
US EPA, Office of Pollution Prevention and Toxics
(PM 222B)
401 M Street, SW
Washington, D.C. 20005
PHONE: (602) 250-3838

I appreciate the opportunity to give my view of what has taken place at this conference. It has been an excellent forum for representatives of government, industry, and academia to share ideas and experiences. As I stated at the beginning of the conference, EPA is looking to initiate cooperative efforts between stakeholders in environmental protection. One thing I've noticed is that we're so used to disagreeing with one another's views that when we meet in a setting like this, before we can talk about areas of agreement and potential cooperative efforts, we really want to argue. Happily, we may be running out of things to argue about.

One area of disagreement that is always near the surface, and that came up here, is the definition of pollution prevention. Does it include recycling? I've been with the Agency's prevention program for four and a half years - since I'm disposed to quantifying things, that's almost 10,000 work hours. I feel like I've spent 8,000 of those hours on this debate. And it's not one of my primary responsibilities. While this is an important debate, the argument takes time away from focusing on where and how we can help each other.

I believe many of the other areas of disagreement that have come up at this conference are much more fruitful areas for discussion. Moreover, we seem to have gotten beyond the arguments to discuss some potential collaboration, especially in the breakout sessions. Some of these areas are:

* What level of aggregation (unit, process, facility) is appropriate for national (and state) reporting requirements?

* What data elements should be included in the reporting requirements?

* Should industry be required to report progress against goals?

We need to take on areas where we disagree, but we need to do so in a manner that is constructive and collaborative. George Williams of AT&T talked about an approach that seems to be very constructive. AT&T is positioning itself for additional reporting requirements, but more importantly, it meets its own potentially changing needs. By sharing information on this and other approaches, I think we have moved an important step toward effectively measuring progress for a company's own uses and toward resolving some of the many issues that remain.

Let us recognize what this conference has been about. There is a difference between the level of information needed by government and that needed by industry. The focus of this conference has been on approaches industry has taken to meet their own needs. Much information is available, and each speaker has described a system that works for each company's needs.

We further need to recognize that there are no right and wrong answers to meeting companies' individual needs. This conference has been an opportunity for information sharing. We can't say one approach is best, but if you use one of them coupled with a problem solving approach, you will likely improve operations, save money, and reduce loadings on the environment. I also think attendees will be able to take back suggestions for changes - large and small - to their measurement systems.

Finally, I would like to mention some of the observations or suggestions that have been made at the conference.

* Put things in terms decision-makers can understand. Just as everyone puts systems in terms appropriate for their own company, the same ideas may need to be presented in different ways depending on who is making the decisions. Also recognize that there may be multiple decision-makers from different organizations - your boss, upper management, government, vendors, clients, academia, and the public.

* Continuous improvement in environmental protection is more important than measurement. But I suggest designing measurement systems that not only leave resources for environmental improvement, but encourage continued environmental improvement over time.

* We have a lot to learn from state requirements and experiences. Many states have detailed information collection and facility planning requirements. National requirements will not need to reinvent the wheel if we learn from state experiences.

* Finally, firms differ, especially, small ones. They have differing capabilities and resources to bring to collaborative efforts and to use in meeting regulatory requirements.

SUMMARY OF DISCUSSIONS

The main points of interest concerning measuring progress in pollution prevention considered by workgroups were the following:

* **application of system analysis,**
* **system inputs and outputs definition,**
* **databases, simulation and information systems application,**
* **pollution prevention measurement types and normalization,**
* **financial aspects,**
* **management practice.**

System Analysis

A system of industrial production has to be defined and boundaries of that dynamic system have to be determined ("black box"). A time of system observation has to be considered. A flow diagram representing material balance is the usual approach of quantifying parameter relationships in an industrial production system.

System Inputs and Outputs Definitions

System inputs (raw and other materials) entering into industrial production process as well as system outputs (products, by-products, process losses, waste, emissions, discharges, nonproduct outputs, releases) should be precisely defined.

Databases, Simulation and Information Systems

To collect, organize, handle and process data on inputs and outputs characterizing any industrial production system, a computerized supported database has to be created. These databases will allow establishment of tracking system for bill of materials, shop production, and product routing. A computerized system will provide material accounting, inventory control (for purchasing minimal quantities of raw materials) as well as computerized integrated manufacturing (CIM). Computer supported simulation could allow direct observation of a system behavior under a variety of conditions, while optimization allows scheduling of resources in such a way that the overall efficiency of the system could be optimized.

Pollution Prevention Measurement Types and Normalization

A material balance is usually applied to measure pollution prevention in industry. Terms such as inventory of production and emissions, purchase records, material inventory, product records and specifications are also being used. Some companies have developed tracking matrices while others use input, byproduct and emission reduction indexes, as well as so called point loss measurement.

Normalization of data to present more meaningful pollution prevention measurement has been used in many different ways. Some practical application showed industries compare data on system inputs and outputs with previous year data and adjust for production, while others use material use efficiency expressed in percentage or economic efficiency. Absolute and normalized pollution levels as well as absolute and normalized pollution reduction are also used in practice. A statistical processing of data using normalization factors (independent variables), regression theory and autocorrelation are applied. The quantity of waste generated is presented per unit of product. Production index and normalization per unit of product at each step of production, is used.

Financial Aspects

The workgroups agreed that the financial aspects of pollution prevention measurement are very important. Cost analysis has to serve as a basis for pollution prevention project selection. Activity based costs (ABC) and/or economic feasibility analysis have to be determined. In industry, placement of environmental costs have to be made into separate accounts and it can serve as a powerful tool for resource optimization.

Management Practice

Total Quality Management -- zero losses or 100% efficiency is only a different name for introduction of pollution prevention practice in industrial production. Effectiveness is measured by the ratio of waste reduction and production. Important considerations for industrial management (concerning introduction of pollution prevention measurement) are time frame, costs, priorities and implementation period. Material accounting could therefore be considered as a standard management procedure.

RECOMMENDATIONS OF THE WORKSHOP

There are different approaches to measurement of pollution prevention progress for different conditions. However, measurement has to be quantifiable and repeatable. A system's units and boundaries have to be defined. Normalization has to be related to toxicity and to units of production. System analysis approaches should be applied in handling environmental data which should be organized and centralized. Studies should be expanded beyond chemical processing sectors. R&D should be directed to develop systems to make Life Cycle Analyssis (LCA) cost-effective. To achieve these goals, top-down management commitment should be provided.

The government should maintain maximum flexibility in applying legislation and regulations related to pollution prevention measurement. It should minimize the burden of reporting by developing consistent formats and adapt regulations to improve environmental practices. It should also establish funding for pollution prevention measurement pilot studies and provide "soft landings" for innovative companies. The role of government should be a "giant facilitator". It should try to help solve the problems not to dictate how they should be solved.

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