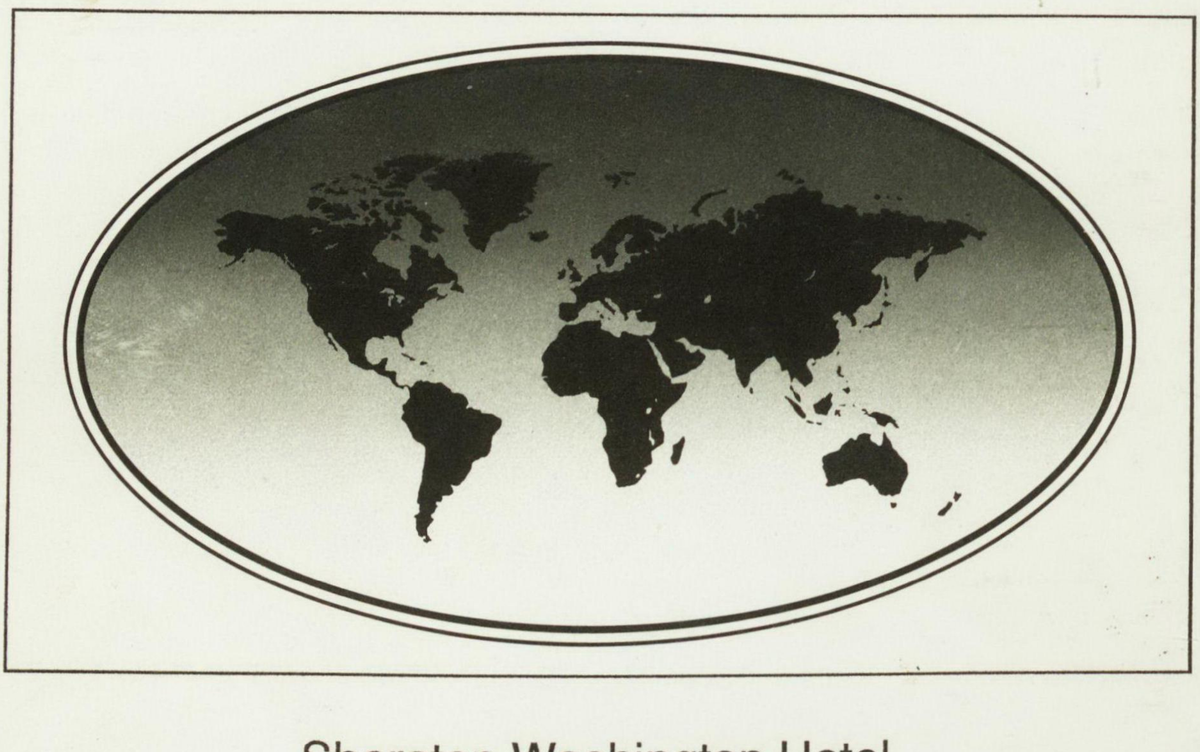
PROCEEDINGS

International Conference & Exhibition

GLOBAL POLLUTION PREVENTION - '91

The Environmental Ethic of the 1990's



Sheraton Washington Hotel
Washington, D.C.
April 3-5, 1991

United States Environmental Protection Agency

CMA Chemical Manufacturers Association

Department of Energy United States of America

National Roundtable of State Pollution Prevention Programs

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Global Pollution Prevention '91

Proceedings of the

Global Pollution Prevention - '91 Conference and Exhibition

Washington, DC
April 3 - 5, 1991

Edited by:
Lorraine R. Penn
Porterfield-Quinn Consultants

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Acknowledgement

Global Pollution Prevention - '91 would like to recognize the Steering Committee that dedicated over a year in the planning and implementation of the Conference. The members of the Steering Committee include:

John Atcheson
Environmental Protection Agency

Jim Bracken
Capitol Convention and Exhibit Company

Bruce Cranford
Department of Energy

Karen Doyne
Fleishman-Hillard, Inc.

Terry Foecke
National Roundtable of State Pollution Prevention Programs

Harry Frazier
Fleishman-Hillard, Inc.

William D. Goins
Department of Defense

Deborah Hanlon
Environmental Protection Agency

Polly Hoppin
World Wildlife Fund and The Conservation Foundation

Frances Irwin
World Wildlife Fund and The Conservation Foundation

John Koutsandreas
Florida State University

Ann Mason
Chemical Manufacturers Association

Edward Miller
Department of Defense

The Steering Committee is also grateful to the Chemical Manufacturers Association and their staff, especially **Suzanne Wills** and **Beth Farrar**, for their substantive and administrative support in planning this conference.

Herbert B. Quinn, P.E.
Chairman
Global Pollution Prevention - '91

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Foreword

Global Pollution Prevention - '91 presented an unprecedented opportunity for Federal, State and local governments, private industry and public interest environmental organizations to review and debate emerging pollution prevention policies and technologies. The Conference developed as a result of the efforts of a dedicated group of volunteers representing Federal and State agencies, private industry and public interest groups.

The primary purpose of the Conference was to provide a forum for the nation's leaders in the area of pollution prevention and source reduction to review on-going progress and to evaluate future directions for this important field. At every turn in the planning process, the Steering Committee worked to assure a balance between public and private issues and between domestic and international concerns.

The presentations and working sessions included experts at the forefront of the pollution prevention movement. The Conference provided insight into EPA's pollution prevention policy, now being vigorously implemented in all Federal and State agency programs, as well as a look at waste reduction efforts instituted by many other national, state and local governments and by private industry worldwide. The Conference provided case studies and information for furthering pollution prevention in the industrial sector and on stimulating industry to develop and implement new processes that will generate less waste and pollution.

The Steering Committee actively sought the participation of foreign governments and international organizations; attempting to provide an international dimension in every technical session. **Global Pollution Prevention - '91** was designed to assure an open and active debate on the issues that will control how we handle pollutants in the next decade. The Steering Committee has made every effort to assure a balanced perspective in each technical session and in the plenary sessions. The technical papers and abstracts presented at this Conference were made available to participants at the Conference. The Session Chair(s) were ultimately responsible for planning and implementing their technical program and presenting papers to the Steering Committee for publication. In some cases, the sessions elected not to present formal papers but to hold roundtable discussions and panels. In these cases, technical papers are not available. Audio recordings, however, are available from the Conference sponsors.

Abstract

The Global Pollution Prevention - '91 Conference/Exhibition

was held in
Washington, DC, April 3-5, 1991.

CONFERENCE SPONSORS & SUPPORT

Sponsors:

U.S. Environmental Protection Agency
Chemical Manufacturers Association
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Support:

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International Association for Clean Technology
National Security Industrial Association

Communications counsel by:
Fleishman-Hillard, Inc.

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MAJOR THEMES

The three major conference/exhibition themes of **Global Pollution Prevention '91** were:

1. **Technical Advances in Pollution Prevention –**
Sessions will focus on process and product development, and research and development and measurement approaches that have been successfully applied.

2. **Industrial/Public Policy –**
Sessions on Industrial/Public Pôlicy will review public and private sector approaches for improving industrial and governmental performance in source reduction.

3. **Media/Education –**
Sessions on Media/Education will focus on the important role of communications to target audiences, including policy-makers, employees, students and the public.

Global Pollution Prevention - '91 is committed to improving the international understanding of approaches for reducing waste and the release of toxic and/or hazardous substances, with special emphasis on source reduction and recycling/reuse of materials.

PREVENTING POLLUTION DURING THE CONFERENCE

Conferences are notorious for being wasteful. Conference organizers typically produce more registration materials than they need in anticipation of a larger than expected turnout or last minute registrants; caterers provide food and beverages in "convenient" and "practical" individual, nonreusable packages; exhibitors give away multitudes of buttons and bags to participants as a free form of advertisement; and participants take home more conference material than they will have time to read.

In keeping with the spirit of the conference -- pollution prevention -- the conference organizers have taken several steps to reduce the generation of waste during the conference, as well as during the time leading up to the conference. Your participation in our pollution prevention efforts is critical to their ultimate success. Our explicit priority in developing a pollution prevention strategy is to reduce the generation of waste a the source through innovative, no or low-tech procedural changes. To the extent that some waste will be generated, we are promoting reuse and recycling of materials.

The following is a list of steps we have taken to make the Global Pollution Prevention '91 conference a "clean conference":

* Reduced the number of promotional and organizational mailings to conference participants and panelists to a minimum.

* Printed conference materials, including brochure, abstracts, and proceedings on double-sided, recycled paper.

* Distributed reusable portfolios tote bags to conference registrants.

* Served beverages in reusable china and glass.

* Served beverages from bulk containers where possible.

* Substituted reusable cloth napkins and tablecloths for paper products.

* Limited the amount of unnecessary packaging around food.

* Issued a set of pollution prevention guidelines to exhibitors and panelists requesting them to avoid distribution of nonessential items (e.g. gadgets, tote bags, extra copies of papers), to print written material double-sided on recycled paper (unbleached and chlorine-free where possible), to encourage participants to take only what they will use, and to make master copies of their material available for immediate review.

* Placed recycling containers throughout the conference area to collect white and colored paper, aluminum cans, glass, and newspapers.

* Designed reusable conference badges.

* Encouraged the use of public transportation by selecting a conference site with ready access to the metro system and by providing information to all registrants about public transportation options.

Please help make the conference a success by taking personal responsibility to reduce, reuse, and recycle. Thank you.

OPENING SESSION

CURRENT AND FUTURE PERSPECTIVES

Introductions

Mr. Stanley Laskowski
Director, Office of Pollution Prevention, EPA

Speakers

Mr. F. Henry Habicht
Deputy Administrator, EPA

Mr. D. Buzzelli
Vice President, Environmental Health/Safety
The Dow Chemical Company

Mr. Leape
Senior Vice President
World Wildlife Fund and The Conservation Foundation

SESSION 1A

TALKING WITH THE MEDIA

Chairperson

Mr. Tom Buckmaster
Fleishman-Hillard, Inc.
Washington, D.C.

Speakers

Mr. Donald B. Shea
President
Council For Solid Waste Solutions

Mr. Rae Tyson
Chief Environmental Writer & Editor
USA Today

Mr. Michael Gough
Program Manager
Office of Technology Assessment

Mr. David Goeller
Media Coordinator
Environmental Action Foundation

Session Abstract

Effective communication and dissemination of information are essential elements of productive pollution prevention efforts. Industry, government and advocacy groups often rely on the media to help communicate their programs and positions to the public.

This session is designed to improve media relations skills and will cover major aspects of working with the media, including message development, relationships with the press, crisis management, use of spokespersons, and communications tips. The session will use examples and case studies, and will include a look at the unique aspects of the environmental media.

SESSION 1B

ENVIRONMENTAL EDUCATIONAL AWARENESS

Chairperson

Dr. Anthony Cortese
Tufts University

Speakers

Mr. Matthew Arnold
Management Institute for Environment & Business
Arlington, VA

Mr. Allan Gagnet
Department of Environmental Resources, Florida

Mr. Steven Levine
Tufts University

Mr. Jonathan Plaut
Allied Signal, Inc.

Session Abstract

Educational Strategies for Pollution Prevention

Preventing the generation of pollution and waste and the conservation of natural resources requires a shift in thinking about the strategies we use to meet human needs and wants. This shift will require that environmental specialists — engineers, scientists, managers, and policymakers—focus on understanding the basic activities and technologies that cause environmental degradation and pollution (e.g., energy extraction, production and use, agriculture, manufacturing, transportation) and examine alternative means of carrying out these activities. Changing fuels, energy conservation, substitution of less toxic materials, integrated pest management and changing production processes to reduce the environmental impact in all environmental media will necessitate expansion of education and training programs for current and future environmental professionals whose training has largely been focused on pollution control and remediation in specific environmental media, such as air.

The paradigm shift must also occur in nonenvironmental specialists whose activities have an important environmental impact. Human activities are both dependent on the natural environment and responsible for its alteration and degradation. Our attempts to meet human needs and wants in an environmentally sustainable manner will require that many professionals be environmentally literate and responsible, i.e. have an understanding of the dependence and impact of their professional activities on the environment and an ethic for responsible stewardship of the planet's resources. All engineers, businessmen, architects, economists and other social scientists, scientists, physicians and international affairs professionals will require education and training for pollution prevention and resource conservation. This awareness, understanding and ethic must also take place at the K-12 education levels as well as for the above professionals.

This session will discuss some of the innovative programs for training current and future environmental professionals in pollution prevention and resource conservation and in promoting environmental literacy and responsibility among all professionals.

On Environmental Education for the Business Manager

Matthew Arnold
Management Institute for Environment and Business

Successful implementation of a pollution prevention program, indeed of any environmental program, requires a strong commitment on the part of virtually every employee in an organization. In a corporation, the success of a program depends not simply upon those professional environmental managers who design and execute it, but upon the designers of new products, who must take in account the environmental impact of a firm's product line; upon those who manufacture products, who must strive to reduce the impact of the production process; upon those who market the products, who must minimize packaging waste and increase the energy efficiency of distribution. Elsewhere in a firm the cost accountants must be able to accurately track environmental costs in order to allocate environmental overhead to individual product lines, and hence reflect their true environmental impact. Project managers must be able to cost the true environmental impact of a new capital project. Perhaps most importantly, senior management must communicate a positive environmental ethic and ensure that superior environmental performance is commensurately rewarded.

In essence, the entire organization must have a common objective to prevent pollution and improve environmental performance, an objective which ideally will be shared by a firm's suppliers and customers. Such unity of purpose cannot be achieved until employees treat environmental standards with the same respect and thoroughness which are accorded standards of taxation, financial accounting or health and safety. This elevation of environmental considerations in the collective conscious of the workforce requires intensive efforts to educate employees about basic environmental issues and standards, and about the concepts and tools of corporate environmental management. Universities have a pivotal role to play in this process, by educating future corporate managers, and retraining those who are already on the job.

An assessment of the priority placed on environmental education in graduate professional degree programs conducted by staff from the U.S. EPA revealed a particularly low level of environmental content in most business management programs, a result which becomes alarming in light of a broad industry consensus that corporate environmental performance would improve with environmentally knowledgeable management.

In response to these conclusions, EPA and AT&T helped establish the Management Institute for Environment and Business (MEB), which is a non-profit coalition of academic, government and corporate resources dedicated to the integration of environmental issues into management research, education and practice. MEB seeks to establish the interrelationship between business management and the natural environment as fundamental knowledge to students of both.

The need for increased business academic attention to environmental issues was highlighted at a series of meetings held in October 1990, entitled Environmental Resource Management: Educating the Business Leaders of Tomorrow, which brought together 50 business faculty and industry representatives from both Europe and the U.S. to identify teaching strategies and a research agenda for environmental education in business schools. The conference attempted to guage the level of environmental content in business education against a scale of corporate environmental concerns, resulting in a clear mandate for academic action on environmental resource management.

Differing priorities in industry and academia

The corporate participants unambiguously placed environmental concerns as a top priority for their firms, hence their managers, in the current decade. They explained that environmental management is not only an appropriate, but an indispensable component of a business education. Their managers must display sensitivity to and knowledge of the environmental challenges that confront their firms.

The business school participants generally agreed that environmental issues are not currently considered an essential component of a business education. Although there are isolated instances of institutional commitment to environmental management education, in European schools especially, there is a clear gap between corporate and academic priorities.

What should they know and how does it get into the curriculum?

To redress this imbalance, the participants explored pedagogical methods to enrich the management curriculum with environmental issues, defined the relevant base of knowledge which business students require, and discussed three or four cases where environmental management courses have been offered with success. There is a discrete set of intellectual issues with which students should be familiar, encompassing ethics, philosophy and natural science. There is also a base of practical knowledge about corporate environmental management which a young manager may need in order to develop competence in her/his job. This practical knowledge should be founded on an ethic of pollution prevention and a long term, holistic view of environmental management.

There was consensus that the championing of environmental education by a respected member of the faculty is most effective at eliciting an institutional commitment to environmental management, and at capturing the interest of other faculty in teaching environmental management issues. Furthermore, faculty must be trained to develop command of the issues, either on their own or with external assistance.

Research as an opportunity and a risk

In the area of academic research, environmental management is a newly emerging field of study. This presents both opportunities for intrepid investigators and potential obstacles to those establishing an academic career. Clearly the range of topics needing attention is broad; the conference participants quickly identified over one hundred viable projects. Moreover, the corporate participants fully endorsed business school research into environmental issues. Research into an emerging area of unambiguous social and business relevance may offer career advancing opportunities.

However, the incentive systems within academic institutions tend to reward creativity, craftsmanship and analytical elegance over relevance. The paucity of data on corporate environmental management renders such analytical elegance difficult to achieve in environmental research. This difficulty is compounded by current economic theories that treat the environment as an exogenous variable in predicting or influencing corporate behavior. These two factors pose a potential barrier to increasing research attention to environmental issues, particularly for younger faculty. Nonetheless, as a legitimate business issue, the environment is certainly a legitimate research issue for business schools. The environment is inherently as deserving of funding as any other management discipline. The remaining challenge for those with a vested interest - government, private industry and the foundation community - is to reduce the barrier by making corporate environmental management data abundant and readily available.

Recommendations

The conference participants generated several recommendations for elevating the importance of environmental issues in business school teaching and research:

1) Establish a network of business school faculty and environmental experts for fruitful exchange of knowledge and experience.

2) Build a clearinghouse/information center for environmental management information including curriculum material, profiles of institutions, leads to potential funders, etc.

3) Generate and make available data on corporate environmental investment and performance.

4) Continue the dialogue between industry and academia though follow-on conferences, and an informal meeting between deans and corporate leaders. Include representatives from developing nations in these efforts.

5) Capitalize on the resources of international organizations such as UNEP/IEO, the International Labor Office and the International Chamber of Commerce to enrich business school education.

Plans & Accomplishments

Subsequent to the conference, substantial progress has been made toward accomplishing the goals set in these recommendations. In early November, the International Chamber of Commerce established a working group on environmental management education to prepare briefing materials and projects for the second World Industry Conference on Environmental Management, to be held in April 1991. Several participants in the conference at INSEAD were included as members of the working group. The primary activity for the working group to date has been the development of an Environmental Management Information Center (EMIC), in direct response to the first two recommendations above.

The Management Institute for Environment and Business has taken the lead development role for the information center and clearinghouse in collaboration with the University of Geneva's Academy of the Environment. The clearinghouse will initially support business school faculty with a network of experts, a curriculum reference service (including case studies, article abstracts, chapter summaries and videos), and a system to quickly design curriculum modules focused on particular topics. As of March 1991, MEB had established 5 - 6 beta-sites for the EMIC, whose intent are to improve the value of the EMIC's services by directly assisting individual faculty.

Independent of these efforts, the Corporate Conservation Council of the National Wildlife Federation is developing a conference to address the full educational needs of business. This conference will take a multi-disciplinary approach to business education, including business schools as an integral component, as well as engineering, natural science, law, etc. This event will occur in late 1991 or early 1992.

The Tufts Environmental Literacy Institute (TELI), which seeks to integrate environmental issues throughout the full undergraduate and graduate curriculum, has had continued success and growth. TELI's goal is to provide graduates with a fundamental awareness and understanding of the importance of the natural environment to life, how all human activities affect the environment, and an ethic for responsible stewardship of the planet's resources. As well, numerous other university efforts at environmental management are under way or expanding.

Consistent with the Tufts program, MEB is currently developing a program of seminars to train faculty in the management of environmental issues. Such training will include a background overview of environmental science, regulation and philosophy as they relate to business management; case study and simulation of selected corporate experiences; and a workshop for developing environmentally related curricula. It is expected that a pilot seminar will be offered by late 1991.

MEB is establishing a program of company-based research to investigate the interaction between business and the environment. Overseen by a Research Advisory Committee of accomplished academics, this research will form an essential contribution to the development of sound environmental policy at both the corporate and government level. The research program will explore management systems and environmental decision-making, environmental costing and capital allocation, product and process design, and external relations.

These innovative educational programs are helping to imbue an ethic of environmental stewardship and pollution prevention in future managers in both the public and private sector. The business community can increase the effectiveness of such programs by communicating their environmental priorities through campus participation, conferences, research consortia, consulting agreements, etc. They also can offer financial support for environmental research, curriculum development or the endowment of chairs. Finally, businesses might consider environmental competence as a criterion in the recruiting process.

The growing consensus around corporate stewardship of the environment will be greatly expanded with the inclusion of mainstream business education. The influence of universities and individual faculty on the thoughts and behavior of virtually every future manager could significantly increase industry's aggregate environmental performance. For the relatively minimal investment required to have such a large impact, environmental education in business school is a definite buy.

AN ENVIRONMENTAL IMPACT PROJECT FOR FIRST YEAR ENGINEERING STUDENTS

Stephen H. Levine, Ph.D.
Department of Engineering Design
Tufts University
Medford, MA 02155

Introduction

Environmental impact problems provide unusual opportunities for first year engineering students to gain engineering design experience. At the same time, experience in an environmental impact study, particularly one involving the very university they attend, produces increased understanding of the complex nature of the issues, and increased awareness of the role that they as engineers can play. 'Hands on' experience in using newly acquired knowledge is an essential component of engineering education. This paper will first describe a group design project, directed at the environmental impact of the Tufts University community itself, presented to primarily first year engineering students. It will then indicate the educational opportunities and advantages of such a project.

Working together with the Tufts Center for Environmental Management (CEM), as part of the project CLEAN (Cooperation Learning Environmental Awareness Now), we identified four areas of environmental impact concern at Tufts appropriate for consideration by first year students. These were:

1. Solid Waste Production
2. Fuel Use
3. Electricity Use
4. Water Use

The Project

We provided some general background and then provided information more specific to the project itself. Students were divided into groups of three to five members. Each group was assigned (i) an environmental impact problem derived from the list of four general areas presented earlier, and (ii) one of three University buildings, Anderson Hall (a classroom/office building), Carmichael (a dormitory), and Cousens Gym. The specific topics assigned were:

Topic 1. Windows and doors represent significant sources of heat loss (or heat gain in air conditioned environments). This loss occurs via radiation, convection (air flow in and out) and conduction. These losses clearly increase fuel use. (This topic is appropriate for Anderson, Carmichael, and Cousens.)

Topic 2. Lighting is a major user of electricity. Adequate lighting is certainly a requirement for both effective utilization of the facilities and for safety. Excess, unneeded, or low-tech lighting represents energy waste, as well as solid waste of short-lived bulbs. (Anderson, Carmichael, and Cousens.)

Topic 3. Americans have traditionally used huge amounts of water, much of it needlessly. This puts excessive strain on municipal water supplies and on sewer systems. Excessive use of hot water has an impact on fuel use as well. (Carmichael and Cousens.)

Topic 4. The production of huge amounts of solid waste is another characteristic of American civilization. Much of this is in the form of paper products. This places a huge demand on resources such as trees to produce the paper and landfills to bury the waste. (Anderson and Carmichael)

Topic 5. Alternative energy sources such as solar energy are often considered as replacements for traditional sources. It may be more realistic to see them as supplementary, providing power for specific uses. As supplementary sources, their use may vary significantly from building to building according to need. (Anderson, Carmichael,and Cousens)

Whatever topic they were assigned for their project the students were directed, as follows, to include:

1. Steps to inform the building occupants about the work they are doing. Data gathering should give affected people some advance notice and be conducted so that it respects people's privacy in their office, dorm, or work out areas. Include a brief description of any problems you encountered and the measures taken to overcome or avoid these problems.

2. Measurement and data collection. Include a description of the methodology used and a detailed record of the data collected. Data gathered should reflect existing conditions and needs. For example, data gathered on lighting should include the wattage and number of existing lighting fixtures, and an examination of the lighting needs. Remember that data gathering and model building often go hand in hand, often in an iterative fashion.

3. Recommendations to reduce adverse environmental impacts and to address needs. These may include designs for both technological fixes (i.e., devices, mechanisms, products, etc.) and non-technological fixes (i.e., policies, procedures, etc.), and should be both needed and feasible. For example, an examination of lighting may suggest the installation of appropriate motion detectors as well as policies on when to turn certain lights out.

4. An engineering analysis of their recommendations. Wherever possible, this means a quantitative description of their effect (e.g., 'this change will reduce water use by 20 -25% from its present level of 330 gallons/day'). It means demonstrating as best they can their technical feasibility.

If appropriate, compare these recommendations to other possible approaches. Evaluate potential disadvantages of these recommendations.

5. A basic economic analysis of their recommendations. How much, if anything, will these recommendations cost? How much savings, if any, will result. What is the payback period? Not every recommendation need produce a cost savings but if one doesn't they should specify on what grounds they are recommending the change. Who pays the cost, Tufts or possibly someone else? Again, evaluate potential disadvantages.

6. Where appropriate, a mechanism designed for ensuring that feedback on performance of their recommendations is obtained in a useful way and made available to affected people. These students, faculty, and staff need to be kept informed as to how the recommended changes are working out to insure their continued participation. Is the feedback system suitable for use in the office, classroom, and dorm? Are individuals able to affect the system?

7. Oral and written reports.

Educational Goals

'Relevance' in education is, at times, an overworked concept. Environmental issues, however, are socially important. They play a major role in the intellectual life at Tufts, and other universities as well. Environmental issues are also technologically instructive. The role technology has played in creating many environmental problems, and the role the students as future engineers can play in solving them, provides 'relevance' we can all agree on. Furthermore, by developing the project in terms of the student's own academic community a connection is made at the personal level. The students are part of the problem, they have an opportunity to be part of the solution, and to see that solution put into action.

First year engineering students are not yet engineers. We can not expect them to be capable of producing highly technical solutions. They are not likely to be even aware of issues pertinent to narrowly defined technologies. Thus, we would hardly ask them to design better blades for a turbine. Broad societal issues, such as environmental concerns, by contrast, are those with which we can expect intelligent high school graduates to have some familiarity, some interest, and in many cases some experience.

While first year students are not yet engineers they are involved in an educational process whose goal is to enable them to design and, maybe more importantly, evaluate technical solutions to problems. Many, though by no means all, technical solutions to environmental problems are within the understanding of these students. Another goal of engineering education, unfortunately often overlooked in the past, should be the ability to determine which if any technical solutions are justified and to envision the possible role of non-technical solutions as well. Environmental issues offer a constant tension between technical and non-technical solutions. You will note that we called upon the students to consider both.

Engineering design is often divided into two broad, somewhat overlapping areas, product design and system design. The environmental impact project described here has aspects of both. Certainly, their is an opportunity for the students to design products useful in reducing adverse aspects of this impact. More generally, reducing the adverse environmental impact of Tufts University gives the students an opportunity to directly work on a system problem, and to confront the many complications inherent in complex systems.

Systems are characterized by the interaction of numerous and varied components. In this project the students were called upon to consider how the specific issue they are considering interacts with a wide range of other problems. For instance, reducing the use of hot water decreases both the need for water and the need for energy for heating. It also reduces the need to produce clean water as well as the need to pump it, both requiring the expenditure of energy. In addition it reduces the load on sewer systems and on water treatment plants, again reducing energy needs as well as all the impacts of building and operating water treatment facilities. However, the use of substantial quantities of very hot water may be critical in getting dishes clean and preventing a number of health problems. The nature of system design problems becomes readily apparent. Furthermore, a full consideration of impacts, both good and bad, forces the students to consider the role of tradeoffs, so central to many engineering design problems.

Conclusion

The best way to make engineering students aware of environmental problems, and the role they have to play in the solutions, is to directly involve these students with a specific problem. Doing this at the beginning of their academic careers may somewhat limit the sophistication of their solutions but it provides them the opportunity to focus on these problems during their educational experience.

POLLUTION PREVENTION AT ALLIED-SIGNAL

Paul H. Arbesman
Director - Pollution Control
Allied-Signal Inc.

Pollution Prevention at Allied-Signal

Allied-Signal Inc. is a multi-faceted company with three key business areas, Aerospace, Automotive and Engineered Materials. Each of these business areas has unique operations involving the processing of raw materials and/or the fabrication of value added products. We recognize that chemical plant operations are different from those related to printed circuit board, automotive brakes or aircraft engine production. Because the company operates in a number of different fields, there is no single approach for the reduction of hazardous wastes and hazardous emissions from our operations. Programs designed at the plant level are the most effective because they are set up by personnel who know their operations and are most able to develop creative solutions to achieve pollution prevention.

Reasons for Pollution Prevention Effort

We have seen a significant evolution in the pollution control field since the new body of environmental law started to take hold in the early 1970's. The focus at that time was the treatment of pollution, usually at the discharge point, to change its character or reduce its volume in order to comply with media-type standards for the air and water. These efforts achieved significant results; the air has become cleaner, the water has improved for recreation and the land resources are becoming better managed.

(1) After this initial large investment, however, residuals, particularly with hazardous characteristics, remain a dilemma to resolve. The cost of going after these residuals with additional treatment options could be exceedingly high because additional treatment may be at the high cost point on the cost benefit curve. This has forced industry to look internally at processes to determine where efficiencies can be achieved which mesh well with yield improvement, wherever possible.

(2) At the same time, we have seen the costs for the management of hazardous residuals, e.g., the cost of hazardous waste disposal, escalate to become another driving force towards waste reduction. There is also the recognition that under Superfund-type legislation industry is joint and severally liable for these residuals which is a further incentive not to have residuals to manage if at all possible.

(3) Another area that has pushed the pollution prevention concept is that of societal concern about the risks of exposure to even minute levels of potentially toxic materials. The question is raised of why the public has to deal with exposure if it is preventable in the first place. The public has yet become convinced that industry has taken sufficient actions to reduce waste, has no further options and that the commodity produced or the plants economic benefit are worth the residual risks.

(4) Legislation is encouraging pollution prevention very directly. The Toxic Substances Control Act (TSCA) tells us that we can only produce safe products. The Resource Conservation and Recovery Act (RCRA) tells us that we should have a formal waste reduction program. Community Right-to-Know legislation requires us to report toxic emission levels allowing the public and government to question what further can be done to minimize or eliminate exposure and the new Congress is considering legislation that would formalize waste reduction requirements in both the hazardous waste and clean air areas.

(5) Beyond these current approaches, one sees the environmental field moving towards an envelope concept where it would be difficult to distinguish specific air, water or waste discharges from the general requirement to reduce the level of toxics released to the environment. Down the road in this blending process risk assessment and risk management techniques must play an ever increasing role in the selection of what reductions should be achieved at what cost.

(6) There is also an underlying belief that those industries that minimize their emissions will maximize their yields and increase their overall efficiencies resulting in a competitive edge over others that do not follow a similar course. While this belief can be debated, it is an undercurrent to the present discussions on mandatory waste reduction targets.

Definitions

It is always helpful when discussing this subject to talk about the terms used and what they mean. The terms generally used in the field are hazardous waste minimization, generation prevention, pollution prevention, waste reduction, toxics use reduction, zero discharge and probably others that appear similar but signal different waste management approaches. Minimization is most commonly understood to mean a lowering of overall levels of potentially toxic releases through whatever means achievable. This could include end of the pipe controls, shipping residuals off-site for destruction or it could include recycling or reuse operations and materials substitution. The newer terms which incorporate the concept of reduction and prevention tend to mean dealing with the front end of the process by reviewing the manufacturing approach and developing concepts for change, including raw material substitution or new technologies that would eliminate or reduce the discharge of the hazardous materials of concern. There are some who say that the only acceptable approach is the latter and that end of the pipe or off-site treatment is an era that should be left behind.

These definitional differences are important in discussing the philosophy of the approach to be taken. But, if a strong company policy on toxics reduction is encouraged, there will realistically be a blend of the two concepts in any successful formula. Because we are dealing with a base of manufacturing operations that is greatly disparate in terms of its age and ability to be cost-effectively modified, in some cases a treatment option could indeed be the most beneficial, whereas a new process design should incorporate the evaluation of materials used and emissions released from the standpoint of overall risk reduction.

In Allied-Signal new construction projects are reviewed for environmental impact. For existing operations, we have adopted a policy manual which includes a guideline on the minimization of hazardous waste as follows:

1. Introduction[1]

Under the 1984 RCRA Amendments, hazardous waste generators must certify the following on all hazardous waste manifests prepared after September 1, 1985:

If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment, OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

EPA has issued a revised Hazardous Waste Manifest form which contains the required generator certification.

Additionally, there is a requirement to submit a biennial report to the appropriate regulatory agency, which provides the following:

- the quantity and nature of hazardous waste generated during the year;
- the disposition of this hazardous waste;
- the efforts made during the year to reduce the volume and toxicity of the waste generated;
- the changes in volume and toxicity of waste achieved in comparison to previous years.

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(1) Excerpts from Allied-Signal Pollution Control Guideline Manual, Section IV.D.2.

2. Purpose

This guideline is to provide an outline for the written program of hazardous waste minimization, which is required at every Allied location generating hazardous waste, as a basis for the certification made on the waste manifest. The program outlined herein reflects segments of programs already implemented by Sector/Company organizations. This guideline is not intended to restrict program development based on site specific conditions. Rather, it is to serve as a baseline model for those elements which all programs should address in order to assure a consistent and technically sound approach.

3. Program Elements

In complying with these regulations, four primary areas should be addressed in developing individual location programs for hazardous waste minimization. These are local organization, baseline data development, system evaluation and documentation/reporting. Prior to examining these individual items, it must be emphasized that the "practicable" achievement standard set out in the regulation is based on a variety of factors including economics, technology and geographic location. The performance objective to be expected of any location is therefore variable according to both individual plant circumstances and the passage of time. This means that a waste minimization program is not a "one-shot" effort, but must be a continuing evaluation of facility operations, technology, applicable regulations and cost/risk alternatives. The principal objective is to reduce hazardous waste; therefore, methods to recycle/reclaim wastes should be evaluated prior to consideration to any disposal methods.

A. Local Organization

A plant committee, appropriate in size to the facility, is needed to develop, implement and manage the plant program. Primary program responsibility lies within the manufacturing group, with input and guidance from technical, financial, operations and environmental staff. A multi-disciplinary approach is essential to proper identification and study of waste reduction and disposal alternatives. An example of committee make-up would be: Director of Operations, Manufacturing Supervisor, Plant Engineer, Accounting Supervisor and Pollution Control Coordinator.

This group must meet on some regular basis, but at least semi-annually. A record of these meetings, with progress reports, must be prepared and maintained in a binder, to document the existence of the location program and provide the basis for periodic reports to the regulatory agency and internal organizations.

B. These regulations state that an assessment must be made of the achievements of the waste minimization program. This requires the development of a benchmark for comparison purposes.

1) The baseline period should be at least one year, but may be longer if the hazardous waste generation rate at a facility is irregular. It is recommended that this period be either the calendar year 1984, or the year preceding the RCRA reauthorization (11/8/83 - 11/8/84), in order to reflect current waste generation rates. Other periods may be selected if local circumstances make these an inappropriate base at some facility, but this decision should be reviewed with the Sector/Company pollution control manager.

2) The units of measure selected may be quantities (gallons, cu. ft.) or ratio, i.e., waste generation to manufacturing rate. The key is to define the baseline in a manner that is appropriate for the individual location and reflects a true measure of production levels and hazardous waste generation rates.

3) Disposal methods and sites must also be identified for the baseline period. The environmental soundness of the disposal method and location is given equal weight in the statute with actual reduction of waste volumes.

4) The Corporate Waste Disposal Information System should provide all required data to develop individual facility baselines. In addition, this system should be referenced in location waste minimization programs inasmuch as it represents a general management tool for monitoring and controlling waste generation and disposal.

C. <u>Systems Evaluation</u>

The waste minimization/risk reduction programs must, by their nature, be individually designed to fit local circumstances. Certain basic steps, however, should be common to the program activities at all locations.

1) Each hazardous waste stream at a facility must be identified by both type and source.

2) Following identification, the local committee can develop a list of potential options for reducing waste volume and/or minimizing disposal risks. Items for consideration could include:

- manufacturing changes to eliminate a waste stream;

- changes in raw material or treating agents which result in less waste or less toxic waste;

- potential recycle or reclamation of wastes;

- pretreatment to eliminate or reduce waste toxicity.

Disposal methods utilized should also be examined and ranked according to their degree of present and long-term risk to human health and the environment. The ranking order will vary from plant to plant according to wastes generated and disposal options available, but an example list in decreasing preference would be:

a) eliminate waste generation

b) recycle/reclaim wastes

c) pretreat to eliminate/reduce toxicity

d) incineration

e) outside recovery with hazardous residue

f) stabilization with land disposal

g) land disposal

Another element in evaluating the risk associated with waste disposal is the soundness of the management of the disposal facility or site, no matter what disposal technology is employed. The Corporate Waste Site Inspection Program which was designed to help assure the Corporation that waste disposal is conducted in an environmentally sound manner and location waste minimization programs must include this activity as it is a significant effort toward reducing present and future threats to human health and the environment.

D. Documentation/Reporting

Minutes or other written record of each committee meeting must be made. Efforts to investigate waste reduction/disposal options, projects initiated and results achieved must also be documented. A multipurpose form developed by the Chemical Sector which provides both meeting and project documentation or another locally developed document should be used.

This corporate guideline was adopted in 1985 to deal with the RCRA requirements that took effect with the 1984 Amendments and required a formalized waste minimization program at the plant level. It was developed at a time of very little government guidance on program content but still stands up well by today's standards. We have encouraged the committees established in our plants, pursuant to this guideline to look at all media for opportunities for reduction, not just hazardous waste. The Community Right-to-Know emission reporting effort has reenforced the need to vigorously pursue those efforts.

Implementation of Program

A guideline on its own does nothing unless it is implemented. Top management support and the commitment of line management at the plant level is required to achieve meaningful results. Efforts must be documented so that they can be tracked and reported on to determine progress. Since there has been much published about the efforts of the chemical industry in achieving waste reduction, I have chosen to report examples from our Aerospace and Automotive units regarding options for waste reduction.

Attachment I shows the agenda for one of the 1988 meetings of Garrett Aerospace units. Committees do not run well unless formalized meetings are held with agendas specifying the topics to be covered.

Attachment II is a list of those particular areas identified for evaluation by the committee as part of the formalized waste minimization program. Looking at this list of eleven items it can be seen that they impact all media (air, water and waste).

Attachment III shows the survey form used to collect baseline data on each of the elements of the waste minimization program giving other pertinent data on who is in charge and current practices.

Attachment IV shows an outline of the discussion regarding waste oil management which lends itself to being followed over time to determine progress.

Attachment V shows that the operations have tracked their disposals costs by quarter and intend to continue tracking those as one indicator of progress of the waste reduction program.

Attachments VI-X show similar activities for our Automotive Aftermarket Division and indicate significant reductions achieved.

These attachments have been selected from presentations prepared by the units for other pollution control professionals in the company to demonstrate program implementation. There was no attempt to strive for uniformity in the areas covered and it is noted that many of the changes are not exotic, but show the application of the new hierarchy of waste management options.

Maintaining Momentum

Two primary concerns are (1) maintaining momentum for these program efforts as the initial reduction targets are achieved and (2) looking toward a potential body of legislation that may be so detailed and cumbersome as to stall progress rather that be an incentive to it. We are in the midst of the classic old adage; why regulate industry if they will do something voluntarily versus why do something voluntarily if industry is going to be regulated anyhow. My sense is that the driving forces that have pushed us to this point of generation prevention are only mounting in terms of the ultimate effect they will have on industry's manufacturing operations. The challenge will be to see how this new philosophy is factored into the standard practice of doing business both in the U.S. and around the world.

In closing, since we operate in many parts of the world, I have enclosed as Attachment XI a table of the waste reduction requirements in effect in some other countries from an EPA report which shows the worldwide concern for this issue. As the European Community moves towards harmonization of requirements in 1992 for the 12 country European block, it appears that waste reduction will be an underlying basis of the environmental ethic for operations in those countries, and we are implementing our pollution prevention programs worldwide. Global warming, ozone depletion and the Montreal protocol are the themes of a growing concern throughout the world that we manage our resourses wisely, provide for sustainable development and improve the quality of life for all people. The concept of reduction of potentially toxic emissions is elemental to this growing worldwide concern for our planet.

ALLIED - SIGNAL AEROSPACE COMPANY

GARRETT ENGINE DIVISION & GARRETT AUXILIARY POWER DIVISION

WASTE MINIMIZATION COMMITTEE MEETING

AGENDA FOR JUNE 27, 1988

I. Waste Generation Data and Disposal Cost for First Quarter of 1988.

II. Meeting Frequency

III. Review of Major on-going Waste Minimization Projects and Progess.

   A. Waste Oil Management

   B. Eliminate Chlorinated Solvents

IV. Waste Minimization Survey

Waste minimization means the reduction, to the extent feasible, of waste that is generated or subsequently treated, stored, or disposed. Waste minimization includes any source reduction or recycling activity undertaken by a generator that results in: (1) the reduction of total volume or quantity of hazardous waste; (2) the reduction of toxicity of hazardous waste; or (3) both, as long as the reduction is consistent with the goal of minimizing present and future threats to human health and the environment.

Source reduction means the reduction or elimination of hazardous waste at the source, usually within a process. Source reduction measures include process modifications, feedstock substitutions, improvements in feedstock purity, housekeeping and management practices, increases in the efficiency of machinery, and recycling within a process. Source reduction implies any action that reduces the amount of waste exiting a process.

Recycling means the use or reuse of waste as an effective substitute for a commercial product, or as an ingredient or feedstock in an industrial process. It also refers to the reclamation of useful constituent fractions within a waste material or the removal of contaminants from a waste to allow it to be reused. As used in this report, recycling implies use, reuse, or reclamation of a waste, either on site or off site, after it has been generated.

ALLIED - SIGNAL AEROSPACE COMPANY

GARRETT ENGINE DIVISION & GARRETT AUXILIARY POWER DIVISION

WASTE MINIMIZATION PROGRAM

1. Waste Oil Management
2. Eliminate Chlorinated Solvents - (Trichloroethane & Genesolv D)
3. Drum Management
4. Coolant Recovery
5. Sludge Reduction - (ECM & Wastewater Treatment)
6. Solvent Distillation Still - (Methyl Ethyl Ketone & Waste Paints)
7. Silver Recovery
8. Expired Shelf Life Material
9. Chrome Regeneration
10. Cadmium Recovery
11. Cyanide Solution Regeneration

WASPRO

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GARRETT ENGINE DIVISION & GARRETT AUXILIARY POWER DIVISION

WASTE MINIMIZATION SURVEY FORM

DATE: ____________

1. CONTACT NAME: ______________________ DEPT. NO.: ____________

PHONE NO.: ____________

2. EQUIPMENT/ PROCESS DESCRIPTION: ______________________________

____

____

PROCESS LOCATION: ____

FORM OF WASTE: SOLID _____ LIQUID _____ GAS _____

TYPE OF CONTAMINANTS: ____

____

WASTE PRODUCED (DAILY): AVE. __________ (GAL OR LBS)
MAX. __________ (GAL OR LBS)

TYPE OF CONTAINER USED BULK _____ DRUM _____ OTHER _____

DESCRIBE THE DISPOSAL METHOD ____________________________________

DESCRIBE ANY OTHER PROCESS IN YOUR AREA THAT IS LIKE THIS ONE

____

____

3. ENVIRONMENTAL MANAGEMENT GROUP

WASTE DISPOSAL METHOD ____

WASTE MINIMIZATION METHOD ______________________________________

____

____

FORM1

WASTE OIL MANAGEMENT

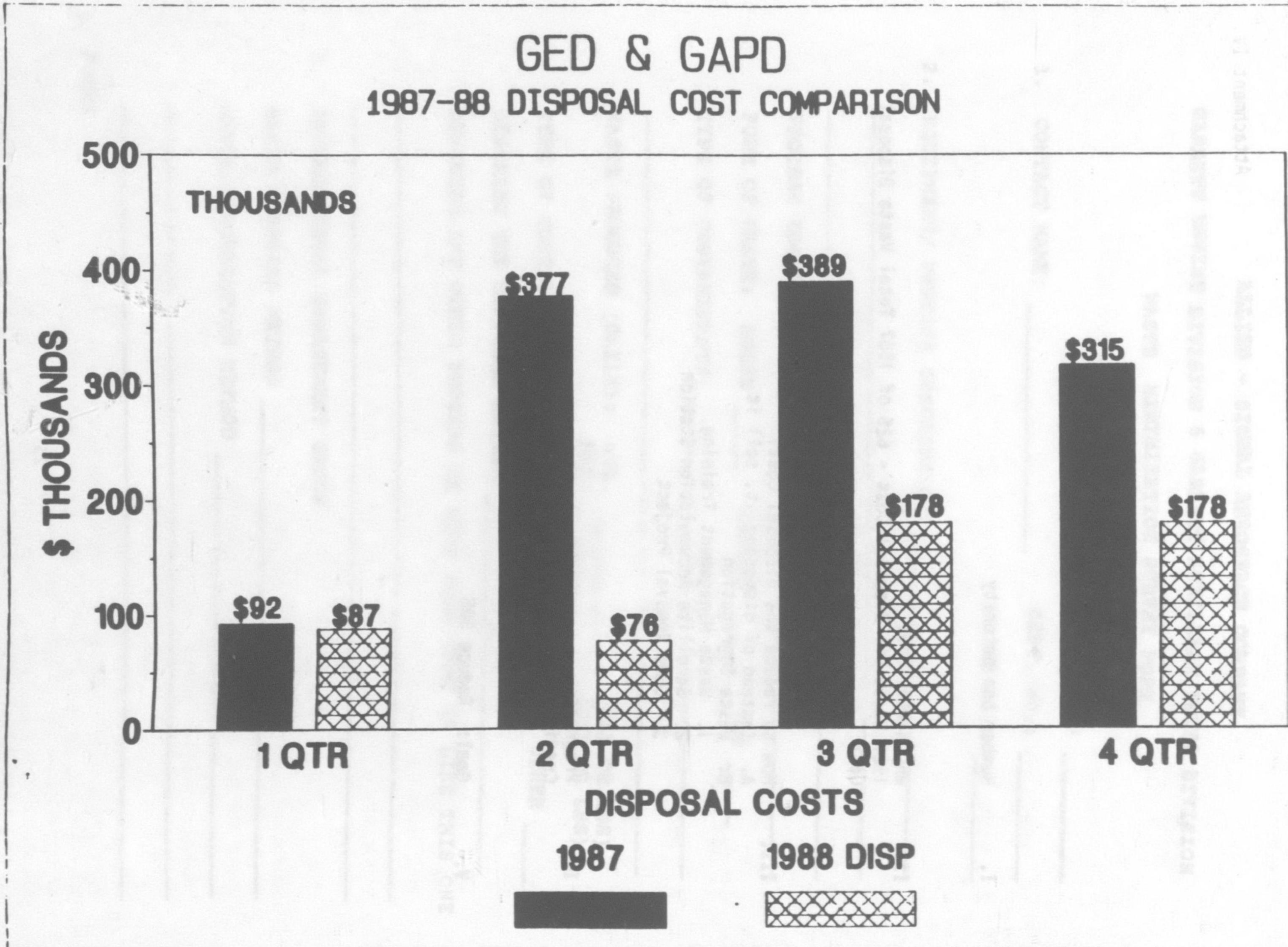
I. Number one priority

II. Why number one?
1987 Waste Oil Disposal Cost = 62% of 1987 Total Waste Disposal Cost

III. How to reduce the Disposal Cost?
A. Instead of disposing it, sell it
B. Waste Segregation
1. Waste Management Training
2. Satellite Accumulation Station
3. Sump Removal Project

IV. Progress
Credit = $1,800.00

V. Goal: Reduce 50%



Attachment V

PROGRAM GOALS

1. TO REDUCE THE QUANTITY AND TOXICITY OF HAZARDOUS WASTE THAT MUST BE STORED, TREATED OR DISPOSED OF AS MUCH AS ECONOMICALLY PRACTICABLE

2. TO ASSURE THAT METHODS SELECTED TO STORE, TREAT OR DISPOSE OF HAZARDOUS WASTE ARE THOSE PRACTICABLE, CURRENTLY AVAILABLE METHODS THAT MINIMIZE PRESENT AND FUTURE THREATS TO HUMAN HEALTH AND THE ENVIRONMENT

3. TO DECREASE THE COST OF TREATMENT OR DISPOSAL OF HAZARDOUS WASTE

4. TO INCREASE PLANT PRODUCTIVITY

BASELINE GENERATION RATES

WASTE STREAM	1984 GENERATION RATE (TONS/YR)
CAUSTIC SOLUTION	248
PAINT WASTE	173
WASTE OIL (HAZARDOUS)	38
METHYLENE CHLORIDE	27
POLYURETHANE	26
MISCELLANEOUS	24
TOTAL	536

MINIMIZATION PROJECTS

CAUSTIC SOLUTION

- REPLACE CAUSTIC SOLUTION PARTS WASHERS WITH BURN - OFF OVEN

PAINT WASTE

- CONVERT FROM SOLVENT TO POWDER PAINT OPERATIONS
- UTILIZE NON-METALLIC PIGMENTED PAINTS
- CONSERVE THINNER AND PAINT BOOTH FILTER USAGE

METHYLENE CHLORIDE

- CONVERT FROM SOLVENT TO PHYSICAL (BEAD-BLASTING) OR HOT-ALKALINE PAINT STRIPPING OPERATIONS
- SCRAP PAINT REJECTS
- SUBSTITUTE POLYURETHANE DISPENSING SYSTEMS' PURGENTS WITH NON-HAZARDOUS MATERIALS

WASTE OIL

- SEGREGATE WASTE OILS AND SOLVENTS

POLYURETHANE

- MODIFY POLYURETHANE DISPENSING SYSTEMS TO ALLOW FOR SEGREGATION OF METHYLENE CHLORIDE PURGENT AND SCRAP POLYURETHANE

MISCELLANEOUS

- RETURN SCRAP PLASTISOL TO MANUFACTURERS
- SUBSTITUTE HALOGENATED SOLVENTS WITH NON-HALOGENATED (SAFETY-KLEEN) SOLVENTS
- UTILIZE ALKALINE CLEANERS TO REPLACE SOLVENT DEGREASERS
- SUBSTITUTE 1.1.1.-TRICHLOROETHANE WITH GENESOLV

HAZARDOUS WASTE GENERATION

RATES (TONS/YR)

WASTE STREAM	1984	1986	% REDUCTION
CAUSTIC SOLUTION	248	0	100
PAINT WASTE	173	47	73
WASTE OIL (HAZARDOUS)	38	42	+11
METHYLENE CHLORIDE	27	18	33
POLYURETHANE	26	10	62
MISCELLANEOUS	24	35	+46
	536	152	72

PERCENT OF HAZARDOUS WASTE MANAGED BY TYPE OF MANAGEMENT METHOD

METHOD	1984	1986	1987*
DISPOSAL/TREATMENT	77	33	37
RECYCLE/REUSE	23	67	63

* PROJECTED

Figure 1.
WASTE MINIMIZATION PRACTICES BY COUNTRY

	JAPAN	CANADA	GERMANY	SWEDEN	NETHRLD	DENMARK
TAX INCENTIVES:						
Waste End Taxes			x		x	x
Tax Incentives	x	x	x			
ECONOMICS:						
Price Support System for Recycling			x		x	
Government Grants as Subsidies	x	x	x	x	x	x
Low Interest Loans	x		x			
TECHNICAL ASSISTANCE:						
Information and Referral Service	x	x	x		x	x
Site Consultation	x	x				
Training Seminars	x	x	x			x
R & D ASSISTANCE:						
Technical Development Labs				x	x	x
Demonstration Projects	x	x	x	x		
Indust. Research			x	x	x	
PERMITS AND PLANS:						
National Waste Management Plans					x	
Waste Reduction Agreements	x					
Waste Reduction as a part of Permits				x		
WASTE EXCHANGES:						
Regional Waste Exchanges	x	x	x		x	x
PUBLIC INFORMATION:						
Focus on Corporate Image	x					
Focus on Consumer Practices			x			

March 11, 1991

Pollution Prevention Education
at the
Massachusetts Toxics Use Reduction Insititute

Jack Luskin, Sc.D. Kenneth Geiser, Ph.D. and Mark Rossi, M.A.

Toxics Use Reduction Institute

University of Lowell

Lowell, MA 01854

(508) 934-3275

Prepared for presentation at the Global Pollution Prevention '91 conference, April 3-5, 1991. Session on Environmental Educational Awareness.

ABSTRACT

The emergence of a pollution prevention ethic offers the possibility for a revitalization of environmental education. A traditional focus on ecosystems and environmental assessment has provided the foundation for understanding our natural world. A paradigm switch is now needed, from an "end of the pipe" model to one of pollution prevention. Pollution prevention is the guiding philosophy of the educational mission at the Toxics Use Reduction Institute at the University of Lowell. The Institute was established by the Massachusetts Toxics Use Reduction Act of 1989.

Traditional Environmental Education

The traditional focus of environmental education in this country has been on ecology, usually through field studies or other methods of environmental assessment. This approach is important because it gives students both a framework and a foundation upon which to build a comprehensive understanding of the interrelated components of the natural world and components of the natural world and the man-made world.

With the advent of the environmental movement in the 1970's, educational programs expanded their scope to include human-caused environmental problems: air and water pollution, scarcity and depletion of natural resources, and species extinction. Environmental education has been addressing the issue of waste, and in particular hazardous and toxic waste, and with good reason.

In the Toxics Release Inventory (TRI) report issued by the U.S. Environmental Protection Agency, data show 6.2 billion pounds of chemical wastes released into the environment and transferred off-site in 1988. "Seven of the 25 chemicals with the largest TRI totals are considered highly toxic...Releases and transfers of the 123 carcinogens on the TRI list constituted eight percent of the TRI total releases and transfers for both 1987 and 1988."[1]

Unfortunately, the focus has been on the commonly accepted solutions such as waste management, recycling and pollution control. While this "end of the pipe" approach might be viewed as necessary because of the waste crisis we are now experiencing, the view is short sighted, and the approach treats the symptoms rather than the cause of the problem.

According to Dr. Joseph T. Ling of 3M:

> Pollution controls solve no problem; they only alter the problem, shifting it from one form to another, contrary to this immutable law of nature: the form of matter may be changed, but matter does not disappear...[I]t is apparent that conventional controls, at some point, create more pollution than they remove and consume resources out of proportion to the benefits derived...What emerges is an environmental paradox. It takes resources to remove

pollution; pollution removal generates residue; it takes more resources to dispose of this residue and disposal of residue also produces pollution.[2]

A New Paradigm - Rethinking Old and Examining New Relationships

The world we knew as kids was far less complex than the world we live in today. For most of us, probably in self-defense, we tend to deal in little pieces of information, we narrow our focus and fragment the universe into small, easily digested bits. The problem, unfortunately, is that these bits become disconnected and isolated. This approach to dealing with the world often leaves us with a narrow vision, or to quote an old saying, "a failure to see the forest for the trees."

To get to the root cause of many of today's waste problems we need to rethink some old relationships and examine some new ones. For example, we fail to see the occupational-environmental relationship; that events affecting the environment inside the workplace also affect the environment outside the workplace (e.g., Bhopal, Chernobyl, etc.). As a result, we find that environmental and occupational health (a division of public health) experts rarely talk to each other. We need to re-examine these relationships and perhaps begin to piece back together those connections we were so eager to take apart. Once whole again, we will find that end of the pipe solutions such as pollution control fail to protect workers, the environment, and public health.

Compartmentalizing doesn't stop with academic or scientific communities. Within our industries, production design engineers and production engineers don't talk to each other, and neither talks to cost accountants. This "fractionalization" goes on and on, so it is little wonder that in terms of pollution prevention, industry is having a hard time "getting its act together."

Another result of our society becoming more complex and specialized is that people are further removed from the processes that produce the very products they consume. Unfortunately, as consumers are separated from the processes that make their lives so comfortable, they are also separated from an understanding of how these processes, and their by-products, affect the health of the environment, and ultimately their own health. People need to be re-connected with those processes. They need to understand them so that they can make intelligent decisions about the value of the end products, and whether they are worth the price we pay, environmentally.

Traditionally in this country there has been a triangle of conflict between the producers (industry), the regulators (government), and the consumers (public interest groups). Not only do we observe poorly compromised environmental and occupational regulations, but we often see minimal industry compliance with these regulations leaving public health and the environment inadequately protected. The irony of this process is that while much of the engineering and management expertise available to correct environmental problems lies within industry, this know-how has rarely been applied for the common good. What is needed is a change in ethos, a shift from confrontation to cooperation.

In 1989 Massachusetts passed the Toxics Use Reduction Act (TURA), the first law in the nation to address this conflict. The goal of this law is to reduce the amount of toxic substances used in industrial processes through cooperative planning by industry, government, and public interest groups.

Recognizing the need for research and education, the TURA established the Toxics Use Reduction Institute (TURI). Also recognizing that many of the environmental problems facing industry were engineering and management based, the legislature placed the Institute at the University of Lowell, a public university known for its engineering and management schools (addressing the engineering/management split). The Institute's director is an environmentalist and its associate director is an industrial hygienist (remember the environmental - occupational split).

The Institute is housed within the Center for Productivity Enhancement, an interdisciplinary, university-wide center established to help regional industry maintain a competitive edge in today's global and highly technological world market. A primary effort of the center is the support of joint engineering/management projects.

The TURI Educational Mission

The Toxics Use Reduction Institute's educational mission is to develop and deliver the training and education necessary for the successful implementation of the Toxics Use Reduction Act. It will provide general information about and actively publicize the advantages of and developments in toxics use reduction.

To the extent possible, Institute education and training programs will be learner-centered and participatory. Students will be active participants in the learning process, with the expectation that after leaving the program they will become active participants in environmental issues. In addition, the Institute will utilize all available means to disseminate information, both traditional and non-traditional, including the use of distance learning technologies.

The Institute's broad mandate includes developing a curriculum for toxics use reduction planners (the experts who will help industry to plan for *reducing the amount of* toxics used). Toxics Use Reduction Planners will learn fundamentals of industrial production / management such as process characterization, materials audits, worker health and safety audits, regulatory and financial audits. Planners will develop an understanding of the goals of toxics use reduction, and then using what they have already mastered, will generate toxics use reduction options. After setting priorities for these options, a plan will be prepared, thus integrating all the previously isolated segments of an industrial program. Final sessions, will include ethics and resources.

The Institute also will provide opportunities for technology transfer to toxics users through courses, seminars, conferences, newsletters, and other events. The development of curricula and for higher education and training for faculty (primarily in engineering and management) on toxics use reduction is a high priority of the Institute.

Toxics use reduction concepts and practices will not be seen as new topics, but rather new perspectives on already existing topics. It has been a recognized problem that curricula developed for inclusion in engineering or management courses are rarely used. They are all to often isolated fragments of information that faculty find difficult to fit into their semester classes. Because the Institute is intimately associated with the colleges of Engineering and Management, it will be working with faculty to design ways to integrate toxics use reduction into existing curricula. Faculty will not have to make room for this material, they will be able to blend the substance of toxics use reduction into their existing class structure.

The Institute will provide toxics use reduction training and assistance to citizens, community groups, workers, labor representatives, and local government boards and officials. This will provide these groups with an understanding of the problems and benefits of different technologies, and will enable them to make informed decisions on whether or not a technology is "appropriate" (as defined by the impacts on the environment and worker and public health) for their community.

The Institute also is working to develop curriculum materials for intermediate and secondary schools to introduce toxics use reduction in new and innovative ways. One such project will involve the use of new distance learning technology to "bring" students into factories to explore an industrial process. Through teleconferencing students will be able to exchange ideas with and ask questions directly of industry experts. The project will have a data collection component that will be enhanced through the sharing of collected data via a state-wide computer network. This capability will enable students to analyze and compare their community with others across the state.

The project also will have an "action research" component in which there will be a small scale intervention in the real world with the results carefully monitored. As a result of the project it is expected that students, as consumers, will have learned about the relationship between industrial processes and the environment, and through the learning process be "empowered" to act to create positive environmental change.

The Institute recognizes that its mission is broad and its resources limited. In order to accomplish this mission the

Institute strongly believes in the need for cooperative educational ventures. The Institute plans to collaborate with interested and involved parties including universities, environmental organizations, labor, public interest groups, industry and government.

Endnotes:

1.EPA, Toxics in the Community, The 1988 Toxics Release Inventory National Report, [U.S. Government Printing Office, 1990], p. 2.

2.Michael G. Royston, Pollution Prevention Pays [New York:Pergamon Press, 1979], p. xi.

SESSION 1C

SUSTAINABLE DEVELOPMENT

Chairperson

Mr. John Atcheson
U.S. EPA Office of Pollution Prevention
Washington, D.C.

Speakers

Mr. Robert Repetto
World Resources Institute
Economics of Sustainability

Mr. William Moomaw
Tufts University
Sustainable Energy
Sarah Hammond Creighton
Center for Environmental Management
Tufts University
Building a Sustainable Future at Home: Initial Lessons From the Tufts CLEAN! Project

Paul O'Connell
USDA
Sustainable Agricultural Practices in the '90s

Session Abstract

As the scale of human economic activity increasingly approaches the influence of global ecological systems, we are facing the issue of defining sustainable levels of development.

This session will focus on exploring sustainable economics, as well as sustainability in the energy, and in agricultural sectors; what it means, what is being done, and what needs to be done, as well as what the implications are for environmental and developmental policies.

The speakers are leading experts in their respective fields who have been instrumental in defining and integrating the concept of sustainability into our activities.

Abstract

Building a Sustainable Future at Home: Initial Lessons from the Tufts CLEAN! Project*

Sarah Hammond Creighton
Center for Environmental Management
Tufts University
474 Boston Avenue
Medford, MA 02155

Prepared for presentation at the Global Pollution Prevention Conference
Sustainable Development Session
April 3-5, 1991
Washington, DC

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Abstract

The Tufts pollution prevention project, known as Tufts CLEAN! (Cooperation, Learning, and Environmental Awareness Now!), is an example of the local action that is essential for ensuring that we can sustain our future needs. The project's primary goals are to reduce the adverse environmental impacts of the university's activities and to engage the university community in that process. In addition, the project will document both its methods and its findings in ways that can be useful to other institutions. Tufts CLEAN! is investigating strategies to address solid waste issues, energy efficiency, water conservation, and proper handling of hazardous materials. Education and outreach are also important and parallel components of the project.

In order to find inter-disciplinary solutions that advance progress on a variety of topics, Tufts CLEAN! has found that it is useful to propose solutions that incorporate technology, institutional policy, and changes in individual habits. The early initiatives at Tufts have also shown the importance of acknowledging and understanding the institution's environmental impacts, the need for a demonstrated commitment from the top, the nature of this commitment, the need to communicate about specific ideas rather than general concepts, and the strength of using the university's students. Barriers to progress have been identified and strategies for overcoming them are being developed and tested. This paper describes the framework for examining change, the lessons learned to date by Tufts CLEAN!, and the barriers to working toward preventing pollution.

Introduction

In April 1990, the Environmental Protection Agency awarded Tufts University a grant to undertake pollution prevention initiatives on the university's three campuses. A university was chosen as a demonstration site since it has many of the same facilities as other institutions: food service, housing, offices, athletic facilities, heating plants, and waste disposal, to name a few. In addition, a university offers educational opportunities and research resources that have the potential to extend a program's effect far beyond the institution. It is hoped that the university will serve as a model for pollution prevention initiatives as well educate both its workers and its students in ways that will multiply the effectiveness of the program.

The Tufts pollution prevention project, known as Tufts CLEAN! (Cooperation, Learning, and Environmental Awareness Now!), is an example of the local action that is essential for ensuring that we can sustain our future needs. Since the 1960s, Tufts has demonstrated a commitment to environmental education and research, and the university had undertaken conservation and efficiency efforts prior to the start of Tufts CLEAN![1] The ways in which these and other efforts are expanded upon and environmental criteria are incorporated into the long-range decision making and priorities of the university are the focus of the project. This paper describes the early efforts of Tufts CLEAN! as well as some of the initial lessons, findings, and barriers.

The Tufts CLEAN! Project

Tufts University, founded in 1852, is a relatively small university, with three campuses in the Boston area and about 7,900 full- and part-time students and nearly

3,500 employees. The university is composed of three undergraduate colleges and seven graduate and professional schools; these include arts and sciences, engineering, law and diplomacy, medicine, dental medicine, and veterinary medicine. The three campuses are located in urban, suburban, and rural settings, with the suburban campus serving the majority of the school's students.

Tufts CLEAN! has two primary goals: to work within the university to reduce the adverse impacts of Tufts' activities on the local, regional, and global environment, and to engage all members of the Tufts community actively in the process of integrating resource conservation and appreciation for the natural environment into the thinking, culture, and practices of the university. The project combines research and analysis with education and advocacy in order to implement pollution prevention measures in areas including solid waste, energy, hazardous materials, and water. Unlike most technical and policy research projects, Tufts CLEAN! has found that the research and education components of the project are linked and must be conducted both simultaneously and iteratively rather than sequentially because of the emphasis on implementation and community involvement in the project. The findings and methods will be documented and shared with other universities and institutions.

Work on Tufts CLEAN! began late in the summer of 1990 when initial staffing and planning were undertaken. An advisory board, representing faculty, staff, and students from across the university was convened to act as a sounding board for ideas. A coordinating committee of deans and vice presidents, chaired by the dean for environmental programs, was also convened to facilitate the implementation of recommendations. Initial projects included a series of qualitative interviews with university students and personnel, meetings with electric utilities and several interested corporate representative with experience initiating similar programs in their companies, gathering information from other universities, training on hazardous materials use in the engineering school, and a graduate student project to examine the extent of hazardous material use on the Medford campus. Projects currently in process include university environmental policy development, an information campaign on opportunities for energy savings, development of an initial audit for dining services, a water conservation assessment, source reduction strategies, inter-office working groups, and numerous student projects.

Framework for the types of change

Pollution prevention initiatives require changes in our infrastructure, our ways of doing business, and our habits and expectations. Research on environmental issues is often categorized into a specific field such as solid waste, energy, water, safety, or hazardous substances. While these topic areas are useful for segmenting the subject matter, Tufts CLEAN! has found that it is useful to develop solutions that incorporate three types of change: technological, institutional, and individual change. This framework is helpful in creating lasting solutions and we expect that it will also promote inter-disciplinary thinking and solutions. For example, in order to address all facets of a problem engineering students need to include institutional policy changes in addition to designing new machinery; economics students need to look beyond costs and benefits to assess the value of individual choices and incentives for changing them.

Changes in Technology

Technology offers significant opportunities to reduce the burden our activities place on the natural environment. Energy efficient lighting, computer controlled heating and cooling systems, low-flow shower heads, and micro-scale chemistry[2] have been heralded for their potential to reduce our electricity consumption, improve HVAC efficiency, conserve water, and reduce the use of hazardous chemicals and the generation of hazardous wastes. One advantage of many technological solutions is the ability to implement change without affecting the users or residents. However this same characteristic may divorce the results of individual actions from their impacts and reinforce the *status quo*. Furthermore, decisions to make changes in technology are often driven by financial benefits and costs alone: lighting fixture and shower-head retrofits are sold on the basis of their quick pay-back periods, rather than on their potential to defer the construction of power plants or the destruction of wetlands for reservoirs. Relying on technology runs the risk of promoting a sense of closure and accomplishment once a task is done, yet as technology develops or research is undertaken, additional initiatives may need to be embraced. Nonetheless, technological changes offer great opportunities if we are to prevent pollution at all. The effectiveness of these changes is enhanced when combined with changes in institution policy and individual habits.

Institutional changes

Institutional changes may manifest themselves as new institutional commitment, policies, and decision making criteria. They can influence numerous internal operational areas as well as the external business of the organization for the long and the short term. For example, a university policy to return a portion of the avoided costs resulting from pollution prevention initiatives to specific departments has the potential to improve energy efficiency, water conservation, and reductions in solid waste generation. Likewise, a policy to include the cost of hazardous waste disposal in the purchase cost borne by researchers can be an incentive for fine arts, biology, and chemistry departments to consider their use of paints, thinners, radioactive isotopes, or solvents.

Institutional changes are especially important if pollution prevention efforts are to be successful and on-going. While the easiest opportunities for effective institutional changes tend to focus on financial incentives or disincentives, it is important that we promote other criteria such as individual responsibility, the value of health and safety, and a long-term approach.

Individual changes

In *State of the World, 1991* Lester Brown describes a new struggle in which individuals will need to be personally involved in ways that change both their own values and behavior.[3] Sustainable projects depend on the success with which individuals undertake meaningful and informed efforts. These individual efforts are also crucial to developing awareness for and understanding of the connection between our own actions and the local and global environmental consequences. Most importantly, individual efforts are the building blocks for institutional change and the power behind the implementation of new technology.

Taken alone, individual efforts to recycle, carry a reusable mug, turn out lights, or take public transportation have value that is primarily symbolic, but cumulatively these efforts can have a much greater significance. At Tufts we calculated that the electricity used to light an average individual's office for an hour resulted in the emission of 0.375 pounds of carbon dioxide (CO_2) and 0.0029 pounds of sulphur dioxide (SO_2), however if half the faculty and staff turn out these lights when at lunch (one hour) each day the annual avoided emissions would be 157,400 pound of CO_2 and 1,200 pounds of SO_2 and the savings would exceed $6,500 each year.

Tufts CLEAN! has found that individuals are easily discouraged by lack of institutional initiatives or by large disasters that seem to negate the effect of their efforts. However, it is that lack of a compelling national and often institutional commitment on these issues that makes the efforts of the individual so essential.

Linking technological, institutional, and individual change

While each type of change has its own advantages, there is power in combining technology with institutional and individual initiatives on almost any issue. Figure 1 shows three examples of initiatives that use technology, institutional policy, and individual habits in order to accomplish a goal.

<u>Lessons Learned to date by the Tufts CLEAN! project</u>

Acknowledge that environmental impacts exist

Universities are microcosms of the larger society in that they consume water, energy, and food and generate wastes and emissions as a result, yet they are generally

Figure 1: Examples of Technological Institutional, and Individual Change to Reduce Environmental Impacts

Type of Change

Goal	Technological	Institutional	Individual
Reduce electricity used by lighting	1. Retrofit with efficient lights, reflectors, ballasts, and sensors.	1. Provide initial capital. 2. Include monitoring of lights in performance criteria for building managers.	1. Turn out lights went leaving a room. 2. Select fluorescent rather than incandescent desk lighting.
Reduce amount of copy paper used	1. Install copy machines with two-sided copying capability. 2. Develop capability to make scratch pads from paper used on one side ("Pre-cycled Pads).	1. Make two-sided copying less expensive than single-sided. 2. Establish a policy that discarded paper should be used on both sides. 3. Establish a policy that inter-office correspondence use both sides of the page.	1. Choose to make two-sided copies. 2. Choose to use Pre-cycle Pads.
Reduce vehicle air emissions	1. Purchase vehicles that are fuel efficient or use alternative fuels. 2. Improve shuttle services.	1. Develop car-pool network. Establish car-pool day(s) when regular hours are adhered to. 2. Reimburse business travellers up to the cost of public transportation when it is available. 3. Establish a fuel efficiency standard for institution-owned vehicles.	1. Select public transportation. 2. Car-pool at least one day per week. 3. Purchase fuel efficient vehicles.

considered to be a "clean" industry. Likewise, the significance of the environmental impacts of service industries, secondary schools, and family homes is not widely perceived. The impacts of these activities at Tufts, in particular, may not be as severe as those of a large industry or a chemical manufacturer, yet the university impacts the quality of the land, water, and air as a direct consequence of its activities and as indirect results of the production of goods and services and transportation of these items to the university. The following statistics provide a gauge of activities and their environmental impacts at Tufts in the 1989-90 school year:

- 3,200 students were housed and fed by the university;
- 14 million copies were made;
- 65 tons of paper towels were purchased;
- $400,000 worth of chemicals were purchased and the university was a large quantity generator of hazardous waste;
- 110,000,000 gallons of water were used;*
- 2,127 parking permits were issued;*
- 1.1 million gallons of fuel oil were burned in 4 central heating plants, resulting in the emissions of 22 million pounds of CO_2;*
- 23 million kilowatt hours of electricity were consumed, resulting in the emissions of another 34 million pounds of CO_2;* and
- 2,373 tons of solid waste were generated, of which 2,294 tons were disposed of in landfills or incinerators and 79 tons were recycled.*

Outlining the nature of these impacts by providing a sense of their magnitude and far reaching effects has been an important and on-going first step for Tufts CLEAN!

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* Pertains to the Medford campus only.

Demonstrate institutional commitment

As with any program or project, commitment is essential. Corporations that have taken aggressive measures to reduce their own environmental impacts have stated that top management needs to demonstrate and articulate a commitment to environmental issues.[4] Likewise, universities feel the need to have that same commitment come from their presidents and top administrators.[5] At Tufts we have observed that this commitment from the top is a powerful directive for getting the participation of people who would otherwise not commit the time or who feel that environmental issues are not priorities.

Visible commitment from a university's administration can be instrumental in encouraging and rewarding efforts within various university operating units. These schools, departments or offices can then respond to their own needs and capabilities to ensure that initiatives are practical and effective. It should be noted that enthusiasm for environmental issues on the part of faculty, administrators, and students who are anxious to "do something" is essential but does not represent the essential top level commitment.

Demonstrated commitment to pollution prevention and natural resource protection includes commitment to:

- expand the criteria for making decisions to include long-term health, happiness, and sufficiency[6] of the place;
- examine the full cost of decisions to include the consequences of production, transportation, and disposal;

- understand that the effort is interdisciplinary, incremental, iterative, and on-going;
- include operations staff in the analysis and decision making process; and
- take chances.

Many proactive corporations have well-established environment, health, and safety policy statements that articulate the corporation's position on environmental issues with varying levels of specificity. These policy statements are usually endorsed by the CEO or the board of directors. Universities are much less likely to have a comparable policy statement or well-established mechanism for implementing the directives provided in such a statement. A policy statement forms a framework for implementation and decision making. In addition, the actual development and subsequent announcement of a policy statement can be instrumental tools for raising issues of substance and developing consensus on policy issues.

Tufts is developing an environmental policy that was written by a small group and presented for review and revision by the environmental advisory board before being presented to the deans and vice-presidents of the university. The president will then be asked to approve the policy and announce it in April 1991. This participatory process was designed to develop a buy-in from a variety of schools and departments throughout the university.

Tufts found that other universities had only energy or recycling policies, so we relied heavily on statements such as the Valdez Principles and corporate policy statements as models.[7] Analogous university policies and their development process are being examined in order to determine the most effective process, content, and follow-up implementation strategies.

A policy statement needs to be backed up by specific implementation strategies. If the university has demonstrated a strong commitment to the process and a policy has been developed and endorsed, there is a framework for proceeding. When these two precursors are absent, efforts can proceed but they are likely to be uncoordinated and the end result will be unfocused.

Communicate about specific ideas

Communication of information needs to address specific rather than general concepts. For example, the concept of source reduction is strengthened when set in context with a particular issue (such as the reduction or paper use) and strategies for implementing this goal. In time the environmental impacts may become decision-making criteria in the same way that cost consideration is today, but that may be a long time in coming. For this reason, Tufts CLEAN! has found that its communications mechanisms are most effective when they outline clear action steps and specific environmental consequences.

A university's unique asset: students

Students offer energy, enthusiasm, ideas, and skepticism to projects and are a resource unique to universities and colleges. Tufts CLEAN! is working with student environmental groups, graduate student projects, and undergraduate group projects connected with economics, engineering, and solid waste classes.[8] Most of our projects are still underway and it appears that we will receive final projects that vary in terms of depth, innovation, and data quality. Project topics include cost-benefit analyses of recycling, alternative fertilizers, electricity and heating retrofits, water conservation, and transportation as well as a solid waste composition study and engineering designs for addressing issues in specific buildings. The Tufts CLEAN! staff was instrumental in designing student projects with the professors, introducing a discussion of environmental impacts and project expectations to each class, and advising the groups on an ongoing basis.

Tufts CLEAN! found that undertaking student projects can create problems within the university unless diligent and thorough legwork to discuss the expectation, data needs, and uses of the final project was conducted prior to giving students their assignments. Centralizing the requests for information has been helpful in avoiding overwhelming university operational departments especially when multiple or duplicate projects are underway.

One risk that Tufts CLEAN! found with using courses within traditional disciplines is that the interdisciplinary nature of the problem or the full understanding of the actual environmental issues at hand may be missed. Alternative courses, such as those that are offered in the Tufts Experimental College, offer opportunities to address issues in this fashion and in a hands- on way. Including operations personnel, such as the director of physical plant, the food service manager, or a member of the grounds crew, can be a powerful way to address real-life issues in a manner that is not bounded by traditional academic disciplines.

Overcoming Barriers

At Tufts, we have discovered that a number of barriers impede our ability to reduce environmental impacts: cost, time, the *status quo*, lack of information, the failure of past efforts, and problems of self-assessment. Developing and adopting an environmental policy will be a first step toward articulating the university's commitment and intent. The second step requires that the unique characteristics of a university, its decentralization, its students, and its focus on education, are used to overcome the barriers that can otherwise impede the process.

Environmentally beneficial projects may require a financial commitment, however, many of these same projects can help avoid costs. These savings may be long or short term and are most often measured in lower utility bills or waste disposal costs. Other financial benefits can accrue in less conventional ways by reducing risk, liability, and exposure to regulations, or improving public image. Other benefits which have an up-front cost may have very long run benefits; for example, the procurement of recycled paper today carries a premium, but its purchase strengthens markets and will eventually help to lower the per unit price. In addition, the diffuse nature of university operations and the centralized accounting system may distribute the financial benefits of specific department efforts to its school. To reward and encourage grass roots efforts, financial incentives need be developed.

Implementation of environmental initiatives requires that people take time from other work to develop programs, provide outreach, work out problems, and follow up. Universities offer numerous resources that can help lessen the amount of time a pollution prevention project needs to tax any particular individual or department. Setting broadly defined goals and encouraging each department or school to determine how it will use existing resources or expertise to attack the problem distributes the effort from one person or department. In addition, students are eager, energetic, and bring a unique perspective to the process and can be valuable resources.

Many university personnel are responsible for keeping things operating smoothly. Initiatives that threaten these operation may be seen as disruptive, invasive, or additional work. Changing expectations so that personnel performance goals reflect the intent of a university environmental policy and the pollution prevention initiatives can be instrumental in overcoming this barrier.

A lack of information can slow progress or result in trading one adverse environmental impact for another. Tufts has found that the university community is often anxious to act, but lacks information. Tufts CLEAN! is trying to direct comprehensive programs to use newsletters, university publications, art exhibits, and contests to convey material in a variety of ways. Successful programs need a technical assistance resource who can look beyond existing programs and can see the interconnectedness of issues. Furthermore, many myths exist that need to be addressed head on.

Most institutions have some failed efforts that are often held up as examples of why similar efforts are not productive uses of time. These false starts or failed programs can be a valuable resource, offering background material and valuable lessons and insight into the types of mistakes that should be avoided or the nature of changes that need to be undertaken.

A comprehensive pollution prevention program can uncover issues that are sensitive for the university. In addition, there may be concern that assessment of sensitive issues can result in assigning blame or in poor public relations for the university. A clear administrative commitment to progress and cooperation rather than retribution should be articulated. Confidentiality should be respected and sensitive materials should be treated with care. This is especially true when student projects involve issues such as the use of hazardous materials or underground storage tanks. Academic freedom and the need to treat sensitive materials carefully within the university may be in conflict when student projects involve presentations and written reports.

Conclusions

The first projects undertaken by Tufts CLEAN! have provided opportunities to affect change and lay the ground-work for pollution prevention strategies in a variety of ways. The importance of projects like Tufts CLEAN! lies in their ability to reduce the environmental burden of an institution and in the lessons that can be extracted for use by others. Only by learning in this applied way can we identify how we must actually undertake the things that we often know must be done. Until our actions themselves are ongoing we cannot hope to ensure a sustainable future.

Notes:

1. For example, lighting retrofits, low-flow shower heads, recycling, and courses using micro-scale chemistry.

2. See *Smaller is Better*, a newsletter from the Department of Chemistry, Bowdoin College, Brunswick Maine 04011.

3. Brown, Lester, *The New World Order*, in State of the World, 1991, Lester Brown et. al., Worldwatch Institute, 1991.

4. See for example, Arthur D. Little, Inc., Center for Environmental Assurance. Current Practices and Future Trends, Environmental, Health, and Safety Policies: Cambridge, Massachusetts: Arthur D. Little, 1988.

5. See for example the proceedings from Campus and Biosphere, St. Olaf College, Northfield MN, March 7 & 8, 1991.

6. See for example Alan During, *Asking How Much is Enough*, in State of the World, 1991, Lester Brown et. al., Worldwatch Institute, 1991.

7. See Environmental Law Institute, Survey Report on Corporate Environmental Policies, Washington, D.C., 1990.

8. The Tufts Environmental Literacy Institute has provided a forum for an economics professor and an engineering professor to use ideas from the Tufts CLEAN! project as subject matter for their classes' group projects.

SESSION 1D

ECOLOGICAL MONITORING AND EXPOSURE ASSESSMENT

Chairperson

Dr. Christopher C. Saint
U.S. Environmental Protection Agency
Office of Research & Development
Washington, D.C.

Speakers

Dr. Christopher G. Saint
U.S. EPA Office of Research & Development
Modeling and Monitoring Systems Staff
Washington, D.C.
The Application of Ecological Monitoring and Exposure Assessment in Pollution Prevention — An Overview

Dr. Guido R. Guidotti
ENEA, Rome, Italy
Ecological Resources in Italy: Waste Impact Problems and Perceptions

Dr. Jerry Akland
U.S. EPA Atmospheric Research and Exposure assessment Laboratory, ORD
Research Triangle Park, NC
Human Exposure Assessment and its Applications to the Evaluation of Pollution Prevention

Dr. William F. Townsend
Acting Deputy Director
Mission to Planet Earth — NASA
Ecological and Environmental Monitoring From Earth Observing Satellites — NASA's Mission to Planet Earth

Dr. Robert B. Pojasek
Vice President, Geraghty & Miller, Inc.
Boston, MA
Going From Questionnaires To A Formal Pollution Prevention Audit

Session Abstract

The session will address potential applications of risk assessment methodology to the evaluation of pollution prevention policies, procedures, and programs. In particular the session will focus on the use of monitoring and exposure assessment procedures for estimating the potential effectiveness of pollution prevention technologies or policies prior to their implementation and in evaluating their effectiveness after implementation. The speakers represent a broad range of interests in the fields of monitoring and exposure assessment.

SESSION 1E

MEASURING AND TRACKING REDUCTIONS

Chairperson

Jeffrey L. Henninger
Air Products and Chemicals, Inc.
Allentown, PA

Speakers

Mr. James W. Craig
Senior Statistician
U.S. EPA, Office of Pollution Prevention

Mr. John R. Weimhoff, Sector Manager
Environment, Safety, and Industrial Hygiene
Motorola, Inc.

Mr. Mark H. Dorfman
Associate Program Director
INFORM, Inc.

Mr. Hillel Gray
Toxics Policy Analyst
MASSPIRG

Dr. Alistair Clark
Assistant General Manager — Europe
Dames & Moore International

Session Abstract

Effective tracking of measurement pollution prevention efforts can help to identify reduction opportunities, establish priorities, develop goals, and determine progress.

On a national basis, EPA's Toxic Release Inventory database is one yardstick being used to measure the progress in reducing certain wastes and releases. However, many current tracking systems, including EPA's Toxic Release Inventory, deal with raw numbers and do not measure the actual impact or benefits of pollution prevention efforts.

Speakers from EPA, States, industry, and the public will discuss these issues and provide enlightening information on their efforts, views and experiences in tracking and measuring reductions. They will provide specific examples of how TRI data is being used to measure and report progress, examine whether current tracking methods correctly measure progress, and discuss what changes may be needed.

The requirements and anticipated effect on the Pollution Prevention Act of 1990 on tracking and measuring reductions will also be examined. International efforts to track and measure reductions will be discussed.

Collecting Data to Measure Pollution Prevention Progress

James W. Craig
Senior Statistician
Pollution Prevention Division
U.S. Environmental Protection Agency
401 M Street SW
Washington, DC 20560

Prepared for Presentation at
Global Pollution Prevention '91
Measuring and Tracking Reductions
April 4, 1981

Collecting Data to Measure Pollution Prevention Progress

There is an increasing need to assess progress that has been made as a result of the multitude of pollution prevention activities. However, methods to measure progress are still evolving, and more to the point, as of early 1991, data are not available to assess pollution prevention progress on a national basis. Nonetheless, the Environmental Protection Agency (EPA) has made significant progress toward developing methods to measure progress. Many studies have been conducted to identify pollution prevention data needs and to assess available information.

Through these studies, EPA has identified much of the data needed to measure progress and developed a general methodology for using these data to measure progress. In addition, Congress passed the Pollution Prevention Act of 1990 (PPA), requiring the EPA to promulgate regulations to collect pollution prevention data in the Toxics Release Inventory (TRI), the major vehicle for collecting data on environmental releases.

This paper will describe methods to measure progress by briefly describing relevant available data and the lessons learned from collecting these data. This paper will also describe how these lessons can be applied in revising TRI reporting requirements. To measure progress a variety of descriptive and quantitative measures are needed, including: number and types of activities implemented, actual quantity change over time, quantity change due to source reduction (after adjusting for other factors such as production or activity level), and changes in quantity recycled, treated, and disposed over time. No one measure of progress can summarize pollution prevention progress, nor should measures of pollution prevention be used without assessing the remaining steps in the hierarchy of environmental protection - recycling, treatment, and disposal.

History of Pollution Prevention Data Collection

The Emergency Planning and Community Right to Know Act of 1986 required the Agency to implement TRI, a multimedia data collection which has become the Agency's major pollution prevention data source. The Pollution Prevention Act of 1990 will require EPA to add pollution prevention data to TRI. However, before describing TRI, this paper will look at hazardous waste reporting requirements - where pollution prevention data collection originated.

EPA's first attempt to quantify pollution prevention progress was in the Hazardous Waste Generator Survey. This survey included waste generation quantity for calendar years 1985 and 1986, quantity recycled in 1986, source reduction and recycling activities implemented prior to and during 1986, percent change in product production from 1985 to 1986, and descriptive waste minimization program information. The survey included production change information because of a recognition that changes in production levels can affect waste quantity. Actual production levels were not included in the survey because of confidentiality concerns. The approach of collecting percent change in production rather than actual production levels was similar to the production ratio used by the Chemical Manufacturers Association in a Survey of their membership.

Because of concern that there was confusion over the activities that should be reported as source reduction and recycling, the Generator Survey required a written description of the waste minimization activity. This makes it possible to remove treatment, beneficial use, and other activities that are not prevention before using quantity information to assess pollution prevention progress. The survey data could then be used to quantify progress of source reduction activities by looking at the actual difference between 1985 and 1986 quantity or by using the production change information to adjust the actual difference for changes in economic and market conditions. The same set of questions covered both source reduction and recycling activities.

Study of Generator Survey data[1] has shown that adjusting for production level is a complex task and that this adjustment is not always appropriate, particularly with multiple product manufacturing, because production does not always influence waste quantity, other factors can also influence waste quantity, and production ratio can be difficult to calculate. Even when adjusting for production is appropriate, the relationship between production and waste generation is not always directly proportional - that is, when production doubles, it does not always follow that waste generation will double.

EPA also found other problems that make it difficult to use Generator Survey data to assess source reduction and recycling progress. These findings are very relevant to the development of pollution prevention reporting requirements. Lessons learned about hazardous waste quantity are equally true for quantity of chemical in waste which is reported in TRI. Some of the more important findings are summarized below.

- Estimates of quantity and metering devices used to measure quantity may be inaccurate and significant error rates are possible.
- Reporting requirements and respondents' understanding of them are changing. Some changes in quantity reported are due to changes in the way the wastes were measured or the accounting practices used by the facility rather than actual changes in the quantities generated.
- Substantial differences in quantity reported can result from changes in definitions of terms used in the reporting form. This can include changes in reporting criteria, including changes in regulatory definitions and clarifications to instructions.
- Effects of pollution prevention projects may not be fully reflected in a single calendar year or may not show up for several years. A database built over time should mitigate this effect.
- The largest facilities unduly influence aggregate quantity measures.

The Generator Survey also did not include sufficient information to assess toxicity reduction. A comprehensive assessment of toxicity reduction is more difficult and expensive (and not neceassarily desireable) than assessing quantity reduction because concentration of individual constituents and the change over time would be necessary to assess the degree of reduction in toxicity achieved. This data can be very burdensome to report and hazardous waste reporting requirements have not required facilities to submit this data in the past. The Generator Survey asked facilities how source reduction activities affected ("Increase," "Decrease," or "No Change") the toxicity of waste generated, but no attempt was made to quantify this effect.

The 1987 Biennial Report required much of the same information as the Generator Survey, with some important changes. The percent change in production was changed to a production index, and respondents were asked to calculate a quantity of waste that was "reduced" using the production index or another more appropriate method. They were also allowed to use another method to estimate progress if actual and adjusted quantity were not appropriate. This allows assessment of source reduction progress using actual quantity reduction, quantity reduction adjusted for production, or using another method which the facility has found to be more appropriate. There were also many improvements in question wording and instructions.

Changes Made in Subsequent Data Collection

For the 1989 Biennial Report, the production index was renamed the activity/production index. This change was made in response to state and industry representatives pointing out that it can be difficult to identify a specific product that is associated with the waste generated and that general level of business activity and other factors may be related to waste quantity. The 1989 Biennial Report also included quantity recycled due to new (rather than ongoing) activities. Also new for the 1989 form was the discontinuation of the requirement to provide a written description of the waste minimization activities. This was replaced by a checklist of 40-50 types of projects to choose from. Because there is still confusion over what is and is not waste minimization, the checklist is fairly detailed in order to indicate to respondents the types of activities that should be reported. In addition, the instructions give examples of the types of activities that should not be reported (treatment, beneficial reuse, etc.) as source reduction.

Toxics Release Inventory Reporting

Over time, TRI has been replacing hazardous waste reporting for pollution prevention information because of its multimedia focus. TRI included an optional waste minimization section when first implemented for calendar year 1987. (The section name was changed to Pollution Prevention: Optional Information on Waste Minimization in 1989.) The Pollution Prevention Act of 1990 requires the Agency assess pollution prevention progress made by facilities required to report in TRI. PPA specifies many of the types of data needed for this purpose and requires that they be added for reporting year 1991.

The optional pollution prevention section of TRI (for years prior to 1991) includes the same type of quantity information - production index and quantity of chemical in waste prior to treatment or otherwise released to air, water, or land for two consecutive years - as the Biennial Report (Biennial Report covers hazardous waste rather than toxic chemicals in waste), but does not allow respondents to use an alternate method to calculate the quantity "reduced" or prevented. Low response rate for the optional pollution prevention section has made it impossible to use this data to assess progress on a national scale.

EPA's experience with hazardous waste data and studies of pollution prevention data needs indicate that assessing progress requires the following: 1) quantity of chemical entering waste prior to recycling and treatment, 2) effect of source reduction activities on chemical in waste and releases to all media 3) adjustment for (or rule out) other factors that affect quantity, and 4) a database built over a period of several years.

The Agency is using these lessons learned as it moves to implement the PPA requirements. Data elements under consideration for inclusion in reporting requirements include: quantity in waste prior to recycling and treatment or otherwise released to the environment, quantity of chemical entering recycling and treatment, production index or other information as necessary to indicate the effects of changes in economic conditions and other factors on quantity, and other information specified in PPA. Also under consideration is quantity of chemical would have been generated in waste if source reduction had not been implemented other TRI chemicals and hazardous wastes affected by the source reduction activities that affect the chemical. The latter is included to allow linkage with the hazardous waste Biennial Report database. This linkage should help in assessment of effects on toxicity of hazardous waste.

Using the lessons learned from available data and studying pollution prevention information needs, implementation of the requirements of the Pollution Prevention Act should result in sufficient data to measure progress over time.

Tracking What Matters:
Toxics Use Reduction Reporting for Production Processes

Hillel Gray, Toxics Policy Analyst

Massachusetts Public Interest Research Group (MASSPIRG)

29 Temple Place, Boston, MA 02111 (617) 292-4800

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Tracking What Matters:

Toxics Use Reduction Reporting for Production Processes

Hillel Gray, Toxics Policy Analyst

Massachusetts Public Interest Research Group (MASSPIRG)

Industry, government, labor, and environmentalists endorsed a comprehensive toxics use reduction effort in Massachusetts. The state's Toxics Use Reduction Act tackles head-on the question of what constitutes authentic prevention, and it focuses reporting on the production process. As a result, we have built a foundation for moving from end-of-pipe pollution controls to "win-win" solutions that make sense for industry, workers, the environment and public health.

What is Prevention? The risks associated with toxic chemicals start at the moment of production, when the risk of exposure begins, and are directly related to demand for their use in business. Besides smokestack-type "pollution," the risks include accidents due to chemical transport through local communities, spills at user facilities, worker exposure, and consumer exposure to toxic products.

The only way to prevent all of the risks associated with inherently toxic materials, therefore, is to reduce and gradually eliminate their production and use. This activity is known as toxics use reduction or TUR.

Toxics Use Reduction. How can industry reduce, avoid or eliminate the use of toxic chemicals? By changing production processes, switching raw materials, or redesigning products, so as to cut down toxics used to produce goods and services. Such front-end improvements can cut costs and liabilities while protecting the environment. To be preventive, firms should not shift toxics from one environmental media to another, or into products or the workplace.

Companies need to enlist process engineers, managers, product developers, R&D and other personnel in a broad effort to change business as usual and cut down toxic inputs. Whereas pollution control and waste management seems relegated to environmental engineers, toxics prevention occurs at the level of production process and product design and must be evaluated and addressed accordingly.

How to Track Reductions. Programs to track TUR reductions begin with three steps: (1) monitor toxics use for each production operation; (2) evaluate progress in toxics use reduction, without misrepresenting reductions due to a change in production level or a shifting of wastes; and (3) communicate TUR progress to top management, workers, the public, and government.

Specific information on production processes is crucial for developing reliable measures of TUR progress. Many facilities use several processes, and the level of production and their type of toxics use can vary significantly. Most alternatives to the use of toxic chemicals are particular to the type of production activity, so the tracking system needs to shed light on where toxics use reduction can actually take place.

Information on each production process enables agencies and citizens to determine whether a reported reduction was achieved by activating a toxics use reduction method or because production was cut back. Process-specific information that is normalized (i.e. indexed) to production helps track shifts in production or the addition of new processes. Process-specific tracking also can empower agencies and the public to compare the effectiveness of a process that is used by different companies.

Facilities should be required to report information which provides a "materials accounting" of toxics use at a facility. This involves a comparison of the amounts of toxics substances produced or brought into the facility with the amounts consumed, lost to wastes prior to treatment, or taken away from the facility in or as products. Such an accounting allows corporate management, agencies, and the public to understand the full picture of toxics use at the facility, where the chemicals come from and where they go.

Tracking and Long-term Prevention Policy. Public reporting of toxics use reduction is the cornerstone of a partnership by industry, government, labor, consumers, and the public to adopt safer technologies and products.

For industry, toxics use tracking at the production process level should feed into comprehensive planning and economic analysis of use reduction opportunities. A few companies, such as Polaroid, are shaping performance evaluations and production goals around TUR indicators.

TUR evaluation will enable government (and investors!) to compare laggards and leaders within each industry. Government should target laggards for assistance and enforcement, and get industry leaders to publicize or commercialize innovations.

Citizens and workers play a key role in toxics prevention. They determine social values and priorities, they have the most to lose from toxics use, and they deserve and need information about toxic problems and solutions. Citizens should have TUR tracking data to advocate for change, to improve workplace safety, and to vote through the marketplace for environmentally-sound products. The public should have the final word in deciding whether pollution prevention has been successful.

SESSION 1F

MEASURING AND TRACKING REDUCTIONS

Chairperson

Mr. H. F. (Guy) Dubec
Occidental Chemicals Company
Niagara Falls, N.Y.

Speakers

Ms. Shelly A. Hearne
Acting Director, Office of Pollution Prevention
New Jersey Department of Environmental Protection

Mr. Steven D. Newburg-Rinn
Chief, Public Data Branch
EPA Office of Toxic Substances

Mr. Gerald V. Poje, Ph.D.
Environmental Toxicologist
National Wildlife Federation

Mr. Richard A. Kleiner
Director, Public Affairs
Louisiana Chemical Association

Mr. Paul R. Wilkinson
Environmental Consultant
DuPont Chemicals Safety and Environmental Resources

Session Abstract

Effective tracking of measurement pollution prevention efforts can help to identify reduction opportunities, establish priorities, develop goals, and determine progress.

On a national basis, EPA's Toxic Release Inventory (TRI) database is one yardstick being used to measure the progress in reducing certain wastes and releases. However, many current tracking systems, including EPA's Toxic Release Inventory, deal with raw numbers and do not measure the actual impact or benefits of pollution prevention efforts.

Speakers from EPA, States, industry, and the public will discuss these issues and provide enlightening information on their efforts, views and experiences in tracking and measuring reductions. They will provide specific examples of how TRI data is being used to measure and report progress, examine whether current tracking methods correctly measure progress, and discuss what changes may be needed.

The requirements and anticipated effect of the Pollution Prevention Act of 1990 on tracking and measuring reductions will also be examined.

MEASURING POLLUTION:
The Toxics Release Inventory
A Case History

Steven D. Newburg-Rinn, Chief
Public Data Branch
U. S. Environmental Protection Agency

This paper will discuss what it takes, from a governmental perspective, to measure and track pollution. It uses the Toxics Release Inventory as a case history to illustrate the nature of this effort. To do so, this discussion will provide basic information about what the Toxics Release Inventory (TRI) is; and a discussion of TRI data management, with an emphasis on what it takes to make such an activity work.

In October, 1986, Congress passed the *EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT OF 1986* ("EPCRA"). This is otherwise known as "Title III of SARA" (the Superfund Amendments and Reauthorization Act of 1986). EPCRA has four major sections:

- §§301-304 - Emergency Planning
- §304 - Emergency Notification
- §§311-312 - Community Right-to-Know Reporting Requirements
- §313 - The Toxics Chemical Release Inventory

It is this latter section, commonly referred to as the Toxics Release Inventory or TRI, on which this paper focusses.

The TOXICS RELEASE INVENTORY is embodied in a reporting rule which requires the annual reporting to EPA of direct release to all environmental media (air, water, and land, or off-site transfer to sewage treatment plants (POTW's) or other off-site facilities (such as commercial landfills). All facilities meeting the following tests must report:

- SIC codes 20-39 (from orange juice manufactures to car companies to members of the chemical industry)
- with ten or more full-time employees
- which manufacture or process more than 25,000 pounds or use more than 10,000 pounds of any one of approximately 320 chemicals or chemical categories.

Industrial facilities meeting these tests submit, annually, information concerning facility information; off-site locations; chemical releases, transfers and treatment; and waste minimization.

What is TRI's purpose. Section 313(h) of EPCRA provides that

> The release forms required under this section are intended to provide information to the Federal, State, and local governments and the public, including citizens of communities surrounding facilities. . . .

To accomplish this, Section 313(j) of EPCRA states that:

> EPA MANAGEMENT OF DATA. - The Administrator shall establish and maintain in a computer data base a national toxic chemical inventory based on the data submitted to the Administrator. . . . The Administrator shall make these data accessible by computer telecommunications and other means to any person on a cost reimbursable basis.

Once the data is collected, and has undergone rigorous QA/QC activities, we have made the data available on-line; on CD-ROM; on microprocessor diskettes; on microfiche; through an annual National Report; and through a reading room and a user support service. The online version of TRI is

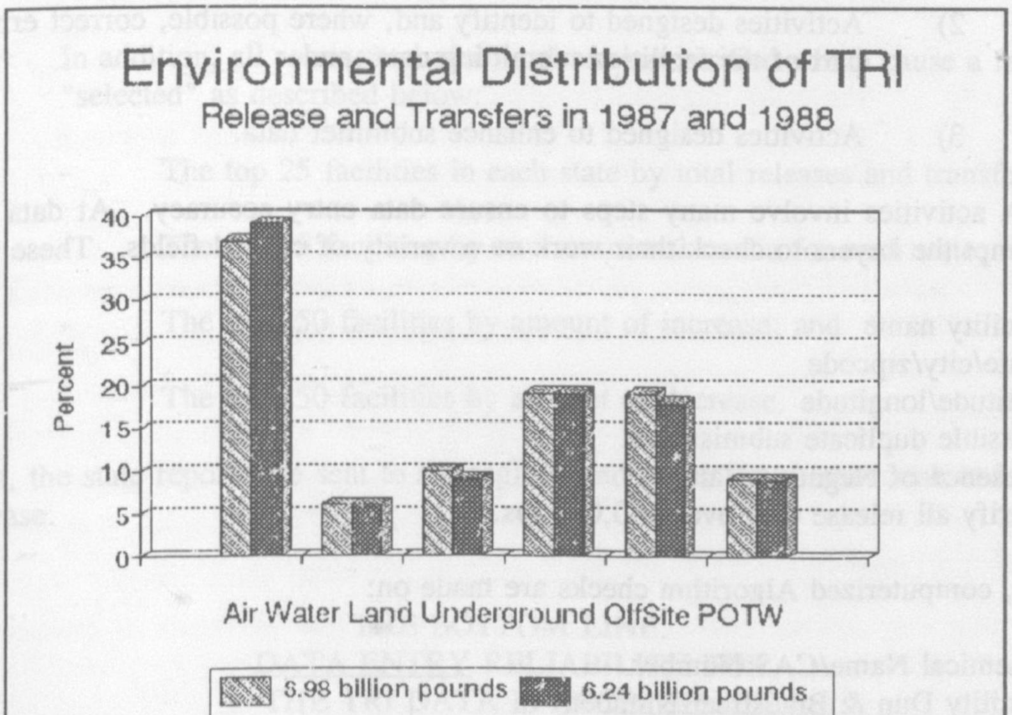
--> Available through the National Library of Medicine's TOXNET System, and

--> Features:

- o a flexible unit record;
- o enhanced data;
- o a menu system for infrequent users;
- o access to complementary databases.

All of this data is not collected for its own sake; it is collected to allow meaningful measuring and tracking of pollution. This can be done at an individual facility level, where the releases of particular chemicals can be directly compared; it can also be done on a nationwide basis (see Table 1 for an example of such an analysis). However, there are potentially grave consequence should a facility appear to have very high numbers. With the release of the 1987 numbers the National Wildlife Federation prepared a report called The Toxic 500. The number one facility in the country sent off-site a very large number of pounds of metal slag. It failed to separate out the amount of listed metal from the rest of the material in the slag. Similarly, this report listed one manufacturer of orange juice, and consumers started being concerned about buying that companies products. As it turned out, in this instance EPA had miskeyed one number for that company, raising the releases from 900,000 pounds to 9,000,000 pounds. *It is critical that substantial QA/QC activities be placed on any effort to measure and track pollution, at all levels (from the facility that reports to the body that collects the numbers to those who use the output).*

FIGURE 1[1]



To understand this effort it is first useful to understand the magnitude of the TRI data collection. On March 4, 1991, there were the following numbers of individual chemical reports in TRI from over 27,000 facilities:

	1987	1988	1989
TOTAL	77,468	83,159	82,836

[1] Figure adapted from Toxics in the Community: National and Local Perspectives, US EPA, September, 1990.

Because facilities submit, on the average, about sixty data elements per form, for the current year it was necessary to date enter over 5 million data elements. At the height of data entry activities EPA utilizes close to 180 people to enter the data, verify it, take quality control steps, and provide the necessary programming and systems support.

To insure the integrity of this much data requires a substantial amount of work on the part of submitters and EPA. EPA's §313 data quality activities fall into three basic categories:

1) Activities designed to identify and correct data entry errors;

2) Activities designed to identify and, where possible, correct errors on the part of the facilities submitting data; and

3) Activities designed to enhance submitter data.

EPA activities involve many steps to ensure data entry accuracy. At data entry edit checks prompt the keyers to check their work on a variety of critical fields. These included:

Facility name
State/city/zipcode
Latitude/longitude
Possible duplicate submissions
Presence of Negative Values
Verify all release data over 100,000 lbs.

In addition, computerized Algorithm checks are made on:

Chemical Name/CAS Number
Facility Dun & Bradstreet Number
Parent Company Dun & Bradstreet Number
NPDES Permit Numbers

Following data entry, four separate types of activities occur to ensure a high level of data entry reliability:

- Verification of at least 25% of each keyer's work;
- Use of a variety of data reconciliation reports to identify aberrations;
- Mailing each facility a copy of its release and transfer numbers for verification purposes; and
- Manual examination by high level staff of critical data elements after all data is loaded.

WHAT DOES ALL THIS ACTIVITY YIELD? Following the keyer verification step random audits of data entry data quality indicate an accuracy rate of about 99.5%. After the three latter steps this rate will be higher still. This results in a high level of reliability overall, but especially for the larger numbers which implicitly impact upon any effort to study trends. Because of the use to which any such collection is made, ANY such effort must pay special attention to the numbers that will be used for analysis purposes. EPA's final checks before data release recognize the need for a high level of reliability for release and transfer records. For example,

- All numbers over 500,000 pounds are verified.

- In addition, all release/transfer numbers are verified which cause a facility to be "selected" as described below:

  - The top 25 facilities in each state by total releases and transfers;

  - The top 25 facilities by environmental media for each state;

  - The top 250 facilities by amount of increase; and

  - The top 250 facilities by amount of decrease.

In addition, the state reports are sent to the regions and states for another look before public release.

THE BOTTOM LINE:
DATA ENTRY RELIABILITY FOR
THE TRI DATA IS EXCELLENT.

Such efforts are essential for any public approach to measuring and tracking pollution.

But OTS has not been willing to have only a high level of data entry data quality. . . . We recognize that various activities on the part of our submitters significantly affect the usability of the data. In addition to those activities designed to insure that EPA has done its job correctly, a number of activities are undertaken to insure that the submitters have done their jobs correctly. Our activities to help submitters actually begin before a single form is even filed with 1) an overall industry guidance package; 2) specific guidance packages for particular industries; 3) a hotline to help with technical questions; 4) a variety of interpretative guidance tools; 5) seminars for industry members; and 6) "Train the Trainers" training.

EPA's activities to improve submitter data quality after submission of data included:

- Issuing Notice of Noncompliance where the facility has made such a significant error that the data cannot even be entered;

- Issuing Notices of Technical Error where a computerized check of the submitter's data (verified by a human) indicates a problem in the submission; and

- Computer-generated changes to
    - Clean up table values, where possible
    - Cleaning up county names
    - Verifying zipcodes vs. state/county
    - Where possible, correcting submitted latitude and longitude
    - Correcting some SIC code anomalies

Finally, because computers don't really think, it is often necessary to normalize data categories to enhance the usability of the data. Some significant normalization activities have occurred with respect to:

- o County names

- o Facility names

- o Parent company names

- o Inserting zipcode centroid latitude and longitude

- o Inserting FIPS codes for state/county

WHAT DOES THE PREVENTION ACT DO TO ALL THIS?

--> It adds as much as 50% more data which must go through the same process, with little additional $ and NO additional time;

--> It will require EPA to change all aspects of its data management approach to insure the same level of data quality for all the additional data elements; and

--> It will require submitters to learn the new reporting requirements, with the expectation that this new reporting will get better over time.

MEASURING AND TRACKING WASTE—

WASTE ACCOUNTING

by

PAUL R. WILKINSON
Du Pont Chemicals
Du Pont Safety and Environmental Seminars

Source reduction is the priority for the 1990s. As industries and businesses try to adjust their successful waste reduction programs of the 1980s to meet the more demanding corporate goals and public expectations of the 1990s, it is becoming clear that we need a more detailed knowledge of our wastes in order to achieve greater source reduction. The fact is that we don't really know our wastes, and if we don't know them or where they came from, then we don't know their costs either. And costs are what get management's attention in determining priorities.

Why is source reduction a problem? Let me throw out a few questions to give you an idea of the nature of the problem.

- ❑ How many waste streams are you tracking to comply with today's regulations?
- ❑ Are these large composite streams or source streams?
- ❑ What are the costs of each waste stream?

- ❑ Do you know how much waste is generated when you shut down a process? when you replace a piece of equipment? or when you start it up again?
- ❑ Which waste stream should you reduce first: the biggest, the most costly, the most toxic, the most public?

These seem like simple questions, but, in fact, they are not, as most of us who have tried to answer them have found out. For answers, we will probably call the environmental person, who will have to call the waste person, who will need to check with several more people to try to pull together the answers. And that brings me to the subject of "waste accounting." In order to "account" for wastes we have to know where they came from, what they are, and how much they cost. In other words, we must have a detailed knowledge of our wastes and we must have that knowledge in a database that is readily available for management control of all waste management activities, especially source reduction.

Traditionally, we think of "measuring and tracking" wastes in terms of compliance—of the need to determine the quantities and constituents of wastes to meet regulatory requirements, and then to follow those wastes from their collection point to their final destination to ensure proper handling. But with today's emphasis on and commitment to massive source reduction—as corporations are saying publicly and repeatedly these days—we have to reconsider our system for measuring and tracking waste. I like to think in terms of waste accounting" because it helps me to associate waste with cost and cost accounting. I am forced to focus on what the waste is, where it is generated, and what it costs, and then to think broadly about the action that must be taken to reduce it at the source. I know that cost reduction requires commitment, organization, and participation by everyone involved if it is to be accomplished. So does source reduction.

What does waste accounting involve? It is the basis for getting a detailed knowledge of all waste streams on a site, including air emissions, waste discharges, and solid waste. So it includes:

- Creating an inventory of waste streams and their sources.
- Characterizing each waste stream for constituents, physical and chemical properties, quantities, etc.
- Costing each waste stream: disposal, treatment, transportation, service, etc.
- Auditing performance against specific waste reduction goals and other management control needs such as compliance, site history, and off-site shipments.

Although accounting for waste is not new, having a corporate waste accounting system may be—or, perhaps it is an evolving system in most corporations. Du Pont has always emphasized waste management and minimization, which requires measuring and tracking the wastes we generate and reducing their impact on the environment. We have not always done as well as we would like in this because our system was time-consuming and cumbersome and not always able to give us timely information. We are resolving that problem now by installing a corporate environmental data management system (EDMS) at each facility. A major reason for developing this data system is our current focus on waste reduction as a goal in itself.

In the 1970s, our focus was on a specific, but limited, number of high-value waste streams primarily because of economic incentives driven by the escalating price of petroleum. In the early 1980s, driven by a new round of environmental laws and regulatory compliance requirements, we focused our attention on a broader list of wastes and began developing internalization strategies that would limit waste treatment and disposal off Du Pont sites. To reinforce this effort, by the mid 1980s, we set a goal to reduce our solid hazardous waste streams 35 percent by 1990. And we have met that goal.

For Du Pont as for many other companies, waste reduction as the right thing to do has become our goal for the 1990s. And this is the difference from the past. Source reduction today is more than an economic incentive or a compliance requirement. It is a priority for environmental stewardship against which we must now continuously measure our performance. We cannot reach the ultimate goals unless we are able to trace our wastes to their sources and find ways to eliminate them at the point of origin.

As we change our management systems to achieve better waste accounting, we are running into some barriers that our previous way of doing business created. The first problem is that wastes are generated everywhere throughout a manufacturing operation and are managed by a lot of different individuals and groups on a site. To pull all the relevant information together to set up a comprehensive database system required that we first pull the people together to make a committed team effort.

Another problem we find is that too often managers view waste reduction as an isolated environmental issue instead of recognizing that it is really a business imperative that has environmental consequences. This is because most of the wastes generated in our plants and factories have become the object of one or more environmental regulations. Management has had to focus resources on the regulatory aspects of waste and has lost sight of the business consequence of wastes as underused or lost resources.

Still another problem lies in the mind-set that it takes highly trained engineers to run a waste minimization program. Certainly long-range solutions require engineering technology, but in point of fact, operators and mechanics are the logical people to identify waste at the source where it is generated. Many good waste reduction ideas are coming from operators, mechanics, and the lab technicians who in their day-to-day operations notice where small changes can reduce or avoid the generation of large quantities of wastes.

Historically, we have assumed that waste is inevitable. But this attitude has to change. We must stop thinking about waste as a noun,—the unwanted result of an activity—and start thinking of it as a verb, in terms of a responsibility we have to take as a result of our actions. This is beginning to happen and the result is that we are seeking responsible, productive, and useful alternatives for the wastes that we used to assume were inevitable.

This brings us right back to the original premise—that we must know our wastes in order to reduce them and we must have a waste accounting system that hold us accountable for knowing our wastes and doing something about reducing them. And we must all play an active role in making this happen.

At Du Pont, we have developed a waste management program that takes a multi-tiered approach to reducing waste. We call it our ReSource Program, with emphasis on sources and resources, rather than on waste—an emphasis on the potential value of all materials, including those we traditionally think about as "wastes." Through this program, Du Pont is finding ways to address the barriers such as commitment, resources, and organization.

Du Pont's ReSource Program has three phases or components, each challenging different segments of the corporation and having different time frames for accomplishment, but each functioning simultaneously and focusing on the same goal—reduction of waste at the source. We call these phases: TODAY, TOMORROW, and AND TOMORROW. To achieve source reduction, all three phases require commitment, organization, and waste accounting.

The TODAY segment focuses on those things that can bring immediate results: on recycling, reuse, sale, and source reduction.. Our operations people are the primary implementers of these efforts. Teams from the line organization are in the best position to identify waste streams and their sources. They then build detailed understanding of each waste stream and recommend reduction alternatives from a "here and now" perspective. We believe that 30 percent of our waste reduction can come from these team efforts. Such simple procedural changes, and, I might add, cultural changes as lengthening the time between the scheduled cleanings of equipment can result in significant reduction in waste with no effect on the process.

The TOMORROW and the AND TOMORROW programs are technology application programs Their principal focus is on research and development and long-range process innovation, including plant construction, the elimination of toxic or waste-producing ingredients, and the conversion of would-be wastes into valuable by-products and co-products.

A key activity of these programs is to identify, characterize, and evaluate all potential, nonuseful streams for waste reduction. Engineers try at the design stage to consider what kinds and how much of these wastes the process will generate and where they will be generated—if any of the wastes are new, and if the estimates on paper are close to what will actually happen when the process changes are in place. They then try to design the waste out of the process. Already this effort is showing us that we need more facts about waste losses from such things as leaking equipment, particularly waste that results when equipment of taken out of operation. And we are generating such data.

We think our approach to waste accounting can be applied generally. It is the basis for what we do in our on-site seminars for which we use a manual called KNOW YOUR WASTE and it seems to be working there.

To start, we suggest that you list everything you know about your waste. When you do that, you may be surprised at how much you do know and equally surprised at how much you don't know.

Create an inventory of all the wastes on the site, beginning with the hazardous air emissions, water discharges, and solid wastes around which regulations now require permits, reporting, manifests, etc. This establishes the basic information from which all the other activities flow, such as deciding which streams to reduce first, for instance the most hazardous, or the most costly, or the one with the greatest volume, or the one the public focuses on the most.

Once the basic list exists—and remember this initial list is a compliance list — then the site waste team must turn to the task of making sure that each waste stream has been assigned a unique identification code. Any identification system that will pinpoint the waste will work. Just remember that in order for the site to be able to account accurately for all the relevant information about the waste stream, there can be no misunderstanding about which waste stream is involved. We just don't have time for duplication.

After a unique waste code has been assigned to a waste stream, then it can be characterized and the growing body of data about the stream can be recorded in whatever system the facility uses. At Du Pont, we believe that our Environmental Data Management System will make it possible for each facility to manage and audit its wastes with increasing efficiency and effectiveness as well as provide corporate summaries for assessing performance.

As the identity and source of each stream is established, you can differentiate information about the costs of activities related to that waste. The costs cover a wide range of activities including: transportation, disposal, disposal taxes, equipment rental, treatment, storage, special containers, permitting, as well as service charges.

Knowing what the law requires, what the level of toxicity is, where the waste comes from, and what the total costs are will obviously benefit your site management in setting priorities about which wastes to try to eliminate first, what alternative approaches to seek, and what final accounting to expect.

Having all this information in an electronic database obviously allows for maximum accessibility and flexibility.

Let me caution you that the process of setting up a corporate-wide waste accounting database is not without its problems and complications and it doesn't happen overnight! Not the system or the use of it. But it is happening by a variety of means—corporate publications like newsletters, electronic bulletin boards, on-site seminars where the participants range from operators to plant managers, and one-on-one discussions and training—all with the focus of achieving a detailed knowledge of waste. We have found that doing all this is leading the way to establishing management control over the measuring and tracking of wastes, and therefore, of their ultimate elimination.

SESSION 1G

REGULATORY BARRIERS AND ECONOMIC INCENTIVES

Chairperson

Mr. Michael Mastracci
U. S. Environmental Protection Agency-ORD
Washington, D.C.

Speakers

Dr. Edgar Berkey, President
Mr. Angel Martin
Center For Hazardous Materials Research
Innovative Approaches to Pollution Prevention by Small Business

Mr. Jack Adams
Vice President of Marketing & Financial Services
National Environmental Technology Applications Corp.
Commercializing Pollution Prevention Technologies

Mr. Rick Reibstein
Office of Technical Assistance
Executive Office of Environmental Affairs
Commonwealth of Massachusetts
Providing Assistance to Small Pollution Sources

Mr. Robert O. Price
Senior Project Manager
Michael Brendman Associate
Methanol: An Environmentally Preferred Alternative Commercial Aviation Fuel For Regional Air Quality Improvement

Session Abstract

Impediments to and incentives for successful implementation of pollution prevention practices are examined from various perspectives and levels of government and business management. Pollution Prevention approaches by small business, state and local jurisdictions and consumers are highlighted by case studies and other direct experience that can point toward more effective policies, management and technical practices for all pollution generators. Included are technology alternatives that can overcome or avoid regulatory barriers.

The case for building a pollution prevention ethic in developing countries is advanced. The status and authority of the national environmental agency, the "carrot and stick" philosophy, industry's pivotal role and the channels for public participation are reviewed. Opportunities to overcome regulatory and institutional barriers and to implement economic incentives that can accelerate pollution prevention practices are discussed.

METHANOL: AN ENVIRONMENTALLY PREFERABLE ALTERNATIVE COMMERCIAL AVIATION FUEL FOR REGIONAL AIR QUALITY IMPROVEMENT

Robert O. Price
Senior Project Manager
Michael Brandman Associates
2530 Red Hill Avenue
Santa Ana, CA 92705

ABSTRACT

Southern California's heavy reliance on petroleum-fueled transportation has resulted in significant air pollution problems within the South Coast Air Basin (Basin) which stem directly from this near total dependence on fossil fuels. To deal with this pressing issue, recently enacted state legislation has proposed mandatory introduction of "clean" alternative fuels into ground transportation fleets operating within this area.

The commercial air transportation sector, however, also exerts a significant impact on regional air quality which may exceed emission gains achieved in the ground transportation sector. This paper addresses the potential, through the implementation of methanol as a commercial aviation fuel, to improve regional air quality within the Basin and the need to flight test and demonstrate methanol as an environmentally preferable fuel in aircraft turbine engines.

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California's South Coast Air Basin (Basin), an area which encompasses Los Angeles, Orange, Riverside, and San Bernardino counties, is plagued with the most severe air quality problem in the United States. The primary culprit in this situation has always been considered to be the area's massive highway-based transportation system. As one approach to dealing with this problem, mandatory implementation of "clean" alternative fuels has been proposed for certain auto, truck, and bus fleets operating within the Basin [1]. However, the commercial air transportation sector, which has largely been ignored as a significant air pollutant source up until now, displays a potential for regional air quality improvement through the implementation of an alternative fuels strategy on a par with that in the ground sector.

On a national scale, aircraft emissions historically have been assumed to account for only a small portion of total emissions from all sources -- approximately 1 percent of hydrocarbons (HC), oxides of nitrogen (NO_x), and carbon dioxide (CO_2) [3]. On a regional and local scale, however, the contributions of aircraft emissions can rival that of the ground transportation sector, and their subsequent potential impact on public health and welfare, can be significant.

For example, the Basin is home to one of the most intense commercial air traffic areas in the country. According to the Federal Aviation Administration (FAA), the Basin hosted approximately 4.6 million aircraft operations during 1987 [2]. Roughly centered around Los Angeles International Airport (LAX), the four-county Basin also encompasses numerous other very active commercial airports. The Southern California Association of Governments (SCAG) indicates that, for the period January-December 1986, domestic commercial air carrier operations at LAX alone totaled 459,683 landing/takeoff (LTO) cycles, for a daily average of 1,259 [4]. An LTO cycle incorporates all of the normal aircraft flight and ground operation modes which impact Basin air quality, including:

- descent/approach from 3,000 feet;
- touchdown;
- landing run;

- taxi in;
- idle and shutdown;
- startup and idle;
- checkout;
- taxi out;
- takeoff; and
- climbout to 3,000 feet.

Assuming an average NO_x emission factor of 45.10 lb/LTO and an average particulate emission factor of 2.38 lb/LTO (both derived from average emission rates estimated by the U. S. Environmental Protection Agency (EPA) for various commercial jets [5]), the level of LAX domestic commercial air traffic alone yields an average daily NO_x emission rate of approximately 56,800 lb. Total daily particulate emissions yield approximately 3,000 lb. For comparison, consider this emission level in terms of equivalent automobiles. A composite passenger vehicle emission rate may be calculated as follows [6]:

- vehicle trips per day (VTD)
- 15 miles/trip (VMT)
- average vehicle speed - 50 mph
- vehicle emission factors (EF):

  1.75 g/VMT (NO_x)
  0.317 g/VMT (particulates)

- vehicle emissions (lb/day) =

$$\frac{VTD \times VMT \times EF\ (g/VMT)}{454\ g/lb}$$

= 0.058 lb/day per vehicle (NO_x)
= 0.010 lb/day per vehicle (part.)

In this instance, one day's NO_x emissions from LAX commercial aircraft operations would be equivalent to nearly 979,300 passenger vehicles, while particulate emissions would be equivalent to nearly 300,000 vehicles. For perspective, consider that under proposed Rule 1601, the South Coast Air Quality Management District (SCAQMD) had originally proposed to target approximately 51,000 nontransit fleet cars and light trucks for mandatory conversion to clean alternative fuels [7].

The primary impetus for previous investigations of substitutes for conventional jet fuel typically stemmed from a desire to identify and develop nonpetroleum-based alternatives for energy security. As with the automotive sector, the sharp fuel price rises and supply curtailments of the late 1970s and early 1980s adversely affected the aviation industry. Subsequent surplus oil supplies and soft energy prices have dulled our collective memory of the "energy crisis" in recent years. Interestingly, the energy question may once again give rise to a renewed push for alternative aviation fuels.

For example, the Brookings Institution has recently raised a new warning about sharply rising oil imports and over-dependence on foreign oil in the 1990s. In addition, the EPA recently noted that the United States consumed more energy during 1988 than in any previous year and that future increases in oil demand are expected in the jet fuel sector. This jet fuel demand has been forecast by New York University to double by the end of the century, driven by a tripled demand for air travel [8].

Information provided in the California Department of Transportation (CalTrans) December 1988 California Aviation System Plan (CASP) gives a further indication of the size of the current and potential future alternative aviation fuel market within California [9]. For example, on the basis of fuel tax revenues, CalTrans estimates that approximately 52 million gallons of general aviation turbine fuel were sold within California in 1987. This is in addition to the approximate 45 million gallons of general aviation gasoline consumed during 1987. During this same period, California commercial air carriers consumed approximately 2.5 billion gallons of jet fuel. CalTrans further predicts general aviation turbine-powered aircraft operations in California to approximately double by 2005. Commercial air carrier operations are forecast to increase by approximately 27 percent during this same period.

There is a growing consensus among air quality and energy officials, as well as environmental leaders in California, that the widespread use of clean-burning transportation fuels, particularly methanol, is the most promising long-term strategy for cleaning up the air and improving our energy security. Effective alternative fuel implementation will target major fuel users/environmental emitters. Continued operation on conventional jet fuel in the commercial aviation sector, however, could mean that current and projected future air traffic levels may overcome ground sector emission gains. For example, commercial air traffic emissions will be exacerbated in Orange County with the planned development of a major new airport. It is estimated that this airport will host approximately 19.4 million passengers annually -- roughly equivalent to current levels at LAX. Consequently, air emissions from the proposed new airport will be equivalent to introducing approximately 1,000,000 additional cars into the air basin.

Clearly, the commercial turbine-powered aircraft sector is not only a significant consumer of petroleum-based fuel, but also a huge source of uncontrolled annual emissions within the Basin. With momentum building at the state and federal levels for analysis and implementation of alternative fuels for air quality improvement in the automotive sector, the time appears ripe to conduct similar investigations in the aviation sector. In this situation, the use of methyl alcohol or methanol as an alternative aviation fuel presents not only a substantial opportunity for sizable reductions in dependence on imported petroleum, but also a significant potential as an environmentally attractive alternative to conventional turbine aircraft fuel.

Methanol as an Alternative Fuel

California has provided the principal proving grounds for methanol fuel/automotive technology development efforts -- efforts which have advanced methanol-fueled motor vehicles to the point of technical readiness for commercialization. Additional demonstration in the stationary sector has led to methanol's choice as "the fuel of the future" in California [10].

Methanol is considered to be a "near-term" alternative to conventional petroleum-based fuels in the automotive sector. The California Energy Commission (CEC) has implemented a public/private partnership with such firms as ARCO and Chevron to establish a state-wide retail methanol distribution network. In addition, preliminary data resulting from a previous CEC project -- the Methanol Clean Coal Stationary Demonstration Project -- indicate that methanol is an environmentally attractive alternative to conventional turbine fuel for stationary peaking turbines, with engine/fuel system conversion relatively straightforward [11].

Methanol already has received considerable attention as an alternative aviation fuel. For example, a Supplemental Type Certificate (STC) already has been obtained from the FAA for piston engine applications of methanol, based on a significant amount of flight testing by Gordon Cooper and William Paynter. Somewhat more limited testing has been conducted with methanol in aircraft turbine engines. For example, early in 1983 General Electric performed an altitude simulation test of methanol in a combustor segment of one of its CF 680 aircraft turbines for the National Aeronautics Association (NAA) [12]. The test further established that methanol as an aircraft turbine fuel would produce low nitrogen oxide emissions, little smoke and operating temperatures lower than with Jet A. This means that methanol could extend combustor life or allow the use of a lower rated engine. In practice this would allow use of an engine with an equivalent power rating, and a subsequent lowered operating temperature, relative to one fueled by conventional jet fuel. Such an approach likely would significantly lengthen engine life.

In terms of market viability, the CEC performed a preliminary assessment of the potential for methanol as a commercial jet fuel in California nearly a decade ago [13]. This analysis was widely distributed and reviewed within the established aviation industry. Despite the passage of time, the study's basic conclusions remain unchallenged. A few of these conclusions are:

- Intrastate commercial airlines represent California's largest "captive fleet";
- On typical intrastate flights, the methanol weight penalty (resulting from its lower per pound Btu content relative to jet fuel) does not significantly increase fuel consumption; and
- Present airline operation and refueling practices could accommodate methanol.

From an air quality perspective, the primary attraction of methanol as an alternative commercial aviation turbine fuel lies in its ability to reduce NO_x formation by as much as 75 percent and particulates (smoke) by as much as 50 percent. Similar reductions have been noted in turbine ground power units fired by methanol. Furthermore, with its lower vapor pressure, methanol could diminish the impact of evaporative emissions from aircraft fuel storage and transfer.

Large-scale implementation of this alternative fuel also is perceived to offer a significant option to decrease ozone levels in urban nonattainment areas [14]. For example, based on modeling simulations for the Basin, the CEC has estimated that a complete changeover to methanol-fueled ground vehicles could result in reductions in peak ozone levels of 14 to 22 percent. To illustrate the magnitude of this potential improvement, all other control measures in the 1982 Revision of the District's State Implementation Plan (SIP) were estimated to reduce ozone levels by only 26 percent by the year 2000 [15].

Barriers to Development

Development of any alternative commercial aviation fuel faces a series of hurdles in the form of resource, technical development, investment, regulatory and marketing barriers. Resource restrictions may adversely affect the price, availability and usability of an alternative fuel; a case in point would be the impact of the minor crude oil shortages of recent years on gasoline availability.

Further differentiated, according to the General Aviation Manufacturers Association (GAMA), alternative aviation fuels face the following barriers [16]:

- Availability;
- Distribution;
- Compatibility;
- Economics;
- Energy density;
- Handling;
- Safety; and
- Quality control.

Availability and supply are key factors for both conventional and alternative fuels. For example, due to low demand, several refiners already have dropped production of grade 80 avgas. By the same token, fuel producers are reluctant to gear up for alternative fuel production in the absence of a large existing or perceived market. Conversely, under current market conditions, engine and aircraft manufacturers are reluctant to expend time, effort and money to develop aircraft designed specifically or exclusively for a new fuel if no one is committed to that fuel's production.

Second only to ready availability, an alternative fuel's market penetration will hinge, to a large degree, on its ability to use the existing fuel distribution system. An alternative which is compatible with an existing or developing fuel distribution system will obviate the need for complex and expensive storage and handling facilities. Efforts already are underway which would aid in methanol's ability to use the existing jet fuel distribution system. California state law currently requires that underground fuel storage tanks which require replacement must be replaced with methanol-compatible tanks.

To be of use to commercial aviation now and in the foreseeable future, a substitute fuel must be compatible with current aircraft engine/fuel systems. Previous CEC staff analyses have shown that methanol appears to be a realistic alternative to petroleum-based jet fuel for certain commercial aviation operations. In general, there is no insurmountable technical barrier to this application. Utility experience has shown that methanol is an excellent turbine fuel and that engine/fuel system conversions are straight forward.

The fuel/direct operating cost ratios of civil aircraft have increased during the past two decades from approximately 0.25 to over 0.60 [17]. The price of jet fuel rose 40% between August 1989 and January 1990 [18] The cost effectiveness of alternative aviation fuels is, therefore, a key factor in the future viability of aviation in general, and the airline industry in particular.

A substitute fuel must compete cost-effectively with conventional fuel. Operators may be willing to pay a premium for a superior alternative fuel, but if the premium is too steep, the alternative will remain stillborn. The primary uncertainties regarding the potential for methanol aviation fuel are economic, relating to such questions as the cost of aircraft engine/fuel system conversions, the future cost of both conventional jet fuel and methanol, and the impact of this fuel substitution on commercial airline and airport operations.

Energy density is another important consideration when screening alternative aviation fuels. Aircraft turbine engines are heat engines, transforming heat released during combustion into useful mechanical work. One result is that aircraft range is, more or less, proportional to fuel-energy density expressed in BTUs per pound or gallon. Lower energy density also can exact a penalty in payload and range. The extra fuel adds weight as well, which increases the fuel burn needed to carry that additional weight.

Studies of alternative aviation fuels are concerned primarily with both quantity and quality as they affect availability, handling, performance and overall economy in terms of both energy and costs.
A prime consideration for any aircraft fuel is handling ease and safety. Although methanol has a wider range of flammability limits, the higher ignition energy required plus cooler lateral heat transfer during combustion result in a much safer fuel than either gasoline or kerosene in a crash or spill situation. Because of the critical safety nature of aircraft operations, aircraft fuel should be of high quality. Fuel quality control translates as a need for an American Society for Testing and Materials (ASTM) or similar technical specification or standard. Typically, alternative fuels either lack technical specifications or their specs are less stringent than those for conventional fuels. Only actual testing can determine whether or not this will affect aircraft performance and operation. For example, the Environmental Aircraft Association (EAA) has convinced the FAA that certain aircraft can operate safely on autogas which conforms to ASTM D-439, a less stringent specification than ASTM D-910 for avgas [19].

Prior to issuance of an alternative fuel STC, the FAA requires a formal written description of fuel properties in the form of an existing or newly proposed ASTM specification. Such a specification (ASTM 900) already has been formulated and approved by FAA, for the STC granted for piston engine aircraft operation on methanol.

Industry may remain skeptical of a new fuel until thoroughly convinced of its technical merits. For example, despite the Experimental Aircraft Associations's hundreds of documented flight test hours and the issuance of STCs, neither the General Aircraft Manufacturers Association nor fuel producers support the use of autogas in aircraft.

Additional development work, including wider industry involvement and development, is needed to establish performance, cost, and emissions characteristics before commercial applications of methanol in the aviation sector can commence [20]. To this end, a proposal has been submitted to the CEC to conduct a research, demonstration, test, and evaluation (RDT&E) project to evaluate the implementation of methanol as a potentially attractive alternative fuel in a vital and totally oil-dependent California transportation sector -- commercial aviation. Additionally, the proposed project will demonstrate the low emission characteristics of a methanol-fueled turbine engine aircraft relative to conventional jet fuel, and evaluate the economics of this methanol application.

Use of a nonpetroleum-based fuel, such as methanol, would help maintain the security, dependability, and viability of California's air transportation industry. Further, use of an oxygenated fuel such as methanol could help improve the air quality of the South Coast Air Basin. Of course, alternative fuels must be shown to be technically acceptable, economically reasonable, and to offer no impairment to commercial aviation safety.

The proposed effort will directly address and aid in overcoming the key alternative fuel development barriers of availability and supply. For example, by technically demonstrating the potentially large existing market for a near-term alternative to conventional jet fuel, the proposed project will provide justification, in addition to that provided by Commission ground sector development and demonstrations projects, for fuel producers to gear up methanol production. Further, by obtaining an STC, other aviation users will be able to adapt or convert their own aircraft under license specifically or exclusively to the new fuel.

Efforts already are underway which would aid in methanol's ability to use the existing jet fuel distribution system. State law currently requires that underground fuel storage tanks which require replacement must be replaced with methanol-compatible tanks. The proposed effort will further document and demonstrate that the methanol alternative is compatible with the existing airport fuel distribution system with relatively minor modifications, obviating the need for complex and expensive storage and handling facilities. Further, the proposed effort will provide additional documentation to that provided in the CEC Methanol Clean Coal Turbine Study that there is no insurmountable technical barrier to an aviation application. Utility experience has shown that methanol is an excellent turbine fuel and that engine/fuel system conversions are straight forward.

A portion of the proposed effort will focus on the economic uncertainties regarding the potential for methanol aviation fuel. This focus will utilize the technical data resulting from the demonstration program to address such questions as: the likely cost of commercial aircraft engine/fuel system conversions; the future cost of both conventional jet fuel and methanol; the potential return on investment and cost-competitiveness of the methanol alternative as a result of efficiency improvements and O&M cost reductions; and the impact of this fuel substitution on current and projected commercial airline and airport operations.

The proposed effort will allow development of technically substantiated and consistent cost estimates and costing methodologies for converting conventional commercial jet aircraft to the use of methanol. The cost estimates will be expressed both in present day and specified future dollars, taking into consideration the expected timing of technology certification, the rate of equipment production, the rate of aircraft system conversions, and the specific configurations of these systems.

The effort will utilize the technical data resulting from the demonstration to address questions related to energy density such as: aircraft range; payload penalties; and the economic and operational impacts of transporting additional fuel weight.

Experience gained in the conduct of the project will yield answers to such safety-related questions as fuel handling ease and safety, and the potential impact of methanol's flammability limits on fire hazard. Additionally, the effort will provide direct turbine engine flight experience data, allowing development of a fuel quality technical specification or standard.

The project responds directly to the various goals of aggressively diversifying California's sources of transportation energy and increasing vehicle efficiency, as specified in the most recent Biennial, Fuel, and Energy Reports, by:

- Concurrently targeting the significant energy/environmental implications of a highly visible, totally oil-dependent transportation sector -- a sector which already has grown by 30 percent between 1984 and 1987, and is forecast to further increase dramatically throughout the 1990s with subsequent increased dependence on petroleum fuels;
- Addressing a present-day transportation technology with inherent adverse air quality implications which potentially may outpace fuel economy gains and emission reductions in the ground fleet;
- Increasing the use of non-petroleum alternative fuels in the transportation sector;
- Addressing the need to reduce regional air quality impacts and the potential for global environmental effects;
- Expanding fuel efficiency efforts to include aviation as a necessary step to control growth in the non-gasoline portion of transportation fuel use;
- Providing a unique and highly visible opportunity for the State (Caltrans) to convert its own small aircraft fleet to clean alternative fuels;
- Providing a mechanism for state and local governments to integrate planning and policies to solve the interrelated problems of energy use and air pollution; and
- Supporting accelerated research, development, and commercialization of an alternative fuel and related transportation technology.

The initial scope of the proposed effort will focus on conversion of a Piper PA-31 or Cessna 400 series twin engine general aviation aircraft to methanol-fueled turboprop operation. The reasons for this approach are the comparable technical data achievable at significantly lowered engineering, development, test, and logistic costs associated with a flight test program of this magnitude relative to a program focused on a large commercial jet aircraft.

For example, preliminary data indicate that methanol is an attractive fuel for stationary peaking turbines, with engine/fuel system conversion relatively straightforward. Methanol has broad applicability in other sectors as well, allowing multi-industry involvement in development. As an alternative aviation fuel, methanol could bring about the union of potential synthetic fuel suppliers with a substantial fuel market.

The use of methanol as a substitute aviation fuel offers the potential for complete independence from imported petroleum. Methanol has broad applicability in other sectors as well, allowing multi-industry involvement in development. As an alternative aviation fuel, methanol could bring about the union of potential synthetic fuel suppliers with a substantial fuel market. Development of aviation methanol turbine fuel could spur developments of automotive turbine applications. For example, a major constraint to development of automotive turbines is the need for high-temperature-resistant (expensive) materials. Methanol burns cooler than conventional turbine fuel, thus opening the possibility of automotive applications. Finally, implementation of methanol as an alternative commercial aviation fuel potentially could provide a stabilizing effect on methanol demand by providing a huge captive fleet market.

To formulate viable long-range plans, it is necessary to balance the benefits and the varied potential impacts of different aircraft transportation fuel technologies. This, then, is the primary utility of the proposed study effort to environmental policy makers, i.e., as a preliminary alternative transportation fuel assessment providing one piece of information necessary for regional air quality formulation and strategy development.

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SESSION 2A

NEW MATERIALS DEVELOPMENT & APPROPRIATE USE

Chairperson

Kenneth Geiser
Director, Toxics Use Reduction Institute
University of Lowell
Work Environment Laboratory
Lowell, Massachusetts

Speakers

Greg Eyring
U.S. Congressional Office of Technology Assessment

David Morris
Institute for Local Self-Reliance

Bertil Petterson
Swedish Trade Union, Stockholm, Sweden

Responder

Pat Costner
Director of Research for Greenpeace— USA Toxics Program

Session Abstract

This panel focuses on the development of new materials and the appropriate use of existing materials. It addresses the need to consider more carefully and systematically health and environmental compatibility now, while materials are still in the development stage.

The panel provides an opportunity:

- To consider forces determining the development and substitution of materials;
- To assess the need for screening protocols for considering health and environmental factors in guiding materials development and substitutions; and
- To determine what policies or practices need to change in order to guarantee a future mix of materials that is safer and more environmentally appropriate.

FROM POLLUTION PREVENTION TO MATERIALS POLICY

Ken Geiser
Toxics Use Reduction Institute
University of Lowell
Lowell, Massachusetts 01854

At the opening of the 1990s we find ourselves recreating a dialogue about materials use that has periodically risen and fallen in our national history. For the past fifteen years we have founded our central efforts to protect the environment on the management of industrial chemical wastes. We have now come to recognize that a more effective way to reduce the risks of toxic chemicals in industrial production is to reconsider our overall approach to materials. The prevention of pollution opens up new opportunities to rebuild our productive and consumptive enterprises in a manner that is safe and clean and appropriate to the natural cycles of materials in the biosphere.

FROM POLLUTION CONTROL TO PREVENTION

During the 1970s, the United States enacted a series of federal and state laws designed to regulate the discharge of chemical pollutants into the environment. These laws and later amendments set restrictions on the release of toxic contaminants into the air, water and land. Together they established a legal framework for controlling, but not stopping the release of toxic pollutants into the environment.

This focus on pollution control has achieved some notable successes, but, in general, the approach has been costly and ineffective. The federal Environmental Protection Agency [EPA] has completed full scale health assessments on less than 100 chemicals, approved acceptable daily intake levels for about 100, issued air emission standards on less than 10 and established effluent guidelines for water on 128. The nation's industries still generate some 290 million tons of hazardous waste a year and in 1988 the EPA accounted for 6.2 billion pounds of toxic chemicals released into the environment from American businesses. There remain an estimated 22,000 inactive hazardous waste disposal sites in the country, of which 1800 are potentially leaking contaminants into groundwater.

While federal and state agencies have pressed forward to regulate releases, license waste treatment facilities, and manifest the transport of hazardous wastes, little attention had been paid to reducing the overall generation of the wastes themselves. Beginning in 1987, this conceptual reliance on waste management as the central domain of policy was broken with the ascendancy of the concept of pollution prevention. By 1989, three states--Massachusetts, Oregon and Illinois--had passed toxics use reduction laws, and the following year another eleven states passed some kind of toxics use reduction or pollution prevention law. The federal Environmental Protection Agency set up a separate Office of Pollution Prevention and, in 1990, the Congress passed the Pollution Prevention Act.

The state pollution prevention initiatives encourage feed stock substitution, end-product redesign, production process reformulation, closed loop recycling and more efficient materials management. By requiring firms to report on toxic chemical use and plan for reductions or eliminations, these laws have extended public accountability into traditional industrial engineering design and production management decision making.

Under these state laws the policy focus has shifted from waste and emission management to industrial risk reduction. But, pollution prevention, even the most fundamental form of toxics use reduction, stops short of addressing two fundamental tasks necessary to achieving a safer and more productive future. First, pollution prevention focuses policy attention upon the phasing out of high risk substances without providing guidance for considering those materials or processes that will become the substitutes. Second, pollution prevention remains distant from the central business issues of technology performance and productivity enhancement and, thus, is easily marginalized in broader discussions of economic development.

Pollution prevention and toxics use reduction could be seen as elements of a more comprehensive approach to the redesign of production processes that adds to the objectives of efficiency, productivity and financial return the principles of clean and safe materials and technologies. In other words, the transition from pollution control to pollution prevention could be seen as one historical step in a policy evolution that leads from risk management to a more comprehensive examination of current materials use and future materials development. Such a paradigm shift would logically unite environmental protection with economic development around the conservation and development of the material basis of the economy.

MATERIALS POLICY IN THE UNITED STATES

This more comprehensive approach to materials use and development has historical roots in the traditions of the conservation movement and nearly a century of sporadic efforts to develop a national materials policy.

The earliest formal federal attention to natural resources and materials development began in 1908 at a White House conference called by Theodore Roosevelt. When

President Roosevelt established the National Conservation Commission, he asserted, "Conservation of our resources is the fundamental question before this nation...our first and greatest task is to set our house in order and begin to live within our means." The Commission study, conducted under the direction of conservation leader, Gifford Pinchot, urged efficient use of materials, development of material substitutes, and a global approach to materials development, but did not directly address environmental or public health protection.

Little more occurred at the federal level in advancing a comprehensive approach to materials until the establishment of the President's Materials Policy Commission in 1952. Otherwise known as the "Paley Commission" after its chairman, William S. Paley, this Commission delivered a far-sighted report called Resources for Freedom which advocated "a national materials policy for the United States" to avoid the economic dislocations of increasingly scarce national resources. The Paley Commission spawned the organization, Resources for the Future, and initiated the "Mid-Century Conference on Resources for the Future." The Mid-Century Conference brought together 1600 scientists, economists and business leaders to consider the protection and development of material resources of the country and resulted in a further call for a national materials policy. The close of the Korean War, led to a relaxation of interest in the nation's material supplies and the interest in materials policy waned.

The new environmental consciousness of the late 1960s led Congress to consider materials resource management during debates over the Resource Recovery Act of 1969. The following year, the Congress passed the National Materials Policy Act and created the National Commission on Materials Policy,

> ...to enhance environmental quality and conserve materials by developing a national materials policy to utilize present resources and technology more efficiently and to anticipate the future materials requirements of the Nation and the World, and to make recommendations on the supply, use, recovery and disposal of materials.

The Commission report provided 108 detailed recommendations heavily weighted towards conservation of materials, accelerated waste recycling, and more efficient materials use. Like the Paley Commission, the National Commission recommended a high level federal agency--a new Department of Natural Resources--to achieve coordinated materials and energy policies.

The Commission's report, which was released in the wake of the Club of Rome's widely read Limits to Growth stimulated a broad array of research reports and conferences. The National Academy of Sciences prepared reports on mineral and materials development and the General Accounting Office prepared reports on materials research needs. In 1975 the Senate Committee on Public Works held hearings on resource recovery and recycling. Those hearings covered a wide range of conservation issues and resulted in the drafting of the Resource Conservation and Recovery Act of 1976.

Although the 1976 Act was entitled "resource conservation'" that broader, more comprehensive vision was lost in the final bill. The largest sections of the law covered the management of solid and hazardous wastes. Little guidance and even less budget were provided for conserving materials or recycling resources. Hazardous waste management emerged as the central domain of environmental policy. By the close of the decade, the tragedy at Love Canal had emerged as the icon of environmental attention and toxic chemical exposure and hazardous waste management had become the centerpiece of government agency concern.

THE NEED FOR MATERIALS POLICY

Although there has been several significant efforts to develop a comprehensive national materials policy in the United States, in practice, materials development and use has evolved in a fragmented and market driven fashion with little attention to environmental protection or social welfare.

The significant risks associated with the use and disposal of millions of tons of toxic chemicals in industrial production might have been more directly confronted had there been national fora for assessing and planning materials development and use. Unfortunately, we needed to wait until the close of the 1980s before we had an adequate data-base for measuring the amounts of toxic materials released to the environment. We do not have a similar data-base for measuring the production and use of toxic chemicals or for assessing the range of workplace exposures.

Without an effective commitment to materials policy, existing materials are widely misused from an environmental perspective.
This has led to several problems.

First, highly toxic materials are uncritically used where human exposures are high. The off-gassing from synthetic building materials contribute to prolonged exposures as in-door air pollutants. Lead and mercury in household paint and asbestos in building insulation maximize human exposure. Chlorine bleached pulp used as a base material for food packaging, disposable diapers, sanitary products, and filler in prepared foods increases the intimate exposure to dioxin.

Second, persistent and durable materials have been employed where the objective is a short use life and easy disposal. Polystyrene and other durable polymers are often used for disposable cups and packaging leading to large volumes of non-biodegradable solid waste.

Third, the effects of the full life cycle of materials is seldom considered in selecting materials for particular uses. Poly-vinyl chloride which is a relatively safe material as a finished product generates large amounts of hazardous waste and high occupational risks during production, does not degrade well as a post-consumer waste, and leads to high respiratory risks during fires. Yet, these non-use risks are seldom factored into either designer or consumer decisions about the use of PVC products.

Forth, large quantities of reuseable resources are disposed of in landfills, sewers and incinerators before the full life value of the materials has been realized. Of the 180 million tons of municipal solid waste generated in the United States in 1988, 73 percent was sent to landfills. Nearly 34 percent of this was paper that can be easily recycled. Organic matter such as food and yard wastes can be composted and returned as soil amendments. Properly designed, the glass and metal containers can be reclaimed and reused.

Fifth, the piecemeal development of regulatory policy has attempted to solve an immeadiate problem only to create new problems through the lack of comprehensive approaches. Thus, waste effluents restricted from one environmental medium are diverted to another. Efforts to reduce occupational risks from chlorinated solvents used in cleaning metal parts leads to the substitution of chlorofluorocarbons, only to raise new risks for the upper atomosphere.

The prospect for new materials that are currently under development appears no less problematic.

The next generation of electronic semi-conductors and the new super-conductors are increasingly dependent on the rarer metals and highly specified production intermediaries for which there is very little research on health or environmental effects.

The new composites which merge polymers with glass or metal fibers unite design flexibility with lightness and strength and may prove to be valuable in terms of energy conservation. Yet, there are potentially high occupational risks associated with the fine powders and fibers of production and serious post-use waste problems due to the durability of the materials and problems of separating the fibers from the matrices during treatment or recycling. Much the same can be said of the new high temperature ceramics and alloys.

As materials become lighter or less materials are required to perform traditional functions, there are opportunities for lower environmental impacts due to lowered material use or lowered energy consumption. But, lighter and less materials could become an invitation to increasing levels of disposability. Rather, the design life of new products needs to be extended by increasing their durability, reusability and repairability.

Finally, the biological sciences may come to offer increasing materials innovations and many of these may be environmentally compatible due to the nature of their organic production processes. On the other hand, the re-combinant and engineered organisms projected from bio-technical research initiatives may raise even more insidious risks than the life-less products of the chemical sciences.

ENVISIONING MATERIALS POLICY

A materials policy that encompasses solid and hazardous waste policy does not replace the need for a sophisticated regulatory system for protecting human health and the environment. But, a materials policy should be more than a restrictive framework; it can set out plans for the development of new materials, the appropriate use and reuse of existing materials, new production technologies, and new areas for economic development. While there is a need for an appropriate materials policy at the federal level, materials policy can be an effective tool for state and private sector planning and certainly has a role in international arenas.

Specifically, materials policies need to:

- improve the overall data-base on current materials use and trends in future materials developments and use;
- seek more appropriate matches between material properties and environmental and occupational health consequences;
- encourage sustainable, "materials cycle" planning that attends to the effects of materials use from extraction and synthesis to disposal and biodegradation;
- seek new efficiencies in materials reuse and recycling including improvements in the durability and repairability of products;
- link materials use to economic development, job and skill development, and improvements in the quality of work life; and
- raise new research opportunities for the development of new materials or the more appropriate use of existing materials.

Planning must be a key component of materials policies. Not only is planning an important tool for comparing and selecting materials options, but planning will be necessary for phasing out the materials of greatest concern and phasing in the materials that are more appropriate and compatible. The conversion of production systems toward cleaner production will require plans that fairly account for those workers, communities and industries that endure the greatest dislocations.

Over the years, the call for materials policies has arisen at times of broad national consensus. Whether the issue was resource conservation, materials scarcity, or environmental consciousness, the driving force was a desire to transcend piecemeal development policies and the short term vagaries of the market. Today, a new consensus has emerged around reducing the risks of toxic chemicals in industrial production. But, risk reduction is not a bold enough objective. We need to reopen the dialogue about materials policy and this time commit our efforts to the development of a cleaner and safer production system that can guarantee a healthier and more sustainable future.

INTEGRATING ENVIRONMENTAL GOALS
WITH INDUSTRIAL PRODUCT DESIGN:

An OTA Study Update

April 3, 1991

by

Greg Eyring
Project Director

and

Matthew Weinberg
Analyst

Office of Technology Assessment
U.S. Congress
Washington, D.C. 20510

Introduction

As pollution prevention has come to be recognized as the strategy of choice for minimizing industrial wastes, there has been increasing interest in steps that companies can take to minimize the environmental burdens of their products, as well as their wastes. Germany, Canada, and Japan have initiated environmental labeling schemes to identify products that have less impact on the environment in their manufacture, use, and disposal. And industrial design societies, industry trade associations, and government policymakers around the world are beginning to explore how products can be made more "green," starting from the earliest stages of the design process.

While several publications have offered general guidance for green product design ("use as little packaging as possible," "design for easy disassembly," "use recycled materials where possible," etc.) there has so far been little experience with implementing these principles in specific cases, and for many products it remains unclear just what the goals of green design ought to be.

At the request of the House Energy Committee and the House Science Committee, the Office of Technology Assessment (OTA) initiated a study in July, 1990 (anticipated delivery: Spring, 1992) to explore the opportunities and challenges associated with green product design. Provisionally entitled Materials Technology: Integrating Product Design with Environmental Goals, the study will examine trends in materials use and product design in four product areas, chosen to encompass a range of different policy concerns and design requirements: automobiles, consumer electronics, packaging, and household chemicals. In addition, the study will compare relevant policy developments abroad with those in the United States and assess the costs and benefits of policies that might encourage designers to incorporate environmental variables more fully into the design process.

Trends in Materials Resources Consumption

Any discussion of product design must occur in a broader context of the technological, economic, and social factors that influence the flow of materials through our society. In this century, there have been dramatic changes in the nature of the materials Americans use to manufacture products. The Bureau of Mines reports that in 1900, 70 percent (by value) of the raw materials consumed in the United States for uses other than food or fuel was derived from renewable sources--agricultural and forestry products. By 1986, the tables had turned; 70 percent was derived from non-renewable ores, minerals, and petroleum. Growth in the use of synthetic polymers (plastics) has been another notable trend. Whereas in 1955 only 8 percent of nonrenewable raw materials consumed were petroleum-based, in the next 30 years this fraction grew to 32 percent.

The rate of materials consumption in the U.S. economy has also undergone some interesting changes. Several observers have noted that the consumption of materials like lumber, steel, aluminum, and cement per unit real gross national product ("materials intensity") has leveled off or declined in recent decades. There is also evidence that the mass of municipal solid waste generated has declined relative to GNP. This "dematerialization" has been attributed to a variety of causes: saturation of consumer goods markets compared with markets for knowledge-intensive products and services; increasing use of more efficient, light weight materials such as high-strength alloys and plastics; and structural changes in the production economy from heavy manufacturing to services.

Some argue that dematerialization of the economy is a natural result of an evolving post-industrial society whose GNP is increasingly created by adding value to materials through increasing their information content, rather than by producing larger quantities. Others argue that declining intensity in the use of metals like steel are caused by substitution of these older materials by newer, light-weight materials such as plastics ("transmaterialization"). Indeed, if materials intensity were measured in terms of volume rather than weight, there might be no measurable dematerialization at all.

In any case, a declining materials intensity in the economy does not suggest that materials and waste flows are declining. Indeed the absolute quantities of materials consumed and wastes produced are increasing; they are just not increasing as fast as GNP. It does suggest, though, that earlier predictions of imminent shortages of resources and waste management capacity were probably too pessimistic.

A Less Visible Trend: Product Complexity

These statistics do not capture a more subtle change with potentially important environmental consequences: a trend toward tailoring of materials and products to meet the requirements of increasingly specialized markets. This trend has been encouraged by a number of technological, economic, and social developments. Progress in chemistry, materials science, and joining technology have made it possible to combine materials together in new ways (e.g., anti-corrosion coatings on metals, or fiber-reinforced composites) to meet performance specifications more cheaply. This has meant that products have become more complex from a materials point of view, making it more difficult to recover materials at the end of the product life.

Increases in the relative cost of labor compared with other production inputs have meant that getting a defective product repaired or serviced can be almost as expensive as buying a new one. This has encouraged the design of more complex, self-contained products (e.g., consumer electronics with batteries sealed inside) that are intended to be used and thrown away. Meanwhile, as improved manufacturing technologies have brought down the cost of such products, more consumers can afford to purchase them and throw them away. Another effect is that with less service in the supermarket and the gas station, packages must be designed to convey more information and be more convenient to the self-service customer.

The application of information technology to all stages of the production and marketing process have made shorter production runs affordable, enabling manufacturers to differentiate their product offerings and aim at narrower market niches. This in turn has led to the paradoxical result that while complex production networks are linking communities and industries more closely together, these same networks allow greater individual freedom and choice.

Changing consumer lifestyles have also encouraged the trend toward more specialized production. The greater diversity of American households has increased demand for more diverse goods. And with more women working outside the home and less leisure time available, the demand for convenience products like single-serving packages and microwavable freezer-to-oven dinners is increasing. The demand for greater convenience has been a factor that has tended to increase the volume of packaging in the consumer waste stream.

Implications for the Environment

At present, these trends in materials use and product design are evolving independently of environmental considerations. But is increasing product complexity good or bad for the environment? Our initial intuition was that complexity would turn out to be environmentally bad, because--like many people--our intuition was focused implicitly on recyclability as the figure of merit for "greenness," and these complex products are generally less recyclable. Recycling has been the most popular environmental policy focus for both government policymakers and the general public for two reasons: first, it deals with the most visible part of the product life cycle--trash disposal and reclamation--which the average citizen recognizes as a problem; and second, recycling can be readily measured, whether in terms of the fraction of trash recycled, or as the fraction of recycled content in a product.

On closer examination, though, product complexity can offer source reduction benefits. For instance, flexible, multilayer packaging has led to less weight per package, and greater consumer convenience, compared with older, rigid packaging. And in the future, lighter polymer composite automobile bodies could lead to fuel savings and emissions reductions over the life of the vehicle, compared with the conventional steel body. These materials changes can result in less solid waste, energy conservation, and cleaner air, even though the products may be more costly to recycle at the end of their useful lives. Unfortunately, despite the fact that source reduction is nominally the number one strategy for addressing the problems of hazardous and solid wastes, it has been largely neglected by policymakers precisely for the two reasons that make recycling so popular: reduction often involves portions of the product life cycle that are invisible to the public (e.g., manufacturing process wastes); and progress in source reduction is extremely difficult to measure.

Thus, from an environmental point of view, there is apparently "good" product complexity and "bad" complexity. To put it another way, product complexity--or its converse, simplicity--per se are not valid criteria of "greenness." From a design point of view, we can expect that there will be design tradeoffs not only among cost, performance, safety, and environmental variables; but also among environmental variables themselves--such as between source reduction potential and recyclability.

Conclusion

In exploring the concept of green product design, one must consider how design choices affect extremely complicated production and consumption networks. While there may be some environmental design imperatives that may be sufficiently compelling to apply to many different products (e.g., "avoid the use of CFCs"), in general we can expect that green choices will only become clear in the context of specific classes of products or production networks. What constitutes green design may depend on such factors as the length of product life, product performance and reliability, toxicity of constituents and available substitutes, existing waste management technologies and infrastructure for various materials, regulatory constraints, and so on. The ongoing OTA work will attempt to sort out some of these distinctions, and evaluate the prospects for reducing green design concepts to practical application.

Local Self-Reliance is the Solution to Pollution

by David Morris

New Materials Panel

Global Pollution Prevention Conference

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Institute for Local Self-Reliance
2425 18th St. NW
Washington, DC 20009
202-232-4108

The Emergence of a New Kind of Materials Policy

Like many nations, the United States has for many years had a national materials policy driven by security concerns. The objective was to preserve access to materials needed to maintain a high technology military capacity. The policy consisted of three strategies: 1) intervention(i.e., building a military capable of protecting access to important materials, most particularly, oil from the mid East; 2) stockpiling strategic materials; and 3) substitution of domestically available materials(e.g. alcohol based synthetic rubber for natural rubber during World War II).

Since the 1960s, a materials policy has arisen driven by a different definition of national security. It is not a response to the threats of war or boycotts, but to the threats created by our own past and present consumption habits. Leaking underground gasoline tanks, leaking landfills, polluted air, water and soil constitute the security concerns underlying the new materials policy.

This policy began in the 1960s and early 1970s with a focus on a small portion of the overall materials stream: chemicals directly harmful to human health. Chemicals like DDT, PCBs, lead, mercury, and asbestos were banned in general or for specific applications. The list of regulated hazardous chemicals grew from a handful in the 1960s, to hundreds in the late 1970s, to thousands in the late 1980s. Dozens of individual laws, including The Toxic Substances Control Act, the Federal Insecticide, Fungicide and Rodenticide Act(passed in 1947 and substantially rewritten in 1972), the Resource Conservation and Recovery Act(RCRA), comprised the foundation for the war against toxics.

In the early 1980s we began regulating solid wastes, and significantly tightened existing regulations concerning human waste. The compass of materials policy widened from a few million to a few hundred million tons.

In the late 1980s the focus expanded once more, this time to include chemicals not directly or indirectly harmful to humans or animals. These were chemicals whose use exceeded the cleansing and recycling capacity of nature and thus posed a very long term threat to life. In 1989, for example, Congress agreed to phase out chlorofluorocarbons(CFCs) for almost all uses because of their effect on the ozone layer. The 1990 Clean Air Act promises a 10 million ton reduction in sulfur emissions and a 2 million ton reduction in nitrogen emissions, the two principal components of acid rain.

In 1991 world governments began to discuss an unprecedented extension of materials regulation that will encompass carbon emission regulations. The U.S. alone burns about 2 billion tons of carbonaceous materials, containing about 75 percent carbon(natural gas) to over 90 percent for certain kinds of coal.

Regulations have encouraged a much more sophisticated tracking of materials use. Manufacturers must now keep manifests that monitor the purchase, use and disposal of hundreds of chemicals. Community Right to Know provisions in federal legislation requires hazardous waste generators over a certain size to report their waste emissions on a plant basis every year. U.S. and German cities are beginning to impose garbage collection fees on weight basis.

Twenty years ago solid waste was divided into two categories: garbage and trash. Ten years ago, in the era of incineration, solid waste planners divided solid waste into two different categories: combustibie or non combustible. Today, as recycling becomes increasingly the primary solid waste management strategy, the waste stream is mapped in unprecedented detail, broken out by material.

Some planners are devising national computer models to track molecular flows. In preparation of an international protocol to reduce greenhouse gas emissions, European ecologists have developed gross molecular products to guide environmental planners in the same way that gross national products guide economic planners.

We've come a long way in 20 years. In the 1970s lead, which comprised less than 1 percent of gasoline, was the target of regulation. In 1990, the light aromatics content of gasoline, about 40 percent of premium gasoline, became the target of federal legislation. In southern California, gasoline itself has been targetted for phaseout over the next 20 years.

Twenty years ago we regulated toxics because of their health effects. Today some states are regulating toxics in packaging because their presence inhibits recycling.

A Materials Policy From the Back End

By increasing the cost of disposal, we are changing the economics of the way we use materials.

From 1870, when industrialization moved into high gear, to the 1970s disposal costs were nominal. Beginning in the 1970s these costs began to soar. The most dramatic change occurred with hazardous wastes, where disposal costs rose from about $10 per barrel in the mid 1970s to $400-$1000 a barrel today.

Raising the cost of disposal encourages entrepreneurs to extract more useful value from a given material. As Buckminster Fuller once observed, pollution is simply an unharvested resource. Raising the cost of pollution makes it increasingly attractive to harvest this resource.

Consider the example of wastepaper. The market value of scrap newsprint in 1990 was $15-25 per ton, about the value it was in 1980. But the disposal cost of a ton of newsprint in places like Minneapolis rose from $10 per ton in 1984 to almost $100 a ton today. The $90 avoided cost of disposal is the major driving force behind the burgeoning materials recovery market today.

The rising avoided cost spurred an increase in the supply of recycled paper. With an increase in supply, policymakers looked to expand demand. They did this by enacting procurement regulations for the public sector, and by enacting scrap content laws for the private sector. At least four states now require significant percentages of post-consumer fiber in major newspapers.

Whey, a byproduct of the cheesemaking process, provides another example of the dynamics of waste recovery. Ten pounds of milk make one pound of cheese and nine pounds of whey. Since whey is more than 90 percent water, it has traditionally been dumped in the sewer. But whey has a high biochemical oxygen demand that burdens sewer systems. The whey waste from making one pound of cheese imposes the same oxygen demand on sewer systems as the annual human wastes from a community 250. Sewer systems responded by forcing creameries to pre-process their whey or find alternative disposal methods. The cost of disposal in 1989 was about 7 cents a pound of cheese.

Entrepreneurs responded by developing and refining technologies for extracting protein from whey and for converting its milk sugars into ethanol. According to a study by the Institute for Local Self-Reliance, the cost of making ethanol from whey sugars is actually less than the cost of alternative means of making the whey acceptable to sewage treatment systems.

Hiking the cost of pollution and waste increases the attractiveness of efficiency, and recycling, and plant matter. The first two are self-explanatory. The third may not be. Plant matter contains no sulfur and little nitrogen, and thus even if burned does not contribute to the acid rain problem. Plant matter absorbs carbon dioxide while maturing, thus reducing the global warming problem. Liquid fuels derived from plant matter contain oxygen, and thus burn more efficiently and reduce such ground level pollutants as carbon monoxide.(The Clean Air Act requires oxygenates after 1992 in gasoline sold in those urban areas that exceed carbon monoxide pollution levels.)

Plastics made from plant matter are degradable. Inks and solvents made from plant matter are less polluting than their petroleum and natural gas based counterparts. When the federal government began seriously considering a phaseout of CFC 113, a solvent used to clean semi-conductor circuit boards, a small Florida firm, in a joint venture with AT&T, made a substitute of orange rinds that is non toxic, non polluting, and competitively priced.

Although increased disposal costs and chemical bans are the primary regulatory tools used to change materials use, a third method is to pay a premium for non polluting production processes. Instead of penalizing polluters, it rewards non-polluters.

This process is in its infancy. Some state utility commissions, like New York, have quantified the pollution from coal fired power plants(excluding global warming) and reward non-fossil fuelled power generation technologies with a l.4 cent per kwh premium. Germany offers a 4 cent per kwh premium for non combustion electric technologies that rely on renewable resources, like wind turbines.

The Principles of a New Materials Policy

The new materials policy is laid out in tens of thousands of pages of regulations stemming from dozens of different federal and state laws and ordinances. Despite the complexity of these regulations, they are guided by a few simple principles.

The fundamental guiding principle is that pollution prevention pays. As Fritz Schumacher reminded us, "The smart person solves a problem. The genius avoids it." The principle was first espoused to govern the way we handle toxic wastes, but is rapidly becoming the guiding principle for all of our waste reduction efforts.

Water conservation is preferable to water treatment. Energy conservation is preferable to new power plants. Re-use and recycling is preferable to new landfills or incinerators.

In the late 1980s state legislatures began translating these principles into law. Half a dozen states adopted preference hierarchies for treating solid waste: reduction, re-use, recycling, incineration and landfilling in descending order. In 1978 the federal government imposed a preference hierarchy on northwest power planning, with efficiency given a 10 percent price premium, then renewable sources of energy, then cogeneration(a process whereby the waste heat of a power plant is harnessed for useful work) and finally, conventional power plants. Ten years later a number of states began changing utility regulations to include a preference for efficiency over power generation.

As we changed the rules we changed the philosophy behind the rules. In the early 1980s, when we discovered leaking landfills, policymakers responded by urging incineration as a way to reduce the need for landfills. In the mid 1980s, when we discovered that incinerators were also polluting, policymakers imposed end of the pipe pollution control technologies. Then in the late 1980s the policy shifted toward recycling. This was done in part because recycling proved to be economically competitive with incineration, but also because we became more systematic in our evaluation of the effects of our materials handling policies.

Recycling, like incineration, was initially viewed as a way to divert wastes from the landfill in order to avoid groundwater pollution. Recycling was viewed as a better alternative than incineration when incinerators were discovered to cause air pollution and potential ground water pollution due to their residual ash. More recently, recycling is supported not because it reduces back end pollution from a landfill or an incinerator, but because it reduces the front end pollution required to make a new product to replace the product thrown away.

A ton of product recycled saves several times its weight in raw materials used to replace that product. A ton of paper recycled saves a ton of coal otherwise consumed to convert wood into paper and more than a ton of other materials either polluted or consumed in harvesting the wood, producing the pulp, or making the finished paper.

Local Self-Reliance is the Solution to Pollution

The more useful work we extract from our molecules, and our photons(the energy in sunlight), the more we move toward local self-reliance. Indeed, a clean environment becomes a byproduct of local self-reliance.

Improving efficiency can radically reduce the amount of materials we use, and thus, our reliance on imports. A 1970 automobile with an efficiency of 15 miles per gallon consumed 2.5 tons of gasoline a year. A 1990 car meeting federal efficiency standards of 27.5 mpg consumes 1.4

tons. A car achieving a Congressionally proposed 40 mpg would consume less than one ton of gasoline per year to travel10,000 miles.

Efficiency reduces our reliance on imports. Recycling increases our reliance on locally generated materials. Manufacturers tend to local near their source of raw materials. As recycling soars, and scrap content requirements expand, or as re-use becomes more prevalent, manufacturers will move closer to consumers. Dairies or soda suppliers who rely on refillable bottles tend to be locally based.

In the early 1970s the increased sophistication of junkyards and the development of modern shredder and compactor technology offered for the first time a reliable and large supply of scrap steel. Steel mills equipped with electric arc furnaces that used 100 percent scrap entered the steel market. Initially they competed for the low end part of the steel market, that is, making pails, and then joists. By 1991 new steel mills operating on scrap were producing thin sheet steel, the mainstay of the appliance and automotive markets. Since 1970 these mills have captured more than 30 percent of the national steel market. They are called mini mills because they are 1/5 to 1/10 the size of their vertically integrated, virgin ore based predecessors.

Eight years supply of scrap steel sits in our driveways and junkyards. Our annual consumption of steel has not increased in the last ten years. Thus we could imagine an almost closed loop steel recycling system, with regional scrap processed in regional plants to manufacture products sold regionally.

Entropy prevents a completely closed loop system for recycled materials. Raw material stock will always have to be added to the scrap mix. But this stock itself can come from a locally available, renewable material: plant matter. Already engineering plastics are derived from a 100 percent sugar base. Wood-plastic composites have been made with very high strength. Because of the bulky nature of plant matter, processing plants will probably be regional in nature. And plastic injection molding techniques allow for producing a small number of a wide variety of end products, thus demanding a more regional market.

This discussion has focussed on the molecular basis for materials, yet a materials policy should think more broadly about the use of materials. The movement of air molecules, for example, is a resource waiting to be harnessed. Wind is not a pollutant, but unharnessed wind is a waste. The Great Plains states have been called the OPEC of wind. South Dakota alone has sufficient wind to generate 40 percent of the nation's electricial needs. One percent of the land surface of Minnesota has wind speeds high enough to provide 60 percent of that state's electrical requirements at prices almost competitive with coal fired power plants, and certainly competitive if a premium were paid for avoided the pollution incurred by coal fired power plants.

Similarly, sunlight is not a pollutant, but if we do not harness sunlight, we are wasting its potential benefit. The amount of sunlight falling on single family homes, about two thirds of all dwellings in the United States, is sufficient to provide all of the energy requirements of an energy efficient household, assuming sufficient storage capacity. In some parts of the country, enough additional energy is produced to power the family electric car.

The result of a move toward efficiency, recycling and a reliance on renewable resources for fuel and industrial materials could be a very different industrial structure. Compare the Koch Petroleum Refinery in Hastings, a little south of Saint Paul, Minnesota with the Minnesota Corn Processors facility three hours to the southwest in Marshall.

The Koch Refinery produces 40 percent of the state's gasoline requirements, about 800 million gallons. It is owned by an out of state corporation, and imports all of its raw materials. The huge complex has been sued several times by regulatory agencies and neighbors because of pollution.

The Minnesota Corn Processors facility is also a refinery, producing corn meal, corn syrup, corn oil, corn starch and, since 1987, ethanol. The plant is owned by 1100 regional farmers. All its raw materials comes from these farmers. A large percentage of its final products are sold regionally, including all of its ethanol. It produces 15 million gallons of ethanol a year, less than 1 percent of the state's transportation fuel requirements.

Minnesota could supply its transportation fuel needs from 100 MCP's or from 2 Koch refineries. Whether corn, or cellulose, or whey is the feedstock for making ethanol is irrelevant to the economic structure that can supply our future transportation fuel.

It all began with a desire to protect human health by limiting the production of toxic materials. Gradually and until recently, unconsciously, a materials policy began to emerge from the ground up. It is a policy designed to extract the maximum amount of useful work from our natural resources. By emphasizing efficiency, recycling, and a shift to plant matter and direct and indirect solar energy, we are not only redefining national security from a localist perspective, but are laying the groundwork for a different economic future.

POLLUTION PREVENTION IN A UNION PERSPECTIVE

Bertil Pettersson, The Swedish Trade Union
Confederation, S-105 53 Stockholm, Sweden

SUMMARY

The users of chemical products constitute an important "control station" regarding the possibility of replacing harmful chemicals with less harmful ones. The purchaser has the opportunity and the duty to investigate possible alternatives, demand information on health and environmental hazards, and promote the development of clean products by their choice of chemicals. The workers and the unions are important factors in this development by demanding clean production technology and by investigating and questioning the products and processes used at their workplace. This paper discusses a strategy for the reduction of environmentally hazardous chemicals at the place of work by means of inventories and the use of recognized compilations of chemicals that are toxic to the environment.

INTRODUCTION

It is true to say that for many years the pollution prevention strategies, the demands for clean technology, and the debate on sustainable development have been considered a threat to the workers' social situation in terms of income and employment. The environmentally clean industrial production implies in many cases large investments in technology as well as research and development -- money that is hard to find in many small and medium sized companies. The alternative is to close down the production.

In the trade union today there is a declared understanding of the necessity to plan for a sustainable development. This knowledge is strongly expressed at central level, and it is slowly adopted at local level. The society, as well as conscious consumers, are demanding products and services that are not hazardous to nature. A clean production line and non-polluting products will constitute the primary conditions for competition and survival on the market.

For the future, it is most likely that environmental pollution is a greater threat to employment than the demands on environmental protection and clean production technology. And the workers are not only risking their jobs in this development, they are also the primary victims of a polluted environment since income, class, and living conditions are closely related.

As a consequence, the workers must take an active part in pollution prevention and a responsibility for the development of clean products and clean production sites. For the workers this will, in many cases, result in demands on education and training, adoption to new and unknown working conditions, and to complicated discussions with management regarding the responsibility for pollution prevention and the investments necessary for the protection of the environment. However, it also means that the experience and knowledge of the workers will be taken into account and that an understanding and consciousness of all professions in prevention strategy is developed.

Several of the national unions have decided on environmental programs, and the Swedish Trade Union Confederation (LO) is presently preparing a program that will define the union policy in environmental issues, form a strategy for the union work on environmental issues, and stimulate and support the debate and activities at local level.

STRATEGIES FOR POLLUTION PREVENTION

In the early phase of pollution prevention, substantial improvement was obtained by focusing on a limited number of industrial processes and plants responsible for the major emissions of pollutants. This strategy is still valid in many parts of the world (e.g., Eastern and Central Europe and in the developing countries).

However, in many countries with a purposeful environment policy we are now confronted with the second phases of environment protection work. The problem is shifting from the large industrial sources of pollution to the hundreds of thousands of products used in endless numbers of ways by millions of people. The sum total of all these emissions and our everyday waste cause the threat of the environment of the future.

During the last decades, the environment problems have also shifted from being primarily local in nature to being diffuse and globally disseminated. In many nations the pollutant loads on the environment today originate in other countries, and in the western world, are increasing attributable to many small sources which have a substantial combined volume.

Environmental work, now and in the future, must focus on limiting the means by which our way of life causes harm to the environment. The work must be characterized by the principle of prevention, and to cope with this problem the work in Sweden is focusing on some major strategies:

- The phasing out of chemicals with unacceptable hazards for health and environment.

- The use of economic instruments in environmental policies.

The principle of substitution goes hand-in-hand with the phasing out of hazardous chemicals. In both cases, the idea is simple. If it is to be possible to avoid pollution and waste management problems in the future, this must be reflected from the production stage onwards. In this work, the participation of the workers is necessary and the substitution principle is a philosophy that must permeate the work at local level.

USERS OF CHEMICALS CONSTITUTE AN IMPORTANT CONTROL STATION

Every transfer of chemical products could be regarded as a control station at which point the purchasers have a unique possibility to demand information on the toxic properties as well as the chemical and physical characteristics necessary for the use. In this way, an important company-to-company responsibility is developed not only concerning the performance of the product but also the possible effects on health and environment.

In occupational safety and health matters, many of the larger companies have this form of "purchase control." It is often the result of union demands in order to prevent the uncontrolled use of hazardous chemicals at the workplace. The construction of the in-plant safety organization with safety committees, safety stewards,and health care services has been a major contributing factor in order to raise the level of awareness in the company control of hazardous chemicals.

The next step of an active union policy is to comprise the environmental as well as the health hazards. In many of the larger chemical-consuming industries in Sweden such as ABB, Ericson, Saab, and Volvo, this process has already started while it must be considered as a more or less unknown strategy for the majority of the small and medium sized companies.

A major obstacle in an "environmental purchase control" is that the recognition of environmentally hazardous chemicals is often a difficult or impossible task for the purchaser. Criteria for classification, labelling, and information regarding environmental hazards have so far only relevance to a very limited number of chemicals, namely those defined as "new substances," while the vast majority of chemicals lack this information. Therefore, other strategies have to be developed in order to trace potential polluters.

A primary step is to do an inventory of existing chemicals at the workplace. For complex chemical products, the composition has to be investigated since the hazardous characteristics of a product are determined by its components.

For chemical products classified as hazardous to health, the component/components of the product causing the health hazard have to be reported by chemical name and percentage, on the label as well as the safety data sheet. In Sweden close to 30,000 of the chemical products used in industry are classified as health hazards. This is approximately 50 percent of the industrial products, and just over 5,000 different chemical substances are reported as hazard-releasing factors and thus possible to detect in an inventory. From the supplier or manufacturer, it is also possible to get further information on the composition of hazardous and non-hazardous chemical products as well as on major impurities.

For the layman, however, the name of a chemical is often not enough to recognize a potential environmental hazard. The worker, as well as the manager, needs some instruments of assistance.

One such instrument is a compilation of nationally or internationally recognized chemicals that are hazardous to the environment.

By comparing the inventory to the list of recognized environmental hazards, the potential polluters are identified; and a strategy for the substitution of these products could be developed.

For many industrial chemical products, there exists already a wide variety of alternatives with more or less the same properties but with different composition. Examples are paints, plasters, glues, cleaners, and cutting fluids. In those cases, a substitution is usually possible at a minimum of cost and effort for the company.

The most difficult situation occurs when alternatives are non-existent, and a risk reduction must be based on the development of new products or new technique. There are a limited number of examples on the development of new products satisfying the user's demands for risk reduction as well as performance. The most relevant ones from the environmental point of view are probably the new generation of Chloro Fluoro Carbons, the so-called HCFCs, still hazardous to the ozone layer but to a much lesser degree and hopefully only the first step in a total risk reduction. From the occupational safety and health area, a good example is the development of industrial paints where the organic solvents are substituted by water in order to prevent neurotoxicity.

THE PRINCIPLES PUT INTO PRACTICE

In order to investigate the occurrence of chemical products hazardous to the environment, the Swedish Metal Workers' Union has recently started a project based on the inventory of chemicals at the workplace and the use of a recognized compilation of environmental hazards as discussed above. It is the union clubs on a large number of enterprises that will be responsible for the investigation of chemicals used in more than one hundred different lines of production.

The basis for this commitment is formulated in the Metal Workers' Union Environment Program. The program underlines the connection between the working and the external environments and the importance of the workers' role since workers' representatives participate in the planning of new work and installations and thereby have the possibility to influence the decisions made by the employer.

The compilation of environmental hazards used as reference in this case is a list prepared by the Swedish National Chemicals Inspectorate. The list could be regarded as a temporary solution while awaiting the development of criteria for classification and labelling of environmentally hazardous chemical compounds and products. The Swedish labor unions and several environment protection organizations have for many years demanded such a labelling system corresponding to the classification and labelling of substances hazardous to health. This will enable legislation in the field of chemicals to contain concrete measures with respect to external environment as well as health.

The environmentally hazardous chemicals have been assessed by a group of experts and includes various categories of chemicals (and families of chemicals) for which sufficient documentation is available to make an evaluation of their hazards (Table 1). The list includes a wide range of hazardous chemicals, from compounds already subject to ban or restriction of use (e.g., DDT, PCB, CFCs) to compounds which have been assessed as hazardous because, in addition to their inherent properties, they interact with other chemicals (e.g., metals) in the environment (e.g., thiram, xanthates).

The results of the Metal Workers' Union project and the experiences from this method of work will be followed closely and, if positive, it will constitute a model for similar projects in other unions.

CONCLUSIONS

It is important to stress that the trade union in adopting this strategy for pollution preventive work is not in any way trying to take over the responsibility of the employer or reduce the importance of management's work and responsibility. The purpose of the workers is to focus the attention to one of the most important problems for the future, and it should be regarded as one of the many instruments needed in the pollution prevention strategy.

From previous union experiences regarding health hazards of chemical products, we know that it is a very difficult task to make the manufacturers respond to their responsibility to investigate and inform. By means of regulations and effective control, the Swedish system for classification, labelling, and information in connection with transfer of chemical products hazardous to health is presently functioning rather well. However, as previously discussed, a corresponding system does not exist for the environmental hazards.

We regard it as necessary that an international system for classification, labelling, and information on environmentally hazardous chemical products is developed. The system should cover all chemical products, and it should give the user enough information to understand the hazards and prevent pollution. Moreover, based on this information, it should be possible to compare different products not only with respect to functional characteristics but also regarding the environmental effects.

In this way, the substitution principle could be an important preventive instrument in the hands of conscious managers and workers using chemicals at work.

TABLE 1

This table presents a list of chemicals which have been investigated by a group of experts and found to be hazardous to the environment. The work has been initiated and funded by the Swedish National Chemicals Inspectorate, and the compilation is made in the form of a book. For each chemical, a short summary of the relevant scientific documentation is provided and a justification of why the chemical has been found to be hazardous to the environment. The list is by no means exhaustive but is rather intended to give examples of the type of chemicals that are of concern with respect to environmental hazards.

Arsenic and its compounds
Atrazine
Benzidine
Benzo(a)pyrene
Cadmium and its compounds
Carbon tetrachloride
Chlorinated paraffins
4-Chloroaniline
Chromium and its compounds
Copper and its compounds
DDT
Dibutylphthalate
1,4-Dichlorobenzene
Dichlorodifluoromethane
Dieldrin and other "drins" (aldrin, endrin)
Fluorides
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Lead and its compounds
Lindane
Mercury and its compounds
4-Nonylphenol
Nonylphenolethoxylates
Octachlorostyrene
Pentachlorophenol
Polychlorinated biphenyls
Polychlorinated terphenyls
Silver-compounds
2,3,7,8-Tetrachlorodibenzo-p-dioxin and other PCDD and PCDF
Tetrachloroethene
Thiram
Toxaphene
Tributyl tin oxide
1,2,4-Trichlorobenzene
1,1,1-Trichloroethane
Trichlorofluoromethane
2,4,5-Trichlorophenoxyacetic acid
Triphenyl phosphate
Xanthates (ethyl-, isopropyl-, isobutyl-, amyl-)

SESSION 2B

TRANSITION OF PRODUCTS AND PROCESSES: SUNSET/SUNRISE

Chairperson

Polly Hoppin
World Wildlife Fund and The Conservation Foundation
Washington, D.C.

Speakers

Paul Muldoon
Pollution Probe and Canadian Institute for Environmental Law and Policy

Stephen Evanoff
Research & Engineering Department
Materials & Processes Technology Division
General Dynamics, Fort Worth Division

Gary Davis
Senior Fellow, Energy Environment And Resources Center
University of Tennessee

Christian-Ege Joergensen
Consultant, Center For Alternative Social Analysis, Denmark

Bill Ryan
Director, National Environmental Law Center
Boston, Massachusetts

Responders

Kenneth Geiser
Toxics Use Reduction Institute
University of Lowell, Massachusetts

Frances Lynn
Institute of Environmental Studies
University of North Carolina

Jackie Warren
Senior Attorney
Toxic Substances Project
Natural Resources Defense Council

Session Abstract

Decisions to phase out uses of, or ban ("sunset"), existing processes or substances that are unacceptably hazardous to health and the environment — such as lead, cadmium, or CFCs — and to introduce ("sunrise") alternatives have widespread impacts. Though there is some agreement about the characteristics of processes or substances which make them unacceptable, we need sunrise and sunset policies that more systematically take into account economic, organizational and technological implications.

The objectives of this panel are:

- To exchange experiences with initiatives to phase out or ban products and processes and introduce alternatives at the local, regional, national, (including other countries) and global levels; and,
- To identify issues that must be addressed if more efficient and effective policies for sunsetting and sunrising are to be implemented.

Developing a Sunset Chemicals Protocol for the Great Lakes Basin: Its Basis, Scope and Analysis of Implementation Issues.

ABSTRACT

By Paul Muldoon and Burkhard Mausberg

The Pollution Probe Foundation
12 Madison Avenue
Toronto, Ontario
M5S 2S1
(416) 926-1907

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ABSTRACT

Toxic contamination has been recognized as a major problem in the Great Lakes region since the early 1970s. Despite some twenty years after the recognition of the problem, toxic chemicals continue to cause serious threats to aquatic ecosystems, wildlife and human health. It is only in recent years that the breath of impacts have been uncovered. While much of the earlier concerns focussed on carcinogenic risks from toxic chemicals, current concerns include a whole range of more subtle effects, ranging from behaviourial changes to reproductive and developmental problems.

The continuing saga of toxic contamination in the Great Lakes can be traced to the failure of the current pollution control approach. A recent study demonstrates that the binational regulatory framework, and those of the eight states and two provinces located within the basin, have not embraced a pollution prevention approach. The failure of Great Lakes governments to embrace the pollution prevention concept is surprising in light of the obligations under the Great Lakes Water Quality Agreement, an agreement signed between Canada and the United States in 1978. This Agreement commits the Parties to the "virtual elimination" of the discharge of persistent toxic chemicals, while new regulatory strategies are to be undertaken in the "philosophy of zero discharge."

This paper reviews various proposed strategies to implement

the virtual elimination goal for the Great Lakes. The basis of these strategies pertain to the reduction in the use, generation and discharge of toxic chemicals. In effect, what is being examined by Great Lakes policy makers, at least on a conceptual level, are material use policies, although they still remain largely undefined.

One component of this policy development process will be examined in detail: the development of a systematic and comprehensive process to phase-out and ban chemicals. This process is referred to as the Sunset Chemicals Protocol for the Great Lakes.

The first few sections of the paper examine the context for the development of a Sunset Chemical Protocol. Included in this section is an explanation of the failure of the current pollution control approach in terms of the costs of toxic pollution and the end-of-the-pipe bias in the regulatory frameworks. Furthermore, the basis, nature, and type of obligations concerning the virtual elimination goal under the Great Lakes Water Quality Agreement are discussed. Fairly recent efforts to revive the goal are described, especially those efforts or proposals to implement a pollution prevention approach in the bilateral and jurisdictional regulatory frameworks of the Great Lakes basin. These strategies range from proposals targeting toxic emission reductions to new institutions which would further the pollution prevention concept.

With this general context in mind, the remainder of the paper focusses on a Sunset Chemical Protocol as a specific component of a zero discharge strategy for the Great Lakes. The origins, definitions and elements of this concept are then examined. In exploring the concept, two clarifications are made. First, while the focus of "Sunset Chemicals" may be on chemicals, it certainly includes a focus on processes and products that use, manufacture, generate or release toxic chemicals. Further, a Sunset Chemical Protocol includes more than a systematic phase-out and banning process, but also a whole range of regulatory options, such as restricted uses and life cycle management requirements.

The following sections then attempt to examine four specific issues with respect to the development of a Sunset Chemical Protocol. These issues include:

- what criteria should be used to determine which chemicals, processes and products should be phased-out, banned or uses restricted?
- what opportunities in existing law and policy exist to ban, phase-out or restrict the use of chemicals?
- are there particular problems or opportunities in the Great Lakes in this context?
- what issues arise in terms of technology transfer and development?
- how should labour and socio-economic issues be addressed and what mechanisms can be examined to mitigate these potential impacts?

The final section then explores the lessons that can be learned from the Great Lakes experience. The attached outline further details the contents of the paper.

Developing a Sunset Chemicals Protocol for the Great Lakes Basin: Its Basis, Scope and an Analysis of Implementation Issues.

Detailed Outline

MATERIALS AND PROCESS CHANGE:

AN AEROSPACE INDUSTRY PERSPECTIVE

Stephen P. Evanoff, P.E.
Manager, Environmental Resources Management Program
General Dynamics - Fort Worth Division

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ABSTRACT

The aerospace industry incorporates a broad array of chemicals in the manufacture of aircraft and other system components. A number of these materials and processes are critical to the quality, performance, and reliability of an aircraft over its lifecycle, which exceeds forty years in many cases. Several chemicals integral to these key production processes have been targeted for elimination, with specific deadlines mandated internationally in the case of CFC-113 and methyl chloroform (1,1,1 trichloroethane). Development, qualification, and implementation of new materials and processes that meet performance requirements is an arduous undertaking and requires significant time, funding, and research expertise.

Elimination of ozone depleting chemicals and chromium processes serve as examples as to the complexity of such changes within a major aerospace manufacturing operation. Applications include use of CFC-113 for printed wiring board cleaning, surface cleaning during aircraft assembly, and as a coolant and lubricant during wing skin rivetting; use of methyl chloroform (1,1,1 trichloroethane) in degreasing and as a carrier solvent for a variety of coatings and adhesives; and use of chromium and its compounds in a number of surface finishing processes, coatings, and sealants due to its favorable corrosion protection characteristics.

Formal procedures for qualifying new materials and the procedures for changing aircraft production specifications are described. The role of material suppliers, subcomponent manufacturers, customers, and maintenance facilities in the development and implementation of alternatives is discussed. The principal obstacles and technical challenges in making such changes are identified. Examples are given of programs within the aerospace industry to eliminate toxic chemical usage. An outline of milestones and participants is suggested to facilitate technically-sound, economical decision making.

OUTLINE

INTRODUCTION

The materials and processes used in aircraft manufacturing are outlined. The status of environmental, health, and safety programs within the industry are summarized with several environmental programs described briefly as examples.

Regulatory Framework

The regulations of most immediate concern to aerospace facilities are described and the implications for aerospace facilities are discussed.

New Material and Process Research and Development

An overview of the general engineering approach taken to identify alternatives, perform testing, and develop implementation concepts is given.

New Material and Process Qualification

The activities necessary to formally qualify and change production specifications are discussed. These activities include development of experimental plans, selection of test methods, data generation, interpretation, coordination and customer acceptance. Examples of existing qualification protocols are given.

IMPLEMENTATION

The participants required for comprehensive implementation of new materials are discussed. These include product vendors, subcontractors, maintenance centers, and the customer. Obstacles to these changes are identified.

Product Lifecycle Considerations

Product performance, reliability, and economics are discussed.

OBSERVATIONS AND RECOMMENDATIONS

Issues that must be addressed to facilitate and coordinate material changes within the industry and the activities required to create an atmosphere that encourages these changes are identified. Future actions that will provide a mechanism for implementing comprehensive and technically and economically sound solutions with a positive overall environmental impact are given.

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SUNSET CHEMICALS
- from a Danish perspective

Christian Ege Jørgensen
Environmental coordinator,
Center for Alternative Social Analysis
Denmark

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SUNSET CHEMICALS - from a Danish perspective

In current years, Denmark, like many other countries, is debating **cleaner technology** and the prevention of environmental problems rather than remedying them in the last resort through purification, waste treatment etc. If such reasoning is to be effectuated in practice, the use of a number of chemical substances particularly hazardous to the environment must be strictly regulated and ultimately cease altogether. Cleaner technology is thus closely linked with the concept of sunset chemicals.

This paper will review how Denmark is trying to restrict the use of a range of such chemicals. I shall describe the barriers confronted, including the demand for the free movement of goods expressed in Europe in the form of the Common Market, the EC, and at the global level in the form of GATT.

Denmark has focused primarily on limiting the use of the heavy metals lead, cadmium, and mercury as well as CFC (chlorofluorocarbons) and PVC (polyvinylchloride) although the latter may hardly be termed a chemical as such. Certain pesticides have also been banned or regulated.

Until the end of the 80's, actual bans were seldom imposed, and if so they were very limited in scope. Although the environmental movement began to call for bans on the most dangerous environmental toxins in 1969/70, in practice very little happened. The ban on DDT was an exception: DDT is now banned in most northern European countries. In Denmark it was strictly regulated in the 70's, but its final use - in forestry - was not prohibited until 1984. The various uses of PCB were terminated at the same pace, or at a somewhat quicker pace, than in the other EC countries.

Denmark pioneered a ban on pentachlorophenol (PCP) - a widely used wood preservative which is contaminated with dioxin and generates large amounts of dioxin when burned. In 1977 Denmark introduced a ban on the use of PCP as anything but a wood preservative. In 1981, wood preservatives were included in the requirement regarding approval prior to marketing of pesticides, and their use has since been prohibited. Not until now has Germany followed suit, introducing its own bans, and an attempt to induce the EC to ban pentachlorophenol has for the present been voted down in 1991.

Apart from these isolated total prohibitions, environmental policy has focused primarily on discharges from industries. The environmental policy of the 70's and 80's has led to significant reductions in the excessive discharges of environmental toxins formerly witnessed from some industries. But as the **use** of environmental toxins was not stopped, **diffuse** discharges resulting from the consumption and disposal of the products could continue. Thus, to an increasing extent, dumpsites and waste incineration plants became serious polluters.

In Denmark, for example, we had 4-5 industries which, until the mid-70's, released large amounts of mercury into their surroundings through stack emissions, waste water discharges and burial of waste. These discharges were reduced to a very low level in the late 70's and early 80's. However, the use of mercury in batteries continued to increase until as recently as 1985/86. Thus mercury pollution from the disposal of batteries - in Denmark primarily via waste incineration - came to far exceed that of the mentioned industries, clearly demonstrating the need for more extensive intervention in the **use** of environmental toxins.

Focus on products

It may be said that the pollution load shifted from **the production process** to **the product**, that the problem of discharges from industrial processes became one of goods with "built-in" environmental toxins. Traditional treatment strategy is clearly no longer viable. Admittedly, the treatment of wastewater can be improved, more filters can be installed in waste incineration plants and dumpsites equipped with better membranes. But this only displaces the problem. Now, almost all wastewater and waste has become environmentally hazardous, and its treatment generates vast amounts of sludge, slag, and fly ash contaminated with environmental toxins.

It must be noted that agriculture has not yet experienced this development. On the contrary, here the production process itself has become increasingly polluting. But at issue here, of course, is to an overwhelming extent diffuse discharges which we cannot treat our way out of.

Until recently, preventative measures to combat environmental toxins typically affected only narrow spheres of application. In the late 70's, regulations were introduced on the use of lead and cadmium in packaging and implements which come into contact with foodstuffs. Mercury in paints was prohibited. The limit for the content of lead in gasoline was lowered several times during the course of the 80's.

Strengthening the environmental front

Around 1983/84 the environmental movement in Denmark began to gain impetus. The ranks of the environmental associations swelled. The largest, The Danish Society for the Conservation of Nature, reached 250,000 members in 1987, which is considerable in a country of only 5 million inhabitants. Most political parties began to call themselves "green" - claiming to attach equal importance to environmental and economic interests. In 1983 the "green majority" established itself in the Danish Parliament. We had and still have a conservative government, but by aligning itself with a single conservative party, the opposition could force the government to carry out specific political decisions concerning the environment.

One of the results of this strengthened environmental consciousness in the population at large and in the green majority in Parliament was the adoption of a number of **action plans**. As opposed to the above-mentioned limited restrictions on individual uses of environmental toxins, the action plans attempt to advance an aggregate solution to a specific problem, for example in the form of a phase-out over a number of years of the consumption of a specific environmental toxin.

However, implementation of these action plans is proceeding but slowly, and with increased integration within the EC - in particular the establishment of the EC's **internal market** as of January 1, 1993 - more obstacles will impede the effectuation of Danish regulations to scale down the use of environmental toxins.

In 1987 the Danish Parliament adopted an amendment of the Act on Chemical Substances and Products. The Minister for the Environment was empowered to require the **substitution** of hazardous chemical substances where technically and economically feasible. This authority has to date only been exerted to a very limited extent. At the same time, commercial interests have extensive influence within the Environmental Board of Appeal, and this body has in several cases overruled decisions by the Ministry of the Environment to prohibit specific pesticides/plant protection agents. Such was the case in 1986 with paraquat and most recently in 1990, when the Ministry banned a number of plant growth inhibitors which appeared to reduce the reproductive capacity of swine. The Environmental Board of Appeal overturned this ban.

Labour legislation also provides opportunities to demand the substitution of substances which endanger the health of employees. Often, these same substances also adversely affect the external environment. This allows the authorities and other bodies working with protection of the internal and the external environment respectively to join forces. To date however, such collaboration has been rare.

While it is very difficult to push through bans on environmental toxins, state **subsidy** of recycling and cleaner technology has clearly been given higher priority. Such funding has increased significantly since 1987, when a fee was imposed on the delivery of waste to incineration plants and dumpsites, and it was determined that the bulk of this revenue was to be earmarked for such subsidy arrangements. Among other things, the substitution of chemicals particularly hazardous to the environment is supported, as is their reuse in order to ensure that the substances are not, or are only to a limited extent, dispersed in the environment.

Relations with the EC and GATT

Since 1973, Denmark has been a member of the European Community, the EC. The foundation of the EC is the Treaty of Rome which stipulates inter alia that a member state may not impose technical barriers to trade (article 30). In other words, it may not adopt legislation which denies the goods of other EC countries access to its domestic market. However, there is an exemption clause rendering it permissible to impose demands which serve solely to protect the natural environment, the working environment, human health etc. provided these demands are not intended as impediments to trade (article 36).

The problem is that environmental legislation can almost always be seen from both sides. One country may adopt legislation with a view to protecting the environment. Another country or an industry which itself finds less restrictive legislation adequate, may claim that a barrier to trade has been imposed. Such disputes must be settled by the EC Court.

Until recently, the EC issued few directives regarding bans or restrictions on the use of hazardous substances. The EC Commission has also accepted that if no concrete directive exists on a given area, a member state may introduce legislation. This clashes with the question of environmental labelling of hazardous substances: for many years the EC has practised **total harmonization**, in other words detailed regulations have been adopted by the EC which the member countries may not tighten nationally.

In 1987 however, a new step was taken towards increased integration within the EC. The so-called Single Act was adopted, as well as plans for the internal market which is to come into existence at the end of 1992. These plans specify that no trade barriers are to exist at all, i.e. national environmental requirements may not be imposed on commodities. If this is put into practice, such an integration would be more comprehensive on this point than that which applies within the United States of America. Here, for example, the State of California is allowed to take the lead, and imposes more stringent demands on the design of cars and lorries as regards their emissions than are enforced at the federal level. In the EC, this would be interpreted as a trade barrier.

The intention is to harmonize all bans and restrictions on the use of hazardous chemical substances within the EC in the same way as is already the case with labelling, as mentioned above.

However, there is an exemption clause, Article 100A Section 4 of the Single Act which is similar to the old article 36 (see above).

The Danish government calls this article the environmental guarantee, and interprets it to mean that it will always be possible to impose more stringent demands if they are not protectionist. The EC Commission, however, finds that this clause may only be utilized to uphold existing regulations in a member state, not to introduce new, more stringent environmental demands, and that this right is to be abrogated at the end of 1992 as it violates the intentions of the internal market.

The "old environmental guarantee", article 36, has been tried in the EC Court with varying outcomes. For example, in 1987 Denmark was convicted of having required notification of new chemical substances which were not subject to notification according to EC regulations. On the other hand, in 1988 when Denmark was brought before the Court for having demanded deposits on beer and soft drink cans, it was acquitted.

The "new environmental guarantee" has not, however, been tried at the Court, one of the reasons being that the Danish government is extremely wary of invoking it. The trend is clearly that it will become increasingly difficult within the EC to impose national environmental demands which affect free trade.

The idea of the internal market is furthermore to harmonize fees, including environmental ones. However, such decisions must be unanimous. But the objective is also to do away with border control between EC countries. If this is effectuated, the requirement of unanimity may be rendered illusory. If transboundary trade is completely free, Denmark can hardly enforce other fees than Germany. Very recently, there has been a good deal of talk of common environmental fees at the EC level, but so far it remains but talk. United Kingdom, among others, has vehemently opposed the idea.

The ban on technical trade barriers applies in principle also to non-members of the EC, as the global free trade organisation, GATT, also is designed to remove trade barriers. But GATT disposes of far fewer means to achieve its goals than does the EC. The EC has thus, for example, attempted to exploit GATT to prevent Sweden and Austria from introducing restrictions on the use of hazardous chemical substances. This involves prohibiting certain mercury-containing batteries and certain uses of PVC. However, in these cases the EC has ultimately accepted that these countries went beyond the EC on certain points.

In the following, I will review some examples of substances which are sought restricted in Denmark.

Cadmium

Cadmium is a heavy metal and one of the most common environmental toxins. In 1980, the Danish National Agency of Environmental Protection released a report showing that cadmium contamination was so widespread that most important foodstuffs were polluted. The Danes' average intake of cadmium was not much below the limits set by the World Health Organisation. As there is considerable variation in the population's intake of cadmium, it was calculated that several thousand Danish citizens must already have exceeded this limit. This implied that it was likely that these people had contracted chronic kidney ailments as a result of cadmium.

Recognizing this, the most comprehensive measure ever taken regarding a chemical substance widely used in industry was introduced. Sweden led the way by introducing a ban in principle on the use of cadmium. Subsequently, a considerable number of exceptions were made where the continued use of cadmium was permitted for a number of years or indefinitely. Its use in accumulators (rechargeable batteries) however, fell beyond the scope of legislation, as did the use of substances that are naturally contaminated with cadmium, e.g. coal and artificial fertilizers containing phosphates. But apart from these areas, which are not comprised by law, the regulations are interesting in that they follow a **positive list** principle, i.e. all usages not cited as exceptions are banned.

Denmark followed by introducing legislation very similar to Sweden's, also with a positive list principle and with largely the same exceptions. This took the form of a Ministerial Order issued in 1983, but the specific bans did not enter into force until 1987 and thenceforward. As is shown in Table 1, attempts to reduce the use of cadmium were in fact successful, despite widespread opposition from industry against Danish and Swedish legislation. It was claimed that the Danish and Swedish market was too small for legislation to influence the consumption of cadmium in many internationalized trades. For example, cadmium is used extensively in the manufacture of automobiles, both in varnish, in the surface treatment of metal and as a stabilizer in PVC.

But other countries followed suit. In Holland, a proposal has now been presented to strictly limit the use of cadmium, and Germany is also well underway. The EC Commission is attempting to stop the national regulations and has instead tabled a proposal for an

EC directive on restricting the use of cadmium. Its scope, however, is far more limited, among other things because it adheres to the

Table 1: Development in the consumption of cadmium in Denmark in tons

	1977/78		1981	1987
	Amount in tonnes	**Relative amount %**	**tonnes**	**tonnes**
Industrial use				
Surface treatment (1)	1	1.4	17	
Alloys	6	7.9		
Pigments incl. Automobile varnish	27	35.4	62	29
PVC plastic	13	16.9	30	
Accumulators	4	5.5	10	10-16
Other	5	6.6	11	
As trace element				
in zinc	3	4.4		
in oil	1	1.2		
in coal	8	10.2	-20	20
in fertilizer	8	10.5		
Total	77	100	150	59-65

negative list principle, i.e. that all uses not mentioned in the directive proposal are permitted. This discrepancy is crucial, as in our complicated society it is difficult to enumerate all the conceivable uses of a substance such as cadmium. When certain applications are banned, the price of cadmium is expected to drop. If the regulations follow a negative list principle, it is likely that some industries will find other uses for cadmium attractive, and thus the legislative process will be back to square one. If the Commission's proposal is adopted by majority vote in the EC - and there is much to indicate that it will be so within the next year - the Commission will take the position that Denmark must abandon its current regulations and make do with the more lenient EC regulations. The Danish government claims however, that it may rightfully maintain more stringent regulations.

In 1989, Denmark moreover introduced a limit on cadmium in artificial fertilizer which is to be gradually lowered until 1998. However, nothing has yet been done about cadmium in coal. Now that reductions in the amounts of cadmium in other areas have been successful, its use in accumulators remains the greatest source of cadmium pollution. Involved here are nickel/cadmium accumulators in the form of both small, rechargeable batteries and large stationary accumulators in for example aircraft, trains and ships. This use has to date been permitted to expand unchecked. Manufacturers have been sluggish in developing alternative accumulators that do not contain cadmium. There are the so-called nickel/hydride accumulators, but as yet they are not widely used.

These accumulators have a long lifespan, and large amounts are in circulation in society. It is thus crucial - regardless of whether a substitute is introduced within the near future - that the spent nickel/cadmium accumulators (NiCd) are collected, and that the collection percentage is high. In 1988-1990 efforts were therefore made in Denmark to introduce a form of retroactive deposit system, i.e. that a deposit is paid when purchasing an NiCd accumulator, but a (smaller) amount is paid out when a spent one is returned, regardless of whether a deposit was originally paid. The aim was to achieve a collection percentage of about 95, where the voluntary collection systems in force hitherto have normally exhibited collection percentages of between 10 and 40% depending on how intensive an effort has been made to disseminate information.

However, the deposit system met with virulent opposition from primarily the retailers' organisations, and the government finally abandoned it.

Henceforth, efforts will focus on a particularly intensive voluntary collection system for NiCd accumulators.

One use of cadmium particularly difficult to manage is the fixed NiCd. Many manufacturers of electrical appliances have found it advantageous to permanently mount the accumulators so that the consumer cannot replace them on his own. In other words, when the appliance no longer functions, for example because the battery can no longer be recharged, the entire appliance is scrapped. At present, such appliances cannot be delivered to battery collection points, and thus end up among the ordinary waste which thereby becomes contaminated with large amounts of cadmium. In this way, an environmental problem has been exacerbated in order to gain what is most likely but a marginal competitive advantage.

The Danish authorities did not believe they themselves could influence the manufacturers on this issue, and therefore tried to have a ban on fixed NiCd's adopted in the EC. One might have chosen to impose a fee on the permanently mounted accumulators, but there were fears that this would lead to increased transboundary trade. Southwestern Denmark, which borders Germany, is particularly affected by transboundary trade. It looks as if the attempt to achieve an EC ban will eventually meet with at least partial success, but the current EC resolution reflects a compromise which restricts but does not entirely prohibit the practice of permanent mounting.

Mercury

Mercury is even more toxic than cadmium, but at the same time is discharged in smaller amounts. Even in a country such as Denmark, which has no significant mercury pollution, there is a suspiciously high content of mercury in certain species of fish. There is no danger of acute catastrophe, as was witnessed for example in Japan in the 1950's. However, a slight increase in the number of birth defects, which may later appear as impairments in development in these children, may be feared. Such an impact was ascertained in a recent study in New Zealand, where the mercury level is similar to Denmark's.

As opposed to cadmium, there is as yet no comprehensive regulation of mercury in Denmark. Efforts to this effect have been going on for several years, but have not yet been concluded. Such regulation risks at the same time being postponed even further by the EC, which will regard it as a technical trade barrier.

The predominant use of mercury in the 80's was in batteries (see Table 2). The Minister for the Environment has made a voluntary agreement with the battery importers on the phase-out of the mercury content in batteries. The mercury content of alkaline batteries in particular has been reduced from 1% in the early 80's to 0.3% in 1987 and now to 0.025%. This reflects an international trend which Sweden and Switzerland have spearheaded through legislation. The major manufacturers have now to a large extent lowered the mercury content. In the above-mentioned EC directive proposal the content has been set at 0.025%, but is not to take effect until 1993.

The most recent surveys of mercury consumption in Denmark date back to 1982/83 (see Table 2). But it appears that the contribution from batteries and various appliances has now shrunk to such an extent

Table 2: Consumption of mercury in Denmark (51).

Application	**1982/83**	**%***	**1977/78**	**Development****
Industrial products				
Batteries	4.7	26	7	-
Electrolysis	3.0	17		0
Instruments etc.	2.2-2.9	14	3	-
Other	0.5-1.7	6	7.5	-

Other applications				
Fillings	3.1	17	4	-
Fungicides etc.	0.9	5	2.3	-
Laboratory purposes	0.7	4	2	-
Other			4.2	-
As additive				
In coal and oil	1.0-2.0	8		+
Other	0.1-0.9	3		?
Total	16.2-19.9	100	30	-

* Calculated on the basis of the mean value of the intervals indicated

**+ Increasing consumption

- Declining consumption

0 Stagnating consumption

? Unknown development trend

that the largest contribution is made by dentists, i.e. from amalgam fillings. Alternatives to amalgam, in the form of plastic fillings, have been developed, but the Danish Health Agency and a majority of dentists do not find these qualitatively adequate to replace amalgam in the most exposed fillings. A minority among the dentists however, find that they are just as effective. The Ministry of the Environment is now funding a project within the cleaner technology programme for the development of plastic fillings; likewise, projects on the substitution of mercury within other sectors are being funded.

It has also been proven that persons with amalgam fillings inhale considerable amounts of the mercury fumes they emit. In Sweden, pregnant women are cautioned against major surgical intervention requiring the use of amalgam. Denmark has issued no similar warning. The minority of dentists mentioned above find that these mercury fumes can lead to serious symptoms; the majority, however, disagrees. The Ministry of the Environment has proposed that a ban on amalgam fillings be introduced in the late 90's, but still faces considerable opposition.

Lead

Lead is found and used in society in much greater amounts than cadmium and mercury. On the other hand, it is not as easily spread in the environment. Until recently, the danish authorities did not regard lead pollution as such as a significant problem. Focus has been on lead in gasoline, where particularly hazardous organic lead compounds are involved which simultaneously are released into the street environment, where they can be inhaled, or along fields and gardens where they may be assimilated by crops via the air.

But it has become evident that metallic lead that ends up on the ground or in the water is also hazardous. Particularly if it ends up in an acid environment, lead is dissolved and can be assimilated by plants. For this reason it is now being discussed whether lead should also be generally regulated.

Lead in gasoline is a serious health problem which was underestimated for many years. In the 30's, the United States began to add lead to gasoline to raise the octane level. General Motors commissioned some doctors to say that this was not injurious to health. But in 1975 the United States also became the first to take steps to introduce lead-free gas along with catalytic cleaners to treat automobile exhausts. Japan followed quickly in its wake, while the EC attempted to keep both lead-free gasoline and catalytic cleaners out of the European market. Not until 1985 did the EC countries decide that lead-free gas was to be allowed on the market, and this did not become obligatory for all member states until 1989.

The Ministry of the Environment has also tried to have lead shot replaced with steel shot, but after pressure from the hunting associations lead shot was prohibited only in special bird sanctuaries. The Ministry of the Environment is now working on an extended ban on lead shot as of 1993, but no total ban is being considered.

Quantitatively speaking, the greatest use of lead is in accumulators in automobiles. Here it has not been deemed realistic to substitute, so efforts concentrate on collection and recycling. But periodically the price of lead falls so low that the manufacturers have no interest in collecting accumulators. The Ministry of the Environment has therefore launched a collection campaign. The amounts are so great that it is environmentally imperative to achieve a very high collection percentage, at least 95 and more likely 98%. It is estimated that about 95% is collected in Denmark, although this figure is highly uncertain. In Sweden, where the distances are much greater, it is presumed that only around 60% is collected.

Chlorofluorocarbons (CFC)

Denmark decided in 1984 to ban CFC in aerosol cans for private consumption. This met with opposition in the EC, but the EC Commission desisted from taking this to the EC Court. Prior to the adoption of the Montreal Protocol in 1987, the EC attempted to weaken it as much as possible, but subsequently made a political about-face. In 1989 the EC resolved to aim for a total phase-out of CFC before the year 2000, and in December 1990 this deadline was brought forward to 1997.

Denmark has chosen implement a phase-out by setting specific dates for each of the most important usages of CFC. The dates have been set according to how far substitution has advanced. Thus, substitution of aerosol cans has come the furthest, while it is regarded as more difficult to replace CFC in refrigeration insulation and district heating pipelines. At the same time, Denmark has introduced a surcharge on both CFC and products containing CFC designed to help alternative substances/methods become more competitive. The EC Commission however, finds that only at the EC level may agreements be reached with suppliers of CFC to limit the supply. The Commission believes that the price of CFC will thus rise and the market mechanisms ensure that substitution is promoted. The Danish strategy is now being followed by Germany and Holland, and it thus seems unlikely that the Commission will bring the issue before the EC Court.

The Danish state has started a special development programme the primary purpose of which is to support the substitution of CFC, secondarily to support the collection and recycling of CFC.

Polyvinylchloride (PVC)

PVC could hardly be called a 'sunset chemical'. But chlorine causes even greater environmental damage, and PVC is the predominant source of pollution by environmentally hazardous chlorine compounds. As opposed to most other countries, Denmark has so many incineration plants that they treat 70% of household waste and a large part of industrial waste. The incineration plants contribute to acidification by releasing hydrochloric acid, as well as to dioxin pollution. In both cases, PVC is the main cause, as it contributes 70% of the chlorine in the waste.

PVC is a relatively cheap type of plastic, but at the same time its technical characteristics are achieved to a large extent by the use of additives which are extremely hazardous to the environment, such as cadmium, lead and phtalates which are not, or are only to a very limited extent, used in other types of plastic.

Denmark encourages severe restrictions on the use of PVC. But it meets with vehement opposition from the manufacturers. Sweden, Austria, Holland, and Switzerland also want to limit PVC, but focus more specifically on packaging. Austria however, also targets all "shortlived" PVC products, i.e. office and hospital articles, toys, rainclothes etc., thus approximating the Danish position. Denmark wants to restrict all PVC which ends up in incineration plants.

The plan is to cut the total consumption of PVC by half by the end of 1992, and subsequently reduce it further over the following years so that the articles mentioned above are discontinued completely. The government has attempted to avoid legislating on this issue, which has become one of the most controversial environmental issues in Denmark. Instead, an agreement is sought between suppliers and consumers, among other things to avoid legislation being obstructed by the EC. But the suppliers and many of the industrial consumers have until recently been reluctant to negotiate. A deadline for the negotiations has been set for April 1, 1991.

Concurrently with these negotiations, several chain stores have launched campaigns for PVC-free products, and it has become one of the slogans of the "green consumers" to buy PVC-free.

What actors can be instrumental in removing sunset chemicals?

As the above has shown, the possibilities for the EC member states to introduce legislation phasing out the use of environmentally hazardous chemicals are being narrowed. If this happens, the dynamics will disappear from the politico-environmental development that allows one or a few countries to lead to the way and others, with time, to follow. Instead, one must continually wait until the majority are convinced - and according to the EC's voting regulations, a majority implies 3/4 of the states - before taking steps to solve an environmental problem, because the interests of free trade are given higher priority than environmental considerations.

So in Denmark, much effort is being made to ensure that the EC may only adopt **minimum regulations** in the area of the environment, so that the individual countries are allowed to implement more stringent environmental regulations. This applies already to environmental regulations that do not concern trade in commodities, for example regulations on the discharges from industries and power plants.

Among other things because of the problems with the open borders, the Danish government is counting less on legislation and more on voluntary initiatives, including consumer-oriented campaigns. In several European countries, the "green consumer guides" have become widespread, and many manufacturers and retailers try to use the environment as a sales parameter. Of course this is all very well, but the problem is that it is enormously difficult for the individual consumer to determine what goods are in fact more environmentally friendly. There is a tendency to expect consumers to be both chemists and ecologists and to presume that they have had time to read weighty volumes before making their purchase.

To alleviate this problem, discussions have been going on for several years whether to introduce **environmental labelling** similar to that practised in Germany for many years. The principle is to confer a positive label on a product if it is environmentally better than its competitors. At the same time, the environmental parameter on which the product excels is to be indicated. If environmental comparisons of products are to be made with any degree of certainty, this constitutes a tremendous task. There has been some criticism of the administration of the system in Germany, where for example certain paints and varnishes with a relatively low content of organic solvents have been awarded the label even though corresponding products exist which contain no solvents at all. Denmark has decided not to introduce its own environmental labelling, but will await a system that is underway within the EC.

The strategy of the green consumer is sound, but it cannot stand alone. Environmental legislation and environmental surcharges are still needed if our planet is to survive.

Christian Ege Jorgensen
Center for Alternative Social Analysis

Toxic Chemical Phaseouts and Bans:
Lessons from Recent State Toxics Use Reduction Efforts

by

C. William Ryan
Policy Director
National Environmental Law Center
29 Temple Place, Boston, MA 02111
(617) 292-8050

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Toxic Chemical Phaseouts and Bans:

Lessons From Recent State Toxics Use Reduction Efforts

Detailed Outline

In recent years, National Environmental Law Center (NELC) staff have advised groups around the country on efforts to promote state toxics use reduction laws. This paper describes our view on how toxic chemical phaseouts and bans should fit into state and federal toxics use reduction programs, and presents our observations on recent efforts in states to promote such concepts.

I. Phaseouts and Bans Should Be An Integral Part of a Comprehensive Program to Promote Toxics Use Reduction

The long-term goal of a toxics use reduction policy should be to stimulate the development of production processes and products which are safe for workers, consumers and the environment. Phaseouts and bans of toxic chemicals should be included as one of three key parts of such a program:

A. To get companies started on thinking about and doing toxics use reduction: require annual reporting on toxics use and reduction plans; provide technical assistance; reform agency mandates to promote reduction.

B. To keep laggard companies up with the leaders: establish performance standards which require all companies producing similar products to achieve a chemical use per unit of product performance as low as that attained by leading companies. A standard should specify what level of performance should be obtained, but should leave to each company exactly how to achieve it.

C. To keep the leading companies pushing the cutting edge of process innovation forward: ban or phase out particularly problematic chemicals.

II. Approaches to Bans and Phaseouts

A. Could apply to individual chemicals, classes of chemicals, use of chemicals in specific products or families of products.

B. Our focus has been to promote bans and phaseouts of individual chemicals or, even better, classes of chemicals. Focusing on the use of a particular chemical in only one product or process is too time-consuming. The result too often is paralysis by analysis.

C. Should select chemicals to ban or phase out primarily on the basis of environmental and health dangers they pose, with limited emphasis on the availability of safe substitute chemicals or processes, or the potential costs of replacements. The goal should be to stimulate the innovation necessary to find safe replacement chemicals, products or processes and to bring replacement costs down. One usually can not predict what the nature of the innovations will be, other than to predict that there will be innovative responses. It is important to establish safe alternatives policies to guide those responses.

D. Proposals should be formulated to help workers whose jobs might be threatened by toxics use reduction innovations to make a smooth transition to other jobs.

III. Recent Efforts to Promote Phaseout and Ban Powers in States

In recent years we have given state Public Interest Research Groups (PIRGs) groups in Massachusetts (MASSPIRG) and New Jersey (NJPIRG) technical advice on efforts to promote toxics use reduction laws which give state agencies the power to ban or phase out chemicals. We offer the following observations on what occurred in those states:

A. Industry Reactions: Strong industry objections, primarily on the grounds that such actions are (a) unnecessary and (b) more appropriately undertaken at the federal level. Industry representatives expressed concerns that state industries would be at a severe competitive disadvantage vis a vis companies in other states and countries. To the extent they were willing to discuss these ideas, they were much more receptive to ideas of phasing out chemicals over time in contrast to immediate bans, in order to allow for innovation and a smooth transition.

B. Public Reactions: Members of the general public were very supportive of strong actions on chemicals known to be particularly problematic, e.g. known or probable human carcinogens. They were generally surprised that state agencies did not already have strong powers in this area.

C. Environmental Agency Reactions: They were supportive of having phase out and ban powers as another way to protect public health and the environment.

D. Labor Concerns: In Massachusetts, where industries are mostly users of chemicals, not producers, concerns were focused mostly on ensuring promotion of safe alternative chemicals and processes. In New Jersey, where there are more chemical producers, chemical workers in particular raised concerns about possible job losses.

D. Other concerns: Others argued against phaseout and ban provisions if there are not corresponding provisions to restrict the introduction of new chemicals and further test existing chemicals.

E. Results: Phaseout and ban provisions were dropped from New Jersey toxics use reduction proposals early in the political debate. In Massachusetts, were dropped only in the last hours of negotiations.

IV. Prospects for the Future

A. We anticipate more and more debate at both state and federal levels on the desirability of phasing out or banning problematic chemicals, instead of trying to control them through cumbersome, often ineffective regulatory controls. Experience with ozone depleter phaseouts has shown that development of innovative alternatives can be stimulated through such actions. Absent effective action at the federal level, such debates will occur more and more frequently at state and local levels.

SESSION 2C

EPA'S OSW POLLUTION PREVENTION ACTION PLAN

Chairpersons

Dr. Manik Roy
Office of Solid Waste
Environmental Protection Agency

Ms. Sharon Stahl
Office of Pollution Prevention
Environmental Protection Agency
Washington, D.C.

Responders

Conference Attendees

Session Abstract

EPA's Office of Solid Waste and the Office of Waste Programs Enforcement have spent the last few months seeking public input, in a variety of forums, into their development of a four-year RCRA Pollution Prevention Action Plan. Shortly after this conference, representatives of the two offices, and the Pollution Prevention Office, as well as some other EPA program and regional offices will start to draft the Action Plan. In this session, the preliminary findings of the past few months will be briefly presented, and then the conference attendees will be asked to comment. This session will be, in essence, the ultimate focus group advising EPA's development of the Action Plan. Preparatory materials will be included in the conference proceedings, distributed upon conference registration. **Please come prepared to participate.**

SESSION 2D

PRODUCT LIFE CYCLE ASSESSMENT

Chairpersons

Ms. Christine Ervin
World Wildlife Fund and The Conservation Foundation
Washington, D.C.

Ms. Sharon Stahl
Office of Pollution Prevention
U.S. Environmental Protection Agency
Washington, D.C.

Speakers

Mr. Norman Dean
Executive Director
GreenSeal, Inc.

Dr. Thomas Lindhqvist
Department of Industrial Environmental Economics
University of Lund, Sweden
A European Perspective on the Limitations and Possibilities with LCAs

Mr. Tim Mohin
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency

Dr. Fran Werner
Director, Corporate Planning, Monsanto Company

Responder

Dr. Richard Denison
Senior Scientist
Environmental Defense Fund

Session Abstract

Analytic tools are needed to identify, evaluate, and reduce environmental burdens associated with alternative products — including the materials from which they are made. Life cycle assessments are one of the most promising of such tools available today, yet considerable work must be done to translate that potential into widespread application.

The objectives of this panel are to explore:

- Applications of life-cycle information in various settings including public policy, industry, decision making, and product labeling—in the U.S., Canada and in Europe;
- Key issues that must be addressed to maximize the usefulness of life cycle assessments; and
- The role of screening mechanisms for selecting priorities for analysis and for streamlining methodology.

SESSION 2E

GOVERNMENTAL APPROACHES TO IMPLEMENTING POLLUTION PREVENTION AT THE STATE AND LOCAL LEVEL

Chairperson

Mr. Terry Foecke
National Roundtable of State Pollution Prevention Programs
Minneapolis, MN

Speakers

Ms. Linda Pratt
Pollution Prevention Program
San Diego County (CA) Department of Health Services

Ms. Kathryn Barwick
Alternative Technology Division
California Department of Health Services
San Diego County
Technical and Educational Assistance Model (T.E.A.M.) Project

Mr. Tim Greiner
Massachusetts Office of Technical Assistance

Mr. Lee Dillard
Massachusetts Department of Environmental Protection

Mr. Paul Richard
Upper Blackstone Water Pollution Abatement District
Prevention: The Blackstone Project

Ms. Maurice Knight
Louisiana Department of Environmental Quality

Mr. John Glenn
Mr. Paul Templet
Tax Incentives Promoting Pollution Prevention

San Diego County Technical and Educational Assistance Model (T.E.A.M.) Project

The role of local environmental regulatory agencies is not only to assure that industry is in compliance with laws and regulations, but also to provide educational information and guidance to industry. The effectiveness of this educational program can be enhanced if a cohesive approach to addressing pollution prevention is developed. At the local level, environmental regulatory agencies have an opportunity to catalyze interactions that will bring about policy and procedural changes for implementing multi-disciplinary pollution prevention programs.

San Diego County encompasses more than 3900 square miles and has a population of nearly 2.5 million. Within its boundaries are a blend of traditional heavy industrial manufacturing, "high-tech" research and development facilities, military installations, and a variety of small businesses. Resulting from these various processes are more than 100,000 tons of hazardous wastes generated on an annual basis. The local government and the environmental regulatory agencies elected to go beyond "business as usual" and the safe confines of established regulations, and to pursue the opportunities to integrate innovative strategies into established regulatory programs.

The "Technical and Educational Assistance Model" (TEAM) project is an interagency joint venture that will test the success of local government multi-media pollution prevention program planning. The development of these programs will address the need to correct the current fragmentation and lack of communication between various media-specific agencies. The outcome will be a variety of cross-training activities implemented within the local regulatory agencies, thereby resulting in a more consistent and integrated approach to providing pollution prevention information to the community.

Coordinating State And Local Agencies For Pollution *Prevention: The Blackstone Project*

The Blackstone Project involved the efforts of three agencies—a state nonregulatory technical assistance program (OTA), a state regulatory program (DEP) and a local sewer authority (UBWPAD)—all working on a group of metal intensive manufacturing firms within the Upper Blackstone Watershed. The combined efforts led to multi-media source reduction training for inspectors, source reduction biased enforcement, time-saving multi-media inspections and on-site non-regulatory technical assistance drove industries to reduce toxics use and waste generation without the burdensome cost of conventional treatment. The talk will cover the Pollution Prevention technical assistance efforts of OTA, the multi-media pollution prevention inspections by DEP and UBWPAD inspectors and the mutual benefits of coordination between the three agencies.

Tax Incentives Promoting Pollution Prevention

A review of the $300,000,000 Louisiana Industrial Tax Exemption Program, constitutionally provided in the 1930's, indicates quite a disparity between jobs created per dollar of tax exemption granted. Often, tax exemptions are given to industries already located within the state for capital improvements, sometimes creating only a few or no jobs for millions in exemptions. Many of these industries are among the heaviest of the states number one national ranking in toxic releases to the environment. Additionally, many of the new industries most heavily courted by the State's Department of Economic Development are industries similar to those already located within the state and which have similarly heavy waste streams.

The Louisiana Department of Environmental Quality has presented a new plan for evaluating industrial tax exemption applications. This is a significant new role in economic decision-making for a state agency charged with environmental protection. In order to continue to expand and encourage the diversification of the state's economic base toward more environmentally friendly industries, the plan calls for scoring tax exemption applications by linking them to the applicants' environmental compliance records and a ratio of emissions to jobs created. There are five bonus point categories included as incentives for the following: emissions reductions, development of recycling systems, use of recycled materials, diversification of the State's economy and location of facilities in parishes (counties) with high unemployment rates.

The "Technical and Educational Assistance Model" (TEAM) Project:

A State and Local Agency Perspective

Presented By

Linda Giannelli Pratt
San Diego County Department of Health Services

and

David Hartley
California State Department of Health Services

Prepared for the
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The "Technical and Educational Assistance Model" (TEAM) Project: A State and Local Agency Perspective

Linda Giannelli Pratt - Pollution Prevention Program

San Diego County Department of Health Services

David Hartley - Alternative Technology Division

California State Department of Health Services

All sectors of society-- government, industry, academia and the general public-- have a role in safeguarding our environment. At the local government level, environmental regulatory agencies have a wonderful opportunity to catalyze interactions that will bring about policy and procedural changes for implementing multi-disciplinary pollution prevention programs. In California, the first phase of a long-term campaign has begun. Our vision is a cohesive pollution prevention philosophy that is advocated by local governments and industry from Eureka to San Diego.

At this point, sharing information between Federal, State and local agencies has become increasingly important. California is truly fortunate to have a committed staff at EPA Region IX, the State Department of Health Services, and throughout local agencies who will continue to strongly advocate the benefits of pollution prevention. By no means is this an easy undertaking. At all levels of government there is, to some degree, a mismatch between rhetoric and action-- a rhetoric which says that pollution prevention is an issue of highest priority, and a level of action that does not provide adequate financial and administrative support.

Three regional pollution prevention committees currently meet on a regular basis to discuss the myriad of issues associated with pollution prevention. The southern California committee typically includes representatives from cities and counties that have more established programs. The San Francisco Bay area committee has perhaps the best blend of representatives from various "media-specific" agencies. The newest regional committee has been established for the Central Valley area, and affords a unique opportunity to guide the development of pollution prevention programs within some of the more rural counties of the State. Representatives from both the State Department of Health Services and EPA Region IX actively participate on each committee. The first "formal" meeting of these groups occurred in October 1990 at the First Annual Statewide Roundtable. While each county and city is unique in its composition and organizational structure, the Roundtable provided the opportunity to identify the major issues and work as a group to clarify the general direction necessary to accomplish the fundamental objectives for preventing pollution.

In order to fully integrate pollution prevention strategies at all levels of government and throughout the various medium-specific regulatory agencies, the State Department of Health Services, together with EPA, is currently administering an EPA funded Pollution Prevention Incentives for States grant. The project, entitled "Technical and Educational Assistance Model" (TEAM), will integrate multi-disciplined pollution prevention programs into local environmental regulatory agencies, and provide educational outreach to the community. The counties of San Bernardino, Ventura and San Diego are taking a leading role in designing and implementing a workable plan of action. In addition to the model county programs, the project includes development and administration of multimedia pollution prevention training sessions to be held throughout California which are designed for environmental regulatory agency staff, as well as a State Roundtable targeted at key representatives from environmental regulatory agencies, primarily at the State level.

The inspiration for the TEAM Project began, in part, as a response to the heightened level of interest in hazardous waste management issues by elected officials and key policy-makers at both the State and local level. In California, counties (or other administering agencies) are required by law to prepare Hazardous Waste Management Plans which outline how 100 percent of the hazardous waste stream generated within their jurisdiction will be treated or disposed. Data collected and evaluated for the Plan pointed to the fact that nearly one million tons of hazardous waste is generated in the State per year. One of the most beneficial outcomes of developing these Plans is that it provided an opportunity for representatives from diversified sectors of the community to discuss many of the complex challenges associated with this broad issue. The interest of these discussions shifted from managing hazardous waste to preventing its generation. This can become a reality only if a number of conditions are in place, which includes communication and coordination between regulatory agencies and, on a much larger scale, a close examination of how consumer choices and the "out-of-sight, out-of-mind" ethic of the general population is affecting the environment. Representatives from environmental health agencies in the counties of San Diego, Ventura and San Bernardino, as well as the State Department of Health Services, strongly felt the need to develop a strategy that would provide educational outreach to both industry and the community at large. Hence, the TEAM Project evolved into a multi-agency joint-effort of the EPA, State Department of Health Services, and local environmental regulatory agencies.

In San Diego County, the TEAM Project is coordinated by the Country Department of Health Services', Hazardous Materials Management Division. The project does not focus on compiling technological advancements for source reduction, but rather on behavioral factors that can influence change. While the benefits of pollution prevention are rarely disputed, there remains a need to institutionalize programs that are dedicated to meeting specific objectives pertinent to this issue. This requires a "cultural change" in firmly established regulatory agencies that for so long have centered on media-specific "end-of-pipe" technologies.

San Diego County encompasses more than 3900 square miles, and has a population of more than 2.4 million. Within its boundaries are a blend of traditional heavy industrial manufacturing, "high-tech" research and development facilities, military installations, and a variety of small businesses. The volume of hazardous waste generated on a yearly basis is approximately 100,000 tons. The administration and enforcement of environmental laws and regulations have been compartmentalized into three agencies:

- hazardous materials management
- industrial waste control
- air pollution control

The County Department of Health Services', Hazardous Materials Management Division has been empowered to enforce pertinent State and Federal hazardous materials laws and regulations. Industrial waste control is performed by five independent programs, each being unique in their field of inspection protocol, permit issuance procedures, and the industrial discharge limitations. The local air pollution control district has the task of protecting public health by achieving and maintaining air quality standards throughout San Diego County.

A typical manufacturing operation may be visited periodically by representatives from each environmental regulatory agency. At these visits, media-specific recommendations are made for waste reduction. Inadvertently, the result may be "media-transfer", i.e., the recommendations made by the representatives from each agency may advocate methods to reduce the waste in their sphere of influence, but that "remedy" may actually cause more waste to be emitted to another media.

The San Diego County Board of Supervisors took a serious look at the hazardous waste management issue and directed a joint-staff Task Force to evaluate pollution prevention options. The Task Force consisted of staff from all of the local environmental agencies as well as Fire Departments and County/cities Planning Departments. The Final Report addressed the current fragmentation and lack of communication between the various agencies and departments, and proposed a number of strategic objectives that will hopefully result in a more cohesive and integrated approach to providing pollution prevention information to the community.

Recommendations included in the Final Report from the Task Force are the following:

- Promote the development of a consistent policy at both the County and City level that contains incentives to minimize the use of hazardous materials and the emission of pollutants from both industry and government operations;

- Advocate that sufficient staff and resources be available for institutionalizing a pollution prevention program;

- Design a strategy to promote various levels of educational outreach activities which incorporates a multi-disciplined approach to pollution prevention;

- Encourage cross-training between staff of local environmental regulatory agencies to enhance the level of consistent information provided to the industrial community;

- Implement administrative changes that would provide a more comprehensive evaluation of pollution prevention activities County-wide, and compile this information into a Multi-Agency Annual Report.

The staff within the County Department of Health Services have enthusiastically moved forward on this project. However, none of this would be possible without the clear support from upper management. They have embraced this concept and have set it as a priority. The results thus far include:

- Development and distribution of the document entitled <u>Pollution</u>

Prevention: A Resource Book for Industry which describes the multi-disciplined approach, illustrates a number of wonderful "success stories" from local businesses, and lists many of the reference information typically requested, such as technical information, industry associations, vendors, and financial assistance available.

- Initial design of the multi-agency cross-training program for field staff from all local agencies.

- Continual meeting of the multi-agency Task Force, which has had many positive results, including a collaborative effort for a number of jointly-sponsored workshops for industry;

- Initial design of a "generic" informational brochure which emphasizes a consistent, cohesive approach to pollution prevention, and is endorsed and distributed by all local regulatory agencies.

There are "champions" in every agency throughout the nation who are eager to begin or enhance pollution prevention programs. Certainly, the road has been paved during the past five years by Federal, State and local representatives who have taken risks, stumbled, gathered themselves together and have moved forward. Much of the groundwork has been done, and this foundation can serve to enhance the ability of local, State and Federal agencies to promote a consistent strategy that will reduce the volume of pollutants released into our environment.

Government can not provide leadership by rhetoric, but we can lead by example. Ultimately, what is being prescribed is "quality management", that is, going beyond "business as usual" and the safe confines of established regulations and technical issues. Government can have a significant impact on the cultural change that needs to take place, the change that will create a social, economic and political system which minimizes waste and maximizes efficient use and reuse of materials. We can take a leading role in this noble endeavor if individuals at both the management and staff levels resolve that it is essential to develop and integrate pollution prevention strategies into established programs. If this commitment is made, then all of us working together as a group of enlightened individuals will make a tremendous difference.

Environment and Economy: Louisiana's Industrial Tax Exemption Program

Maurice Knight
John Glenn
Paul Templet, Ph.D.

ENVIRONMENT AND ECONOMY: LOUISIANA'S INDUSTRIAL TAX EXEMPTION PROGRAM

Maurice Knight
John Glenn
Paul Templet Ph.D.

Introduction

Louisiana's pollution problem is well known. With the heaviest concentration of petrochemical producers and processors in the country, traditionally weak environmental regulations and a Department of Economic Development (LDED) which actively sought to expand the petrochemical sector of the economy, Louisiana has had an unfortunate environmental history. With the support of Governor Roemer and under the leadership of Secretary Paul Templet, the Louisiana Department of Environmental Quality (LDEQ) has made great strides in the last three years toward addressing this problem. The Secretary has guided the agency to a 2.5 fold increase in staff with a corresponding budget increase of greater than forty million dollars. These increases alone have had significant impacts on the state's pollution problems. Still, however crucial the LDEQ staff and dollar increases have been in addressing the state's pollution problems, other, more profound changes have taken place. The agency has dramatically shifted in its understanding of how the it should operate. The LDEQ has taken broader approach to solving complex issues, an approach that goes beyond the traditional boundaries of the LDEQ as an environmental protection agency.

A Shift In Direction At The LDEQ

Throughout the seventies and early eighties most environmental agencies in the country were reactive in nature, i.e., their agendas were set directly and indirectly by public pressure. As environmental problems were identified, the public conveyed concern to their respective law making bodies, laws were passed and agencies began attempting to implement these laws with what resources were available. The prime example of this is the U.S. Environmental Protection Agency.

In the first years after its formation, the LDEQ followed this scenario. For example, the agency began by looking only at the laws and regulations which it was responsible for implementing and adopted an internal structure which mirrored those laws and regulations. And in its day to day operations, the LDEQ carried on the existing tradition of environmental protection agencies by looking primarily at the various end of pipe emissions control solutions to the pollution problems facing the state.

While there were quiet rumblings from small sections of Louisiana's academic community (see Houck,1986), there was no institutional effort to look at the pollution problem in Louisiana in a broader context. There certainly was not a concerted effort to involve the LDEQ in any type of issue scanning activity to anticipate approaching environmental problems or define the scope of existing ones. Lacking a broader more "holistic" approach to the state's environmental issues meant the LDEQ was not as effective as it could have been. LDEQ had no clearly defined structure directed at identifying preemptive measures that would reduce the potential for furthering existing problems and which would reduce the likelihood of new problems emerging.

In 1988, with the inauguration of Buddy Roemer as Governor, the rumblings in the academic community were tapped. Dr. Paul Templet, a professor in the Institute for Environmental Studies at Louisiana State University was named Secretary of the Department of Environmental Quality. Through Templet, Louisiana's academic community was suddenly given a voice in state government. As a result of this new influence, the agency was fundamentally reorganized. New Assistant Secretaries for the line offices were named, a new Office of Legal Affairs and Enforcement and a new Division of Policy Analysis and Planning (DPAP) were created in the Office of the Secretary. Under the new Director Vicki Arroyo, who came from EPA, and with the guidance of Secretary Templet, DPAP began to carry out the type of broad scanning of issues which had previously been lacking in the agency.

This required new categories of professionals to be hired which are not traditionally associated with state environmental programs. These included professionals such as planners, landscape architects, economists, health scientists and industrial hygienists. The result has been a wide variety of new approaches to solving environmental problems. The following discussion outlines one of DPAP's most controversial efforts. Known as the industrial tax exemption project, this effort links a corporation's environmental record and pollution discharge level's to the amount of tax exemption which it may receive.

THE LOUISIANA INDUSTRIAL TAX EXEMPTION PROGRAM

The Goal At LDEQ: Source Reduction

The U.S. Environmental Protection Agency's nationwide Toxic Release Inventory (TRI) identifies Louisiana as leading the nation in the total amount of toxics released into the environment. The LDEQ has been particularly concerned that Louisiana leads the nation in toxic releases to water, is first in the nation in the toxic chemicals disposed of by underground injection, and is fourth in the nation in releases to the air (Louisiana Toxics Release Inventory, 1988). In all, a total of 982,488,518 pounds of toxic chemical releases were reported in Louisiana in 1988.

The goal of the LDEQ is pollution reduction. With a new emphasis on source reduction of waste and pollution instead of end-of-the-pipe controls, Secretary Templet directed DPAP to begin implementing waste minimization in the state through an EPA Source

Reduction and Waste Minimization grant. Through this project, it became evident that as much as ninety-three percent of Louisiana's hazardous waste was generated by less than seven percent of the industrial facilities in the state. Correspondingly, Louisiana's largest environmental dischargers and sometimes largest violators were also in this seven percent.

The Ten Year Industrial Tax Exemption In Louisiana

The Industrial Tax Exemption program in Louisiana is the cornerstone of the Department of Economic Development's effort to attract industry to the state. The program was provided through the Louisiana Constitution in the 1930's with the primary goals of producing jobs and attracting industry which otherwise would locate out of the state. A great part of this incentive is exemption from ad valorem property taxes for five years, renewable for an additional five years.

The tax exemption legislation authorizes the Louisiana Board of Commerce and Industry to grant exemptions from a number of state, county, and municipal property taxes. The local taxing authority has no direct voice in the decision for exemption and at the end of the exemption period, the property is assessed at its depreciated value. Most of the exempted money would have gone to local school boards or local road improvement funds. Today, the industrial tax exemption program is one of the largest programs in the state, exempting over three hundred million dollars in taxes annually. The tax exemptions received by companies in Louisiana far out weighed any penalties which might be assessed for environmental violations.

In the past, the exemption awards and renewals have been virtually automatic. In an effort initiated by Secretary Templet and DPAP Director Vicki Arroyo, and Administered by State Policy Administrator John Glenn, LDEQ began the effort to tie the industrial tax exemption program to the environmental performance of industries applying for tax relief.

Economic Tax Incentives-The Key To A Cleaner Environment

The LDEQ, moving beyond strictly defined jurisdictional boundaries, asked to work with the Louisiana Department of Economic Development to modify the industrial tax exemption program. The goal was to help both state departments meet their respective goals. Since many of the companies receiving the industrial tax exemptions were among the largest dischargers in the state, and some were also among our most serious environmental violators, it was apparent that this was a case of one government arm working without the other.

In addition, the Commerce and Industry Board responsible for approving industrial tax exemptions sees economic development in the classical sense, i.e., economic development and economic good standing is viewed as a function of labor, capital investment and goods and services produced. Lost in this formula are the potential impacts of development decisions on the finite natural resources of the state and on the human and environmental health of an area. By not including these elements in the economic development formula, economic gains may in fact result in net losses to the state due to the resulting environmental impacts and loss of quality of life.

After DPAP's first contacts with Louisiana Department of Economic Development it became clear that regardless of environmental costs, their perceived role and priority was to attract companies to locate in Louisiana. Environmental protection was not their concern. According to LDED, it was up to LDEQ to deal with issues like pollution reduction and prevention once industries had located in the state. There was no recognition of the connection between a clean environment, economic well being and the ability to attract future economic development. LDED seemed to ignore that the general effectiveness of relying on tax exemption programs has been questioned. Industry today considers many other factors in location decisions. These include cost and proximity of raw materials, access to transportation routes, energy access and costs, available labor pools, general operational cost levels as well as other factors.

Despite LDED's attitude, a number of facts began to emerge concerning Louisiana's environmental and economic status. The industrial tax exemption program has been in effect since 1936. Yet Louisiana still ranks forty-sixth in the nation in per capita income. It is clear that many of the industries receiving the largest tax exemptions granted had extremely high capital investment to job ratios. Further, many of those industries which were being heavily recruited were similar to those already located in the state. Many of the exemptions granted were to companies already located within Louisiana for expansions which created few or no permanent jobs. Sometimes exemptions were granted for capital or infrastructural upgrades which the company would have probably performed anyway, with or without a tax break. The potential results of this trend were not encouraging.

As a result, the Department of Environmental Quality proposed a system whereby all tax exemptions would be tied to environmental considerations and diversification away from the large dischargers which represent the existing industry in Louisiana. This led to debate between LDEQ's wish to reduce emissions and waste in the state and LDED's wish to simply produce new jobs. This battle quickly spilled over into the Governor's office and became a statewide issue.

<u>An Environmental Point System</u>

The original LDEQ concept was to develop a system which would start at zero with points accrued up to one hundred. The number of points would correspond to the percentage granted of the total requested tax exemption. Industry and all the major industrial lobbying associations within the state felt that this was too restrictive. A compromise was reached stipulating that only half of an industry's tax exemption award would be tied to an its environmental score. The potential combined reduction in industrial tax exemption awards for any given facility due to the environmental review is thus fifty percent of the amount of exemption requested---twenty-five percent from previous environmental penalties and twenty-five percent from the jobs to emissions ratio.

After several meetings it was decided that the LDEQ would be responsible for evaluating an "environmental section" attached to the tax exemption application. It was also agreed that only environmental penalties which had been finalized and no longer in question would be used in the evaluation. Using anything prior to final decisions would amount to undermining due process. It was also agreed that companies would begin with the full fifty points available in the environmental section of their application. A graduated deduction scheme would be developed for environmental violations and an emissions to jobs ratio.

Environmental violations were rated as follows:

Final Action Amounts(thousands)	Percentage Points Added
Less than $10,000	5%
$10,001 to $25,000	10%
Greater than $25,000	15%

When the program is fully implemented, an environmental record going back five years will be considered and different violations will be cumulative to the twenty-five percent allotted for this category. Older violations will count less than recent ones, diminishing in value by twenty percent per year until the sixth year when they will no longer be considered. For example a violation would reduce a tax exemption award by eighty percent of the value of the penalty received (as calculated above) if the exemption was applied for the following year.

LDEQ recognized that tax exemptions related to final penalty actions could encourage industry to contest virtually every violation and penalty. By delaying final decisions, industry would not realize the impact of environmental violations on tax exemption awards. In order to address this, the rules for the environmental section of the exemption program stipulate that all violations that are voluntarily settled will have their impact on tax exemption awards reduced by half.

For example, a ten to twenty thousand dollar violation would normally result in a ten percent reduction in the tax exemption. If voluntarily settled, this same penalty would result in a five percent reduction in the tax exemption award. A definition of what constitutes "voluntary settlement", as far as a time limit or initial level of contestment, has not been decided and needs to be addressed. This last concession was absolutely necessary. Without it, the program would have been mired in litigation.

This scheme does allow some companies with multiple violations to receive higher scores. However, it was felt that violations needed to be discounted over time to offer reward for improving environmental performance.

In order to reconcile LDEQ's mandate to reduce emissions and LDED's goal of creating employment, LDEQ recommended the development of an emissions to jobs ratio. Implementation of this ratio binds the state's environmental and economic goals together and creates a unified approach to solving the related problems. It offers greater incentives to industries which are labor instead of pollution intensive. The jobs data includes full time equivalent construction and contract personnel hired by the facility (full time equivalents are figured at 2080 hours per year) Construction jobs are divided by ten because of their temporary nature.

There was some discussion about including a qualitative component to evaluate the jobs created based on an average equivalent facility salary. By looking only at the numbers of jobs relative to emissions, it is in the interest of the companies to create more lower paying jobs. However, this proved too difficult to accomplish and was dropped. It may become necessary to provide a qualitative element in the future.

Only two types of emissions/discharges were considered in the ratio: toxic releases, which are recorded yearly by the LDEQ, and criteria air pollutants. These were chosen because they represent the most serious pollutants and because data for these two groups was already being collected. Criteria air pollutants were divided by ten since they are less toxic than the TRI emissions. This results in a composite number that actually under-estimates the real amount of emissions released.

Companies are awarded percentage points based on the levels of emissions released per job created. These are then grouped into the following scheme with increasing reductions in tax exemption award for increasingly higher ratios.

EMISSIONS LEVELS (LBS)	AMOUNT ALLOTTED IN EXEMPTION AWARD
Greater than 10,000	0%
5001 to 10,000	5%
2,501 to 5,000	10%
1,001 to 2,500	15%
501 to 1,000	20%
Less than 500	25%

However equitable this system might seem, industry considered it punitive since companies could only lose points. Positive incentives needed to be built into the process to further encourage industrial tax exemption applicants toward true environmental progress. Five categories of bonus points were created in order to reward companies for making progress. These bonus point categories only apply in making up points lost in other penalty categories. As a result, companies can accrue a maximum of one hundred points or one hundred percent of their requested exemption.

The first category of bonus points concerns emissions reductions. A facility can receive up to fifteen bonus points, equal to fifteen percent as applied to the exemption request, for a LDEQ approved emissions reduction plan. The plan must specify at a minimum a five percent reduction in emissions per year. The five percent is normalized between criteria air pollutants and TRI listed pollutants on a ten to one basis similar to the jobs/emissions ratio. One bonus point is granted for each two percent of the emissions reduction per year on a compounded decreasing scale.

The second bonus points category is for recycling and is worth a total of five points. One point is awarded for each one percent of recycled hazardous waste in a closed loop system. This is figured as a percentage of a company's total output product of the facility. Bonus points are also available for using recycled materials at a rate of one bonus point for each 5% of recycled material as again compared to the facility's total output.

This structure proved unrealistic. In the first reviews of environmental sections of tax exemption applications, companies had difficulty receiving these bonus points. John Glenn, administrator of the project is presently working with representatives of industry to modify this bonus point category so that it acts as a real incentive.

The third category of bonus points is available to recycling companies that manufacture consumer products. Ten bonus points are available in this category. The object of this category is to encourage different kinds of industry to locate in Louisiana than those which we have traditionally attracted. This was more of a priority for the LDEQ than for the LDED.

The fourth category offers fifteen bonus points for projects which create at least one new job per thirty thousand dollars in tax exemptions in counties with unemployment rates greater than one percent above the state's average. This presently is an all or nothing category.

The last bonus point category contains a potential ten points and is awarded to companies which are considered to diversify the states economic base. Again, this is an all or nothing category. The LDED has control over awarding of points in this category. The LDEQ is at present insisting on some review of decisions on diversification bonus awards. The Department of Economic Development has sent the Department of Environmental Quality information on the criteria by which points in this category will be awarded and is negotiating on the final criteria.

Restrictions And Guidelines

There are some restrictions which LDEQ has successfully included into the tax exemption scheme. Industrial tax exemptions will be automatically reduced by fifty percent for any company that produces more than twenty percent of a material that is banned or designated to be banned for use by the U.S. EPA. For example, this would include a pesticide like DDT or CFC's which could be manufactured and sold in another country.

Also, no tax exemptions will be given to any company which imports more than fifteen percent of its hazardous waste for disposal. This would include companies that import hazardous waste from other facilities owned by the parent or another subsidiary of the parent corporation for disposal in Louisiana. This stipulation excludes any waste disposal company from receiving tax relief through the exemption program.

One of the important results of tying the tax exemption program to environmental records is related to ability and willingness to pay. Penalty fines levied against facilities for environmental violations are limited by the need to justify the amount of the fine. It is easy to see that for some facilities, the penalty levels are less than the cost of preventing or avoiding the violations.

A much more dramatic cost/benefit ratio becomes apparent when looking at emissions and discharges. The industrial base in Louisiana is among the most capital intensive in the world. Billions of dollars of capital have been invested to process and generate waste a specific way. This creates tremendous capital inertia against changing pollution emission and waste generation patterns in industry. Staying with the existing capital investment, discounted over time, greatly hinders efforts by government agencies to encourage the new capital investment needed for pollution prevention.

With the industrial tax exemption connected to a jobs/pollution ratio, there is now a substantial incentive to reduce pollution emissions and discharges. Also, the ability and willingness to pay penalties for environmental violations is seen in a different perspective when fines in the thousands have the potential to cost millions in lost exemptions.

Results

It is a little too early to tell exactly what effects these changes in the tax exemption program will have on emissions and discharge reductions. However, one result that has already been seen is the increase in tax revenues to local government. The first three tax exemptions reviewed were reduced by seven and four tenths million dollars. Much of this is local parish (county) assessed taxes.

Interestingly, one of the first facilities reviewed came back to the LDEQ requesting another review of the environmental section of their tax exemption application. The reason given was that they had not taken seriously the environmental part of the application. Once they realized the economic potential of their pollution reduction efforts, the company wanted the opportunity to provide more information on their pollution reduction program. The LDEQ later discovered that final corporate approval for their pollution prevention plans, which they now wanted to include, was received one month and three days after this company lost a portion of their tax exemptions.

CONCLUSIONS

The development of these changes in the industrial tax exemption rules have been accomplished under an emergency rule order from the Governor. They were also developed and implemented in an extraordinarily short three month period. The process was very intensive, forcing all parties to present their arguments for and against the program along a very compressed time line. There will undoubtedly be changes to the "environmental scorecard" in the future as needs are reevaluated and redefined.

A more traditional planning approach could have been followed and would have taken a much longer time period to accomplish. However DPAP staff considered the advantages of this questionable. Instead, the LDEQ moved rapidly and now has an operational environmental assessment program for industrial tax exemptions with the expectation that it will be a living document that will change over time with the needs of the state.

This process moves the Louisiana Department of Environmental Quality beyond looking at strictly a regulatory framework and into an entirely new approach to solving pollution problems in the state. In order to solve Louisiana's pollution problems, the LDEQ recognized that it had to address the states economic problems as well. It could not simply introduce more and more stringent regulations on generators after their location into the state.

Environmental protection agencies must move beyond their traditionally perceived, expected or established boundaries. There is already a legal basis for doing this. This is true in most states. The National Environmental Protection Act (NEPA) is far under-used for justifying these actions at the national level.

With the new proposed cabinet level status of EPA, and with the legal and legislative support in place, the EPA has an opportunity to also begin taking a more active role in influencing policy and process in other agencies and departments which have traditionally been given sole proprietorship in their decisions.

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SESSION 2F

NON-GOVERNMENTAL AND FINANCIAL APPROACHES TO IMPLEMENTING POLLUTION PREVENTION AT THE STATE AND LOCAL LEVEL

Chairperson

Mr. Terry Foecke
National Roundtable of State Pollution Prevention Programs
Minneapolis, MN

Speakers

Ms. Donna Toy Chen
Los Angeles (CA) Hazardous and Toxic Materials Project
City of Los Angeles, Bureau of Public Works

Michael Meltzer, Ph.D.
Jacobs Engineering Group, Pasadena, CA

Mr. Lupe Vela
Community Development Department
City of Los Angeles
Typical Obstacles in a Government/Private Technical Firm/ Industry Waste Minimization Assessment Study

Ms. Monica Becker
Tellus Institute
Boston, Massachusetts
Mr. Robert Pojasek
Geraghty & Miller, Inc.
Boston Massachusetts

Mr. Tim Greiner
Massachusetts Office of Technical Assistance

Ms. Terri Goldberg
Northeast Waste Management Officials Association
Full Cost Accounting For Pollution Prevention:
Case Studies and Methods

Mr. Stan Springer
Washington Department of Ecology

Mr. Lawrence Istvan

Chair of Advisory Committee For Hazardous Waste Part B Permits and Plans

An Integrated Approach to Implementing Waste Reduction

Session Abstracts

Institutions such as non-profits, academic institutions, environmental organizations and trade and professional associations all play a significant and growing role in promotion and implementation of pollution prevention. Such initiatives as legislation, applied research, direct promotion and policy and technical coordination are growing in importance. The approaches and philosophical orientation of several of these organizations will be presented, along with bases of support and recent products and initiatives.

Typical Obstacle in a Government/Private Technical Firm/*Industry Waste Minimization Assessment Study*

This paper discusses the strategies, logistics, and typical obstacles that must be dealt with in a government—private industry—private technical firm waste minimization assessment. We will discuss the reasons for conducting the study—political, environmental, and economic and introduce the organizations involved and the steps that we took in the study:

- Selecting the shops;
- Site visits, data collection;
- Report review, and,
- Implementation.

Full Cost Accounting For Pollution Prevention: Case Studies And Methods

This presentation will focus on the principles of full cost accounting (FCA) methods, why they are important for planning for reducing pollutants and wastes, and case studies of the application of these methods at actual firms. FCA is a method for determining the "full" life cycle costs of investments which are directed at, or have implications for, pollution generation and management. Many states that are implementing toxic use reduction laws are increasingly interested in asking firms to apply FCA methods as part of pollution prevention (PP) planning. These states believe that full cost accounting will help firms understand that toxic use reduction can help safeguard and promote competitiveness of business.

The panel will present the preliminary findings of four projects on FCA. Allen White from the Tellus Institute will present the initial results of their review of existing FCA methodologies, tests of such methods against conventional accounting methods in case studies, identification of obstacles to FCA implementation, and recommendations on how such obstacles may be overcome. This work is being funded by the New Jersey Department of Environmental Protection and the U.S. EPA. Bob Pojasek from Geraghty & Miller will present his work on developing a practical guide to using FCA principles to help justify PP projects in industry. Mr. Pojasek is the Chairperson of the Economics Council of the American Institute for Pollution Prevention, which has received funding from EPA to support the project. Terry Goldberg, Pollution Prevention Program Manager at the Northeast Waste Management Officials' Association (NEWMOA) and Tim Greiner, Project Director at the Massachusetts Office of Technical Assistance will present the preliminary results of several case studies of FCA efforts at Massachusetts firms and development of a training program for state officials and trade association staff on FCA.

An Integrated Approach to Implementing Waste Reduction

Private sector involvement in pollution prevention is critical to success. A panel of representatives from Washington State discuss how the varied interests of industry and citizens are being pursued, both independently and in cooperation, and some issues and problems they encountered.

An industry representative explains efforts underway to reduce hazardous substance use and waste generation. Industry initiatives are stimulated by the need to satisfy consumer preferences, reduce liabilities, and take advantage of flexibility that could be lost through regulatory approaches.

Citizen efforts focus on educating the public and government officials about hazards, promoting public accountability, and creating a climate for change.

Washington State encourages voluntary efforts to reduce hazardous substance use and hazardous waste generation, and has enlisted the help of citizens and the business community to carry out a new state law.

Industry and citizen interests participated in a state effort to develop rules implementing Washington's Hazardous Waste Reduction Act. Although sharing many pollution prevention objectives, their viewpoints differ on issues such as public access to information, focusing on priority problems, measuring success, and the level of detail required in planning for hazardous substance and hazardous waste reduction at industrial facilities.

TYPICAL OBSTACLES ENCOUNTERED AND LESSONS LEARNED IN A GOVERNMENT SPONSORED NON-REGULATORY WASTE REDUCTION ASSESSMENT STUDY FOR INDUSTRY

Donna Toy Chen
City of Los Angeles

Michael Meltzer
Jacobs Engineering Group, Inc.

Lupe Vela
City of Los Angeles

**Prepared for Presentation at
Global Pollution Prevention '91
Washington, D.C.**

Session 2F: Non-Governmental Approaches to Implementing Pollution Prevention

March 1991

Typical Obstacles Encountered and Lessons Learned in a Government Sponsored Non-Regulatory Waste Reduction Assessment Study for Industry

DONNA T. CHEN, MICHAEL MELTZER, LUPE VELA

This paper discusses the typical obstacles encountered and the lessons learned in a government sponsored hazardous waste minimization assessment study. The assessment was conducted by a private consulting firm for private industry. The private industry targeted was metal finishing. This study illustrates the commitment to pollution prevention by government, efforts to instill this commitment in local businesses, and illustrates real life successes and failures in encouraging pollution prevention programs in local businesses.

Background:

Recently, the Los Angeles metal finishing industry has been subject to increased attention from citizens' groups and regulatory agencies. Concern exists because of the perception that metal finishing shops use poor management practices with respect to hazardous materials, thus contributing to existing pollution problems in air, water and soil, and increasing risk to surrounding communities.

As a result of a fire and explosion at a plating company located in a mixed commercial/residential area in the east Los Angeles area, a Los Angeles City Councilwoman proposed an ordinance which calls for all metal finishers to be relocated to inner manufacturing zones. Throughout the years the City of Los Angeles has allowed both platers and residential dwellings to co-exist in various zones ranging from light to heavy manufacturing activity. Until recently, "buffering" (setting up conditions to assure residents' safety) was not carefully reviewed when locating a manufacturing facility in a mixed zone.

Many metal finishing shops are located in east Los Angeles, an area targeted for economic revitalization through a state Enterprise Zone Program. In addition, the shops show a risk to public and worker health and safety from the results of a survey conducted by City of L.A. Industrial Waste Inspectors. Of the total metal finishing shops rated in "poor" condition in Los Angeles, thirty percent are located in east Los Angeles.

Because of the growing awareness of environmental concerns regarding platers and the councilwoman's proposal, the Eastside Enterprise Zone (EEZ) staff of the City of Los Angeles Community Development Department (CDD) undertook a preliminary survey to assess the socio-economic characteristics of the industry in East Los Angeles and to determine the nature of the regulatory issues confronting the platers. The survey found that in this area, the metal plating industry constitutes a significant source of local employment. It is estimated that the plating shops employ over 750 local residents and that forced relocation of the plating shops would cause additional unemployment and economic hardship in the area. The survey concluded that communication and continuous education between government agencies and platers were crucial toward improving perceptions, working conditions, and the development of future environmental regulations.

Partly as a result of this survey and the industrial waste inspector survey, the City of Los Angeles Hazardous and Toxic Materials (HTM) Project and the CDD have joint efforts to reduce hazardous waste generation and to improve waste management in plating shops, and to help them to achieve the following goals:

- Regulatory compliance with all local, state and federal laws;
- Reduction of environmental risk;
- Better protection of worker and public health, and
- Elimination of the need for relocation

The HTM Project selected Jacobs Engineering Group, Inc., to work with the EEZ shops. Five electroplating facilities have been identified for participation in the program. The program objectives are:

- Develop workable regulatory compliance and hazardous waste reduction options for the five electroplating shops selected;
- Demonstrate to the management of the above-mentioned facilities the technical and economic feasibility of the identified regulatory compliance and waste minimization options;
- Assist in implementing the most promising options and monitor resulting improvements in regulatory compliance and reduction in waste generation; and
- Use the experience gained with the five facilities as a basis to expand the scope of the waste minimization program to other plating firms.

The organizations involved:

HTM Project : This project funded, organized, coordinated and managed the assessment study. Mayor Tom Bradley and the Los Angeles City Council established the HTM Project to better manage and minimize the generation of hazardous wastes in the City. The office is located in the Board of Public Works in City Hall.

As a non-regulatory technical assistance office, the HTM Project works with both city departments and city industries concerned with management of hazardous materials and hazardous wastes. The Project's primary goal is to affirm the Mayor's waste minimization policy by reducing the generation of hazardous wastes and promoting the national waste minimization goals throughout Los Angeles. HTM Project services currently available to city industries include:

1) Information Clearinghouse - An information resource center provides access to literature sources, contacts, and case studies on waste reduction techniques for specific industries or waste streams. The Clearinghouse can provide regulatory information, contact numbers and specific instruction to assist in compliance.

2) Onsite Technical Assistance Provides source reduction assessments and onsite regulatory assistance to City departments and businesses in the City of Los Angeles.

3) Outreach and Training Program - Presentations on pollution prevention to industries, trade association, professional organizations, and citizen groups can be provided. Depending on the audience, these programs range from an overview of the City's HTM Project to in-depth discussions of technologies and regulations for specific industries.

The Community Development Department: The staff will be providing low interest financing and assistance to the targeted metal finishing shops. The CDD is responsible for the delivery of all community services to city residents. This includes housing assistance, job training, human services programs and business assistance to low income area. The EEZ is a program managed by the Industrial and Commercial Division of CDD. The Zone program is responsible for administering a tax credit program for businesses, providing business technical assistance and low-interest financing. In addition, the program staff have been involved in investigating avenues to assist different industries such as plating, printing, and furniture to understand new environmental regulations to help them remain within the City of Los Angeles.

Jacobs Engineering Group, Inc.: The firm's Hazardous and Toxic Materials Division conducted the compliance and waste reduction assessments for the shops. Jacob's is a nationwide environmental consulting firm providing technical assistance to the HTM Project, especially in the area of hazardous waste reduction.

City of Los Angeles Bureau of Sanitation: The Enforcement Division of this Bureau inspects industrial waste discharge permittees monthly. The Enforcement Division provided background information on potential candidate shops during the selection phase and worked with the HTM Project and Jacobs Engineering to provide sampling equipment.

Planning Department - the department prepared the original motion and an alternate for consideration by the City. They worked with CDD and the metal finishing association to revise the proposed ordinance. The alternative motion would require metal finishers to obtain and hold a "conditional use permit" to operate. To obtain the permit, metal finishers would have to show compliance with all local, state, and federal laws. In addition they assisted with a review on zoning status for plating shops.

Step 1: Selecting the Shops

Shop selection involved the interaction between CDD, HTM, and the Bureau of Sanitation Industrial Waste Enforcement Section. It is significant that the Enterprise Zone program has and maintains a good working relationship with many of the plating shops in the EEZ , especially since this is a government sponsored program and could be viewed as hostile. The Enterprise Zone program's relationship certainly helped to obtain volunteers and cooperation from the list of candidate shops. The candidate shops were reviewed for any current enforcement action developing against them in the Bureau of Sanitation , in addition to their willingness to participate for the duration of the program and for their representation of the many shops in the EEZ. Other checks were made with the Department of Planning to ensure that none of the shops would be immediately subject to zoning change requirements and which pose such a risk to the community that even implementation of recommendations from the study would not improve their risk. Likewise, those shops which did not appear viable for the duration of the study and role as a model were not selected. We considered criteria such as financial situation, ability to compete for business, to come into regulatory compliance, ability to finance for pollution control equipment and interest in implementing waste reduction recommendations. Out of the nine shops considered, five were selected for the study.

STEP 2: Site Visits and Data Collection

Shops were visited several times in order to introduce the goals of the study to them, and to collect data. It is important to obtain permission of the owner or manager for all visits, and to inform them of all plans; for instance, the specific personnel to be interviewed. The Project cannot succeed without the support of management.

The first visit's functions are to introduce the project to shop management, and to obtain their support for it, and agreement to participate. During this first visit, representatives from the city HTM Project, the CDD, and Jacobs attended, so that the shop personnel had an idea of project organization. A series of subsequent visits were carried out by Jacobs staff only, for data collection purposes. After promising waste minimization options were identified and screened to select the best ones, the CDD again visited the shops to offer financing assistance for implementing the options.

STEP 3: Report Review

The report contained a description of operations and current waste management, site assessment findings, waste minimization opportunities assessment, and recommendations for personnel health and safety. The names of the shops were kept confidential by referring to them by code letter. The whole report, containing all shop chapters and appendices, was sent to each owner for review. We now realize that only the chapter applicable to that shop owner should have been sent for his review, first, rather than the whole document.

First, the size of the document and layout could easily be presumed as a final format. The report appeared ominous. Second, some owners were concerned that some details in the general description of the shop were enough for regulators and competitors to identify them by the EEZ boundaries, and the exclusive work that they do. These fears had to be calmed and changes immediately incorporated into the report. It is highly important that communication lines be kept open for all their concerns. Most concerns were directly called in to CDD. We assured the participants that the four copies of the report would not leave the HTM project manager, the CDD program manager, and Jacobs Engineering for public review and that the information would be held confidential. Even so, there were bad feelings on the part of one shop owner because Jacob's hadn't shown him a draft before it was shown to city personnel. He was afraid the city personnel might show or talk about the report to inspectors, and wanted to edit the draft for accuracy first. This shop owner eventually declined to continue with the project.

STEP 4: Implementation

The rapport helped in that fact sheets developed listing waste reduction options for each remaining shop were readily received. Enthusiasm for immediate implementation of new procedures and purchase of equipment varied widely. One shop owner obtained financing and already purchased low technology equipment recommended. Another has applied for financing for equipment purchases. One shop of the five decided not to participate after the first draft was released for their review. In a second shop, the study and recommendations were well received by the shop foreman, but final decision was made by the general manager, who, citing slow work and time constraints did not want to consider implementation at all at this time.

The third shop is obtaining a loan and will be implementing low cost waste reduction methods. Although the financing through CDD has excellent conditions, it takes about four months to obtain the money. The longer it took to get word from the loan committee, the less the enthusiasm for implementation.

Conclusion:

We have learned that although this was a non-regulatory study conducted by a non-regulatory office, there is still a fear of government and the regulations thrust upon the participants. The city is now more sensitive to their issues and is approaching the issues more carefully. The metal finishers now feel more comfortable in working and interfacing with city employees on a personal, not government basis.

Both metal finishers and the City have come to realize there are issues which they can come together on: 1) Waste reduction - can improve the metal finisher's bottom line; 2) Compliance and community safety; 3) Zoning requirements.

The metal finishing association in working with the city, has grown up politically through continuing dialogues on the issues. Most importantly, the city's perceptions that metal finishing is a dirty business, and the metal finisher's perception that the city is a dirty bureaucracy has disappeared, and a better understanding of each other and their goals are helping to shape a better environment for all citizens in Los Angeles.

Recommendations for an agency to have a Successful Program:

- Maintain good working relationship with metal finishing association
- Have previously established and constant interaction on positive basis between CDD and businesses
- Expend extra efforts to maintain trust and confidentiality
- Keep touching base with enforcement group and address problems early
- Have continuous interaction between government agency and industry: e.g. sending out drafts of new regulations, offering workshops, visiting
- Respond earlier, if possible, to monetary matters such as loan approvals and delivery of money to keep enthusiasm and confidence up

ABSTRACT

Financial Assessment of Costs and Savings from Pollution Prevention Investments: Case Studies and Research

by Terri Goldberg, NEWMOA Pollution Prevention Program Manager

This presentation will describe three projects that are currently underway to review methods of assessing the full costs and savings associated with pollution prevention investments and to develop case studies that evaluate the methods. There are three financial assessment tools that are currently available: EPA's Benefits Manual, a method developed by General Electric, and a computer software package developed by George Beetle. The three projects have been coordinating their review of these tools.

The first project, sponsored by EPA through the Northeast Hazardous Substance Research Center, is designed to develop a training program for state regulatory and technical assistance staff on financial assessment methods for pollution prevention. The Northeast Waste Management Officials' Association (NEWMOA) and the Massachusetts Office of Technical Assistance (OTA) are managing the training project. The project has produced a review of the existing methods and is currently finalizing a number of case studies of Massachusetts firms that have made pollution prevention investments. The second project, sponsored by EPA's American Institute for Pollution Prevention and managed by Robert Pojasek at Geraghty and Miller, is designed to develop a booklet for business on financial assessment methods. The third project, funded by EPA and the state of New Jersey, is being conducted by the Tellus Institute. Tellus is developing case studies that evaluate available financial assessment tools at New Jersey firms and pulp and paper manufacturers nationwide. The presentation will summarize each of these projects and conclude with some observations based on the preliminary results of the case studies.

SESSION 2G

FEDERAL/INTERNATIONAL LEGISLATIVE AGENDAS

Chairperson

Mr. Bob Kerr
Kerr & Associates, Inc.
Reston, Virginia

Speakers

Ms. Kate English
Legislative Director
Office of Congressman Howard Wolpe

Mr. Rick Hind
Legislative Director of the Toxics Campaign, Greenpeace

Mr. Edward Jamro
Environmental Protection Superintendent
Monsanto Indian Orchard Plant
Springfield, Massachusetts

Ms. Fran McPoland
Legislative Assistant, Office of Congressman Esteban Torres

Ms. Joyce Rechtschaffen
Legislative Assistant and Counsel
Office of Senator Joseph Lieberman

Mr. Eric Schaeffer
Special Assistant to the Administrator
U.S. Environmental Protection Agency

Session Abstract

Last fall, Congress passed the Pollution Prevention Act — the first piece of federal legislation designed expressly to promote multi-media pollution prevention by industry. While the Pollution Prevention Act has widespread support, and while almost all parties agree to the need for increased efficiency and better resource and energy conservation to improve both the country's environmental quality and economic performance, there are substantially differing perceptions of what the best future steps should be, and of the appropriate legislative framework for bringing about the necessary changes. The speakers at this session, some of whom are involved in drafting current Congressional proposals, will present varied views on potential future federal legislation, and some concrete experience on implementation of current state programs.

SESSION 3A

FEDERAL GOVERNMENT ROLES

Chairperson

Dr. Allan Hirsch
Vice President, Environmental Sciences
Midwest Research Institute
Falls Church, Virginia

Speakers

Mr. Allan Burman, Administrator, Office of Federal Procurement Policy
Ms. Dinah Bear, General Counsel, CEQ

Mr. John A. E. Hannum
Office of Chief of Naval Operations
The Navy Hazardous Materials Control and Management Program

Mr. Bert Metz, Counselor for Health and Environment, Netherlands Embassy

Session Abstract

This session will explore achievement of pollution prevention and waste minimization within the Federal sector. Topics to be discussed will be EPA's proposed pollution prevention strategy for Federal agencies. The U.S. Navy's program will be described as an example of how one agency is accomplishing pollution prevention. The role of Federal procurement policy will be discussed, as will opportunities for using the Environmental Impact Statement process under NEPA to identify and incorporate preventive measures in plans for major Federal programs and projects. The innovative pollution prevention program of the Netherlands government will be outlined, and within that context, examples of what Dutch agencies are doing to reduce their own wastes will be discussed.

FEDERAL LEADERSHIP IN POLLUTION PREVENTION

Allan Hirsch, Ph.D.
Midwest Research Institute

Prepared for presentation at Global Pollution Prevention '91
April 3-5, 1991; Introduction to panel on Federal Government Roles

At a time when pollution prevention is becoming an important theme of governmental regulatory programs, the Federal government has both the opportunity and the obligation to set an example for the nation. The session this morning will explore how the government is approaching the challenge of minimizing the wastes that result from its vast array of activities and programs.

This morning's speakers will discuss:

1. EPA's Federal Pollution Prevention Strategy. Both the Pollution Prevention Act of 1990 and the EPA Appropriations Act of FY91 direct EPA to address Federal agency activities as part of its efforts in this area. EPA has been working to develop a strategic framework for Federal actions.

2. The role of procurement policy in encouraging waste recycling and reduction. The Federal government is a major, and in some cases the principal, market for many products and materials. Federal procurement policy can send an important message to industry in demonstrating a demand for recovered or less polluting materials.

3. Use of National Environmental Policy Act procedures as a preventive measure. NEPA

requires Federal agencies to undertake comprehensive environmental impact assessments for their major projects and programs. Over the last 20 years, NEPA has become an important vehicle in encouraging agencies to anticipate and prevent environmental impacts associated with their activities. NEPA analysis has great potential for supporting pollution prevention objectives, and can be a particularly valuable tool for use with activities such as natural resource management, which have not traditionally been addressed through Federal environmental regulation.

4. An example of a Federal waste minimization and pollution prevention program. The Navy's program provides a practical example of how an operating Federal agency is proceeding to minimize its wastes.

5. Programs of the Netherlands Government. In keeping with the international theme of the conference, the Netherlands' innovative approaches to waste minimization in their governmental sector will be described.

THE ROLE OF THE NATIONAL ENVIRONMENTAL POLICY ACT IN PROMOTING POLLUTION PREVENTION

Global Pollution Prevention '91 Conference
Washington, D.C.
April 3, 1991

Dinah Bear
General Counsel
Council on Environmental Quality

Introduction

While infrequently characterized as such[1], the National Environmental Policy Act[2] (NEPA) was the nation's first pollution prevention statute. It remains a viable, comprehensive and significant tool for promoting pollution prevention in the federal government, and it provides the philosophical foundation for pollution prevention strategies in the private sector. The purpose of this paper is to discuss the linkage between NEPA and pollution prevention, and to suggest possible ways of furthering this linkage to effectively promote pollution prevention in the federal government.

NEPA: Historical Background - Goals and Policy

It is worth spending a few minutes reflecting on NEPA's origins and its mandate. NEPA was the first of the major environmental statutes passed in the United States as the result of the environmental movement in the late 1960's[3]. The Santa Barbara oil spill, decline in species of wildlife, and

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1. But see, "Using the National Environmental Policy Act to Prevent Pollution" by Steve Ells, Director, Office of Government Relations and Environmental Review in "1990 in Review", New England Regional Office, U.S. Environmental Protection Agency.

2. 42 U.S.C. §§4321-4347.

3. NEPA was passed by Congress in December, 1969, and signed into law by President Nixon on January 1, 1970. It was the President's first official act of the new decade.

dramatically increasing air and water pollution problems led Congressional committees to begin examining possible legislative responses to citizen concerns about the environment. Testimony by numerous witnesses convinced Congressional members that something new and broader was needed, rather than duplication of previous attempts to address single issue problems.[4] Further, the federal government was viewed as both a major cause of environmental problems and an obvious instrument of change.[5]

Congress decided to redintensify its efforts toward environmental protection by articulating a national environmental policy. In so doing, Congress charged the federal government to:

> "use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may -
>
> "(1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
>
> (2) assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings;
>
> (3) attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;

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4. For example, Congress had passed a Federal Water Pollution Control Act in 1948, and an Air Pollution Control Act in 1955.

5. See, "The National Environmental Policy Act", Chapter 2 of the Twentieth Annual Report of the Council on Environmental Quality, 1990, pp. 18-21, for a historical perspective on the passage of NEPA.

(4) preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice;

(5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and

(6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources."[6]

As part of its declaration of national environmental policy, Congress also recognized that:

"each person should enjoy a healthful environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment."[7]

Implementation of NEPA: Identifying and Preventing Problems through the Environmental Impact Assessment Process

To ensure that the goals and policies of NEPA were actually implemented by federal agencies, Congress directed agencies to consider the environmental implication of their actions before making a decision on a proposed federal action. Through preparation of what has become known as the environmental impact statement (EIS), agencies were directed to consider:

1) the environmental impact of the proposed action;

2) any adverse environmental effects which cannot be avoided should the proposal be implemented;

3) alternatives to the proposed action,

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6. 42 U.S.C. §4331(b).

7. 42 U.S.C. §4331(c).

4) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

5) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.[8]

The Council on Environmental Quality (CEQ)[9], was charged under NEPA with oversight of the federal government's compliance with NEPA. CEQ issued guidelines for carrying out the environmental impact statement process in 1970[10], 1971[11], and 1973[12]. In 1978, CEQ issued comprehensive regulations[13], binding on all federal agencies, implementing all procedural provisions of NEPA and subsequent Executive Orders.[14] Those regulations, still in effect virtually intact[15], apply to all agencies and potentially all actions of the executive branch, excluding only

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8. 42 U.S.C. §4332(C).

9. CEQ was created in Title II of NEPA as an agency in the Executive Office of the President. Its primary functions include advising the President on environmental policy, preparing an annual report on the state of the environment, reviewing and apprising federal programs in light of NEPA's Title I policies, analyzing environmental data for identification of trends, and overseeing the environmental impact statement process.

10. 35 Fed. Reg. 7391 (1970).

11. 36 Fed. Reg. 7724 (1971).

12. 38 Fed. Reg. 20550; codified at 40 C.F.R. §1500 (1973).

13. 40 C.F.R. Parts 1500-1508 (1990).

14. Executive Order 11514, as amended by Executive Order 11991 (May 24, 1977).

15. The sole amendment to the CEQ regulations was an amendment to 40 C.F.R. §1502.22, dealing with incomplete or unavailable information in an EIS. 51 Fed. Reg. 15625, April 25, 1986.

the President and his immediate staff[16] and the implementation of the pollution control statutes by the Environmental Protection Agency (EPA)[17].

The premise of NEPA's policy goals, and the clear thrust for implementation of those goals in the federal government through the environmental impact assessment process, is a proactive one: "look before you leap"; evaluate and debate a proposed action before it is taken; avoid, minimize, compensate adverse environmental impacts before action is taken. Indeed, one of the most compelling and constant themes running through the CEQ regulations implementing NEPA and the thousands of NEPA judicial decisions which have been issued since 1970 is the necessity of completing the environmental analysis before a decision is made regarding a proposed action, and the prohibition against taking any action before the completion of the process which would limit the choice of reasonable alternatives.[18] Further, alternatives in an EIS must contain an explanation of how each alternative and

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16. See 40 C.F.R. §1508.12 for the definition of "federal agency" under NEPA.

17. Congress has exempted EPA from NEPA's requirements for certain statutes; see, for example, exemptions in the Federal Water Pollution Control Act (33 U.S.C. §1371). In other instances, EPA has maintained, and the courts have upheld, its use of the "functional equivalence" doctrine to avoid NEPA compliance. The courts have pointed to EPA's primary mission of environmental protection as a rationale for use of the functional equivalence doctrine. See e.g., Environmental Defense Fund v. EPA, 489 F.2d 1247 (1973); Portland Cement Association v. Ruckelshaus, 486 F.2d 375 (1973).

18. 40 C.F.R. §1506.1.

any decision based on it will or will not achieve the goals set forth in Title I of NEPA.[19]

Virtually the entire structure of NEPA compliance was designed by CEQ with the goal of preventing, eliminating or minimizing environmental degradation. In an ideal world, NEPA compliance, thoughtfully and fully implemented, would minimize pollution from federal projects to an extraordinarily low level.

NEPA and Pollution Prevention: A Strong Link Yet to be Forged

Given the fact that NEPA is, by its very nature, a broadly applied statute which seeks to prevent pollution and other environmental degradation, why hasn't more attention been given to NEPA in the recently renewed debate about pollution prevention? Let me suggest several reasons:

. . . . pollution problems have been almost exclusively addressed through single-media command and control statutes, which rest on a different philosophy than either NEPA or pollution prevention.

. . . . NEPA has not been utilized, either as a matter of law or policy, in the administration of EPA's pollution control laws; thus, environmental professionals who work in the pollution field are often simply not familiar or comfortable with the NEPA process (and vice versa). Essentially, quite separate

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19. 40 C.F.R. §1502.2.

professional communities have developed around implementation of NEPA and the pollution laws.

. . . . While implementation of NEPA by federal agencies has contributed to pollution prevention, it has not been the rhetorical rallying cry of NEPA implementation. To some extent, this is a matter of semantics in the type of language different bureaucracies utilize to describe their functions.

. . . . Finally, the judiciary's emphasis on enforcement of NEPA's procedural mandate as opposed to interpretation of NEPA's policy goals has discouraged some in both the federal bureaucracy and in non-governmental environmental organizations from thinking of the environmental impact statement process as a means of achieving substantive results.

Fortunately, the situation is beginning to change. The Bush administration has endorsed pollution prevention as a major goal; indeed, as early as 1989, President Bush observed that:

> "For too long, we've focused on clean-up and penalties after the damage is done. It's time to reorient ourselves using technologies and processes that reduce or prevent pollution -- to stop it before it starts."[20]

In 1990, Congress passed a Pollution Prevention Act.[21]. CEQ published a survey of government and private efforts to begin

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[20]. President George Bush, Remarks to Ducks Unlimited Sixth International Waterfowl Symposium, Crystal City, Virginia, June 8, 1989.

[21]. HR 5834, the Omnibus Budget Reconciliation Act of 1990, Sections 6601, et seq.

implmenting the concept of pollution prevention[22], and EPA established an Office of Pollution Prevention and began work on a pollution prevention strategy. Several federal agencies, notably the Department of Defense, Department of Energy, and the General Services Administration, have begun aggressive pollution prevention programs[23].

At the same time, in numerous conferences and workshops marking NEPA's 20th anniversary, many observers expressed concerns regarding the lack of linkage between NEPA's procedural requirements and the achievement of its substantive goals. The bond between the thrust of the NEPA process and the goal of pollution prevention is particularly timely and compelling. Some possibile ideas include:

. . . . CEQ, working with EPA and other federal agencies, could identify the types of federal actions which ordinarily present the most fruitful opportunities for integration of pollution prevention. Typically, these actions will either involve a federal agency as a generator of pollution (for example, certain federal facility functions), as a significant

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22. <u>See,</u> "Pollution Prevention", Chapter 6 of the Twentieth Annual Report of the Council on Enviornmental Quality, 1990, pp. 215-257.

23. For example, DOD and EPA have agreed to a joint demonstration of a model community concept, in which three facilities in the Chesapeake Bay area -- Langley Air Force Base, Norfolk Naval Base, and Fort Eustis -- will incorporate pollution prevention into all installation activities. The Twenty-First Annual Report of the Council on Environmental Quality, to be published in spring of 1991, will identify several significant agency initiatives in a chapter on "Technology for Pollution Prevention".

purchaser and consumer of goods, or as a formulator of federal policy;

. . . . CEQ could issue guidance to federal agencies, highlighting the identified opportunities for the most feasible integration of pollution prevention techniques into federal decisionmaking through the environmental impact statement process;

. . . . EPA, through the Office of Federal Activities and regional offices, could begin identifying and encouraging comprehensive integration of pollution prevention approaches in their routine review of NEPA documents;

. . . . CEQ, with the assistance of EPA, could issue guidance to federal agencies regarding the use of recycled paper for NEPA documents - true integration of pollution prevention with the NEPA process!

CEQ is convening an interagency process with the support of the White House and EPA to identify and implement opportunities for furthering pollution prevention in the federal government. In that forum, we will be explore the use of NEPA and other mechanisms for promoting pollution prevention. The ideas presented here are only beginning suggestions - further discussion between experts in NEPA and pollution prevention may well yield additional ideas. I welcome your thoughts and suggestions.

SESSION 3B

POLLUTION PREVENTION THROUGH ENERGY EFFICIENCY

Chairperson

Mr. Bruce Cranford
Waste Reduction Program Manager
Waste Materials Management Division
Office of Industrial Technologies, CE-222
United States Department of Energy
Washington, D.C.

Speakers

Dr. Michael Overcash
Director, Department of Chemical Engineering
North Carolina State University
Raleigh, NC

Multi-Industry Pollution Prevention and Energy Evaluations

Mr. Ken Nelson
Dow Chemical
Plaquemine, LA

Reducing Waste and Conserving Energy, Allies or Adversaries

Mr. Al Schroeder
Waste Materials Management Division
Office of Industrial Technologies, CE-222
United States Department of Energy
Washington, DC

Industrial Waste Sources in the USA

Mr. Tom Gross
Director, Office of Waste Reduction
Office of Industrial Technologies, CE-222
United States Department of Energy
Washington, D.C.

The Department of Energy Office of Industrial Technologies, Industrial Waste Reduction Program

Session Abstract

Improvements in energy efficiency impact pollution prevention in a variety of ways. Generally, improved energy efficiency means reductions in pollution. Real world experience indicates this is not always the case. This session will focus on evaluation techniques, what we know and do not know about waste data, and an approach to improving the technology base for pollution prevention.

Reducing Waste *and* Conserving Energy

— allies or adversaries —

Kenneth E. Nelson
U.S. Area Manager, Energy Conservation
Dow Chemical U.S.A.

ABSTRACT

Conserving energy, reducing waste and improving yields often occur simultaneously. In developing projects we normally attempt to quantify savings. In doing so, we must understand the effect these projects have on overall energy consumption and waste production. In this paper, we'll review some basic principles of energy production (to understand the relationship between fuel consumption and power/steam production), and then discuss the various parts of a plant that may be affected by waste reduction, yield improvement and/or energy conservation projects, concentrating on those areas most often overlooked or miscalculated.

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I. ENERGY BASICS

Before getting into the main body of this paper, I want to spend a few pages on some basic energy concepts. All too often, these subjects are not adequately understood, leading plant engineers and managers to erroneous conclusions and poor decisions. We will see that there are various types of Btus and that they are not interchangeable. Analyzing the energy needs of any project or process requires a good understanding of Btu accounting.

Fuel Values

One of the least understood and most confusing aspects of energy conservation is the existence of different types of Btus. The most common fuel for boilers is methane (CH_4), and it is normally purchased on a higher heating value (HHV) basis. Unfortunately, except in unusual circumstances, we do not get HHV from methane, we get only its lower heating value (LHV). Energy is required to vaporize water, and the difference between the HHV and LHV is related to whether H_2O produced during combustion is referenced to the liquid or vapor state.

$$CH_4 + O_2 \longrightarrow CO_2 + H_2O$$

HHV =	23,879 Btu/lb	(water in liquid state at 60°F)
LHV =	21,520 Btu/lb	(water in vapor state at 60°F)
	2,359 Btu/lb	(needed to vaporize water)

We can also use carbon monoxide (CO) as a fuel, but in this case no water is produced. The HHV and the LHV are therefore the same.

$$CO + \tfrac{1}{2}O_2 \longrightarrow CO_2$$

HHV = 4,347 Btu/lb
LHV = 4,347 Btu/lb

If you were buying CO on a HHV basis, however, it would be <u>incorrect</u> to equate the HHV of CO to the HHV of CH_4. CO is actually more valuable (compared to CH_4) than its heating values would indicate.

To value CO or other fuels such as hydrogen (H_2), ethane (C_2H_6), propane (C_3H_8), etc., it is important to put them on a common basis. Because methane is our most common fuel, relating all heats of combustion to the higher heating value of methane makes good sense. This is easily accomplished by multiplying the LHV of a fuel by the ratio of the HHV of CH_4 to the LHV of CH_4. The result is a "methane-equivalent" higher heating value which will be abbreviated as HHV_{ME}.

$$\text{For CO,} \quad HHV_{ME} = (\text{LHV of CO}) \frac{\text{HHV of } CH_4}{\text{LHV of } CH_4} = 4{,}347 \frac{(23{,}879)}{(21{,}530)} = 4{,}821 \text{ Btu/lb}$$

Note that the HHV_{ME} of CO is 10.9% higher than either its LHV or HHV (4,821 vs. 4,347). In Table 1, various LHV, HHV and HHV_{ME} values are listed. When comparing fuel prices ($/MMBtu) and/or fuel consumption (Btu/lb of product), methane equivalent values (HHV_{ME}) should be used to give consistency. Note that fuels such as carbon monoxide, ethane and propane are <u>more</u> valuable than their HHVs would suggest, while hydrogen is <u>less</u> valuable than its HHV.

Compound	LHV Btu/lb	HHV Btu/lb	HHV_{ME} Btu/lb	HHV Difference
Methane	21,520	23,879	23,879	0 %
Carbon Monoxide	4,347	4,347	4,821	+10.9 %
Hydrogen	51,623	61,100	57,282	- 6.2 %
Ethane	20,432	22,320	22,672	+1.6 %
Propane	19,944	21,661	22,130	+2.2 %

Table 1. Comparison of Heating Values

Electricity and Steam

If electricity is being purchased, and steam is made in a package boiler, relating usage to <u>cost</u> is easy, just look at the amount paid for electricity and the amount paid for boiler fuel. Relating use to <u>Btu consumption</u> is also straightforward. Electricity can be considered to be made at 10,000 Btu/KWH (a typical power plant efficiency in the U.S.). The "methane equivalent" higher heating value (HHV_{ME}) of the fuel used to produce steam in a boiler can be allocated to the pounds of steam produced. Note that this is not the <u>enthalpy</u> of the steam. When cogeneration is used to produce electricity and steam, however, distributing Btus requires a greater understanding of the thermodynamics and efficiencies involved.

Cogeneration

In Figure 1, we have a simple cogeneration cycle which includes a boiler, steam turbine and condenser. Steam is being extracted at some intermediate pressure. Allocating fuel use to steam and power is more complex and will not be discussed in detail in this paper. Only the results will be presented. The reader interested in pursuing this subject is directed to two publications:

Forget About Heat Losses, Stop Wasting Work Kenneth E. Nelson Chemical Engineering Magazine McGraw-Hill, Inc. November 23, 1987	Availability (Exergy) Analysis M. V. Sussman (Tufts University) Mulliken House 1361 Massachusetts Ave. Lexington, MA 02155

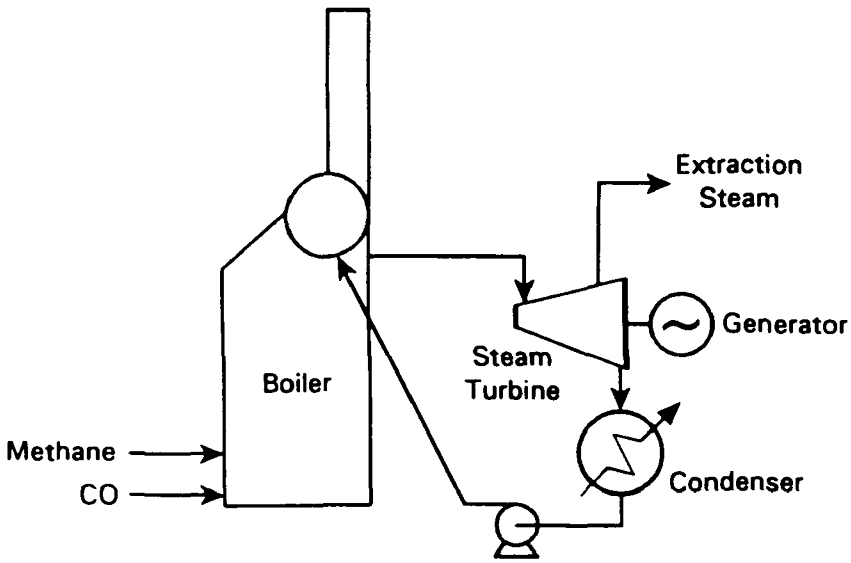

Figure 1. Simple cogeneration cycle

The recommended method uses a thermodynamic function called "available work" to assign a value to steam that can be related back to fuel consumption. The procedure is as follows:

1. Calculate the available work for each level of steam produced:

$$W_{max} = (H - H_o) - T_o(S - S_o)$$

where: W_{max} = Maximum theoretical work available from steam, Btu/lb
H = Enthalpy of steam at actual temperature and pressure, Btu/lb

H_o = Enthalpy of steam at reference temperature, Btu/lb
T_o = Reference temperature, °R (where °R = °F + 460°)
S = Entropy of steam at actual temperature and pressure, Btu/lb°F
S_o = Entropy of steam at reference temperature, Btu/lb°F

2. Convert W_{max} values to equivalent KWHs:

$$W_{KWH} = \frac{W_{max}}{3413 \text{ Btu/KWH}} (0.80)$$

where: W_{KWH} = Practical work achieved from steam through an 80% efficient steam turbine, KWH/lb steam.

3. Allocate fuel, expressed as HHV_{ME}, between steam and power:

Electricity produced = KWH = KWH_1
Steam produced = lb steam (W_{KWH}) = KWH_2

Total equivalent power produced = $KWH_1 + KWH_2 = KWH_T$

$$\text{Fuel allocated to electricity} = (HHV_{ME}) \frac{KWH_1}{KWH_T}$$

$$\text{Fuel allocated to steam} = (HHV_{ME}) \frac{KWH_2}{KWH_T}$$

Dividing the fuel allocated to electricity by KWH_1 gives Btu/KWH. Dividing the fuel allocated to steam by the total pounds of steam gives Btu/lb steam. Applying an appropriate fuel value ($/MMBtu) gives $/KWH and $/lb steam.

Establishing the cost of making power in this manner is extremely important when selling cogenerated power to a utility company or when selling steam to an outside user. Other factors may influence the way in which "book costs" are established, but one should not lose sight of the true thermodynamic costs involved.

II. EVALUATING PROJECTS

Evaluating energy conservation, yield improvement and waste reduction projects is an important function at any plant site. The methods used vary from company to company and from year to year, depending on a variety of factors. In this section, we will discuss some important criteria which should always be considered. There is no "right" way that fits every situation, but the following principles need to be understood.

Cost Books

Throughout the evaluation process, it is important to distinguish between the actual value of installing a project and the way that project will be reflected on the cost books. Rarely are actual and cost book values the same. The main concern should be with the actual cost, which is usually an incremental cost that takes into account all the various changes that must be made to implement a project. It is not unusual to define a project which has an excellent ROI (return on investment), but causes the book costs of a product to increase.

Similarly, projects which look great on the costs books may actually lose money. Avoid a "cost book mentality" when evaluating projects.

Consider entire site

One of the most common mistakes in evaluating energy and waste reduction projects is failing to look at the complete picture. All proposed changes should be related to net "fence line" changes. This is not always straightforward, and decisions must be made concerning, for example, whether incremental or average values will be used. Establishing steam and power values (average or incremental) that reflect actual cost to the site is the first major step.

Next, values should be established for purchased raw materials and for products which flow between plants within the site. These will probably be different than "cost book" numbers, which include a variety of miscellaneous overhead charges. Saving a lb of product, a KWH of electricity or a Btu of fuel gas rarely affects these overhead charges.

Finally, the cost of waste treatment and landfill needs to be determined. It is appropriate to plan for future costs. Putting material in an existing landfill, for example, may not be costly. But what happens once that landfill is full and another needs to be opened (if, indeed, that is possible)? If a new landfill costs $1MM and can hold 10MM lb, it may be desirable to charge (or credit) landfilled material at $0.10/lb or more.

Increase production or reduce raw materials?

Whenever yield improvements are made, a plant has two options:

- Increase production, increasing raw material and energy use
- Keep production constant, decreasing raw material and energy use

Increasing production may carry with it other liabilities such as:

- Additional salesmen to sell the product
- Additional containers, bags, tank cars or tank trucks in which to ship product
- Additional people to produce, analyze or distribute product
- Additional waste to dispose of

These items should be considered individually, together with any other site-specific changes that will be needed. Further, when additional raw materials are required from plants at the site, additional energy and raw materials will be needed by those plants. They will also create increased quantities of waste when running at higher rates. Sometimes, running at excessively high rates produces a disproportionate amount of waste or energy. Existing air or waste permits may also be exceeded.

This is not meant to imply that increasing rates is the wrong thing to do, but the costs and ramifications should be known and evaluated properly.

Similarly, when production is kept the same and less raw materials are used, plants supplying those raw materials use less energy and produce less waste. At complex sites, a computer program may be necessary to determine the full impact of process changes. Such a program need not be highly detailed, but should contain all major variables affecting the decision to do a project.

III. COMMON MISTAKES

Next, we'll look at some common mistakes made in evaluating projects. Most of them are obvious once they are understood, but many are easily overlooked or misinterpreted.

Incremental Profit ≠ Net Profit

When a plant is running at full rate and the opportunity for extra sales arises, many managers automatically choose to "push" the plant to make extra pounds. They assume that the incremental production is profitable, which may or may not be the case. Consider the following example:

A plant was running at its capacity rate of 1MM lb/month, making product at $0.50/lb. Sales of another 100,000 lb/month (a 10% increase) at $0.65/lb became possible, but an inefficient and waste producing unit would need to be put into operation. The plant manager decided in favor of the incremental production, and was very satisfied with his decision at the end of the month when he looked at the following comparison:

	Production lb/month	Production Cost $/lb
Full Rate	1,000,000	0.50
Pushed Rate	1,100,000	0.52

Obviously he made the right decision because costs increased by only $0.02/lb; they were still making $0.13/lb profit. Great move! Or was it?

The question the plant manager should have asked was: How much will it cost to make the additional 100,000 lb/month? Using the above figures, we find the following:

Cost of making 1,000,000 lb/month = 1,000,000 ($0.50) = $500,000
Cost of making 1,100,000 lb/month = 1,100,000 ($0.52) = $572,000

Incremental cost of making 100,000 lb/month = $72,000, or $0.72/lb

Incremental production was selling for $0.65/lb, but cost $0.72/lb to make. They lost $0.07/lb, or $7000 that month! The plant should not have made the extra product.

Pumps: 100 hp ≠ 100 hp

Pumps have nominal hp ratings, but rarely do these ratings reflect the actual power used. A 100 hp pump probably isn't using 100 hp. There are two ways commonly used for determining actual pump hp. The simpler (and less accurate) is to refer to the pump curve. If the pump is large, actual volts, amps and power factor should be measured. The formula for calculating power in a typical three-phase balanced system is:

$$W = \sqrt{3}\, E\, I \cos\theta$$

where:
W = power used, watts*
E = potential, volts
I = current, amps
$\cos\theta$ = power factor

* 1 KW = 1000 watts = 1.34 hp

Many people measure the volts and amps, but fail to measure the power factor. When a pump is running unloaded, the power factor may be as low as 0.6.

Lighting: 100 watts ≠ 100 watts

Although this section may not save you a great deal of money, be aware that ballasts consume electricity. A 40 watt incandescent bulb consumes 40 watts, but a 40 watt fluorescent fixture consumes 40 watts plus an additional 25% (10 watts) in the ballast. Sodium vapor lights consume an additional 15% in the ballast.

Lights that are turned on and off frequently may burn out more quickly, not only increasing maintenance costs (new bulbs plus the labor to install them), but creating waste (burned out bulbs need to be disposed of). Keep track of your actual experience! Fluorescent bulbs last far longer than incandescent bulbs, and the resulting maintainance savings and waste reduction may justify switching.

Another common motivation for changing to more efficient lighting is that it reduces air conditioning costs. Air conditioning systems, however, do not require a Btu of electricity to remove a Btu of heat. Some of the most efficient require only one-tenth of a Btu of electricity to remove a Btu of heat. Also, be aware that more energy will be needed to heat a building when more efficient lighting is installed.

Incineration: Fuel savings ≠ Fuel savings

Waste burners need to be closely examined when evaluating projects which increase or decrease the amount of waste burned. In Figure 2, we have a simple waste incinerator which recovers heat by generating steam in a convection boiler.

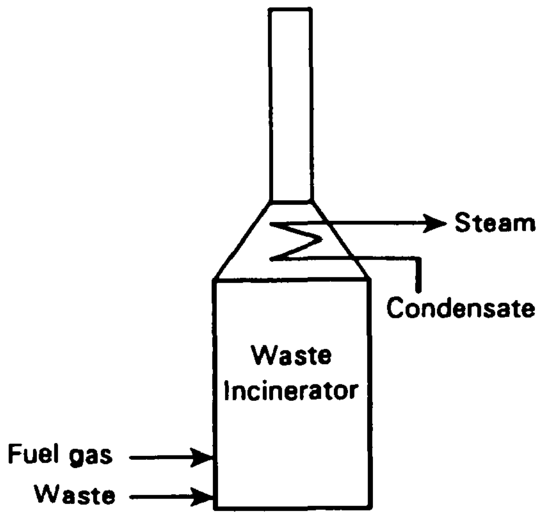

Figure 2. Waste incinerator

If the incinerator is run more efficiently by monitoring CO or O_2 in the stack, less fuel gas is needed (a plus), but less steam is produced (a minus). Both of these changes must be considered in evaluating the economics of increasing fuel efficiency.

Similarly, burning some waste products adds to the heat produced (directly replacing fuel gas), while burning others requires additional fuel (to achieve decomposition temperatures). Either way, the amount of steam is affected.

Burning waste products in existing boilers or furnaces can reduce overall furnace efficiency by affecting other variables. It may:

- Change air/fuel ratio beyond control limits
- Invalidate control logic (e.g. burning H_2 while monitoring stack CO)
- Decrease flame temperature, giving incomplete combustion
- Change radiant and convective heat transfer coefficients beyond those appropriate for the furnace design

Whenever such changes are made, all of these factors should be considered.

Waste Disposal: Treating ≠ Saving

When studying waste streams, we can easily get trapped into the thinking that the answer to a waste problem is always installing some sort of treatment facility. We may choose, for example, to spend millions to build a new waste incinerator, open a new landfill, or expand an existing water treating plant. Such facilities are liabilities. They incur costs. They consume energy. They are non-productive. They usurp valuable human resources.

Whenever possible, a far better approach is to spend capital to reduce or eliminate the production of waste. Not only are the ongoing costs of a treatment facility avoided, long term yield improvements are realized. Before embarking on any waste treatment projects, always consider alternatives that avoid waste generation.

Steam Traps: 100 Btu ≠ 100 Btu

Some steam trap sales representatives add up the Btus heat lost when steam traps blow through. When calculating cost savings, they equate these low level heat Btus to fuel gas Btus. They rarely distinguish between whether high or low pressure steam traps are involved or whether the heat and condensate are recovered.

- A steam trap dumping to the ground wastes low level heat (which is not usually equivalent to Btus of fuel gas) and condensate (which must be replaced).
- A steam trap blowing into an enclosed return system does not lose condensate unless the condensate collection tank is boiling. Virtually all the heat is recovered because hot condensate (which is now even hotter because of blowing traps) is returned to a deaerator. There are losses, but they are small and are associated with heat levels. Our earlier look at valuing steam on an available work basis can be incorporated into a loss analysis.
- Malfunctioning traps can create process problems. A blowing trap on a reboiler, for example, may cause unsteady column control or limit the capacity of the reboiler.

Some manufacturers sell condensate collection systems which use steam pressure rather than a pump to move condensate. The HHV_{ME} fuel gas necessary to move condensate is quite different. From an energy consumption standpoint, pumping is far cheaper, although there may be other reasons for choosing a pressure system.

Furnaces: Thermal efficiency $\neq$ Fuel efficiency

One of the difficulties associated with promoting energy conservation is the lack of understanding about energy levels. Electricity represents the highest energy level normally available. Next is fuel gas or fuel oil, or steam, depending on how that steam is produced. Whether that steam is produced in a boiler or by cogeneration is important. The "thermal efficiency" by which that steam is produced is not important. The key is how much equivalent methane fuel gas (HHV_{ME}) was required. Consider the two systems shown in Figure 3.

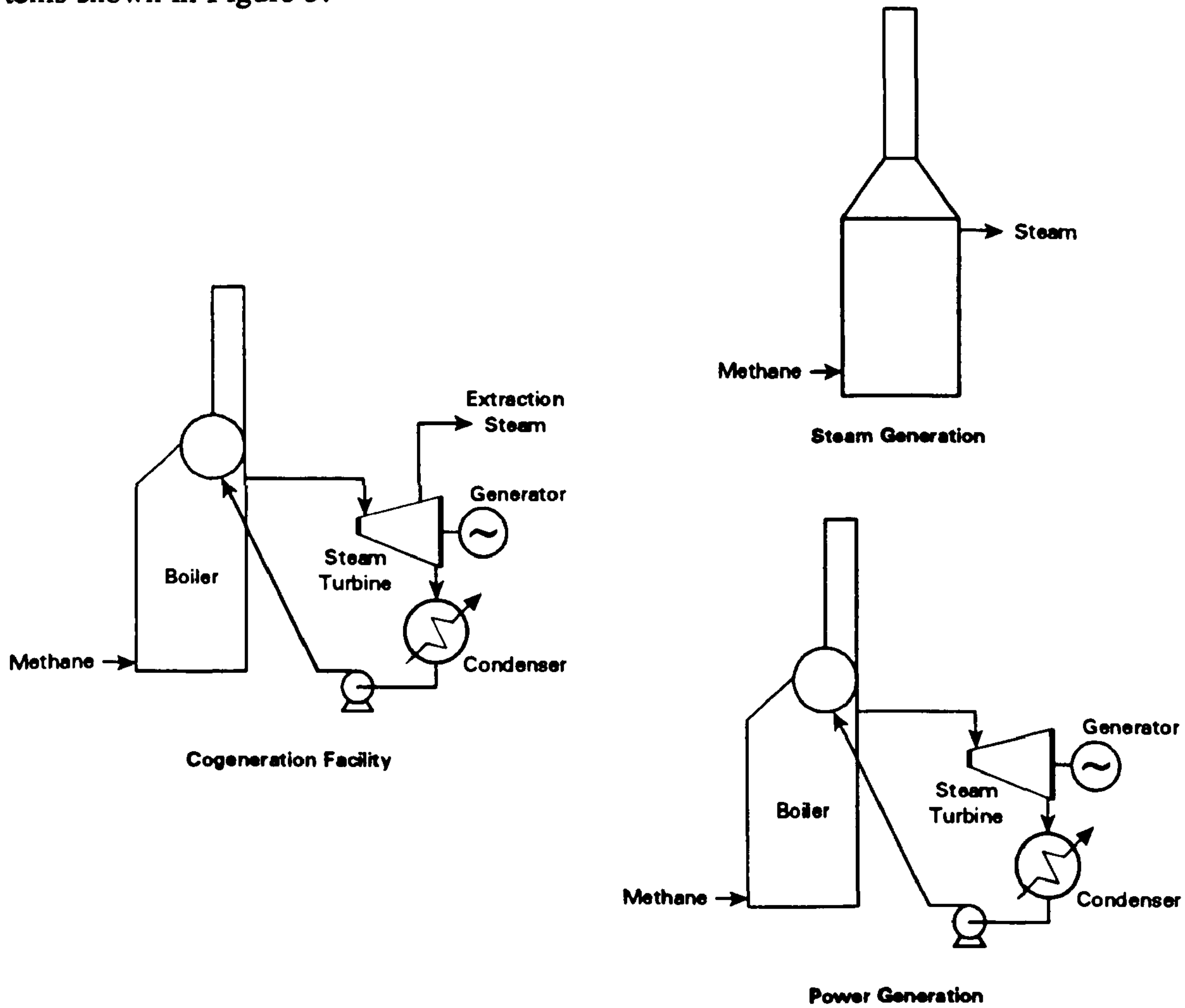

Figure 3. Comparison of Cogeneration with independent power and steam generation

The system on the left is a cogeneration facility where steam and power are produced simultaneously. In the system on the right, power is produced at a local utility company, and steam is produced in the plant using boilers. Even though all of the boilers are and the steam turbines are 80% efficient, the system on the left uses less methane. If a cogeneration cycle using a gas turbine, heat recovery unit and steam turbine were used, even less methane would be needed, and such gas turbine based combined cycles represent the future for cogeneration.

IV. CONCLUSIONS

We have covered a variety of topics in this paper. We have seen the importance of valuing fuel, steam and power correctly. We have discussed the need for determining the true impact of projects, separate from the way those projects will be reflected on the cost books. And we have looked at a number of mistakes commonly made in evaluating projects or situations.

Sometimes reducing waste and conserving energy are allies, working together to reduce plant costs. Sometimes they are adversaries, reducing waste by using additional energy. The biggest challenge we face is thorough, accurate evaluation. Reaching erroneous conclusions is incredibly easy, and far less tolerable today than it was in the past. To succeed in the 90's, we must understand the impact of changes in greater depth and in more detail than ever before. We cannot afford "avoidable errors".

Industrial Resources in the U.S.A.

Mr. Al Shroeder
Waste Materials Management Division
Office of Industrial Technologies, CE-222
United States Department of Energy
Washington, DC

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INDUSTRIAL WASTE SOURCES IN THE USA

Abstract

Waste management data sources are examined which lead up to an estimate of over 10 quad waste potential and a total solid waste estimate of 12 billion dry tons (excluding coal overburden, nuclear) per year. In addition, gaseous wastes add 5 billion tons nationally and liquid wastes 735 billion tons. A priority ranking is presented for 4-digit industry SIC codes based on energy costs, SIC value added, and pollution costs. A process costs systems approach is discussed to define innovation priorities that will reduce energy, pollution, and process costs most effectively. Current OIT estimates for the total waste quantities emitted and disposed nationally are discussed.

INTRODUCTION

This paper examines a different method of looking at waste and energy costs that is based on products produced. First we will introduce some distinctions in waste data sources and then we will put waste costs into the overall context of total social environmental costs. Within this context, overall energy and waste intensities will be used to rank 4-digit industry SIC codes according to the intensity of pollution production, energy use, and value added to find the most likely areas for research to reduce both energy use and pollution.

ENERGY AND ENVIRONMENTAL CONTROL COSTS FOR PRODUCT TYPES

The purpose of investigating energy and pollution costs with respect to product codes is to be better able to target innovative research to maximize the benefit of research expenditures. Processes which are energy inefficient also tend to be material inefficient.

There are several distinctions in the pollution and energy data which are important to distinguish for industrial processes.

- Generated pollution=(Removed pollution-added in removal) +Emitted pollution
- A system approach is needed to look at energy, pollution, and economics, as higher efficiency pollution and energy modifications may lead to reduced economic competitiveness due to higher capital and operating costs.

WASTE MANAGEMENT COST INFORMATION & TONNAGES

Table I lists kinds of cost that are a part of the system defined in controlling pollution, energy, and optimizing the system for making products at the lowest cost.

TABLE I

I. Costs associated with the processing of materials to make products--
   a. Costs due to the use of energy in processing of materials, such as electricity and fuels.

b. Raw feedstock materials invested to make products such as petroleum to make chemicals, coal carbon in iron reduction, gas in ethylene manufacture, and wood in wood products.
c. Costs to make off-specification products which become wastes.
d. Costs sunk to make process wastes.

II. Environmental control costs--
a. Capital costs associated with the building and installation of pollution control equipment.
b. Operating costs for pollution control installations such as maintenance, replacement of equipment, manpower, insurance
c. Energy and materials consumption of pollution control processes

III. Waste disposal costs--
a. Collection cost, including equipment, manpower, operation, insurance
b. Storage and containment costs.
c. Treatment of waste at offsite/onsite facility.
d. Disposal of waste at offsite/onsite facility.
e. Post-disposal remediation, monitoring, landfill maintenance costs.

IV. Costs due to effects of pollution emitted (tons) from making products--
a. Costs due to health effects such as health care costs, more mortality.
b. Costs due to effects on plants, crops, animals and the ecosphere.

In 1990, data was obtained from many sources at DOE/OIT for the purposes of comparing waste quantities in solid, liquid, or gas form; reported energy use; and pollution control costs-all by 4-digit SIC. None of the sources examined really linked up the information into a database. One of OIT's purposes is to be able to estimate tradeoffs among pollution control costs/process energy costs/and pollution quantities on an industry by industry basis. At present this gathered data has 133 reference sources listed. Included in the data are the following:

o NEDS/AIRS EPA data for reported emissions of particulates, SOx, NOx, CO, VOC by 4-digit SIC codes. This data is supplied by the state. 1987 data for SIC 1-99. 42,622,252 tons listed contains 92 mass% of industrial air emissions An additional 8% =3.7 million tons are in small sources.

o HAZMAT data from EPA summed by the reported 4 digit SIC code. Although detailed stream information is available, EPA has summed it for us to get a 4-digit level indication of the BTU's available and the total tonnage. 1985 data SIC 1-99. 533 million tons are listed.

o Toxic waste (TOSCA) information has been summed at the 4-digit level to give an indication of total quantity of waste by 4-digit SIC. Since all toxics are also hazardous, this info will be considered as a subset of HAZMAT data. 1988 data SIC 1-99 4 million tons are listed.

o The National Pollution Discharge Elimination System (NPDES) has monthly reports filed by each of the 2+ million outfalls in the US. Data was collected from the data for each month of 1988 for each of the 9 EPA regions and summed for the qualities of flow, BOD, and Suspended solids. 1988 data SIC 1-99= 735 billion tons are listed as discharged.

o Solid wastes that are nonhazardous had to be accumulated from numerous sources as no EPA database exists that addresses nonhazardous wastes. The primary source is EPA's report to congress on nonhazardous wastes. Multiple sources are used and they are sometimes not in agreement, in which case several references are listed with the "best believable" listed. Data dates vary from mid 1970's for agricultural quantities to 1989 for mining wastes. SIC 1-99 17.9 billion tons are listed.

o CO2 data (2 digit level) is available and soon will be in the data. It has not been determined if a sufficiently detailed analysis of fuel use is available to generate the data at the 3 or 4-digit level. 5.1 billion tons are listed in SIC 1-99 (fuel, process, and electricity use)

o Cost data on pollution control operating and capital expenditures by 4-digit SIC are taken from MA-200(86)-1, Pollution Abatement Costs and Expenditures, *1986* compiled by bureau of the census, covering SIC 20-39. 1986 data. $2.8 billion capital and $12.3 billion operating cast are listed.

o Size of the 4-digit SIC was estimated using the Value Added by Manufacture number from Statistics for Industry Groups and Industries M86(AS)-1 Table 2 column F, and costs of electricity and fuels, Table 4 column A. 1986 data SIC 20-39 with $1035.4 billion value added by manufacture SIC 20-39 are listed.

Energy values in wastes add up to about 15 quads. Discharge tonnages add up to about 752 billion tons total. Data is still being accumulated on SIC 1-19 and SIC 40-99. The data needs work on internal consistency and comparison to data on water use from NPDES vs water use from the 1982 census, "Water Use in Manufacturing" MC82-S-6 and "Water Use in the Mineral industries". Similar statements can be made about gas and solids. Additional errors are present due to industry using the incorrect 4-digit SIC code, and because the SIC code itself is revised by the census periodically, putting some information in question as to what system was used.

<u>A PRIORITY RANKING OF INDUSTRIES AT THE 4-DIGIT SIC LEVEL WAS PERFORMED</u>

Most of the published information on costs by industry are reported at the two, three, or four digit SIC level. At the 4-digit level SIC codes contain dozens of processes, and the data is too imprecise to target research. Generally a given plant has products that fall into several different codes; Plants are tabulated according to the <u>MAJOR</u> SIC code. This is especially true in the chemicals industry, the initial target of our waste reduction / minimization efforts at OIT.

The purpose of this exercise was to get a relative "measure of interest" ranking of the various groupings of industries at the 2-digit, 3-digit, and 4-digit SIC levels for 1986. Only SIC 20-39 data are available. The analysis was performed in LOTUS 123 by entering in the industry value added (column f, table 2 of 1986 ASM report m86-Statistics for Industry Groups and Industries), the SIC codes, and total gross annual pollution control cost(Table 4a from

Current Industrial Reports MA-200(86)-1). Three rankings are then performed on the spreadsheet:

The 4 digit SIC's were ranked three ways:

a. By the value added with highest value= rank 1. (ranking measured the relative size of the industry group)
b. By the quantity of dollars spent on pollution control operations with highest cost= rank 1. (The ranking measured the relative size of pollution problems in the group)
c. By the cost of pollution control divided by the value added times 100 with highest value= rank 1. (The ranking measures the relative size of pollution problem in the group. The measure is the percent of value added spent on pollution control)

Next, an overall rank total (=rank a +rank b +rank c) was done. In the overall rank total the three factors are equally weighted. Also, no particular type of pollution cost is considered more important than any other. The overall rank total was then ranked with the lowest rank being the most important group from OIT's view. Since energy values at the 4-digit level are not available, the energy use factor needs to be considered in looking at this final ranking. Another factor is the number of processes that a given 4-digit SIC represents. From the practical standpoint of trying to work with as few processes as possible with the biggest potential impact, 4-digit grouping with few processes are preferred. The output from this Lotus file is attached with only 4-digit industries. Data has been gathered from Census Bureau publications on energy costs, pollution control costs (operating+capital), and value added at the 4-digit SIC code level. Rankings of the industries are performed with highest rank for highest dollar value. The rationale used is that as DOE we will be most interested for the purposes of waste minimization in industries with the highest pollution control costs, the largest value added and the highest energy costs. The ranks are then added to get a ranksum which was then ranked to give an overall level of interest. The following are the top industries:

2911 petroleum refining
3711 motor vehicles and passenger car bodies
3312 steel works, blast furnaces (including coke ovens), and rolling mills
3714 motor vehicle parts and accessories
2621 paper mills
2869 industrial organic chemicals, not elsewhere classified
3662 radio, television, and telecommunications equipment
2821 plastic materials, synthetic resins, and nonvulcanizable elastomers
2819 industrial inorganic chemicals, not elsewhere classified
2631 paperboard mills
2834 pharmaceutical preparations
3674 semiconductors and related devices
2824 manmade organic fibers, except cellulosic
2865 cyclic organic crudes and intermediates, organic dyes and pigments
2899 chemicals and chemical preparations, not elsewhere classified
2879 pesticides and agricultural chemicals, not elsewhere classified
2851 paints, varnishes, lacquers, enamels, and allied products

At the two digit level, SIC 28 was ranked number 1.

OIT INFORMATION EFFORTS UNDERWAY ON SYSTEM ENERGY/WASTE CONTROL COSTS

In order to define waste management costs at greater resolution, work was undertaken with the Bureau of the Census to allocate pollution and energy dollars spent by product code for the approximately 18,000 responding plant facilities in the pollution abatement cost survey. The pollution survey currently only goes to SIC 20-39. Additional information on energy use and product code flows and values are imported to the pollution control cost data files from the Current Industrial Reports and 1987 Census of Manufactures. Since the Census is unique in that it has availability and access to data on a plant by plant basis, they are the only possible group who can perform the analysis.

The rationale for allocation of pollution control costs by product code includes the following reasons:

A. Product flow data is gathered by the census on a frequent basis. Process data is not gathered at all. Most product codes have few processes responsible to them, so there is good resolution to the picture.

B. From a strictly economic standpoint, a plant site is generally a profit center, with the plant manager responsible for balancing costs with revenues for the operation of the plant. To the greatest extent possible, he is going to recover the pollution and energy costs in the wholesale/retail price of the product. Thus the product revenue streams (product prices times the product flows) can be used to allocate pollution and energy costs.

C. Data can be made available for publication. So long as the data cannot be linked to individual companies (Census nondisclosure laws require this) national summaries can be made of the data.

POTENTIAL INFORMATION EFFORTS ON EMISSION TONNAGES AND COSTS

Currently information on emissions are gathered by the EPA in several databases based on federal and state reporting by industry. EPA maintains a EP- identifier number that is derived from the DUN and BRADSTREET listing for companies. If the DOC Bureau of the Census links up the EP identifier numbers with the Bureau's unique identifier plant code, the pollution emissions can be allocated to product codes in the same way as costs are currently being done. A comparison of cost and tonnage emission data will indicate which emissions are the "cheapest" per ton to control, and which are the most "expensive" per ton to control. Since this control cost data is only gathered for SIC 20-39, only manufacturing can be addressed, even though the pollution emission data is gathered for SIC 1-99.

The data reporting systems for:

1. EPA's AIRS/NEDs (gas emissions such as SO2, NOX, VOC, CO, particulates).
2. EPA's NPDES (National Pollutant Discharge Elimination System reports on flow, BOD, COD, Suspended Solids, and metals).

3.EPA's HAZMAT (Hazardous Materials).
4.EPA's TRI (Toxic Release Inventory).

can thus be linked with products revenue streams, apportioned, and a summarized report prepared. Tonnages of emissions can potentially be linked to a damage per ton estimate. This portion of pollution costs are perhaps the most difficult to estimate.

POTENTIAL INFORMATION EFFORTS ON EMBODIED ENERGY AND ENERGY MATERIAL COSTS.

Every 5 years the manufacturing survey gathers through a survey the cost of energy purchased from all US manufacturing plants. The last survey done was in 1987, and the next will be done in 1992. The energy cost information on these plants will be used in conjunction with production levels to get an apportioned energy cost (specific energy use) at the 7-digit product code level. This estimate of the energy invested in the product can then be compared with specific pollution cost investments at the 7-digit product code level and used to target research towards industry/processes which are pollution and energy intensive. Feedstock energy (both petroleum and wood) uses will be included in the energy cost statistics. Energy generation from non-purchased sources such as waste wood to energy use in the pulp and paper industry are accessible. Coal use in steel-making is another example of a chemical/energy feedstock being used that may not show up as a purchased fuel. The first level of information sought is for dollars spent on energy and pollution control at the product code level. A second level of information is to determine:

1.) Tonnages generated, tonnages controlled, and tonnages emitted to match up to pollution control dollars categories. Tonnage estimates allow one to estimate how much reduction in emissions might result for different pollution control expenditure levels. This needs to be done in the three mediums of solid waste, air pollution, and water pollution.

2.) Breakdowns of the type of energy use (coal, diesel, gasoline, lubricants, natural gas as fuel, natural gas as feedstock, wood as fuel, wood as feedstock etc. as in the MECS survey) to be matched up to total dollar spent for electricity and total dollars spent for fuels. Electricity use generates waste as well as BTU losses at the power plant, and in transmission.

Thus every product code can have associated with it a matrix of values reflecting its embodied energy use and pollution. If material input charts can be constructed, it is possible to make an estimate for the embodied energy and pollution costs in products. For example, in the case of a complicated piece of equipment like an automobile, the actual energy invested at the auto assembly plant will not show the embodied energy invested in making each component. If the materials components are known, embodied energy and pollution costs can be tracked through several stages of manufacture, so that the embodied energy and pollution costs for a waste item going to disposal can be estimated.

POTENTIAL INFORMATION OUTSIDE OF INDUSTRIAL SECTOR

Although some energy use information (total dollars spent only) is available for mining, and agriculture, other sectors of the economy such as construction, transportation, retail, wholesale, services, and government have very poor information on energy and virtually no detailed information on pollution. Based on a summary of emission data, one could conclude that only about 18% of the total cost is addressed in industry (scaling based strictly on tonnages). Total pollution costs for the whole economy are estimated at 85-100 billion per year.

RELATIVE IMPORTANCE

The total volume of annual identified waste is roughly 160 cubic miles of liquid material, 1 cubic mile of solid material and 1000 cubic miles of gaseous material (99.5+% CO_2). From a volume standpoint, gas is the most important. From a mass standpoint, liquids are the most important. From a cost standpoint, solids are the most important.

Energy Efficiency Through Industrial Waste Reduction

Thomas J. Gross
Office of Industrial Technologies
U.S. Department of Energy

Jack Eisenhauer
Energetics, Inc.

The recently published National Energy Strategy specifically recognizes the importance of minimizing industrial wastes. The far-reaching repercussions of our nation's industrial waste situation have made it an appropriate focus of national attention and a priority for coordinated action. The multiple benefits that will accrue to the nation as a result of reducing industrial wastes, and the economic and societal costs of not doing so, have prompted the creation of the U.S. Department of Energy's Industrial Waste Reduction Program (IWRP). The program was established to develop and commercialize, in conjunction with industry, cost-effective waste material reduction technologies and practices that will reduce industrial energy use.

While many environmental and economic benefits will accrue from reducing industrial wastes, DOE's primary interest lies in saving energy -- an important component of industrial wastes. Many companies that generate waste materials are also wasting valuable energy. This energy is embodied in unused or poorly used raw materials, in the energy content of the waste streams, and in the energy required to treat and dispose of wastes.

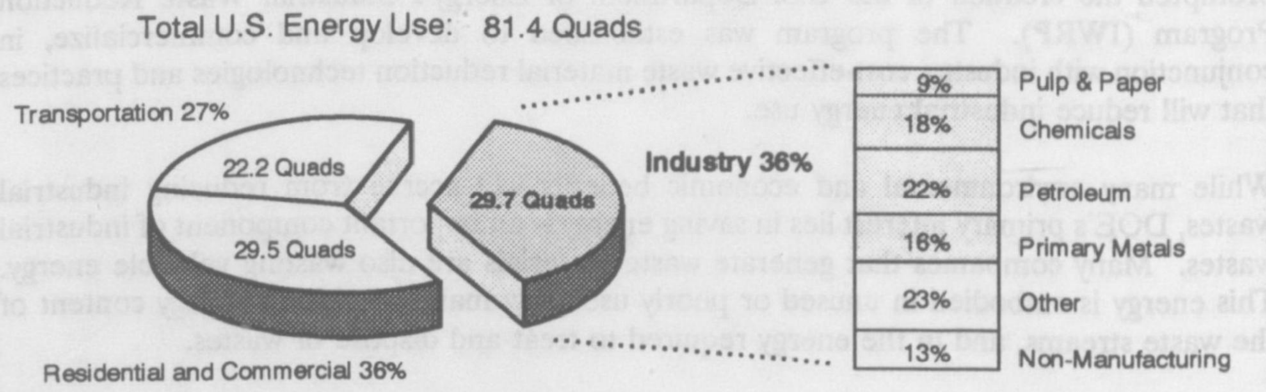
The objectives and activities of pollution prevention and industrial waste reduction are similar; however there are some notable differences in emphasis. The emphasis of ***energy efficiency*** is often on reducing energy use by improving the efficiency of energy-using equipment or improving the efficiency of an energy-consuming process or system. However, this may overlook potentially large energy savings opportunities "embodied" in industrial waste materials. Estimates of the potential energy associated with industrial waste streams, and their treatment and disposal, are as high as 24 quadrillion British thermal units (quads) annually -- roughly equivalent to the direct fuel inputs to industry (Schroeder 1990). Therefore, waste material reduction should be considered as part of an overall energy efficiency strategy.

The emphasis of ***pollution prevention*** is often on avoiding the introduction of hazardous wastes into the environment by eliminating them at their source. Pollution prevention efforts tend to concentrate on waste streams that pose serious threats to human and biological life; non-polluting wastes are a secondary concern. This emphasis may cause important pollution prevention opportunities to be overlooked, such as the "embodied pollution" in non-hazardous waste products that use energy in their manufacture and use. Therefore, energy efficiency, resulting from optimal use of raw materials in manufacturing, should be considered as part of an overall pollution prevention strategy.

Industrial Energy Use and Waste Generation

Industry accounts for about one third of all energy currently used in the United States. In 1989, U.S. industry consumed over 29 quads of primary fuels and feedstocks, at a cost of about $110 billion (EIA 1990a). Over half of all industrial energy use, and approximately 75% of energy use in manufacturing, can be attributed to four industries: chemicals, petroleum and coal products, primary metals, and pulp and paper (Exhibit 1) (EIA 1990b).

Exhibit 1. Industrial Energy Use in 1989 (EIA 1990a, EIA 1990b)



Even with currently foreseen efficiency improvements, the National Energy Strategy projects that U.S. industry will increase its annual energy consumption by over 25% within the next 20 years (DOE 1991a). By 2030, demand for energy could double and energy costs could triple. The need to reduce energy use and waste generation in industry will become more important as energy costs become a larger portion of industrial production costs.

The total U.S. waste stream is huge but there is relatively little reliable data on quantities, reduction opportunities, and costs. Our best estimate at this time is that industry, including agriculture and mining, produces about 12 billion tons of waste each year, 8 billion tons of which is generated by manufacturing industries. While a relatively small percentage of this waste is hazardous, it is the hazardous wastes that incur the highest disposal costs and for which we have the best data. Even for hazardous wastes, most data is reported for wastes emitted after treatment rather than what is generated. Exhibit 2 shows a rough accounting of industrial waste streams compiled from several data sources (EPA 1988, EPA 1986).

Not surprisingly, many of the industries that are large energy users are also major waste producers. Although data is sketchy, the pulp and paper industry is the largest producer of non-hazardous waste, while the chemicals, primary metals, and petroleum and coal products industries are large producers of both hazardous and non-hazardous wastes (Exhibit 3). Furthermore, roughly two-thirds of toxic wastes, a primary target of pollution prevention efforts, are released from three of these industries (chemicals, primary metals, and pulp and paper). The chemicals industry alone accounted for nearly half of all toxic releases in 1988 (EPA 1989).

The cost to industry of handling, cleaning, and disposing of wastes was estimated at about $45 billion in 1989, and total national

Exhibit 2. Estimates of Industrial Waste Streams (EPA 1988, EPA 1986)

Total: 12 Billion Tons

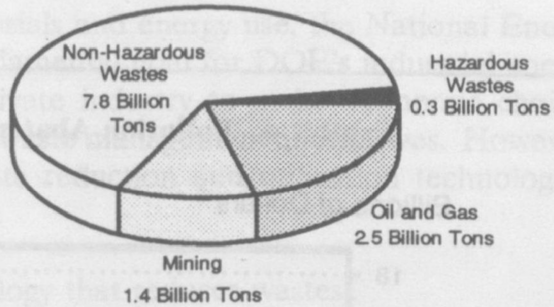
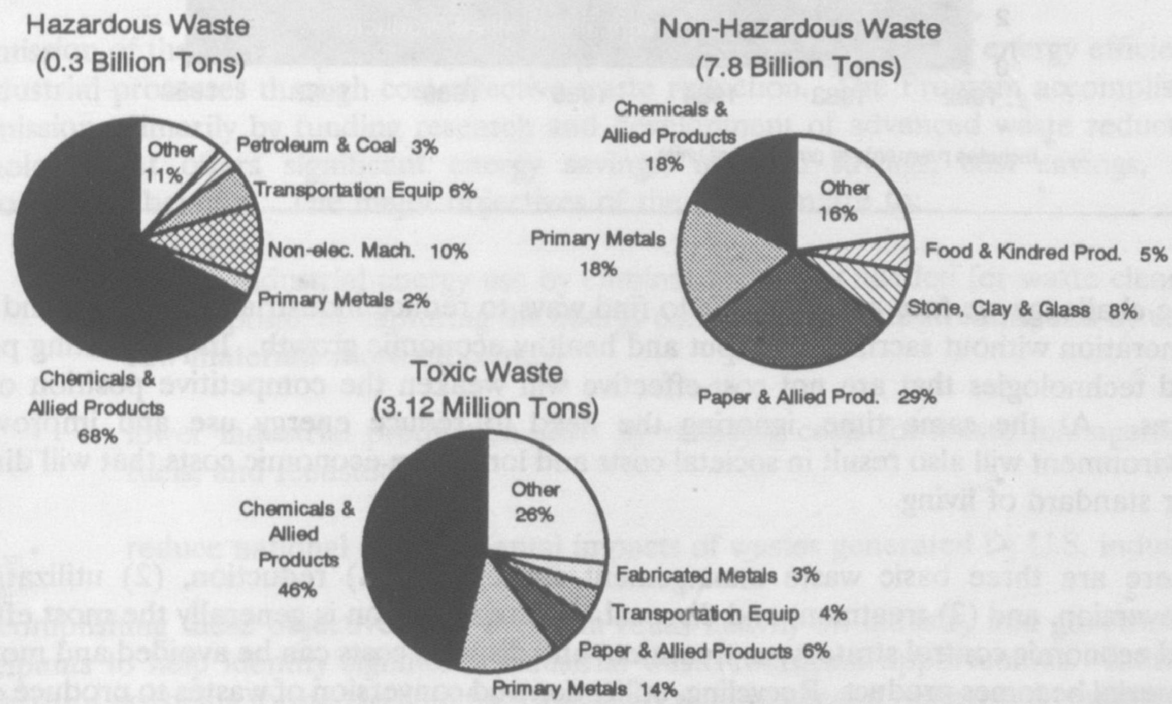
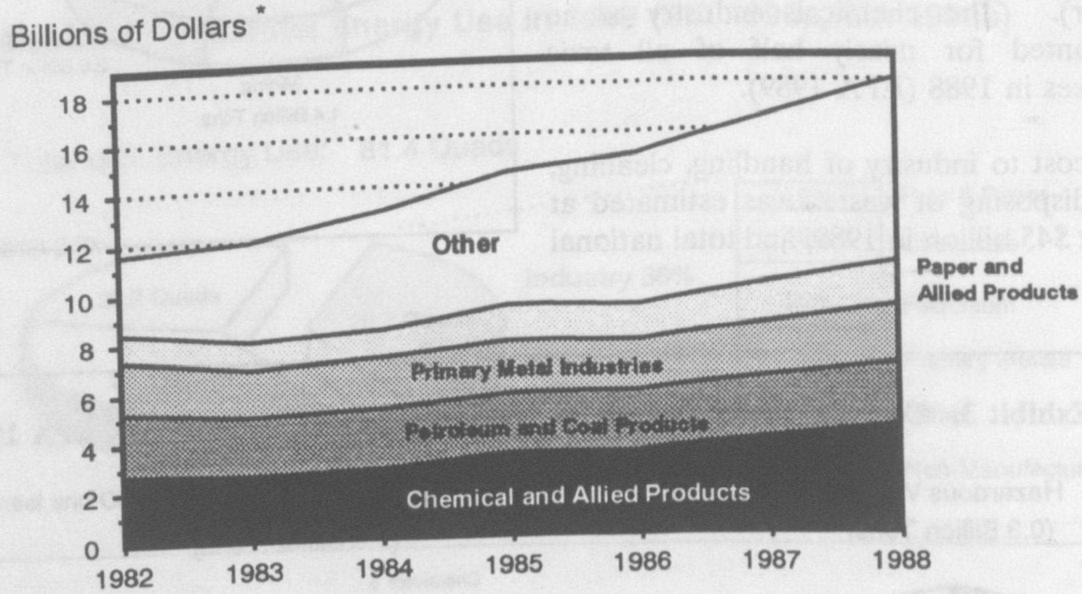


Exhibit 3. Contributors to Industrial Wastes (EPA 1988, EPA 1986, EPA 1989)



environmental spending was estimated at over $80 billion (DOC 1989, DOC 1990). As shown in Exhibit 4, these costs have grown over the past two decades and are projected to increase at least through the year 2000. As one might expect, the four major waste generating industries identified above accounted for about half of all industrial waste costs in 1988. In addition to costs, improper handling of some industrial wastes has desecrated the air, contaminated drinking water, polluted the ground, caused families to relocate, led to numerous liability suits, and has created a public distrust of industry.

Exhibit 4. Pollution Abatement Costs (DOC 1989, DOC 1990)



* Includes payments to government units.

The challenge we face as a nation is to find ways to reduce industrial energy use and waste generation without sacrificing output and healthy economic growth. Implementing policies and technologies that are not cost-effective will weaken the competitive position of U.S. firms. At the same time, ignoring the need to reduce energy use and improve our environment will also result in societal costs and long-term economic costs that will diminish our standard of living.

There are three basic waste management strategies: (1) reduction, (2) utilization or conversion, and (3) treatment and disposal. Waste reduction is generally the most effective and economic control strategy, as treatment and disposal costs can be avoided and more raw material becomes product. Recycling, utilization and conversion of wastes to produce energy or another product is an acceptable alternative, particularly when waste reduction is not practical. In fact, the conversion of a waste to a useful product can create significant economic benefits. The least desirable approach -- and the most widely practiced -- is waste treatment and disposal. As a practical matter, nearly every process will require some waste treatment and disposal.

The Industrial Waste Reduction Program

Recognizing the critical link between waste materials and energy use, the National Energy Strategy establishes waste minimization as a fundamental goal for DOE's industrial energy program. It calls for continued reliance on private industry to make economic choices regarding development and commercialization of waste management alternatives. However, to help overcome the barriers to advanced waste reduction and utilization technologies, several important areas are identified for action:

- R&D on advanced process technology that reduces wastes,
- R&D on waste use and conversion technology,
- Regulatory changes to foster improved waste management, and
- Information and outreach.

To carry out these actions, the Assistant Secretary for Conservation and Renewable Energy has established the Industrial Waste Reduction Program within the Office of Industrial Technologies. The Program works in partnership with industry, trade and professional associations, States, and other Federal agencies to identify and address industrial waste management issues.

The mission of the Industrial Waste Reduction Program is to improve the energy efficiency of industrial processes through cost-effective waste reduction. The Program accomplishes this mission primarily by funding research and development of advanced waste reduction technology that offers significant energy savings, material savings, cost savings, and environmental benefits. The major objectives of the Program are to:

- reduce industrial energy use by eliminating energy needed for waste cleanup and disposal, by capturing the energy contained in waste streams, and by using raw materials more efficiently;

- lower industrial production costs by reducing costs for waste management, fuels, and feedstocks;

- reduce national environmental impacts of wastes generated by U.S. industry.

In accomplishing these objectives, the Program relies heavily on industry and government participants to help identify significant industrial waste reduction opportunities. Industry partnerships are being formed to help fund and carry out the needed research, development, and testing of promising technologies. R&D efforts are complemented by an aggressive outreach and technology transfer effort to ensure the effective use of the developed technologies and to inform industry of existing technologies and practices that provide simple waste management solutions.

The IWRP has identified five basic waste reduction strategies by which industry can eliminate waste streams before they enter the discharge pipe:

- improving "housekeeping" (simple plant maintenance procedures and production practices)
- recycling waste within the industrial process
- redesigning the production process
- feedstock substitution
- redesigning the product to optimize material use

These strategies comprise the fundamental mechanisms through which nearly all waste material reduction occurs. The importance of each of these approaches is recognized by the Program and they have been built into the main elements of the Program.

Program Structure

To meet waste minimization goals set forth in the National Energy Strategy, the Office of Industrial Technologies has designed its Program to take advantage of the most promising waste reduction opportunities in the near-, mid-, and long-terms. To do this, the Program is divided into five fundamental elements:

1) Industrial Waste Characterization (Data Base Development)
2) Opportunity Assessments
3) Technology R&D Projects
4) Technology and Information Transfer
5) Institutional Analysis

Each Program element is designed to work with industry to reduce waste materials in industry and support actions leading to such reductions by overcoming important barriers that currently exist. The five elements are integrated within the Program, and each provides information and results that are needed for other elements.

Industrial Waste Characterization is required to better understand the types and magnitudes of industrial waste streams and the opportunities for reduction. The lack of good comprehensive data on industrial waste will create problems, particularly in the initial stages of the Program. Without reliable data, it is difficult to determine with any confidence the highest priority technology needs. As such, this element provides a valuable input to the Opportunity Assessments.

Opportunity Assessments combine available data, expert advice and analysis to identify the highest priority waste reduction opportunities within industry, consistent with Program objectives. This element supports studies and assessments, in conjunction with industry advisory groups, relevant trade associations and others, to help identify potential R&D projects and other activities most appropriate for Program funding.

Technology R&D Projects form the core of the Program and will account for most of its budget. This element includes diverse R&D activities supported by the Program and conducted by industry, national laboratories, and universities to provide technological solutions for near-, mid-, and long-term applications. Project selection is influenced by the results of continuing Waste Characterization and Opportunity Assessments work and is based on established evaluation criteria.

By nearly every measure, the chemicals industry faces the largest waste management challenge -- and likely the greatest opportunity to cut material use, energy use and production costs. This industry accounts for nearly half of all toxic releases and roughly $4 billion in pollution abatement costs. In addition, it is the fifth largest contributor to value added in products and is a net exporter of goods. As a result, the Program will initially focus on technology R&D that can cut waste generation in the chemicals industry. During the initial stages of the Program, DOE is also seeking to work with major industrial users of chemicals on reducing their wastes. As the Program evolves and Opportunity Assessments are conducted for specific industries, R&D will be targeted at additional industries and waste streams.

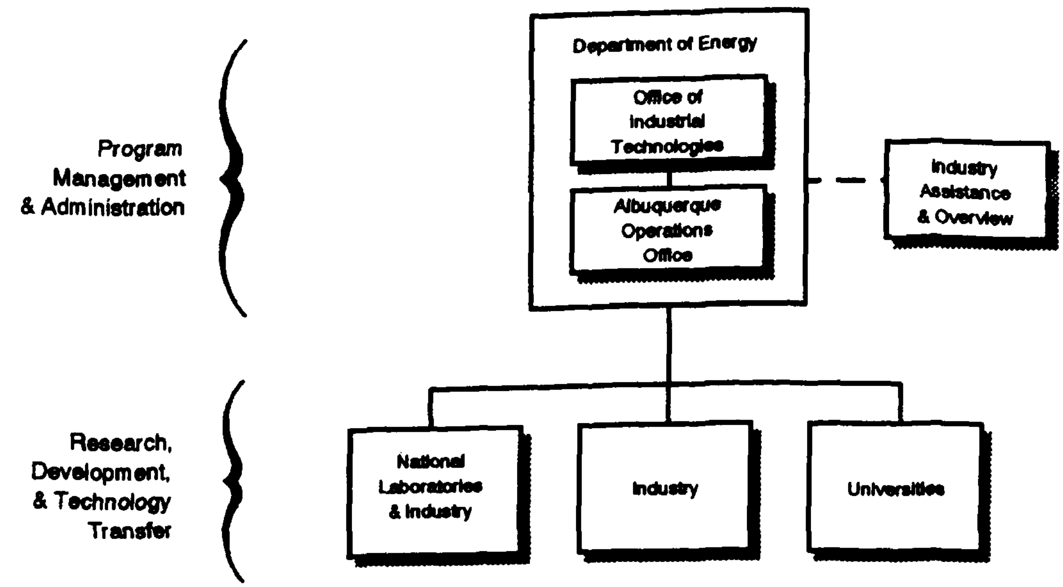
The **Technology and Information Transfer** element is a vital part of the Program. It is integrated with the other IWRP elements, other OIT technology transfer activities and the DOE industrial energy audit program. Many waste reduction solutions involve the adoption of developed and simple changes in production practices; this program element increases the likelihood that such changes will be adopted. Technology transfer is also built into the planning and implementation of all technology R&D.

Institutional Analysis is required to better understand the key factors affecting industrial investment in waste reduction. Studies will be conducted to identify the major non-technical barriers to the adoption of waste reduction practices and technologies. These studies will be conducted in conjunction with industry to determine which factors are the most critical and how the Program can be designed to overcome them. Analysis of financial and structural factors that affect technology adoption may include the cost of capital, macroeconomic factors, firm size, and industry-specific competitive pressures. Analysis of non-financial barriers, which are also important in technology adoption, may include regulatory requirements, liability concerns, propensity to innovate, corporate philosophy, specific market conditions, and product specifications.

Program Management and Coordination

The IWRP will only work if industry is closely involved in all aspects of the planning, R&D and overall implementation of the Program. The Program will use all mechanisms available to it to make this happen. This includes industry and government partnerships, joint

Exhibit 5. Organization of DOE's Industrial Waste Reduction Program

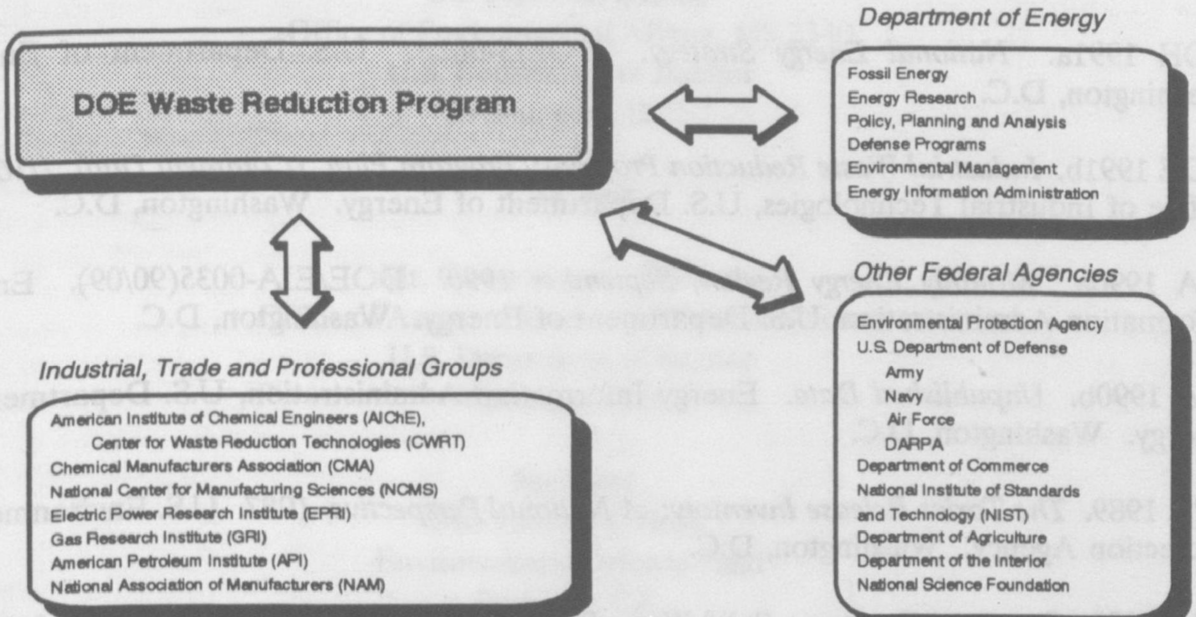


technology development and implementation, and education and information outreach. In addition, the Program draws on expertise from Federal laboratories, academia, and government. Each program function is assigned to the organization best equipped to accomplish the work. The overall structure for implementing the Program is shown in Exhibit 5.

One way for DOE to work more efficiently with industry is through Cooperative Research and Development Agreements (CRDAs), a relatively recent outgrowth of the National Competitiveness Technology Transfer Act. This allows DOE's national laboratories to enter into cooperative agreements with private firms to conduct joint R&D, with appropriate provisions for protection of data and patents. CRDAs engage industry in cooperative R&D that benefits from the scientific and engineering resources of the DOE laboratories, and help to effect the transfer of results to industry. It is also expected that a major portion of the total activity will result from DOE contracting directly with industry for R&D and other work. This will be accomplished in response to solicited and unsolicited proposals.

The objectives and activities of the Program are shared by numerous other organizations and programs, both government and private. The Program will coordinate its activities with other agencies, trade groups, and organizations involved in waste reduction and pollution prevention. In particular, the National Energy Strategy calls for coordination with the Environmental Protection Agency on regulatory reform opportunities and with industry on technology opportunities. Coordination, integration and joint funding of activities will be vitally important as the Program evolves. Exhibit 6 lists some of the organizations with which DOE intends to work closely in carrying out the Program.

Exhibit 6. Selected Organizations with Interests in Industrial Waste Reduction



Industrial Waste Reduction: Good for Industry, Good for the Nation

Industrial waste reduction is an attractive solution to challenges of reducing both industrial energy use and industrial pollution. The National Energy Strategy, as a result of DOE's extensive hearing process and intensive analysis efforts, recognizes the value of industrial waste reduction, utilization and conversion as fundamental components of a comprehensive energy efficiency strategy. Through coordinated efforts with industry and government participants, DOE's Industrial Waste Reduction Program will help the nation face the challenges of industrial waste management through targeted R&D programs, active technology transfer efforts, and a better understanding of industrial waste issues.

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SESSION 3C

POLLUTION PREVENTION IN NATURAL RESOURCES MANAGEMENT

Chairperson

Mr. Jonathan Deason
Office of Environmental Affairs, MS 2340
U.S. Department of Interior
Washington, D.C.

Co-Chair

Ms. Gwendolyn A. Williams
Office of Assistant Secretary, Water & Science
U.S. Department of Interior
Washington, D.C.

Speakers

Mr. Thomas J. Graff
Environmental Defense Fund
Berkeley, CA
Mr. K. C. Bishop
Chevron, USA
San Francisco, CA

Mr. William P. Horn
Birch, Horton, Bittner & Cherot
Washington, D.C.
Ms. Sheila Tooze
Canadian Embassy
Washington, D.C.

Mr. Kenneth K. Tanji
University of California
Department of Land, Air & Water Resources
Davis, CA

Session Abstract

Throughout many parts of the world, we are witnessing a rapidly increasing awareness of the need for pollution prevention and waste minimization as an effective and efficient means of dealing with hazardous waste problems. Although most of the attention in this area focuses on industrial processes and product development, substantial opportunities exist to reduce waste streams from natural resources management activities as well.

Examples include reductions in toxic or hazardous discharges from agricultural operations through more intelligent utilization of pesticides and fertilizers; reductions in waste discharges associated with offshore exploration and development of oil reserves; use of economic incentives to reduce the use or encourage substitutes for chemicals used in a variety of natural plants that need reduced pesticides of fertilizer applications; increases use of natural controls in natural resources management, such as predators or wildlife habitat protection techniques; improved use of the latest technologies for accident prevention, such as backflow prevention in chemigation operations; and education, demonstration and training programs. Such approaches hold much promise for addressing the very difficult problems associated with the release of toxic or hazardous substances from natural resources management operations.

POLLUTION PREVENTION: A COMMITMENT TO ENVIRONMENTAL EXCELLENCE

Presented by K.C. Bishop III
Chevron Corporation
San Francisco, California

Presented to the 1991 Global Pollution Prevention Conference
Washington, D.C.

Chevron Corporation has worked hard to earn our reputation as one of the oil industry's most responsible companies. We are proud of that reputation and accept the challenge to operate in the new era of pollution prevention. Chevron looks forward to opportunities for making our current operations better, for planning new operations to minimize impacts on the environment and finally, for restoring damaged environments.

Chevron is a multinational corporation with major interests in oil production, refining and marketing of gasoline, chemicals, coal, minerals and research. We believe that for our corporation to operate in sensitive natural environments, we must limit the degradation of our world's natural resources. Whether it is operating in an urban area, in the developing world, or the arctic wilderness of Alaska, we look forward to preventing pollution and providing the products and energy for today's modern society.

Pollution Prevention: Emission Reductions

Our corporation has a long established commitment to the "traditional" pollution prevention approach. This traditional approach--namely waste reduction--was fueled at Chevron by economic considerations as well as environmental concern.

In 1986, we began our SMART program. SMART stands for Save Money And Reduce Toxics. Our goal is to have a 65% reduction in land disposal of routine, process related hazardous waste by 1992. By the end of 1989 (the last year we have a complete report), the Chevron Companies had reduced their waste by 60%. Even with these reductions, the cost of hazardous waste has continued to increase. This effort includes source reduction, recycling and alternative treatment options. As we work into the 1990's, the focus is now turning to reducing our nonhazardous waste. This reflects a natural maturing of the program as well as the success of the toxic waste program.

Another natural extension of the SMART program is Chevron's SMART Air program. This program began last year and again reflects the "pollution prevention" philosophy spreading throughout our corporate culture. In the first 9 months of this program, we reduced our EPA--classified toxic air emissions by 9%. A broad range of activities and operating companies contributed to these reductions: Chromium emissions were eliminated from our cooling towers at our Philadelphia and Richmond, California refineries; an extensive inspection and maintenance program reduced methylene chloride emissions by 70% at Chevron Chemical Company Richmond Agricultural Chemical Plant; use reduction and better experimental design helped Chevron Research and Technology Company achieve a 25% reduction in solvent emissions.

Chevron Chemical Company is also a participant in the Chemical Manufacturers Association's Responsible Care Program. Among its other principles, the program commits the members to an "ongoing reduction of wastes and releases, giving preference first to source reduction, second to recycle/reuse, and third to treatment." This entire program pledges the CMA members to manage their business according to 10 Guiding Principals--which are shown in Table I. Other sessions of this Conference focus on this program and, I urge you to attend them and see how an industry's value system can evolve.

Preventing Natural Resource Damage

Chevron successfully conducts oil and gas exploration and production activities in sensitive environments all over the world. In these environments, pollution prevention often means planning a project to have minimal impact on the natural environment. One of the most unique areas is Papua New Guinea. Papua New Guinea has immense expanses of intact tropical rain forests and rich diversity of indigenous cultures.

Chevron has been involved in exploration activities in Papua New Guinea since taking over Gulf Oil's operations there in 1985. Chevron is the operator of the Kutubu Project Joint Venture. In December 1990 the Papua New Guinea government granted licenses for production and pipelines, allowing the Joint Venture to proceed with development and export of oil from the Southern Highlands area.

The Joint Venture has made every effort to protect the rain forest in planning and implementing the Kutubu Project. We have used helicopters to airlift drilling field equipment and supplies from the outlying base camp across the jungle to drill sites. This method limits the impact of exploration work to clearing small isolated areas in the forest and minimizes the construction of roads.

We have also decided to bury the entire 107 mile onshore export pipeline. As a result, the amount of rain forest cleared will be less than 20% of that cleared for construction of an aboveground pipeline. Further, less than one-half of the area cleared during pipeline construction will remain cleared during operation.

Other environmental protection measures included:

- minimizing the amount of roads needed for the production phase;
- preparing waste management plans (including source reduction); and
- prohibiting hunting or disturbance of native animals, birds and plants.

When Chevron drilled an exploratory well near the Arctic National Wildlife Refuge (ANWR), we again demonstrated our commitment to minimizing disruption of the natural resources. All evidence of our activities should be gone after only three years. Extensive precautions were taken to contain all wastes, protect the tundra and to minimize any disruption of wildlife. If ANWR is opened, we'll use this same commitment to minimize the impacts just like Papau New Guinea and our other operations in sensitive environments around the world.

Closer to home, Chevron used both source reduction and treatment to allow extremely sensitive rainbow trout to live in our undiluted wastewater effluent at the Richmond Refinery. This was a major effort. It wasn't easy. It wasn't cheap. And it wasn't clear that it could even be done. All potential contaminants had to be controlled--not just listed toxics. But Chevron, today, has trout living in our effluent--I might add, these trout are right in the refinery cafeteria for everyone to see. That doesn't mean we have completed reducing our emissions. We are still looking for more opportunities and continue to make improvements. Moreover, we are also cutting back on our fresh water use to do what we can during the current drought California. So far, we've reduced freshwater use by 3 million gallons per day, and we're still looking for more ways to conserve.

In 1988, Chevron's coal company, Pittsburgh and Midway Coal Mining Company, donated water rights to protect the Gunnison River. David Harrison, Chairman of the Nature Conservancy said this donation is perhaps "the first major private dedication of water rights in the western U.S. to keep water flowing instead of diverting its use for hydroelectric power, agriculture or industry." The Gunnison River is a premier trout stream that flows through the Black Canyon of the Gunnison National Monument. The gift will ensure that the rivers flow will be strong enough to continuously support populations of fish and other wildlife, including the endangered river otter.

At our El Segundo, California refinery, we have another endangered species, the El Segundo Blue Butterfly. In 1982, activities were initiated to arrest the declining numbers of these species through habitat restoration. The decline had been found to be related to loss of habitat from urban encroachment and increasing abundance of weeds.

When constructing a pipeline from Rangely, Colorado, to Vernal, Utah, Chevron recognized that a construction project of this magnitude would affect sage grouse habitat and possibly disrupt the birds' unique social behavior. Chevron hired biologists and ornithologists from Brigham Young University; they were joined by representatives from Wyoming Fish and Game Department and the U.S. Bureau of Land Management. The group studied the birds and habitat; located nests; and, completed a plan to cause as little disruption as possible. The result was a carefully planned and timed pipeline construction. Red flags were placed to designate the mating and nesting areas. When work along the pipeline reached a red flag area, the entire operation--400 workers and tons of equipment--moved away. At the end of the nesting season, after the birds had moved away, crews returned and completed the pipeline.

Restoration: Making Things Better

As discussed previously, pollution prevention means reducing emissions or avoiding degradation of our natural resources. However, at Chevron, we have looked for opportunities to do more than avoid problems. We are looking for chances to improve the environment--either through creation of needed habitat or through restoration of habitat previously degraded through man's activities.

Chevron has supported the National Research Council's effort to identify restoration techniques that work in aquatic habitats--riparian habitat, wetlands, etc. Restoration "science" is needed to correct past mistakes and to recognize what works and what doesn't. This report--by some of the best scientists in the U.S.--should be out by the end of the year.

An unusual example of recycling and environmental improvement stemmed from Chevron's early efforts to prevent underground pollution. Before there were requirements, Chevron realized that underground gasoline storage tanks could leak. Chevron, U.S.A. began our "TIP" or Tank Integrity Program. This program identifies, tests and then replaces old metal tanks with fiberglass tanks which do not corrode. However, there was the question of what to do with old metal tanks. In 1983, a Chevron employee suggested using them to create artificial reefs. As many people are aware, the coral reef formations, of central Florida, have been severely depleted. These reefs are home to a vast variety of marine life and small fish who, in turn, are vital to the growth and survival of larger game and commercial fish. Attempts to create artificial reefs from old tires had been largely ineffective. Working with environmental and local government groups, Chevron developed a program to utilize the old tanks. Chevron selected 160 of the "car-sized" tanks, cut open the ends (to give fish access) and sand blasted them clean. The tanks were then barged out to sea and lowered into five locations--each about 2-3 miles off shore and in approximately 60 to 170 feet of water. These Chevron reefs and others like them are now quickly accumulating a covering of sponge, coral and algae. Bait fish are gathering to next and spawn--and attracting larger fish. They are providing ideal feeding spots and shelter from predators and the strong Gulf Stream current.

At our Pascagonla, Mississippi Refinery, Chevron worked with state and federal agencies to construct a 25 acre tidewater marsh adjacent to a nearby estuary. The new marsh was excavated from a planted pine forest and natural vegetation introduced. Salt water marshes are among the most productive natural ecosystems known. This provides the habitat a variety of migratory and waterbirds, furbearers and reptiles; serves as a nursery and feeding ground for finfish and shellfish, which are harvested commercially in nearby waters. It also serves to buffer adjacent uplands from storm damage. What had once been a few isolated pockets of mostly inadvertently created wetlands with a heavy industrial environment is now a successful sanctuary for fish and wildlife.

Chevron doesn't only look for opportunities in or around our plants. After the devastating forest fires in California in 1988, Chevron employees assisted with the very real job of erosion control and reforestation. In Yosemite, Chevron has embarked on a two year program with the park service to remove asphalt and invasive vegetation and to re-plant the native oak habitat. On these occasions, over 100 Chevron employees, broken into ten-person teams, camp for the weekend and basically work from dawn to dusk. We've had to resort to a lottery to see who could go--the demand was so positive.

The Future

These successes are not the whole story. Chevron was a leader in developing the industry standard for accident prevention, in establishing the Marine Oil Spill Response Corporation and in searching for energy conservation opportunities. More recently we introduced our new supreme unleaded which we believe is superior to any other gasoline on the market in reducing automotive pollution. These efforts and others like them will continue.

Pollution prevention is the future. The philosophy means more than reducing emissions and avoiding degradation. It is a business philosophy that allows us to provide the products society demands but at the same time looking for ways to protect our natural resources. This philosophy is founded on strategic environmental thinking, acknowledging society's environmental agenda and controlling sources of pollution. Chevron is striving to integrate environmental issues into out business decision-making process. Our decisions must and will continue to make economic sense, but they must also make social, political and environmental sense.

> "Establishing a higher level of commitment to environmental problem solving throughout the company, I'm convinced, will minimize Chevron's exposure to regulatory burdens, increase our credibility with the public and give us a profitability edge over our competitors."
>
> K.T. Derr
> Chairman of the Board
> Chevron Corporation

Responsible Care:®
A Public Commitment

GUIDING PRINCIPLES

Member companies of the Chemical Manufacturers Association are committed to support a continuing effort to improve the industry's responsible management of chemicals. They pledge to manage their businesses according to these principles:

- To recognize and respond to community concerns about chemicals and our operations.
- To develop and produce chemicals that can be manufactured, transported, used and disposed of safely.
- To make health, safety and environmental considerations a priority in our planning for all existing and new products and processes.
- To report promptly to officials, employees, customers and the public, information on chemical-related health or environmental hazards and to recommend protective measures.
- To counsel customers on the safe use, transportation and disposal of chemical products.
- To operate our plants and facilities in a manner that protects the environment and the health and safety of our employees and the public.
- To extend knowledge by conducting or supporting research on the health, safety and environmental effects of our products, processes and waste materials.
- To work with others to resolve problems created by past handling and disposal of hazardous substances.
- To participate with government and others in creating responsible laws, regulations and standards to safeguard the community, workplace and environment.
- To promote the principles and practices of Responsible Care by sharing experiences and offering assistance to others who produce, handle, use, transport or dispose of chemicals.

April 1990

recycled paper

PRESENTATION TO GLOBAL POLLUTION PREVENTION '91 CONFERENCE AND EXHIBITION

By
William P. Horn

The principles of pollution control and abatement began to change in the 1980's. A greater awareness arose regarding the possibilities of harnessing or exploiting market forces to further environmental objectives. It became apparent that government had effective environmental conservation tools other than its traditional coercive powers.

It is a well accepted doctrine that pollution, in its myriad forms, can create major social costs. This has been the philosophic underpinning of the law of public nuisance enunciated over a century ago. That is, he who causes a public nuisance must pay its costs. However, development of efficient and equitable means determining of recovering those costs has been difficult. Methodologies to precisely calculate the external costs of pollution are the subject of heated debate and many contemporaries argue that these costs are a small price to pay for the public and private benefits generated by certain activities that pollute. Public policy has tended to avoid the issue of assignment of tangible costs and focus instead on proscribing, or prescribing, certain types of activities and behavior. It is interesting to note that our courts also shied from this field. Many environmental lawyers of the late 60's and early 70's were sorely disappointed by the failure of public nuisance doctrine to ripen into an effective anti-pollution weapon.

The result was an array of Federal environmental programs that focused on prescribing behavior through the exercise of regulatory power. Little attention was directed at assigning costs and addressing internal factors that led companies and individuals to engage in polluting activity. This regulatory scheme was one way of combating the externalized social costs of environmental degradation. It dominated the 1970's and typifies the alphabet soup of measures administered by the U.S. Environmental Protection Agency (EPA).

Dissatisfaction with this kind of program grew and contributed in some measure to President Reagan's election on a platform that argued for a cutback in the Federal regulatory role. Part of the critique of these programs was -- and is -- that the regulations lend themselves to political gamesmanship; that in every system, there is a way to surmount or circumvent it. Washington, D.C., is full of people, available for hire, skilled in this "gamesmanship." Regulatory grams are also coercive no matter how beneficial. The long arm of the government in a large nation will sometimes be less than sensitive and understanding. A popular backlash seems to follow many of the environmental programs because ultimately people do not like to be told "no" by their government.

It has long been recognized that forcing entities and individuals to bear directly the overall environmental costs of their activities would effectively stop an array of environmentally damaging activities. Internalizing these traditionally externalized costs and putting them on the balance sheet could do more to stop environmentally adverse activities than reams of Federal Registers and armies of enforcement personnel. The bottom line -- the effort to contain costs and maximize profit -- could become one of the environment's staunchest allies.

Two 1980's era programs demonstrate the success of the concept. Neither program addresses a pollution issue per se in terms of effluents or emissions -- each involves land use and conservation. However, the principles appear readily applicable to more traditional pollution matters.

The first was the Coastal Barriers Act enacted in 1982. Development of coastal barrier islands -- thin ribbons of sand like Cape Hatteras -- had been checked for decades by costs. Insurance was often unavailable or exorbitantly priced in these storm prone areas. One built at risk and suffered the losses when Mother Nature served up a hurricane. Uncle Sam changed the rules in the early 1960's when taxpayer supported (i.e., subsidized) Federal flood insurance was extended to coastal barriers. A building explosion followed and with every coastal storm the taxpayers paid the insurance bill that supported a new round of construction.

The 1982 Act was designed to ensure that this cycle would not affect undeveloped barriers. It set out a simple rule: Federal flood insurance would be unavailable for construction within designated areas. Landowners were free to develop their property within the areas -- the law imposed no new regulatory limitations. It simply withdrew the Federal financial subsidy and made developers bear the costs (and risks) of development. The withdrawal of this Federal "carrot" had an enormous positive impact on land conservation along the Atlantic and Gulf Coasts. Taxpayers are no longer underwriting coastal development and such activity has diminished.

Congress and the Reagan Administration decided to try a second experiment -- the "swampbuster" provisions of the 1985 Farm bill. Again the program relied on the withdrawal of a Federal carrot rather than the imposition of new regulatory restraints. Farmers who drained wetlands and converted them to croplands would be ineligible for agricultural benefits (e.g., price supports). Farmers were completely free to engage in such conversions but would not continue to be the beneficiaries of Federal assistance. The loss of financial support -- the internalized cost consequence of wetlands conversion -- induced most farmers to cease the practice. The program has been an enormous success and aided wetlands conservation efforts.

New efforts to internalize pollution costs are part of 1990's major Clean Air Act Amendments. Twenty years of "simple" regulation was not up to the task of controlling SO_2 emissions. It remains to be seen if the market/cost features of the new Acid Rain package do any better. I believe they will.

It remains to be seen whether the principle of internalizing costs will continue to be employed in the field of environmental regulation. I am persuaded that this approach will become widely adopted as it has two very attractive features: first, it is demonstrably effective and makes the corporate bottom line an environmental ally; second, it is effective without resort to coercive regulatory programs that rely on legions of Federal enforcers -- properly structured the programs have automatic pilot features, or should I say hidden hand, that keep them on course.

The Green Plan Pollution Prevention Initiative For The Great Lakes Ecosystem

Presented to the
Natural Resources Session

Global Pollution Prevention '91
Washington, D.C., U.S.A.
April 1991

Presented By:
Sheila Tooze
Environmental Affairs Officer
Canadian Embassy

Written By:
Kevin G. Mercer
Environment Canada

Abstract

The focus of this paper will be to discuss the Government of Canada's Green Plan initiative for Pollution Prevention in the Great Lakes and St. Lawrence Ecosystems. The paper emphasises that pollution prevention is the logical extension of the movement toward environmentally sustainable development begun with the report of the Bruntland Commission and the subsequent call by Canadians for a more environmentally responsible agenda from government.

The paper also emphasises that pollution prevention is not the exclusive realm of either "environmental engineers" or the "radical fringe" environmental interest groups but a multi-sectoral social, technical and policy issue.

The focus of the Pollution Prevention Initiative is that for too long we have considered pollution a cost-of-production for any particular sector rather than a cost to all society. We have also seen how there are no "safe" limits for the release of persistent toxic substances, regardless of how they may be diluted with clean water. Both Canada and the United States have committed themselves to the goal of virtual elimination of persistent toxic substances. This goal has also become the policy focus and cause for action by ENGOs and businesses. The facts are unrefutable. Persistent toxic substances are no longer acceptable in any concentration. We are now acknowledging that there is no more right-to-pollute and that liability for pollution is both a sectoral and societal responsibility.

To address these concerns, the federal government's Green Plan pollution prevention initiative focuses its efforts on a multi-sectoral round-table approach within which sectoral initiatives are designed to meet the objectives for the larger goals of virtual elimination of both point and non-point sources of persistent and non-persistent toxic substances.

CRISIS OR OPPORTUNITY - POLLUTION PREVENTION IN THE GREAT LAKES?

Unlike the other participants in this seminar, I will not limit myself to discussing the role of pollution prevention in natural resource development. Instead, it is fortunate that, on March 5, the Minister of Environment, the Honourable Robert de Cotret, announced Canada's pollution prevention initiative for the Great Lakes - St. Lawrence.[1] In my comments that follow, I will briefly sketch an outline of the long road that the federal government has followed as it has moved from the remedially oriented Great Lakes Action Plan to the Pollution Prevention Initiative in its quest for a workable solution to problems plaguing the Great Lakes.

In 1990, the Institute for Research on Public Policy and the Conservation Foundation published Great Lakes-Great Legacy? a call to action on the problems facing the Great Lakes. They wrote, "What is needed to rescue the Great Lakes region from its continuing environmental decline is the will to act and the discipline to take a long-term perspective."[2]

In late February 91, the Canadian Institute for Environmental Law and Policy and the U.S. National Wildlife Federation published a summary report of their three year study on water quality in the Great Lakes. A Prescription for Healthy Great Lakes calls for Canada and the United States to immediately implement the zero discharge conditions of the Great Lakes Water Quality Agreement by banning, sunsetting and reducing certain toxic chemicals. If this is undertaken immediately, they add, it will still be thirty years for the measures to ensure a return to a healthy ecosystem.

Until the 1970s, it seemed we took for granted the health and continuing prosperity of the Great Lakes ecosystem. It provided our industries and municipalities with water, transportation and the disposal of waste; provided leisure and supported a major tourism industry; and through it all, it was expected to fulfil its role as a natural habitat, complete with healthy waterfowl and fish populations. Fortunately, we have not ignored the warnings of increasing waterfowl mortality rates and dwindling populations resulting from pesticide bio-accumulation. We have addressed the eutrophication of Lake Erie and have cut back on phosphorus emissions. Still, baby cormorants with crossed bills illustrate that more needs to be accomplished. We have fish populations riddled with tumours and lesions from exposure to toxic substances in the waters. Unfortunately birds cannot live on pasta and wine and the fish have no choice but to live where we flush our wastes.

Whether by wilful negligence or through unfortunate circumstances of ignorance, we have degraded the Great Lakes ecosystem and now must bear responsibility for the actions required to halt and reverse its decline.

Yet despite the toxic burden, the Great Lakes Basin still fosters life for many major ecological, social and economic communities. In some cases we have fought back pollution and have reclaimed some past losses. Most important, through it all, we have developed an understanding that the integrity of each lake, each species, and indeed our own population, is dependent upon the continued good health of the whole ecosystem.

For human populations, the Great Lakes ecosystem is a giant water catchment basin covering an area of 767,000 km.[2] which collects and holds 21% of the world's fresh water. Unfortunately, in the face of plenty we are wantonly wasteful and sometimes shockingly negligent when it comes to caring for the water resource. Its rainfall is contaminated with acid or other emissions sometimes from many thousands of miles away. Its tributaries, groundwater and run-off may be contaminated with rural or industrial point and non-point source toxic discharge from automotive manufacturing, petroleum refining and steel in the southern lakes, to pulp and paper and mining and smelting further north.

In addition to the toxic loading of these industries, the approximately 35 million humans (1/8th of the total population of Canada and the United States) living in the basin contribute sewage and other waste. 1/3rd of all Canadians and 1/7th of all U.S. residents depend on the Great Lakes for their water. Combined Canada-U.S. water usage for various purposes is 655 billion gallons or about 2.5 trillion litres/day.[4,5]

Once used, or even before coming in contact with the Great Lakes, this water (whether rainfall, run-off or discharged) can become contaminated with heavy metals, organic and inorganic chemicals and various nutrients and pesticides many of which settle in the basin waters and sediment. Complicating this toxic loading is the fact that despite having a massive flow of 22,000km^3, only 1% of lake volume is outflow.[6] Once persistent toxic substances find their way into the lakes, they are not flushed out or diluted and bio-accumulate and bio-magnify throughout the food chain.

Yet, despite our concerns about Lakes' degradation and our loss of their use in several areas, we the inhabitants of the basin, tend to under-estimate how much we are responsible for the toxic load that includes agricultural chemicals, household cleansers, landfill leachate, industrial discharges and air emission fallout.

Furthermore, there are many stakeholders in the Great Lakes basin with diverse interests ranging all the way from water quality, lake levels, transportation, shoreline erosion and flooding, diversions and consumptive uses, wetlands preservation, alien species, waterfront revitalisation, toxic substances loading, to recreation and tourism. Add to this the complex mix of jurisdictions: eight states, two provinces and two federal governments as well as numerous municipal and regional governments.

The lakes themselves contstitute an important economic force in the region. They facilitate transportation, energy generation, manufacturing and processing. As an inland water transport route, an average of 40 million metric tonnes of cargo is moved through the Seaway on some 5,000 vessels. There is an estimated $46 million Canadian commercial fishery on the Great Lakes and a larger sport fishery. A great deal of the $8.8 billion and 402,000 person years of work that tourism contributed to the Ontario economy in 1986 alone come as a direct result of the Great Lakes. Each one of these industrial, municipal and recreational uses adds pollutants.

Arrayed against the forces degrading the integrity of the lakes' ecosystem is our scientific knowledge of the biological and chemical make-up of the lakes. In March, Environment Canada, released a comprehensive report[7] on the implications of toxic chemicals in the Great Lakes. Accompanying this growing scientific understanding is a consensus from grass roots community organisations to the executive suites of government and business that acknowledge the importance of putting ecology on an equal footing with economy. This is where the notion of environmentally sustainable development has become one of the new watchwords for policy planners and decision-makers.

SUSTAINABLE DEVELOPMENT

Support for the concept of sustainable development has grown since it was first used by the World Commission on Environment and Development in 1987. The federal government pledged its support for sustainable development by creating the National Task Force on Environment and Economy, a policy that was emulated by every province and which has begun to be accepted by the business community. Sustainable development is considered development which ensures that the utilisation of resources and the environment today does not damage prospects for their use by future generations.

However, when it comes to the Great Lakes ecosystem, we are in a deficit position. For too long we have failed to properly account for the cost of our use of the lakes, and the severe damage inflicted by uncompromised growth. An analogy might be that it is time to stop borrowing on an institution that has little left to give and to pay back our debt.

Pollution prevention is the most effective means of returning to the balance of a healthy ecosystem. One in which we do not have to spend vast sums on environmental rehabilitation, in which we are not afraid to drink the lake water, and in which we can still pursue the economic goals necessary to support our society.

This need not entail reduced growth. But, it does require us all to integrate environmental considerations into our daily personal and business decisions. As the Canadian Chamber of Commerce outlined in its review for its members, "Business is the key because it is private enterprise that provides most of our goods and services. It is business people who can and must find solutions that will allow them to continue to work without creating more environmental problems."[8]

These solutions, in favour of options that result in <u>less</u> pollution being generated, are not a burden to doing business. In some cases they mean reduced costs, through reduced waste and improved efficiency by improved production methods.

Sustainability also requires that business follow product stewardship practices; taking responsibility for its product from production through to final consumption. Pollution prevention is an integral part of stewardship that must be there in all steps of a product's life-cycle.

Where does one start, particularly when operating a small business with no in-house environmental knowledge? Many changes simply call for the application of common sense and the old business principles of economy and thrift. It does not make business sense to waste energy, to use excess virgin raw materials or to pay disposal fees for something that can easily be recycled or exchanged.

Sustainability is achievable and we are capable of making the choices to bring it about. But we must do it now! We must make an honest effort to make pollution prevention a constant part of our daily lives at work and home. The hope for achieving this understanding and for sponsoring the effort required will come from the Green Plan's Pollution Prevention Initiative.

THE POLLUTION PREVENTION INITIATIVE

What is pollution prevention and what distinguishes it from all other environmental responses?

Most important, it is proactive rather than reactive. Its basis for action is grounded in changing our consumption habits, the ways we accomplish our economic tasks and other aspects of our daily lives. Pollution prevention dramatically reduces the need for expensive end-of-pipe solutions and habitat rehabilitation. In short, prevention is the most cost effective means of preserving the Great Lakes ecosystem.

The Green Plan Pollution Prevention Initiative considers prevention to be the responsibility of every individual, all business sectors and levels government. The Government of Canada seeks to make constructive partnerships with all sectors of society to meet the goals of pollution prevention. Through this cooperative effort we can halt the march that has led us to the point where almost irreparable damage has been done to the economic, recreational and natural uses of the Great Lakes.

GREAT LAKES WATER QUALITY AGREEMENT AND POLLUTION PREVENTION

The pollution prevention initiative is a comprehensive national response that builds upon the many years of research and rehabilitation. As a party to the 1972 Great Lakes Water Quality Agreement, Canada is committed to the 1978 Amendment for the reduction and the eventual virtual elimination of discharges of persistent toxic substances. The Pollution Prevention Initiative reiterates that commitment.

The key to achieving the pollution prevention objective of virtual elimination is informed decision-making based on high-quality environmental science, education and information. To make wise decisions, we must know and understand the ecosystem and the inter-relationships between the natural environment, the economy and our daily lives. Scientific and technological research and development provide the basis for our understanding of the problems and our efforts to find workable solutions. Education and information ensure that, in their day-to-day decisions, Canadians living in the Great Lakes basin and St. Lawrence understand the environmental and health implications and take responsibility for them.

THE POLLUTION PREVENTION INITIATIVE IN DETAIL

On March 5, the Minister of Environment unveiled the Government of Canada's commitment to the principle of achieving the virtual elimination of toxic substances in the Great Lakes, first outlined in the Green Plan. The announcement pledged the government to commit $25 million for the 5 year Pollution Prevention Initiative. The Initiative is comprised of three components:

- strategy development;
- demonstration projects; and
- education and community awareness.

1. The central element of the strategy development will be the formation of a Great Lakes multi-stakeholder group for guidance of the multi-sectoral strategy and the establishment of a Centre for Pollution Prevention in Burlington, Ontario. The centre's role will be to coordinate the stakeholders and to solicit and coordinate the participation of economic, governmental, public and individual representatives across all sectors.

   Stakeholders will be responsible for developing and directing their respective sector's response to pollution prevention strategies. They will be challenged by their peers and by examples of sectors that lead in the field of prevention.

   The centre will also be an information clearing house to assist stakeholders' understanding of what constitutes pollution prevention, how to integrate it into one's own actions and how to inform one's members.

2. The second component of the initiative, is the evaluation and implementation of demonstration projects. These projects will highlight advances in pollution prevention and will incorporate several initiatives in concert with similar projects on the U.S. side of the lakes. Demonstration projects will assist industry and other parties with the development of proven pollution prevention technologies for their individual sector or business. Through the Centre, projects will be allotted seed money to demonstrate techhnologies or processes that reduce or eliminate the production, use and generation of persistent toxic substances.

   Major demonstration projects are planned for reduction of discharges by the automotive industries and the pulp and paper industry. Each is a major contributor to highly toxic substances as a result of their manufacturing processes.

3. The third aspect of the initiative, and possibly the most important from a social perspective, will seek to integrate pollution prevention into the daily routine of our lives. This means "spreading the word" to all levels of society. Through education and community awareness, residents of the Great Lakes basin and the St. Lawrence River will learn, accept and make pollution prevention part of their daily lives. By developing educational material for schools, supporting community pollution prevention and working with local interest groups, prevention can be fully integrated at the personal level throughout the community.

In the final analysis, the success of pollution prevention requires concerted action by all of society. There is now a growing file of companies, large and small, throughout several sectors, taking the lead in initiating preventative practices for the elimination of persistent and non-persistent toxic substances in the course of their daily work. Pollution prevention can take several forms and can contribute to the overall objectives of a firm while reducing expenditures.

An example of pollution prevention that pays is demonstrated at Dofasco Steel's Hamilton plant. Dofasco built new water cooled fume hood collectors for its steel furnaces that prevent leakage of gases into the atmosphere and improves gas scrubbing. Instead of returning the cooling water immediately to the harbour, the stream from the process is used as process heat in the manufacturing process. The last step reduces the use of fossil fuels and ensures the water is at ambient temperature before being returned to the harbour. The process replaces 24 600 litres of heavy oil for process heating which represents a reduction in CO_2 and SO_2 emissions of 68 200 tonnes and 10.6 tonnes respectively. Dofasco estimates that the value of the steam generated by the evaporative hoods saves $1.330 million per year.

A more policy oriented case has seen the Canadian Chemical Manufacturer's Association initiate a code of product stewardship practices for all its member's products.

However, to be effective, pollution prevention requires the combined efforts of independent or small business. It is this sector that in aggregate produces a large amount of toxic emissions. Here also, is the greatest benefit to be gained by applying the principles of environmentally sustainable development to businesses.

CONCLUSION

The Green Plan's Pollution Prevention Initiative is a beginning. Its approach emphasises making all society responsible for its actions. It requires that stakeholders, individuals and organisations representing major sectors of the population and economy understand and accept their role. It evolves from better science, improved decision-making structures, and partnerships between stakeholders in the environment. On this last point, that means us. There may be some who have greater responsibilities for preventing toxic pollution but it pertains to us all in every aspect of our daily lives.

Canada and the United States, as parties to the Great Lakes Water Quality Agreement, and through their own domestic initiatives are the first partnership in an array that will encompass all elements of society on both sides of the lakes. The two federal governments along with their provincial and state counterparts are working toward measures for bilateral cooperation on sectoral and non-sectoral initiatives.

Among the most hopeful of these is a plan to designate Lake Superior as the first lake for virtual elimination. On the premis that the lake is the least polluted, the objective is to halt and turn back the damage that has been done. Even considering how relatively healthy Lake Superior is in comparison to the others, the project will still require immense cooperation and work with stakeholders in its watershed. The major point source contributor to Lake Superior pollution is the pulp and paper industry. Pilot projects with the industry will target toxic chemicals for reduction and elimination through the restructuring of the production process and the use of less toxic substances throughout the mills.

In closing, it remains to be said that we must accept responsibility for the health of the Great Lakes. Their sustained future is ours and that of generations to come.

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Pollution Prevention in Natural Resources Management with a focus on Nitrates and Pesticides in Agricultural Production Systems

Kenneth K. Tanji
Department of Land, Air and Water Resources
University of California, Davis

Introduction

Our agricultural production systems provide a bountiful supply of food and fiber, but they are obtained at some cost to our water, soil and air resources. For instance, agriculture is the largest single nonpoint source (NPS) of surface water pollutants, which include sediments, nutrients, pesticides, animal wastes, salinity and trace elements. According to the EPA (1989), agricultural NPS pollutants have contributed to impairing the water quality of 64% of the USA's 266,000 km (165,000 miles) of rivers and 57% of the USA's 3.3 million ha (8.1 million acres) of lakes. Furthermore, a recent national survey of drinking well water conducted by EPA (1990) reveal that at least half of the drinking wells contained detectable concentrations (0.15 mg/liter) of nitrates and about 1.2 to 2.4% contained nitrates exceeding the maximum contaminant level (MCL) of 10 mg/liter. In this same survey 4% of the rural domestic drinking wells and 10% of the community drinking wells had detectable residues of at least one pesticide though none exceeded the MCL. A significantly greater percentage of pesticide and nitrate detections in wells were made in intensively cropped lands, where pesticide and fertilizer usages are high, areas with high groundwater vulnerability exist, or both.

This paper addresses opportunities for the prevention of water pollution in agricultural crop production systems, with a focus on nitrates and pesticides. This paper contains two central themes: "everything has to go somewhere" and "an ounce of prevention is worth a pound of cure."

Agricultural Crop Production Systems

Agricultural crop production systems may be viewed as a "biological factory" (Hillel, 1991) utilizing solar energy, carbon dioxide from the atmosphere, water from the hydrosphere and mineral nutrients from the geosphere.

Today's intensive crop production systems have evolved over millenia from food gathering of native plants and animals, to domestication of herbivorous animals, to slash-and-burn agriculture in forested lands, to extensive farming of arable land with little or no inputs of manures and fertilizers, to self sustaining farming, which involves cultivation of crops that provide food for humans and livestock, return of livestock and human wastes to the soil and cultivation of crops that fix nitrogen gas from the atmosphere. These farming systems, some of which are still being practiced, have low to moderate productivity per unit area (Frissell, 1978).

Intensive agriculture in developed countries consists of continuous inputs of fertilizers and pesticides. This allows a steady export of crops and livestock products. Such agricultural systems tend to have a deleterious effect on our environment. In the past, agriculture mostly involved "on-site" measures that enhanced the production of crops and livestock. In recent decades, we have become more aware of the "off-site" effects of farming operations, such as degradation of the quality of surface waters. And today we, including farmers, have become acutely aware of "out-of-sight" contamination of ground waters.

The principal agricultural sources of NPS pollutants are nutrients, including nitrogen and phosphorus; sediments and the nutrients, pesticides, salinity and trace elements associated with them; pesticides, including herbicides, insecticides, fungicides, nematicides and miticides; dissolved mineral salts (salinity); and livestock wastes, which contain nutrients, salinity, trace elements, pathogens, and oxygen-demanding constituents.

Water pollution from agricultural and other sources was initially a local problem, but has now spread to regional, national and even global levels. Factors contributing to the extensive nature of water pollution are exceedingly complex and interactive, a topic that I will be addressing later. For now, suffice it to say that factors include the mobility of the pollutant, persistence of the pollutant, and the surface soil and hydrogeological conditions which can affect an area's vulnerability to pollution.

Nitrates

Plants derive their essential mineral nutrients mainly from the soil, but obtain some from the atmosphere and water. Nitrogen, by far, is the nutrient that is most limiting for crop production. Under intensive crop production, the soil's reservoir of nitrogen tends to become depleted and is replenished by both natural sources, such as crop residues and animal manures, as well as by synthetic nitrogen fertilizers derived from the atmosphere by various industrial processes. These nitrogen fertilizers include anhydrous ammonia, urea, ammonium nitrate, ammonium sulfate, calcium nitrate and sodium nitrate. An estimated one-third of all agricultural production in the USA stem from nitrogen fertilizers (Meyer and Coppock, 1980). The amount of nitrogen removed from the soil by harvested crops in the USA varies from 20 to 40% of the amount of fertilizer applied for most vegetable and fruit crops, and from 40 to 70% for most grain and forage crops (Meyer and Coppock, 1980). To assess what happens to the rest of the nitrogen fertilizer requires an understanding of the soil nitrogen cycle.

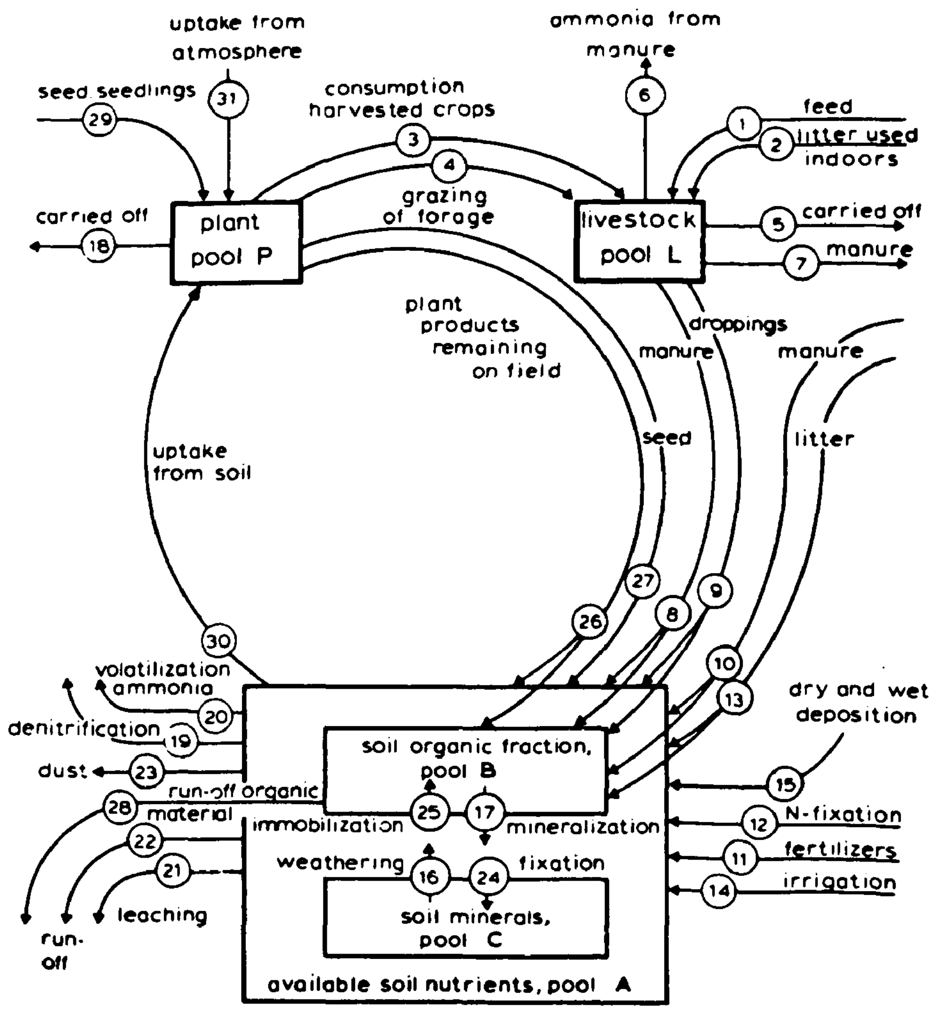

Figure 1. Flowchart of 31 transfer pathways of nutrients in an agroecosystem (Frissell, 1978).

Figure 1 (Frissell, 1978) presents the cycling of nutrients, including nitrogen, in agroecosystems. The principal nitrogen pools are plant, livestock and soil, which is further subdivided into inorganic and soil organic nitrogen pools. Arrows directed to a pool indicate inputs of nitrogen, arrows leaving a pool indicate outputs, and arrows going from one pool to another indicate transfers between pools within the agroecosystem; a total of 31 transfer pathways. More details on soil nitrogen are found in Stevenson (1982). Figure 2 (Pennsylvania State University, 1988) depicts a simplified version of the soil nitrogen cycle.

Losses of nitrogen from croplands include volatilization of ammonia, microbial denitrification producing nitrogen and dinitrogen gases, surface runoff of mineral and organic forms of nitrogen, leaching of nitrates into ground waters, and removal of nitrogen in the harvested crop.

Of particular interest in this paper are losses of nitrogen in surface runoff and deep percolation, including:

1. Dissolved nitrogen gases (nitrogen, dinitrogen, ammonia, etc.)
2. Soluble inorganic nitrogen (ammonium, nitrate and nitrite).
3. Soluble organic nitrogen (amino acids, sugars, etc.)
4. Particulate organic nitrogen (suspended matter consisting of plant and animal origins).
5. Sorbed inorganic nitrogen (exchangeable and fixed ammonium in sediments, etc.).

The discharge of the above forms of nitrogen varies with site-specific conditions. All of the above forms may be present in surface runoffs and the first three forms may be present in percolating waters. The nitrogen species

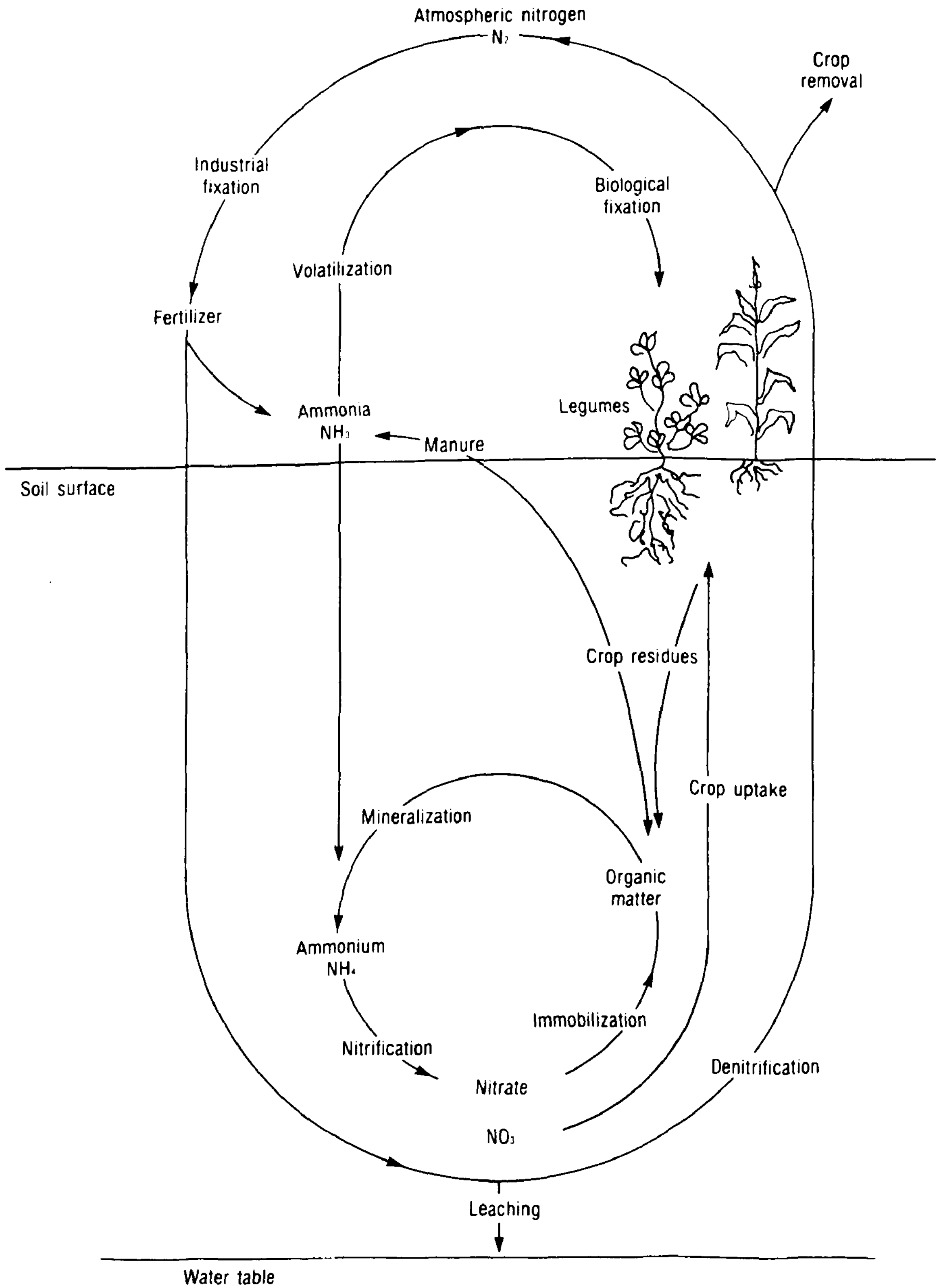

Figure 2. The soil nitrogen cycle (Pennsylvania State University, 1988).

that are most frequently measured are nitrate or nitrate plus nitrite, while ammonium and ammonia are less frequently measured, and dissolved and suspended organic nitrogen are infrequently measured.

Ammonium and ammonia in high pH waters should be more frequently analyzed. They indicate that pollution and the inefficient use of ammonia/ammonium fertilizers has occurred, and are highly toxic to aquatic organisms.

Nitrate is of importance because it plays a role in eutrophication of surface waters, may cause methemoglobinemia in high concentrations, indicate that excessive leaching has occurred, and may be detrimental to certain crops during the maturation stage. Significant concentrations of nitrite may occur only under unusual anoxic (reduced) conditions. Organic nitrogen present as nitrogenous fraction of the biochemical oxygen demand (BOD), when determinations of BOD are made for more than 5 days of incubation, also indicates pollution has occurred, and may lower dissolved oxygen (DO) in the receiving waters and contribute mineralized forms of nitrogen to waters.

In surface runoff from close-growing crops, such as pasture and flooded rice fields, organic nitrogen usually dominates over the mineralized forms. In widely-spaced crops, such as furrow irrigated field crops, ammonium and nitrate may be more prominent than organic nitrogen.

Preventive measures to minimize nitrate accumulation in waters will be first addressed by potential management options on existing cropping systems and later by options requiring substantial changes in farming.

Focusing on leaching of nitrate into ground water, the two main factors are the amount of leachable nitrate present in the crop root zone and the amount of water percolating through this root zone. The former is influenced largely by the rate and timing of nitrogen inputs. The latter is influenced largely by the rate and timing of infiltrated precipitation or irrigation waters. These two factors are closely interrelated.

Fertilizer-use efficiency, --the percentage of applied nitrogen taken up by the crop--, is a key determinant to leachable nitrate present in soils. Figure 3 presents the results of field studies of corn grown in the San Joaquin Valley of California (Meyer and Coppock, 1980). Fertilizer-use efficiency decreased and unaccounted-for losses of nitrogen (leaching and denitrification) increased with excess fertilization. Increased yield of grain per kg/ha of applied nitrogen became smaller as the rate of nitrogen application was increased (yields actually declined with excess fertilization) and the nitrate leaching potential to groundwater was increased.

Some leaching of nitrate is inevitable in almost all farmlands since agriculture is practiced in an open system, but some areas are especially vulnerable to leaching. Soils most sensitive to nitrate ground water contamination are those that have high water infiltration rates, high water transmission rates throughout their profiles and low denitrification potential. Crops that create a high potential for nitrate leaching are those with low fertilizer use efficiency and those that require high nitrogen input to insure rapid vegetative growth, such as vegetable crops. Leaching of nitrate is more likely when the amount of infiltrated precipitation or irrigation exceeds the water storage capacity of the soil profile.

Measures to prevent nitrate leaching losses from the use of fertilizers include proper management of the application rate, method and timing of application, and use of the proper type of fertilizer. The amount of fertilizer to be applied should be guided by soil, water, and plant tissue tests. Tests of soils and waters indicate how much nitrogen will be available to the crop.

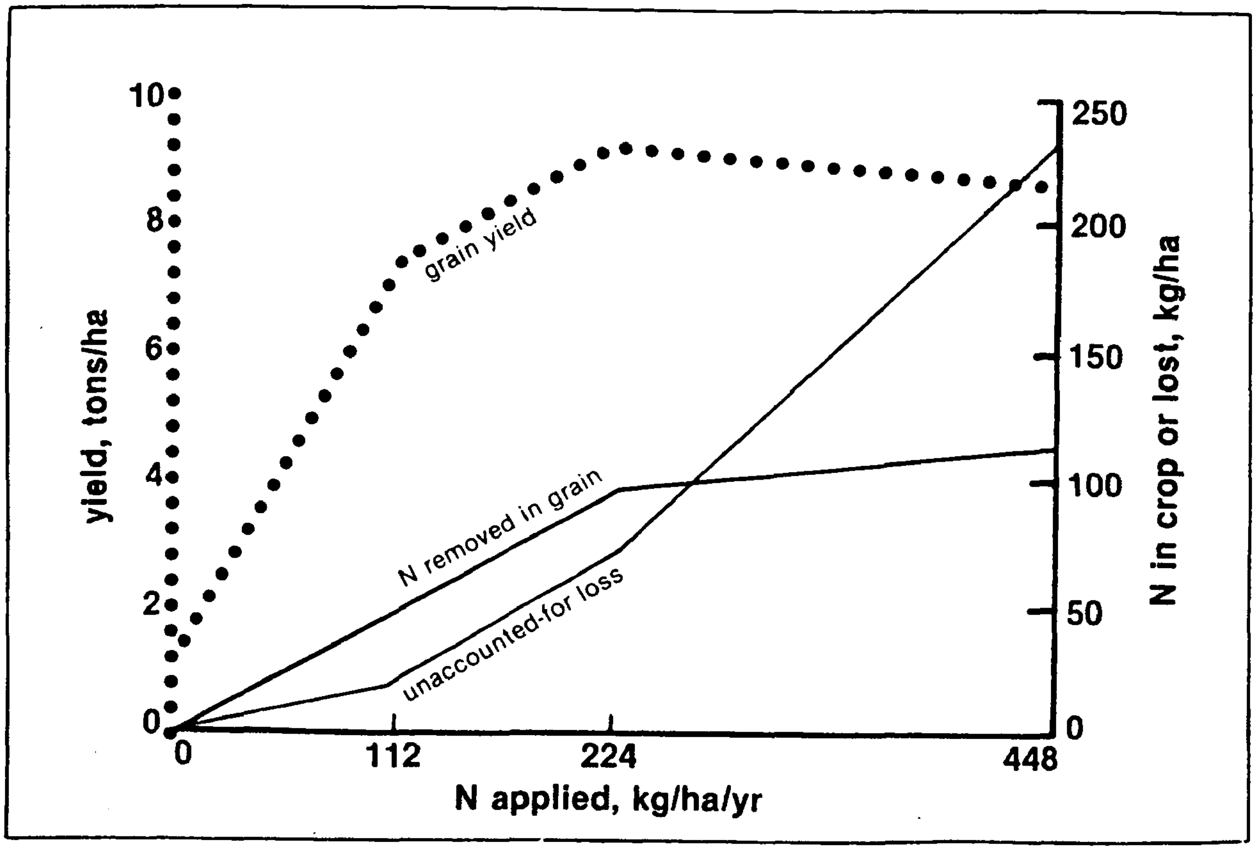

Figure 3. Corn grain yields, crop removal of nitrogen and unaccounted-for losses of nitrogen in the San Joaquin Valley (Meyer and Coppock, 1980)

Tests of plant tissues indicate whether or not the growing crop is deficient in nitrogen. Fertilizers should be incorporated into the soil by injection, disking, or plowing to minimize losses in surface runoff. Nitrogen should be applied during those periods of time when the plant most needs the nitrogen. And the pollution potential of the form of fertilizer (granular, gaseous, liquid, suspension or slurry) should be considered. Some forms are highly soluble and highly subject to leaching. Some release nitrogen over a period of time, such as slow-release nitrogen fertilizers or those containing nitrogen inhibitors.

Other management practices that help to prevent pollution include crop rotation, no-till and conservation tillage to reduce runoff losses, as well as use of legumes and animal wastes as sources of nitrogen (NRC, 1989; OTA, 1990).

Pesticides

In agriculture, the use of pesticides has had a history of several hundred years. Initially, the pesticides used were naturally occurring substances, such as sulfur as a fumigant, ground tobacco and its extract nicotine formulated as nicotine sulfate (Black Leaf 40), the plant pyrethrum and its crushed dried flowers or seeds, petroleum oils and various inorganic chemical, such as arsenic, lead and copper.

As agriculture shifted into a more intensive crop production system the pest-predator relationship was disturbed, clearly cultivated fields were desired and crop rotation systems become limited, all of which contributed to the increasing use of herbicides, insecticides, fungicides, nematicides, and miticides. During the 1950's, new organic chemicals were discovered, and the use of synthetic pesticides escalated. The consumer began to expect attractive-looking food products without blemishes or insects. However, Rachel Carsons' Silent Spring, published in 1962, gave rise to public concern over the threat posed by pesticide to the health of people and wildlife.

Pesticide contamination of our surface and ground waters continues to be a growing source of concern. The use of some pesticides, e.g., DDT, an insecticide, and DBCP and EDB, nematicides, have been banned due to their toxicity. Some of these banned pesticides and some of those currently in use are quite persistent, with half-lives of years to decades, while others have short half-lives of days to months. Some pesticides are acutely lethal to people and wildlife,. Others are sublethal. Still others are innocuous.

Figure 4 (Sawhney and Brown, 1989) shows the reactivity and mobility of pesticides applied to croplands. The principal losses of pesticides include surface runoff and leaching, volatilization, and chemical and microbial degradation. In regard to potential ground water contamination, four major factors are involved: the properties of the pesticide, the characteristics of the soil, other characteristics of the site, and management practices.

Pesticides that dissolve readily in water are likely to leach. But many moderately to highly soluble pesticides do not leach because they are adsorbed or tightly held by soil, particularly by the soil organic matter clays and fractions. Pesticides which have high vapor pressure are highly volatile and may be easily lost to the atmosphere. Some highly volatile pesticides are less soluble in water and do not contribute to the contamination of ground water. Another property of the pesticide is its degradability by chemical processes, such as photolysis or photochemical degradation, hydrolysis, oxidation, or by microbial processes. The pesticides may be degraded to innocuous products, such as carbon dioxide, water and inorganic constituents. However, some pesticides are degraded into intermediate products which may be more toxic than the parent compound.

The fate of a pesticide applied to soil depends largely on two of its properties: sorption and persistence (Rao and Hornsby, 1989). The tendency of the pesticide adsorbing to soil particles is typically evaluated by its partition coefficient (K_{oc}) defined as the concentration ratio of the pesticide in the sorbed state to the pesticide in the soluble state. The

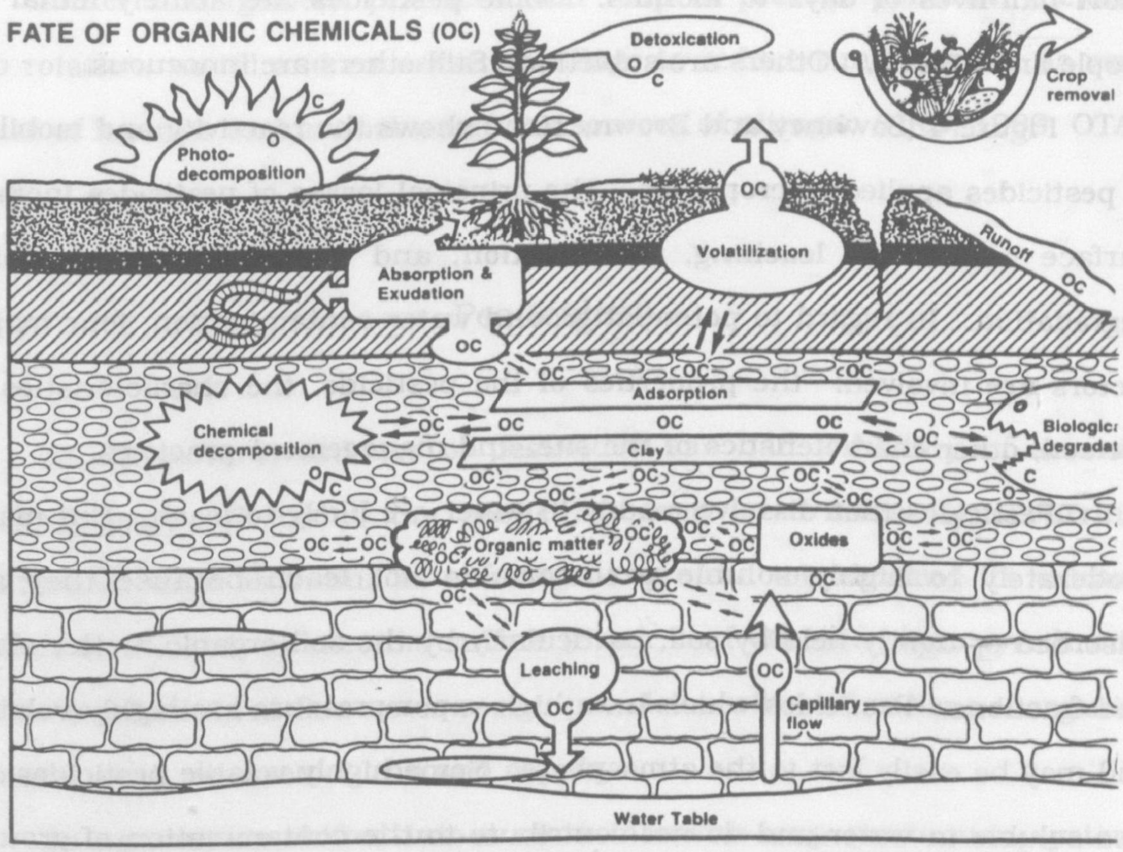

Figure 4. Reactions and movemenet of pesticides (Sawhney and Brown, 1989).

smaller the value of K_{oc}, the more likely it is that the pesticide will be subject to leaching. Such pesticides are referred to a "leachers".

Persistence refers to the "Lasting-power" of the pesticide in question and is related to the extent it is degraded over time. This degradation time is measured in terms of half-life ($t_{1/2}$). A half-life is the amount of time it takes for one-half of the original amount of the pesticide in the soil to be deactivated. The half-life of the pesticide to be completely degraded is longer than that based on deactivation.

Table 1 (Rao and Hornsby) presents partition coefficients and half-lives for deactivation of pesticides used in the state of Florida. The K_{oc} values of these pesticides in surface soils vary widely and is based on the pesticide's chemical properties. For a given pesticide, sorption is greater in soils with larger soil organic matter content and leaching is expected to be less. The $t_{1/2}$ values also show a wide range of values. Those pesticides with half-lives of 30 days or less are classed as non-persistent, half-lives greater than 30 but less than 100 days as moderately persistent, and half-lives greater than 100 days as persistent.

The second major factor influencing the potential for a pesticide to contaminate ground water is the properties of the soil. These include the soil's texture, permeability and amount of organic matter. Texture refers to the relative proportions of sand, silt and clay fractions. A coarse-textured soil, which contains mainly sand and silt, has a lower water holding capacity than finer-textured soil. Soils high in clay and organic matter offer greater opportunities for the pesticide to be adsorbed. Permeability of soils is related to pore sizes (filled with water and gases) and the distribution of pore sizes, and gives a measure of how fast water will move through the soil profile. Generally, coarser-textured soils are more permeable than finer-textured soils. These properties of the soil are mportant in assessing the leachability of pesticides. For instance, increasing the organic matter content of soils through incorporation of cover crops, minimum tillage and application of manures will increase the soil's ability to retain both water and pesticides and hence lessen the potential for ground water contamination.

Table 1. Pesticides Used in Florida and their Partition Coefficients and Half-Lives (Rao and Hornsby, 1989).

Common Name	Trade Name(s)	K_{oc} (ml/g OC)	$T_{1/2}$ (days)
NON-PERSISTENT (half-life 30 days or less)			
dalapon	Basfapon, Dowpon	1	30
dicamba	Banvel	2	14
chloramben	Amiben	15	15
metalaxyl	Ridomil	16	21
aldicarb	Temik	20	30
oxamyl	Vydate	25	4
propham	Ban-Hoe, Chem-Hoe	60	10
2,4,5-T	Dacamine 4T, Trioxone	80	24
captan	Orthocide, Captanex	100	3
fluometuron	Cotoran, Lanex	100	11
alachlor	Alanex	170	15
cyanazine	Bladex	190	14
carbaryl	Sevin	200	10
iprodione	Rovral	1000	14
malathion	Cythion	1,800	1
methyl parathion	Penncap-M, Metacide	5,100	5
chlorpyrifos	Lorsban, Dursban	6,070	30
parathion	Thiophos, Bladan	7,161	14
fluvalinate	Mavrik, Spur	100,000	30
MODERATELY-PERSISTENT (half-life greater than 30 but less than 100 days)			
picloram	Tordon	16	90
chlorimuron-ethyl	Classic	20	40
carbofuran	Furadan, Curaterr	22	50
bromacil	Hyvar, Bromax	32	60
diphenamid	Enide, Rideon	67	32
ethoprop	Mocap	70	50
fensulfothion	Dasanit	89	33
atrazine	Attrex	100	60
simazine	Princep	138	75
dichlobenil	Casoron	224	60
linuron	Lorox, Aflon	370	60
ametryne	Evik	388	60
diuron	Karmex	480	90
diazinon	Basudin, Spectracide	500	40
prometryn	Caparol, Primatol Q	500	60
fonofos	Dyfonate	532	45
chlorbromuron	Maloran	996	45
azinphos-methyl	Guthion	1,000	40
cacodylic acid	Bolate, Bolls-Eye	1,000	50
chlorpropham	Beet-Kleen, Furloe	1,150	35
phorate	Thimet	2,000	90
ethalfluralin	Solanan	4,000	60
chloroxuron	Tenoran, Norex	4,343	60
fenvalerate	Extrin, Sumitox	5,300	35
esfenvalerate	Asana	5,300	35
trifluralin	Treflan	7,000	60
glyphosate	Roundup	24,000	47
PERSISTENT (half-life greater than 100 days)			
fomesafen	Flex	50	180
terbacil	Sinbar	55	120
metsulfuron-methyl	Ally, Escort	61	120
propazine	Milogard, Primatol P	154	135
benomyl	Benlate	190	240
monolinuron	Aresin, Afesin	284	321
prometon	Pramitol	300	120
isofenphos	Oftanol	408	150
fluridone	Sonar	450	360
lindane	Isotox	1,100	400
cyhexatin	Plictran	1,380	180
procymidone	Sumilex	1,650	120
chloroneb	Terraneb	1,653	180
endosulfan	Thiodan, Endosan	2,040	120
ethion	Ethion	8,890	350
metolachlor	Bicep	85,000	120

A third major factor is the other conditions of the site. In regions where the depth to the water table is shallow (several feet), the pesticide will more quickly leach into the ground water within weeks to months. In regions where the water table is deep (hundreds of feet), the leaching of pesticides to ground water would take much longer, such as decades. Furthermore, a shallow depth to the water table offers less opportunities for the pesticide to be sorbed and degraded. Soil structure refers to the manner in which soil particles are aggregated and cemented by clays and organic compounds. It affects the movement of water. The presence of macropores (channels) formed by decayed roots, earthworms and shrinking of clayey soils significantly helps pesticides to move downward. These macropores serve as preferential flow paths for water and dissolved pesticides, and thus enhances leaching. Hydrogeologic properties deeper beneath the soil profile are also important. The "underground plumbing" affects how fast and how much pesticides are likely to contaminate ground water. The presence of highly permeable materials, such as gravel, would allow greater movement of pesticide contaminated waters, while layers of clay may inhibit deep percolation. Another condition of the site to be considered is climate. Higher volumes of rainfall or irrigation applications enhances leaching of pesticides. Warmer temperatures enhance the rate of degradation and volatilization of pesticides.

The fourth major factor is management practices. Pesticides sprayed on crop plants are less likely to leach, but may be more subject to runoff loss. Pesticides incorporated into the soil will have a greater tendency to be leached. Most of the pesticides detected in ground water are those that are incorporated into the soil. The rate and timing in their application have a large influence on leachability of pesticides. The larger the amount of pesticide applied and the closer the time of application to rainfall or irrigation, the more likely it is that the pesticide will leach to ground water.

In light of the above four major factors, pesticides are most likely to contaminate ground water when the pesticides used have high solubility, low adsorption to soil particles and longer persistence, when soils are coarse-textured and low in organic matter, when the site has a shallow depth to ground water and a wet climate or heavy irrigations, and when pesticides are injected or incorporated into the soil.

Preventive measures for pesticide contamination of surface and ground waters are manifold. They include using pesticides only when needed; identifying the soil's vulnerability to excessive deep percolation; avoiding the use of pesticides known to be "leachers"; following the label's instructions on the timing of and rate of application; applying pesticides only to the target site; delaying irrigation after the application of pesticides; to avoid irrigation runoff; and using Integrated Pest Management (IPM).

IPM integrates pest control techniques that are both ecologically and economically sound. IPM involves understanding the pest in question, its host crop and its natural predators. An IPM program may include such practices as monitoring of pests; cultural controls that reduce pest problems, such as crop rotation; water management to reduce runoff and leaching and plant diseases; crop canopy management and sanitation to reduce overwintering of pests; development of varieties of crops that resist pest damage; use of the sun's heat to kill pests by placing plastic sheets on the soil surface; cover crops to maintain not only crop production, but to minimize pest problems; use of pheromone dispensers to attract males; and use of biological controls, such as predators, parasites, and pathogens (Flint, 1989).

Summary

Since agriculture is practiced in an "open system", residuals of drainage waters and applied agrichemicals are inevitably produced and discharged into the environment. This open system is subject to the vagaries of climate, and consists of heterogeneous soil properties and "underground plumbing". The effects of agriculture are felt "on-site" (farmland), "off-site" (surface waters) and "out-of-sight" (ground waters). Nevertheless, protection of our soil, water and air resources could be realized by recognizing that "everything has to go somewhere" and "an ounce of prevention is worth a pound of cure".

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SESSION 3D

POLLUTION PREVENTION RESEARCH, DEVELOPMENT AND DEMONSTRATION NEEDS

Chairperson
Mr. Gregory G. Ondich
Office of Research and Development
U.S. Environmental Protection Agency
Washington, D.C.

Speakers
Mr. Elliott Berkihiser
Manager, Chemical Reduction
Corporate Safety, Health & Environmental Affairs
The Boeing Company
Seattle, WA

Mr. Ken G. Koller
Group Manager, Technology Development
EG&G Idaho, Inc.
Idaho Falls, ID

Mr. Michael Kosusko
Chemical Engineer
U.S. Environmental Protection Agency
Energy Engineering Research Lab.
Research Triangle Park, NC

Mr. John Warren
Center for Economics Research
Research Triangle Institute, Inc.
Research Triangle Park, NC

Session Abstract

There are a number of technical and non technical approaches that can be used to determine how to conduct pollution prevention research. Product, process, and recycling/reuse research are some to the technical approaches. Within each of these approaches, there are various methods such as product research—modifications, substitutions, and life cycle analysis; process research—alternative feedstocks, emissions/efficiency testing and operational modifications, and recycling/reuse — capture/recovery alternatives, various specification requirements and different reclamation processing techniques. Socioeconomic and institutional research are the primary non-technical approaches and these may include market incentive evaluations, behavioral analysis, and regulation/enforcement assessments.

Beyond these approaches anticipatory research should be conducted on emerging technologies that could be utilized to prevent or address future environmental problems, as well as changes in nontechnical factors that could contribute to or prevent problems. Technology transfer and technical assistance prevention research approaches to provide the best mechanism for rapid and broad dissemination of information to potential users.

DEPARTMENT OF ENERGY SOLVENT SUBSTITUTION

Anne E. Copeland
Waste Technology Development Department
Idaho National Engineering Laboratory
Idaho Falls, ID 83415 USA
(208) 526-1281

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INTRODUCTION

The Department of Energy (DOE) began their solvent substitution research in 1987 through a collaborative effort with the Air Force. The Air Force Engineering Services Center (AFESC), at the request of the Air Force Logistics Command (AFLC), initiated the research project "Biodegradable Solvent Substitution" and contracted the work through EG&G Idaho, Inc. The objective of the program was to find safe substitutes for the solvents used for metal cleaning at AFLC installations. The work was performed on site at Tinker Air Force Base, Oklahoma.

APPROACH

The program was structured in three phases, each lasting one year. EG&G performed a majority of the work at a pilot plant facility, located at Tinker's Industrial Wastewater Treatment Plant (IWTP). This pilot plant is a small scale replica of the IWTP.

Phase I - Phase I consisted of data collection, establishment of criteria for substitute cleaners, a market search of available products and screening tests. EG&G surveyed AFLC to determine their current cleaning processes, what solvents were used and in what applications. The survey revealed that the primary solvent use was in metal cleaning using perchloroethylene, methyl chloroform, trichlorotrifluoroethane, and PD-680 (stoddard solvent) to remove oils, greases, carbon, and masking wax used for selective plating.

The criteria AFLC established for new substitute cleaners included: (1) efficiency - substitutes must be at least as efficient as current solvents; (2) flashpoint - flash point must be greater than or equal to 200 degrees Fahrenheit; (3) biodegradability - a product must biologically degrade, as measured by its chemical oxygen demand (COD), in six hours (actual retention time) in Tinker's IWTP to the NPDES permit limit of 150 mg/l; (4) corrosiveness - products must not cause corrosion rates to exceed 0.3 mil/yr on specified metals (see Table 1) as measured by ASTM Methods F483-77, "Total Immersion Corrosion for Aircraft Maintenance Chemicals," and F519-77 for hydrogen embrittlement.

After searching the market for available products, EG&G contacted 215 companies and selected 175 samples to screen. The products were screened for biodegradability, soil solubility, cleaning efficiency, and corrosiveness. Of the products that passed the screening tests, six were chosen for continued evaluation in the program. It should be noted that all of the products corrode magnesium at a rate greater than 0.3 mil/yr. Two of the six products were later dropped form the program, one for low flashpoint, and the other for a toxic component. During Phase III a new product, already tested for performance in one of Tinker's overhaul shops, was incorporated into the program. Of these five final products, two are aqueous and three are organic, or not water dilutable.

Phase II - In Phase II the chosen products were subjected to extended performance tests. These tests included process enhancements (temperature, agitation, ultrasonics), cleaning capacity, rinsing requirements and the impact on Tinker's IWTP. Results showed that a process temperature of 140 degrees Fahrenheit coupled with pressurized spraying or vigorous agitation and rinsing gave the best results. Ultrasonic enhancement, due to its numerous variables, was not pursued further in this program. It was, instead, placed under its own, separate program.

To determine the effects of these products on Tinker's IWTP, the candidate substitutes were processed through the pilot plant. The used products were sequentially fed through the pilot plant and their effects on each unit process were monitored. The results were that while all were biodegradable in the laboratory jar tests, only one product was successfully treated in the pilot plant. One problem encountered with the other products was that they floated the metal sludge that had been intentionally removed from solution and precipitated. While with some of the cleaners this effect could be counteracted by adding ferric chloride, the IWTP personnel were not in favor of adding another chemical to the process or the associated costs. Another problem, which occurred with only one of the products, was that when the cleaner was mixed with the rest of the waste stream, the bacteria would not acclimate to it. In other words, the bacteria preferred the other "food" available and would not consume our cleaner. Therefore, it passed through the plant untreated.

Phase III - In Phase III the cleaners were tested in full scale production. The process conditions shown to be optimum in Phase II were demonstrated in an agitated immersion tank and a cabinet spray washer, similar to a large dishwasher. Agitation was achieved by recirculating the cleaner through a pump located outside the tank and reinjecting it into the tank through submerged jet spray nozzles. The pump rate turned over the volume of the tank once every two minutes. Only the aqueous cleaners were tested in the spray washer due to the explosion hazards associated with heating and atomizing the organic products. The tests were conducted in two production shops at Tinker using actual engine and aircraft parts. The parts were soiled with plating wax, oil, grease, light carbon deposits and heavy, baked-on carbon from the hot sections of the jet engines. These parts, normally scheduled for chemical cleaning, vapor degreasing or cold solvent cleaning, were rerouted to the test process. The acceptance criteria for product performance levied by Tinker's process engineers were that the parts had to be clean enough (1) to undergo fluorescent penetrant inspection (a method of nondestructive inspection) and (2) to accept paint. Only four of the five products were tested in production since two of the products are chemically very similar.

RESULTS AND CONCLUSIONS

Overall, the aqueous cleaners, 3D Supreme and Fremont 776, performed far better than the organic products. They successfully removed oil and grease from 100% of the parts and light carbon deposits from approximately 80% of the parts subjected to the tests in 5-15 minutes process time. The shop operators reported the aqueous products cleaned better than vapor degreasing. These products did not, however, completely remove the masking wax or the heavy baked-on carbon, even after 90 minutes in the immersion tank.

Of the two organic products, Orange-Sol's De-Solv-It removed the masking wax moderately well, with a process time of 30-45 minutes. It was, however, restricted by part configuration. Tinker's "worst case" part was very intricate and so all wax was never removed. Other less intricate parts were successfully cleaned. Exxon's Exxate 1000 also removed the wax, though not as well as the De-Solv-It. One disadvantage of the organic cleaners is odor. De-Solv-It, a terpene-based cleaner, has a heavy citrus odor and the Exxate 1000, an acetate ester, is very pungent. Exxate 1000 did cause headaches when not vented.

The baked-on carbon deposits from the hot sections (combustion, turbine, exhaust, and afterburner sections) was never successfully removed within acceptable process times. Though in some cases the aqueous cleaners succeeded with much time and effort, they did not remove heat scale or corrosion. Since the solutions currently used to remove scale and corrosion (acids, bases, and oxidizers) also remove the heavy carbon very quickly, they will not be replaced with any of the cleaners from this program.

As a result of this program, Tinker's overhaul and maintenance shops are beginning to replace their vapor degreasers and cold solvent tanks with both of the aqueous products, 3D Supreme and Fremont 776. Even though the 3D Supreme won't be treated through the base IWTP, it cleans better than Fremont 776 in some applications and has numerous advantages over halogenated solvents. Alternate treatment and possible recycling methods for 3D Supreme will be pursued under current research efforts.

LONG RANGE PLAN

The Idaho National Engineering Laboratory (INEL) continues research on solvent substitution and other waste minimization projects for DOE covering a variety of areas. These include Solvent Utilization Handbook, Volatile Organic Compounds (VOCs), Alternative Paint Strippers, Spray Forming, Laser Enhanced Jet Electroplating, Non-Cyanide Strippers, Ion Vapor Deposition of Aluminum and Chromium Reduction. Many other projects are underway in the areas of biotechnology and waste treatment. (See Table 2). As collaborative efforts these research programs will significantly reduce the waste generated by both the Departments of Energy and Defense. Additionally through technology exchange agreements, they will benefit much of private industry as well.

TABLE I. METAL SAMPLES USED FOR CORROSION TESTING

Copper, CDA110 ETP
Nickel 200
Aluminum, AL2024
Steel, C4340
Aluminum, AL7075
Aluminum, AL1100
Stainless, 410
Admiralty Brass, CDA443
Carbon Steel, C4340, C1020
Stainless, 310S
Inconel 750
Monel MK-500
RMI Titanium
Waspaloy Alloy
Magnesium AZ31B

TABLE 2. EG&G WASTE MINIMIZATION R & D PROJECTS

Biotechnology R&D Projects	Waste Minimization R&D Projects	Waste Treatment R&D Projects
Uranium Mill Tailings Contam	Solvent Handbook	Waste Reclassification
Microprocessing of Organic Waste	VOC's	Low Level Contaminated Metal Recycling
Bioprocessing of Mixed Waste	Paint Stripping	Recycle/Recovery
Bioabsorption of Metals	Spray Forming	Metals Recovery
Soil Farming	Non-Cyanide Strippers	Low Metals
Chrome Reduction	Laser Enhanced Electroplating	Chrome Treatment
	Ion Vapor Deposition	High Energy Decomposition of Hydrocarbons
	Biodegradable Solvents	Bicarbonate of Soda Stripping
	Air Toxic Emissions	

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DEMONSTRATION OF EMERGING AREA SOURCE PREVENTION OPTIONS FOR VOLATILE ORGANICS

by

Michael Kosusko

United States Environmental Protection Agency
Air and Energy Engineering Research Laboratory
Organics Control Branch
Research Triangle Park, North Carolina 27711

DEMONSTRATION OF EMERGING AREA SOURCE PREVENTION OPTIONS FOR VOLATILE ORGANICS

ABSTRACT

The national ambient air quality standard for ozone (0.12 ppm) is exceeded in over 100 areas throughout the U.S. Extensive reduction of volatile organic compound (VOC) emissions is required for attainment. The difficulty of dealing with stationary area sources has been a major obstacle to attaining these reductions. Area sources may contribute as much as 50 percent of national VOC emissions, and the increasing emissions from such sources may be outpacing efforts to control the diminishing base of uncontrolled point source emissions.

A work group, under the leadership of EPA's Air and Energy Engineering Research Laboratory, is participating in a research program, entitled, "Demonstration of Emerging Area Source Prevention Options for Volatile Organics." The purpose of this presentation is to describe the program and its status.

The program's goal is to reduce VOC emissions from stationary area sources by developing, evaluating, and/or demonstrating pollution prevention options. The program includes two project areas: (1) Alternative Coating Materials and Processes, and (2) Consumer Product Prevention Options. Other work group members include EPA's Region 9, EPA's Office of Pesticides and Toxic Substances, EPA's Office of Air Quality Planning and Standards, the South Coast Air Quality Management District, the Northeast States for Coordinated Air Use Management, the New York State Department of Environmental Conservation, and the California Air Resources Board.

GLOSSARY OF ACRONYMS

AEERL	EPA, Air and Energy Engineering Research Laboratory
CARB	California Air Resources Board
EPA	U.S. Environmental Protection Agency
NAPAP	National Acid Precipitation Assessment Program
NASA	National Aeronautics and Space Administration
NESCAUM	Northeast States for Coordinated Air Use Management
NYSDEC	New York State Department of Environmental Conservation
OAQPS	EPA, Office of Air Quality Planning and Standards
OPP	EPA, Office of Pesticides Programs
OTS	EPA, Office of Toxic Substances
SCAQMD	South Coast Air Quality Management District
VOC	Volatile Organic Compound

BACKGROUND

The U.S. ozone non-attainment and air toxic problems have been among the most unyielding problems facing the U. S. EPA. Efforts to achieve extensive reductions in VOC emissions, thereby reducing ambient ozone concentration, have not been successful partly because of the difficulty of dealing with stationary area sources. An area source, as defined for this paper, is one that emits less than 9.1 Mg/yr (10 T/yr) of each VOC and less than 22.7 Mg/yr (25 T/yr) of combined VOCs. Collectively, small area sources may contribute as much as 50 percent of VOC emissions.

Since many of these sources are not amenable to add-on control devices, they must be mitigated through prevention methods such as product substitution, solvent reformulation, and evaporation control. Although some progress has been made, the lack of demonstrated substitutes for VOCs is commonly the principal barrier to reducing emissions from area sources. Many State and local agencies are trying to force reduction through regulation, but they are not able to push regulation beyond demonstrated technology. Industry seldom finds it advantageous to publicize progress and have it become the state-of-the-art for new regulations.

The goal of this project is to aggressively attack this standoff by understanding how to reduce VOC emissions from stationary area sources by developing, evaluating, and/or demonstrating pollution prevention options. The project consists of two tasks:

1) Demonstrating the viability of VOC emissions reduction through alternative coating materials and processes; and

2) Identifying and evaluating consumer product prevention options.

For each task, the concept to be employed is that VOC emissions will be reduced via prevention technology, inferring a decrease of ambient ozone concentrations and resulting in a reduction of exposure to air toxics. By the year 2000, the reduction for the source categories selected for this project could represent up to 9 percent of non-mobile area source VOC emissions. Industrial partners will be sought for each of the planned demonstrations and will be particularly important for the "demonstration of alternative coating materials" task.

DEMONSTRATING THE VIABILITY OF VOC EMISSIONS REDUCTION THROUGH ALTERNATIVE COATING MATERIALS AND PROCESSES

Several projects concerning alternative coatings will be conducted under this task. Many will be co-funded by EPA's Air and Energy Engineering Research Laboratory (AEERL), the South Coast Air Quality Management District (SCAQMD) (which includes Los Angeles), and industrial partners. Industrial partners will be identified during 1990. A work group including AEERL, EPA's Office of Air Quality Planning and Standards (OAQPS), EPA Region 9, the California Air Resources Board (CARB), and SCAQMD has been formed to provide guidance for this task. In addition, the work group will obtain feedback from representatives of EPA Regions 1 and 2, EPA's Office of Toxic Substances (OTS), the New York State Department of Environmental Conservation (NYSDEC), and the Northeast States for Coordinated Air Use Management (NESCAUM).

The focus of this effort will be the reduction of VOC and other emissions from coating operations. Coating operations release approximately 15 percent of stationary area source VOC emissions as estimated by the 1985 National Acid Precipitation Assessment Program (NAPAP) emissions inventory. Many of these sources cannot be impacted by add-on controls at a reasonable cost due to their small size and/or the difficulty of capturing emissions. The reduction of solvent emissions from architectural and other coatings continues to rely on prevention technologies such as the replacement of VOC with water or non-photochemically reactive solvents; the use of high solids coatings; improvement of the efficiency of transfer of the coating to the coated surface; or improved capture and recycle of evaporating solvents. In current practice, reformulation with non-photochemically reactive solvents often leads to other environmental problems, such as increased toxicity, greater stratospheric ozone depletion potential, and worsened multimedia effects. These potential impacts will be evaluated and avoided throughout the coatings substitutes research effort. There is also potential for eliminating the use of solvent-based coatings altogether. The use of such coating-free materials would eliminate emissions during the manufacture and the life of the products by avoiding the coating process.

Three projects are proposed to prevent solvent emissions from coating operations. The first two, an Evaluation of Potential Coating Technologies and a Surface-Coating-Free Materials Workshop, will bring together information about opportunities for prevention, will provide a basis for future demonstration projects, and will allow the transfer of existing prevention technology from existing users and suppliers to other potential applications. The third project will consist of several Coatings Demonstration Projects.

1. EVALUATION OF POTENTIAL COATING TECHNOLOGIES

The potential of alternative solvents or coating formulations, improved application technology, and enhanced curing techniques for reducing the emissions of VOCs, air toxics, and other pollutants will be assessed. Several emerging technologies will first be screened to assess their potential for small- and large-scale demonstration.

Each promising technology's ease of use, process economics, suitable product appearance, and resulting product durability will then be demonstrated in laboratory-scale testing. These evaluation and demonstration activities will consider the impact of military specifications and other widely accepted standards on the usefulness of the prevention technology. The focus of this effort will be on technologies which can prevent emissions from small, dispersed, stationary area sources. These include small job shops (such as auto refinishers and custom cabinet makers) and non-manufacturing settings such as architectural and industrial maintenance. However, technologies for larger area sources will be considered for demonstration if suitable opportunities for small, dispersed area source prevention are not available.

In addition, a report will be produced which will summarize the technical status of pollution prevention and control during the use of coatings. This will include the results of the preliminary evaluation studies. Of particular interest will be the evaluation of potential manufacturers' ease of use, manufacturing economics, product appearance, and product durability leading to an analysis of market potential.

2. SURFACE-COATING-FREE MATERIALS WORKSHOP

During the evaluation of potential coating technologies, the purpose is to identify coatings which are more environmentally acceptable than those currently in use. In contrast, the objective of the Surface-Coating-Free Materials Workshop is to eliminate the need for coatings entirely.

EPA's background work on VOC area sources has revealed that architectural and industrial maintenance coatings constitute a significant source of VOCs (an estimated 8 percent of 1985 non-mobile area source NAPAP emissions) and organic and inorganic wastes. Not only do emissions occur during the application of the initial coating, they occur each time the surface is recoated during the lifetime of the object or structure. If materials and/or products could be developed which do not need coating, during either manufacture or use, significant reductions of VOC emissions, solid wastes, and sludges can be avoided. This effort will identify opportunities for the development of surface-coating-free materials. These results will be summarized in a report for use by industry and government researchers, and the general public interested in pollution prevention for coated materials.

The technical status of coating-free materials will be evaluated to identify opportunities for demonstration and of viability of these materials. Contacts will be established with industry (e.g., vinyl siding and metal products manufacturers) in order to identify key personnel, new developments, and opportunities. A dialogue will also be established with the Department of Defense and with the National Aeronautics and Space Administration (NASA) to identify emerging technologies. A workshop will then be sponsored in which opportunities will be identified and evaluated, and a technical basis for selection of several material or product technologies for further development will be established.

3. COATINGS DEMONSTRATION PROJECTS

Several demonstration projects will be undertaken to establish the economics, ease of manufacture, quality, and durability of products coated in a more environmentally acceptable manner. The first two will be demonstrations of a new coating system or systems for use by wood furniture manufacturers and by auto refinishers. These will begin during fiscal year 1991. It is anticipated that promising technologies will have already undergone preliminary evaluation and are available for demonstration in these areas. A third demonstration project will be identified during 1991 as the result of discussions with potential industrial partners, the Department of Defense, and/or NASA.

Additional demonstrations will be selected for completion during fiscal year 1992 as a result of the Evaluation of Potential Coating Technologies effort and the Surface-Coating-Free Materials Workshop report. Each demonstration will result in a final report which will analyze other potential applications of the technology, schedule follow-up efforts to confirm the durability of resulting coated products, and evaluate its impact on VOC emissions.

CONSUMER PRODUCT PREVENTION OPTIONS

Two areas of research are included under this task. The first addresses consumer products and will support several efforts to reduce VOCs, air toxics, and other environmentally adverse emissions from these products. These efforts include Federal, State, and local regulatory development, the development of low-polluting product options, and the transfer of information to the public, industry, and interested government groups. The second effort concerns the use of VOCs, stratospheric ozone depleters, and greenhouse gases as pesticide inerts. The primary purpose of this effort is to reduce the amount of these compounds used in, and thereby emitted from, pesticides.

A work group including AEERL, OAQPS, EPA Region 9, EPA's Office of Pesticides Programs (OPP), EPA's OTS, NYSDEC, and NESCAUM has been formed to provide guidance for this task. In addition, the work group will obtain feedback from representatives of EPA Regions 1 and 2, CARB, and SCAQMD.

1. BACKGROUND AND ANALYSIS OF PREVENTION OPTIONS FOR CONSUMER PRODUCTS

A. Introduction

Consumer products are a significant, uncontrolled source of VOC emissions. Emissions from these products also contribute to air toxics, stratospheric ozone depletion, global climate problems, degradation of indoor air quality, and multimedia effects. Add-on control devices are generally not economical for small, widely distributed sources such as consumer products. Hence, innovative pollution prevention options are needed. This program includes the resources needed to accelerate the process of developing and implementing these options. This will result in reduced ambient ozone and organic air toxic concentrations due to the release of fewer VOC emissions.

During 1989, AEERL and OAQPS, in a cooperative effort, initiated information gathering from the consumer products industry. The concept of consumer products was defined and the key players and product types were identified as a first step toward holding a symposium concerning these products. The Symposium on Regulatory Approaches for Reducing VOC Emissions From the Use of Consumer Products[1] or Consumer Products Symposium, was held with extensive industry participation during November 1989. On a parallel course, New York, California, New Jersey, and other states are continuing to develop regulations for consumer products. AEERL is working to expand New York's emissions estimate for the New York City metropolitan area to the entire NESCAUM region. In addition, AEERL has nearly completed studies of VOC emissions from aerosol products and charcoal lighter fluid.

OAQPS continues to be active in the consumer products area during 1990 by initiating projects which address issues which were identified as being critical at the Consumer Products Symposium. These projects include: 1) An inventory of VOCs in consumer products; 2) Determination of the fate of VOCs in consumer products in wastewater, 3) The fate of VOCs from consumer products after land disposal; 4) Aerosol consumer products study; 5) Analysis of potential VOC reductions from aerosol spray paints; and 6) Comprehensive background development for deodorants and antiperspirants.

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[1]U.S. Environmental Protection Agency. "Symposium on Regulatory Approaches for Reducing VOC Emissions from the Use of Consumer Products," EPA-450/3-90-008, January 1990.

B. Planned Research Activities

The program proposed in this research plan integrates pollution prevention concepts, the critical research needed for minimizing VOC emissions, AEERL's 1989 research results, state regulatory research and activities, and the anticipated results of OAQPS' 1990 program.

i. Consumer Product Test Method Development

The development of test methods for determining VOC emissions from consumer products has been identified as the highest priority research activity for this area source category. Many states are considering rules to limit VOC emissions or content of these products. These rules will use criteria such as maximum VOC content by weight or percentage of VOC removed from products via reformulation. There are presently no widely accepted methods for completing these measurements. Hence, the development of test methods is a key component of regulatory strategies to reduce VOC emissions from consumer products. Similarly, industry needs widely accepted methods to evaluate their progress in reducing VOC in their products.

Test methods are needed for several consumer product types, such as volatile organic liquids, aerosols, volatile organic solids, and solids containing residual organics. AEERL has initiated a work assignment to: 1) identify existing and potential test methods; 2) clarify the types of measurements needed to support the regulatory, inventory, and research communities; and 3) synthesize this information into a research plan. Examples of existing test method information include the OTS shelf survey of potential public exposure to chlorinated solvents and the methods identified in CARB's draft rule for consumer products.

Test method development will begin during fiscal year 1991. Annual progress reports will be produced that describe the resulting methods in detail. Testing of specific products is not anticipated at this time.

ii. Prevention Options Research

Methods to reduce emissions from consumer products, which make up approximately 10 percent of the non-mobile area source VOC emissions inventory, are limited to prevention options, such as reformulation and product substitution. Although industry is ultimately responsible for developing new products which result in reduced emissions, this process must be accelerated to ensure that Clean Air Act Amendment deadlines are attained. In this process, there will likely be technical and institutional barriers to overcome. The Agency could play a key role in identifying and overcoming these barriers in order to facilitate change.

Prevention options research will build on the earlier efforts of the work group participants and other interested parties. *Aerosols have been* identified as a key area where significant impacts may be made through reformulation and product substitution. However, a significant scoping study is needed to identify other areas in which research and demonstrations are warranted. The proposed scoping study and demonstration project are described below.

a. Prevention Options Availability Report and Data Base

The objective of the first (scoping) study is to define the range and categories of products for evaluation during this effort. Emphasis will be on products that are the greatest contributors to VOC emissions based on existing emissions estimates. Within the defined scope of products, a priority list of solvent substitutes will be established for study. The focus will be on identification of environmentally acceptable (i.e., with respect to VOC content, tropospheric ozone formation potential, and stratospheric ozone depletion potential) replacements for high volume photochemically reactive organic compounds used in the formulation of these products. Attention will be given to health-based concerns and multimedia effects. These key solvent substitutes will then be the focus of additional studies directed toward assessment of safety considerations, such as acute and chronic health effects. The results of this effort should feed into other prevention options research in the overall project.

In addition, this effort will evaluate ongoing prevention research to identify both demonstration opportunities and technical/institutional barriers which can be impacted by this and other research programs. The information which is obtained will be assembled into a document suitable for transfer to the public, to industry, or to governmental researchers or regulators.

b. Demonstration Project

The Prevention Options Availability report will identify potentially viable consumer product substitutes and technical/institutional barriers to prevention of VOC and air toxic emissions. In order to inject potential substitutes into the marketplace, projects to demonstrate the effectiveness of technologies and/or overcome institutional barriers are necessary. This task provides for one or more of these demonstrations. A final report will be prepared for each demonstration.

c. Aerosol Propellant/Packaging Changes

AEERL has just completed the initial work in this research area and will publish a report characterizing the nature of this source sector and potential prevention options. Approximately 3 billion units are utilized in the U.S.

each year. Such units release approximately 590,000 Mg (1.3 billion lb) of various organics to the atmosphere. Research to be undertaken during fiscal year 1991 will enable EPA to pursue implementation of aerosol product emissions prevention options. Research activities may include:

- Defining alternatives to organics for propellants and carrier solvents in aerosol packaging, such as compressed inorganic gases;

- Investigating several new, and improving existing, packaging alternatives to aerosols;

- Calculating VOC and air toxic emission reductions which may result from the use of alternative propellants or consumer product packaging options;

- Evaluating innovative and existing aerosol packaging; emphasis will also be on the possibility of refilling containers, thereby reducing VOC emissions as well as waste disposal problems; and

- Incorporating results into a technical options report.

2. DEVELOPMENT OF THE TECHNICAL BASIS FOR A PESTICIDE INERTS STRATEGY

Carriers and solvents in pesticide formulations are potentially the source of substantial environmental problems on both domestic and global scales. OPP has addressed toxicity issues in its pesticide inerts strategy. However, these solvents, many of which are VOCs, stratospheric ozone depleters, or greenhouse gases, continue to be released to the atmosphere during use of the pesticide. For example, the large amount of VOCs released puts pesticides high on the list of sources which are being addressed by states and urban areas attempting to achieve the ozone standard. The pesticides inerts strategy does not presently have a technical basis for dealing with this cross-regulatory problem. The proposed research will establish an extension of the inerts strategy by developing a technically based decision making approach which can be used by OPP in influencing choices of inerts utilized in pesticide formulations. Specific research activities will include:

- Enhancing other VOC reduction projects by identifying the amounts and types of inerts used in pesticides; and

- Extending the current four category inerts approach by developing a second tier of categories which will not only take into account primarily photochemical reactivity but also consider stratospheric ozone depletion and greenhouse potential factors.

PERFORMANCE MEASURES

The effective performance of this project will be assessed by monitoring progress in four areas.

1. COMPLETION OF RESEARCH PRODUCTS

The timely completion of quality research products is the first, and most easily assessed, step toward reducing emissions from area sources.

2. TECHNOLOGY TRANSFER

Completion of the proposed research will provide an impressive array of pollution prevention information for coatings and consumer products. The success of this project must be judged on how efficiently this information reaches its audience. Industry needs to provide environmentally safe products and use acceptable processing techniques. The consumer needs to know that low-polluting alternatives are available and use them. Federal, State, and local air pollution control agencies need to drive the process through innovative regulation and effective ombudsmanship of emerging low-polluting technologies.

3. APPLICATION OF RESULTS

The successful application of the results of this research program is, in many ways, a more meaningful benchmark than the success of technology transfer efforts as evaluated by the number of reports and presentations that are provided to the public. Results can be catalogued in such areas as: 1) Use in policy and regulatory development; 2) Documentation of continued applications research in industry; 3) Use of demonstrated prevention options in commerce; and 4) Acceptance of prevention options as established methods for reducing VOC, air toxic, and other pollutant emissions.

4. EVALUATION OF IMPACT ON VOLATILE ORGANIC EMISSIONS

As an overall measure of success, projections of the total environmental gains expected from all program components will be made at the end of each year. Each research effort will need to determine the magnitude of its success by establishing a baseline against which to quantify emissions reductions.

SUMMARY

Under the leadership of EPA's Air and Energy Engineering Research Laboratory, a research program, entitled "Demonstration of Emerging Area Source Prevention Options for Volatile Organics," is underway. The program's overall goal is to reduce VOC emissions from stationary area sources by

developing, evaluating, and/or demonstrating pollution prevention options.

The program includes two major project areas. The Alternative Coating Materials and Processes task seeks to meet this goal initially through the preparation of two background documents: Evaluation of Potential Coating Technologies, and Proceedings: Surface-Coating-Free Materials Workshop. These will bring together information about opportunities for prevention and provide a basis for future demonstration projects. Several coatings demonstration projects will then be selected and completed. The second program area, Consumer Product Prevention Options, addresses consumer products and pesticide inerts. In doing so, it will support several efforts to reduce VOCs, air toxics, and other environmentally adverse emissions from these products.

Given the continued close cooperation of the work group members -- EPA's Air and Energy Engineering Research Laboratory, EPA's Region 9, EPA's Office of Pesticides and Toxic Substances, EPA's Office of Air Quality Planning and Standards, the South Coast Air Quality Management District, the Northeast States for Coordinated Air Use Management, the New York State Department of Environmental Conservation, and the California Air Resources Board -- and the successful solicitation of industry participation, substantial benefits to the environment are anticipated from this project.

A NEW PARADIGM FOR POLLUTION PREVENTION R&D: SUMMARY REPORT OF THE ENGINEERING FOUNDATION CONFERENCE ON FUTURE DIRECTIONS IN POLLUTION PREVENTION R&D

John L. Warren, Conference Chairman
Program Director, Hazardous Waste Policy
Research Triangle Institute
Research Triangle Park, NC 27709

Alison Gemmell, Process Engineer
CH2M Hill, Inc.
Emeryville, CA 94608

Daniel J. Watts, Deputy Director
Hazardous Substance Management Research Center
New Jersey Institute of Technology
Newark, NJ 07102

R. Scott Butner, Chemical Engineer
Battelle Pacific Northwest Laboratory
Richland, Washington 99352

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A NEW PARADIGM FOR POLLUTION PREVENTION R&D: SUMMARY REPORT OF THE ENGINEERING FOUNDATION CONFERENCE ON FUTURE DIRECTIONS IN POLLUTION PREVENTION R&D

1. INTRODUCTION

The Engineering Foundation sponsored earlier conferences on waste minimization in 1986 and 1988 and other organizations, such as EPA and AIChE, have sponsored large conferences on pollution prevention technologies and policies. Attendees at these meeting and other professionals in pollution prevention believed that it was appropriate to have a small conference to focus on future directions in pollution prevention R&D.

This paper summarizes the conference held January 27 - February 1, 1991, in Santa Barbara, California. In addition to the Engineering Foundation, the Conference was sponsored by the American Institute of Chemical Engineers (AIChE), the National Science Foundation, Battelle Pacific Northwest Laboratory, the U.S. Environmental Protection Agency's Risk Reduction Laboratory, and the Research Triangle Institute.

An Engineering Foundation Conference is an organized forum for discussion among professionals of a timely and important subject in engineering or at the interface of engineering and other disciplines. At the 5-day conference, the conferees live and work together onsite in a retreat-like setting, which is aesthetically satisfying and free of extraneous distractions. Because of the structure of the Conference, a sense of community developed among the participants that cannot be adequately captured in a formal presentation.

This paper focuses on the key recurring themes in the seven plenary sessions and the five Working Group sessions. Working Groups fully attended by all members provided for small group discussions of the four recurring themes:

- the emerging pollution prevention paradigm,
- reduction in chemical use,
- pollution prevention and the product life cycle, and

- pollution prevention and global issues.

The result of the variety of papers, presentations, Working Group meetings, ad hoc sessions, and late night discussions was a smorgasbord of ideas and suggestions. This paper provides a compact overview of those discussions. Details are available in the conference summary report—*A New Paradigm for Pollution Prevention R&D: Summary Report of the Future Directions in Pollution Prevention R&D Engineering Foundation Conference*, available from the Engineering Foundation.

Section 2 addresses the terms we used to frame the conference. Section 3 reviews components of the paradigm relevant to pollution prevention while Section 4 discusses the overall themes that came from the conference. Section 5 lists some of the specific R&D recommendations made by the Working Groups. The final section reviews future Engineering Foundation Conferences.

2. POLLUTION PREVENTION: A NEW PARADIGM

When the Conference Committee was planning the program we assumed everyone knew the meaning of pollution prevention. However, we quickly found out that even experts held a wide range of opinions about pollution prevention and what is meant by practicing it. Consequently, we focused an initial session on pollution prevention as an emerging paradigm. In simple terms, a paradigm is a set of shared beliefs, a way of looking at the world.

Two decades ago, science historian Thomas S. Kuhn wrote in *The Structure of Scientific Revolutions* of "paradigm shifts." He described these as sudden, dramatic changes in the basic belief systems on which scientific inquiry is built. These shifts, he maintained, are discrete events in time that occur when the existing set of basic assumptions about the world (the existing paradigm) begins to limit our ability to explain the world around us. These shifts are much more dramatic than simply the introduction of a new theory or hypothesis, because they entail reexamining the *cultural* belief system (religious, political, and economic), rather than simply replacing one set of scientific assumptions with another.

In recent years, the term "paradigm" has been overused. The results of the discussions of this conference, however, made it clear that using the term is warranted in discussing what must be done to embrace an effective pollution prevention ethic. The old paradigm focused on end-of-the-pipe control technologies in response to command-and-control statutes and regulations at all levels of government. However, pollution prevention, a shift from the old paradigm, changes the ways in which we as engineers and technical researchers look at the world. Emphasis should now be placed on looking at environmental management in a more holistic and systems-oriented approach focused on source reduction through process improvement and modification and an appreciation that everything *is* connected to everything else.

This paper presents a vision of what must be accomplished to complete the shift to the new pollution prevention paradigm, as well as our thoughts on how we can expedite an effective transition. We have also attempted, to the greatest extent possible, to reflect the wide range of opinions on what this new paradigm entails. The intent is not to provide answers but rather to provide the results of a week's worth of serious discussions by a wide range of engineers and other technical professionals. We want this vision and discussion to serve as a catalyst for serious discussion by others as policies and research agendas are formulated and implemented.

3. THE VISION: COMPONENTS OF THE POLLUTION PREVENTION PARADIGM

Three components form our vision of the pollution prevention paradigm:

- social change,
- sustainable development, and
- individual and corporate responsibility.

3.1 Social Change

One of the most surprising aspects of this conference was the rapid convergence of opinion on one important point: The most important challenges are not technological in nature, but involve changing our basic patterns of consumption and use of materials, products, and energy. This realization was particularly surprising in light of the predominance of scientists and engineers in attendance.

Although we debated the definition of environmental degradation (as distinguished from environmental releases), most agreed that any finite rate of environmental destruction was unacceptable over the long term. Increasing population (in itself an issue of concern) and the demand for improved standards of human welfare (especially for developing nations) dictate that resource demands will eventually outstrip increases in efficiency of material utilization. The important issues are when this will happen and what we should do about it.

3.2 Sustainable Development

The U.N. World Commission on Environment and Development defined sustainable development as that which "... meets the needs of the present generation without compromising the ability of future generations to meet their own needs."

An unresolved issue at the conference was whether the goal of pollution prevention was simply to eliminate discharges of materials to the environment (zero discharges), or whether it extended to the idea of sustainability. The two terms are not mutually exclusive, but they differ in implication.

Conference participants agreed on the importance of sustainable development to the future of global environmental management. However, opinions varied on specifics and the extent to which decisions about pollution prevention should be consistent with the goals of sustainable development.

3.3 Individual and Corporate Responsibility

As individuals working in corporate environments, we need to take our knowledge of pollution prevention home with us and disseminate that knowledge to families and friends. As individuals in corporations, we also need to speak up and suggest ways to accomplish pollution prevention inhouse. Corporations may wait for a pollution prevention "champion" before committing time and resources to R&D or full-scale projects. Individuals can be those champions.

4. REALIZING THE VISION: OVERALL CONFERENCE THEMES

Several themes arose during the conference. This section briefly discusses the following themes:

- Need for rational, informed decisionmaking
- Use of product life cycle analysis (PLCA)
- Need for enhancing the environmental business ethic
- Importance of the different roles of major players
- Technology and pollution prevention
- Energy and pollution prevention
- Integration of an environmental ethic into the engineering design process
- Pollution prevention and the developing world

4.1 Need for Rational, Informed Decisionmaking

The conference participants expressed a clear need for a rational basis for decisionmaking at the following levels:

- policy,
- regulatory,
- engineering design process,
- consumers,
- corporate management, and
- shop-level workers.

4.2 Use of Product Life Cycle Analysis (Define PLCA)

Product life cycle analysis (PLCA) is a new way to challenge our normal way of thinking about resources. PLCA quantifies materials and energy usage and environmental releases, assesses the impact on the environment, and develops ways to improve the product, process, or activity. although recognized as a valuable decision tool,PLCA has limitations and is not a panacea for individual decisionmaking or goal setting. PLCA includes several phases of a product life that can be targeted for pollution prevention:

- the raw materials acquisition phase;
- the formulating and product processing phase; and
- the reuse, recycling, or maintenance phase.

PLCA models currently focus on the inventory of releases throughout the life cycle, because that is where we have the most information. More needs to be done in assessing impacts and in determining what can be done about the impacts (improvement analysis). Impacts can be presented qualitatively or quantitatively, yet, to compare products, we need a standardized approach. Developing a PCA methodology should be a priority, including clear notations on boundary conditions.

4.3 Need for Enhancing the Environmental Business Ethic

A shifting paradigm implies changes, not in a corporation's core values or beliefs, but in how the corporation and the individuals in the corporation act on those values. In most discussions, we were unable to *not* talk about whether a firm or institution had an environmental business ethic. Experience seems to indicate that firms with a clear environmental ethic espoused by top management and backed by corporate resources are better able to accomplish pollution prevention R&D and subsequent implementation.

4.4 Importance of the Different Roles of Major Players

Pollution prevention R&D is affected by a variety of institutions and factors. The conference did not make an exhaustive list of these. The following players may significantly affect the extent to which pollution prevention R&D can be conducted in the United States.

Each player brings a unique perspective and expertise to pollution prevention R&D. Cooperation between players and integration of ideas were generally considered desired goals; however, working group members recognized that barriers exist and inhibit full cooperation.

Barriers range from industry's need for confidentiality and quick results to educators' preference for long-term theoretical studies whose results can be published and broadly applied.

4.4.1 Industry

Industry refers to businesses that manufacture products and generate wastes. Industry is thought of as fast-paced, decisive, profit-oriented, and able to allocate budget toward R&D. Industry can contribute to the success of pollution prevention by

- eliminating or reducing wastes generated during manufacturing,
- demanding and paying for full cycle raw material/waste management services (e.g., solvent purchase/recycle/reuse services, cardboard packaging recycling services),
- funding R&D out of profits, and
- providing consumers with environmentally sound options.

4.4.2 Consumers

Consumers represent individuals from the general public who demand environmentally sound products, both in their manufacture and use, but may also be constrained by costs versus benefits. Consumers can contribute to the success of pollution prevention by

- identifying and communicating their motivation for purchasing products (e.g., minimum environmental impact versus product cost),
- participating in educational forums to be better informed,
- disseminating information throughout communities,
- demanding environmentally sound products,
- practicing pollution prevention in the home, and
- influencing social change.

4.4.3 Educators

Because the new environmental paradigm places responsibility not only on corporations but also on each individual, each individual needs to be prepared to make rational, informed decisions. This includes not only a basic understanding of environmental consequences resulting from everyday actions, but also a deeper scientific and environmental literacy. For example, consumers must have a basic understanding of how risk is measured and how uncertainty is included in data. Consequently, educators play a key, catalytic role.

Educators consist of those responsible for kindergarten through twelfth grade (K-12) education, vocational schools, universities and colleges, and continuing education instruction. Educators, as referred to here, are not limited to people with engineering or technical science backgrounds. Educators can contribute to the success of pollution prevention by

- teaching pollution prevention concepts at each level of education, with particular long-term emphasis on K-12;
- integrating pollution prevention concepts into each course of instruction so the concepts permeate students' thinking rather than standing alone;
- providing a consistent thread of pollution prevention reinforcement from kindergarten through continuing education (consistency through a lifetime cannot be achieved by any of the other roles); and
- providing individuals with education that can serve as a basis for rational, informed decisionmaking.

4.4.4 Government

We do not expect to shift to a pollution prevention paradigm through the actions of government alone. Nonetheless, government has a powerful and important role to adopt in encouraging pollution prevention. To a large extent, government reflects the will of the people. Government consists of two different groups of people: those who pass laws (the heavy hand) and those who provide assistance (the helping hand).

Each group has a distinct role in pollution prevention. The role of government in passing and enforcing laws on product manufacturing and waste management is to force industries to provide environmentally safe products and use low environmental impact methods to manufacture products.

The second component of government—technical and economical assistance—performs research, provides funds, and disseminates information. Ideally, the role of this player is to compile information from each major player and provide it to the other players that need it. Government assistance can contribute to the success of pollution prevention by

- funding and performing research not covered by the other major players;
- finding and supporting industries willing to perform demonstration projects and go public with the results;
- finding end uses for research performed by educators;
- serving as a trusted (same side of the fence) technical link between the regulators who do not understand the technical constraints of proposed laws; and
- serving as a focal point for comprehensive, multimedia pollution prevention strategies.

4.4.5 Special Interest Groups

The primary importance of special interest groups is their ability to combine elements of the major players listed above, exchange information, and implement ideas with fewer barriers.

In this context, special interest groups include the following:

- service industries,
- national laboratories, and
- trade associations/professional societies.

Each of these will be briefly defined and discussed regarding their role in pollution prevention. More detail will be provided in the conference summary report.

Service industries provide a service in addition to, or instead of, a product. These industries typically lease products, rather than sell them, so they are ultimately responsible for the used product. Service industries are closely tied to a cradle-to-cradle mentality, instead of a cradle-to-grave mentality.

National laboratories, managed by private companies and funded primarily by government agencies, traditionally link government with energy research, policies, and conservation. National laboratories are an example of the cooperative effort between government, educators, and industrial major players. The primary contributions of national laboratories to pollution prevention include

- continuing the link between government-funded research and the application of that research, either within the government or by industries that have access to the published information, and
- linking energy conservation to waste management and resource management in general.

Trade associations and professional societies, as cohesive industrial groups, play a useful role in pollution prevention. These players can identify group priorities for pollution prevention and then provide a ready source of funding for R&D from group memberships or contributions from industries that will directly benefit. Their role is cooperative in nature and produces results that can be shared among the groups in relatively short time frames. Confidentiality barriers are mitigated by this approach.

4.5 Technology and Pollution Prevention

Five technology issues were addressed and include the following:

- chemical-use reduction,
- clean materials,
- clean technology,
- appropriate technology, and
- information technology.

Just as pollution prevention methods are prioritized in a well-known hierarchy, allocating resources to R&D could be prioritized for the five issues stated above. Chemical-use elimination should be a first priority in pollution prevention if the chemical is highly toxic or produces a high volume of relatively toxic waste. However, for the sake of practicality, chemical-use reduction or optimization should also be a strong priority. Examples of chemical-use elimination include using laser cleaning methods to replace solvent cleaning methods. Examples of chemical-use reduction include fine-tuning chemical additions for chemical reactions. Chemical-use reduction has an additional advantage because it can be studied or applied by several of the major players.

Clean-materials research addresses the root of the pollution problem and can be implemented by several of the major players. Money and time spent on materials research may be used in more than one industry. Numerous related issues, such as unknown long-term toxicities of clean materials and contamination of clean materials during a process, also need to be addressed.

Clean-technology research should focus on processes that currently produce the greatest quantities of waste or high toxicity wastes as well as processes that revolutionize a manufacturing process for a group of similar industries. For example, clean technologies could be developed for the pharmaceutical industry for the reduction of volatile organic compounds.

Appropriate technologies for developing countries could be researched and implemented using relatively small additional money and time. R&D could focus on individual countries' particular concerns and their cultural and material factors that would influence recommending one technology over another. The relatively small amount of time spent on implementing these already developed and proven technologies would go a long way toward reducing pollution on a world-wide balance.

Information technology may be divided into two components: database management and routine calculations, and "smart" computer programming

Conference attendees agreed that most existing industrial and government databases do not contain useful information for pollution prevention evaluations. Therefore, R&D for developing an effective database would be appropriate. The usefulness of this database to industry should be considered and incorporated in the database design. Currently, many industries feel that the databases developed by government from industrial waste tracking reports or materials use tracking reports (e.g., SARA Title III-Form R) take up valuable staff time that could be better directed toward constructive pollution prevention.

"Smart" computer technology, although an important technology, may be a lower priority item. Because of the relatively small group of experts working in this field and the limited number of people trained to use the resulting "smart" programs, money and time allocated to this area would not have the immediate, wide-spread applicability as the other technologies mentioned above.

4.6 Energy and Pollution Prevention

Attendees, concerned about the war in the Middle East and recognizing the renewed importance of energy conservation, pointed out that pollution prevention policies can learn from the energy conservation policies of the late 1970's and early 1980's. Three predominant themes were discussed:

- energy optimization,
- limitations of renewable energy for sustainable growth, and
- coordinated approach to energy use and pollution prevention.

Energy optimization, also referred to as energy conservation, has long been the subject of R&D and full-scale implementation. Lessons learned during these studies can be applied to developing pollution prevention programs.

Renewable energy includes wind, solar, and ocean-current technologies. Limitations of renewable energy such as high cost, ability to replace only a small percentage of existing energy needs, and climatic and geographic limitations may parallel limitations of pollution prevention and its role in sustainable growth.

Finally, a coordinated approach between energy use and pollution prevention is needed. The impact of a less polluting process or piece of equipment must be weighed against an increase in energy consumption or increase in need for nonrenewable energy. Pollution prevention impacts on energy balances should be given the same weight as pollution prevention media transfer issues. Ultimately, a coordinated mass and energy balance approach, already a part of good design engineering, should be the goal of pollution prevention R&D.

4.7 Integration of an Environmental Ethic into the Engineering Design Process

Current engineering curricula may include a separate environmental course; however, environmental engineering students are the only ones likely to take these courses. Environmental considerations, particularly pollution prevention themes, should be integrated into every engineering course such that the concepts become as critical to engineering design as overall quality and cost control. Environmental considerations should be included as a separate lecture within each course and should also be reinforced throughout the entire course. This reinforcement can be achieved through laboratory projects, homework assignments, and grading criteria.

4.8 Pollution Prevention and the Developing World

One plenary session was devoted to global issues. During the session we realized that European concerns were entirely different from developing nation concerns. In Europe, concern for product utilization optimization and low waste generation has been evolving over the last 10 to 20 years. Many laws and social attitudes have already made the transition from waste treatment to waste reduction, and even on to product utilization optimization.

In contrast, developing countries, still striving for adequate food and shelter for their general population, are evolving toward a level of concern for the environment that the United States experienced over the last 10 to 20 years. The challenge to the industrialized world is to work within the developing country's constraints (e.g., culture, education, resources) to achieve environmental quality without ignoring the overriding concerns for food and shelter.

Educational and vocational training currently devoted to food, shelter, sewage, or transportation systems could be adapted to simple treatment technologies or simple clean technologies, so the work force would need minimal additional training. Additional training that builds on techniques learned for basic goods and services will probably be more acceptable to the workforce than fancy, new training on complicated black box technologies or processes. If available and affordable, clean materials can be suggested and used rather than problem materials used in the past.

Two additional ideas presented at the conference included one old idea and one new. The old idea is to encourage the industrialized countries to use their knowledge and proven technologies, adapted as necessary, and market their products or services to the developing countries. The new idea, more radical in its approach, is to investigate alternate development pathways toward environmental quality. This approach, if it considered the constraints of each developing country, may be able to bypass certain pollution prevention development stages (such as the treatment technology stage) and go straight to a sustainable development or product utilization optimization stage. Alternately, a completely new development pathway, never used by an industrialized country, could be investigated.

5. VISION SPECIFICS: IDENTIFIED RESEARCH AND DEVELOPMENT NEEDS AND SCIENTIFIC FRONTIERS

Scientists and engineers can design new cultural belief concepts and agree on rapidly and relatively easily. They can easily list environmental goals, objectives, and visions. Developing the strategy and tactics to get from today to where we want to be in the future is difficult. Even more difficult is the task of assembling the information and tools needed to move into the future. That is the role of research, development, and demonstration.

The Conference participants constructed a new vision:

- It heralds substantive changes in consumption and use of materials, products, and energy.
- It requires no deterioration in environmental quality.
- It has components of sustainable development.
- It assumes individual and corporate responsibility.
- It depends on knowledge and consideration of all relevant factors in the design, use, and reuse of materials and products.

A substantial challenge remains in developing the ability for society as a whole and for groups or individuals to be able to live and operate within the scope of this vision. A significant role of a research and development initiative is to provide and support the new inventions, procedures, plans, and ways of thinking that can advance the implementation of the new vision.

5.1 Design and Implementation of Effective Research and Development

To achieve the intended effect, a research and development activity or program should be designed to accomplish the following goals:

- to encourage relevant questions for research,
- to gather information, conceptualize, and create new technologies to address the questions, and
- to refine these new results to a usable form and implement them in the most effective way.

To further the vision espoused at the conference, research results and innovations will be important to and should be implemented by many groups. Different types of information and specific pathways to implementation will be necessary for each group. In the past, a particular research challenge in the area of pollution prevention or source reduction has been the need to conduct meaningful research and development in an industrial setting or on the shop floor. The challenges include the need to establish appropriate experimental controls in the midst of a dynamic and changing milieu, the need to conduct research without adversely affecting the ability of the company to operate and continue to manufacture their product, and the need to devise new technology or approaches that can take into consideration the ability of the organization to purchase or acquire any new types of raw material required and the willingness of the company's customers to buy any products with different characteristics.

One of the first steps on the way to implementing the vision of the conference could be identifying and developing ideas and procedures for effectively carrying out such industrial-based research activities.

5.2 Global and Local Ecosystems

Another important issue we discussed at the conference was the need to heed the requirements of the global ecosystem as well as to understand that every action of an individual, organization, or industry first has a potential effect on some local ecosystem. An improved understanding of the interconnections between local actions and effects and global impacts should be a research and development objective. Significant attention has recently been given to global warming concerns and to the causes that engender these effects. More research is needed to develop better models and increase our understanding of issues such as global air circulation patterns, climate, and biological effects of higher levels of contaminants in surface and ground waters, particularly as they may affect the oceans, the contributing causes and long-range effects of changing land use patterns such as increased urbanization and other changes leading to deforestation and desertification. Such increased understanding and greater emphasis on the effects of human activity on the global environment should also lead to developing optimized plans to reverse, where appropriate, counterproductive land-use patterns.

We can expect research to increase our understanding of the interconnections and impacts of changes in local ecosystems on the global environment. Research can lead to plans for improving or stabilizing local environments for the eventual improvement of the global situation. More importantly, these local improvement plans should, with additional research and development, be able to pinpoint specific actions of individuals, groups, or industries within the local ecosystem's geographical boundaries that should be modified to have the desired beneficial effect on local and global environments.

5.3 Fate and Transport of Pollutants

To understand the potential environmental effect of the residuals of human activity, knowing the possible pathways for movement and modification of any released contaminants is important. The growth of this increased understanding and knowledge will depend on new research and development activities addressing questions such as the following:

- What is the mode and rate of natural degradation, if any, of materials emitted into the environment?
- If the rate is slow, what is the impact of increasing concentrations of the materials on biological systems and on physical systems throughout the world?
- If the rate is fast, what are the chemical products of degradation? Do these products degrade equally fast and what impact might they have on biological and physical systems?
- How are contaminants moved throughout the world? Is such movement solely a physical phenomenon depending on air and water transport or are biological vectors involved?
- How can products be made, used, and decommissioned to have as low a negative impact as possible on the environment?

5.4 Data and Information Sciences Needs

A special session at the Conference provided an opportunity to discuss the existing prolific research efforts to collect and analyze data on chemical usage and throughput, energy consumption, and pollution prevention efforts by industries in the United States. Devising a procedure to facilitate easy access and generous use of the data currently being accumulated seems desirable. As a minimum, this procedure would require a central catalog capability of what is available and where to find it. A computer access system to allow rapid data recovery and correlation with information about chemical and energy use trends found for other industries or groups would be more useful.

Easy access to an expanded data base such as this will allow researchers to consider additional research and development goals such as the following:

- determining chemical and emission flows throughout and between classes of industries;

- identifying technologies and practices already in use at specific sites that may be broadly applicable;
- determining opportunities for exchange of manufacturing wastes or for recycling or other reuse;
- ranking of industry classifications, product classes, or specific chemical uses that may generate the greatest concern in light of the information gathered from fate and transport and ecosystem effects studies;
- identifying gaps in the availability of data leading to creation of research and development plans to obtain the missing types of information;
- monitoring pounds of waste generated regardless of regulatory requirements (e.g., pollution prevention on a nonregulated, and usually unreported, stream could affect a regulated stream);
- developing a list of properties in addition to the typical physical properties that will indicate to a design engineer the potential environmental impact of selecting a material (e.g., toxicology, biodegradability, "recyclability," potential for reuse);
- from a government perspective, reporting useful information that proves progress is being made;
- standardizing reporting because many state governments want to coordinate and establish an information clearinghouse for a pollution prevention database;
- establishing commonalities between industrial processes employed across industries as a basis for developing pollution prevention strategies;
- creating user friendly computer program that can take databases and allow novice users to extract only the information they need; and
- making material balances simple so that consultants can hand over the procedure to clients in a useable format.

5.5 Technologies for Pollution Prevention

Historically, much of the research and development attention on technologies for pollution prevention has focused on the practices and needs of the industrial manufacturing sector. The Conference suggested that the needs go beyond that sector, reaching to the product selection, use, and disposal habits and practices of the general public. Technology research and development needs, therefore, should be broadly addressed.

The discussions at the Conference targeted pollution prevention through chemical use reduction, recycling, and reuse. Consequently, technological research and development issues relate to these practices. Conceptually, industry uses chemicals in different ways to accomplish specific manufacturing objectives. Any new technologies to reduce pollution by altering aspects of chemical usage must consider the reason for the use of the particular chemical and provide an alternative less-polluting procedure to accomplish the manufacturing objective.

5.5.1 Separations

The concept and practices of separation, concentration, and purification of materials represent the foundation on which modern industry is built. The needs range from extractive industries such as mining, metallurgy, and petroleum recovery to purifying minute quantities of biologically active products from genetically engineered organisms.

New technologies for separation should address the issues of purification of the desired product while reducing the quantity or degree of hazard or facilitating recovery and reuse of the substances left behind. The separations area could include the following specific research and development areas for new technology:

- Identification and engineering of equipment for conducting separation procedures under new conditions that improve the efficiency of the process. An example may be using supercritical conditions of temperature and pressure which may change solubility characteristics, allowing the use of smaller quantities of solvents and frequently permitting the use of benign solvents such as carbon dioxide.

- Development of capability to introduce additional screening techniques to allow separations to be accomplished using smaller amounts of solvent. Increased ability to combine such selective membranes with other technologies such as electrophoresis or magnetic forces would allow further reduction in solvent use and in the volume of the waste stream.
- Continued development of closed loop extraction technologies allowing continual recovery and reuse of any solvents required in extraction or related separation approaches.
- Identification and development of new solvents that have the necessary separation effectiveness but have significantly reduced levels of hazard or risk compared with the solvents currently used for specific separation operations.

5.5.2 Reactions

Much of the chemical industry produces items of commerce by carrying out chemical transformations in solution. In some cases, the solvents used can be recovered and reused; in other cases they are disposed of as waste. Other related events such as emissions to the air of volatile solvents and carryover of portions of the solvents in water washings also have potential negative environmental impact. To address these issues, research and development faces a significant challenge. Some initial approaches to the situation could include the following:

- Identification and development of techniques to carry out chemistry in highly concentrated solution or without solvent.
- Identification and development of techniques to increase the use of catalytic or pseudoenzymatic reactions to lead to higher yields of purer materials.
- Identification and development of techniques to facilitate the use of solid state or gaseous state chemistry instead of solution phase chemistry.

- Ultimately designing and creating new chemical materials with the desirable functional properties of other existing materials, but which can be prepared and used with reduced levels of negative environmental impact.
- Establishment and refinement of computer-based artificial intelligence approaches to reaction and process design and implementation could lead to improved and optimized processes to produce the highest product yield of good quality while, at the same time, maintaining waste generation and the level of emissions at the lowest possible level.

5.5.3 *Other Material Transformations*

Discussions at the Conference highlighted concerns about human health or environmental risks inherent in certain materials and products because of their chemical composition. In addition participants were concerned about the long-lived nature of certain products even after disposal and about the inability to recapture usable components of certain products because of the way in which the disparate parts are joined together. In general, participants were interested in encouraging the development and use of materials that could be used and reused several times. Research and development activities to address these concerns and goals could include the following:

- Identification of chemical traits and characteristics that make a particular substance or material "riskier" than others, followed by the synthesis of economic replacements for such materials that are less risky and have comparable or superior performance.
- Identification and development of novel techniques for producing composite materials that can be easily separated into its components at the end of the useful life of the product.
- Creating and producing new materials from the perspective not only of optimizing the cost-performance characteristics in its initial use, but also of facilitating the recovery and transformation into secondary and further uses.

5.5.4 *Other Uses of Chemicals*

Considerable discussion at the Conference involved other uses of chemicals that have significant potential for negative impact on the environment. As an example, two such uses deal with modification of surfaces, specifically in the form of cleaning and of surface coating. Typically, both of these practices use solvents. At present, chlorinated solvents are used in degreasing metal surfaces. Similarly, various volatile solvents are used as carriers for surface coating operations such as spray painting. We list some examples of this type of technological need:

- Identification and further development of techniques to facilitate surface cleaning, including ultrasound activation, plasma and related energy-transfer-based surface cleaning approaches, and combinations of these approaches with nonhazardous water-based cleaners.
- Reconsideration of the need in all cases for extensive cleaning prior to the next production or maintenance step.
- Research, development, and further refinement of alternatives to standard coating operations with volatile solvent-based materials could have significant, positive pollution prevention potential.

5.6 Decisionmaking

A key conclusion of the Conference was that, ultimately, significant progress in pollution prevention would depend on the regular decisions and actions of individuals and of groups. We do not always know why decisions are made or actions initiated that may affect the environment favorably or unfavorably. Sociological and, to some extent, psychological research could help address questions such as the following:

- How much perceived environmental advantage must be contained by a product or new practice to persuade an individual to substitute for present usage?
- What is the best way to communicate environmental advantage to a consumer?

- How much, if any, additional cost or labor outlay is a consumer willing to make for an environmental advantage?
- Does a consumer consider possibilities for product reuse and recycling when purchase decisions are made?
- Are corporate environmentally related decisions made with the same premises as individual decisions?
- Does the manufacturer of products shown to have positive environmental impacts have a market advantage? If so, how can these impacts be designed into products and communicated to consumers?

5.7 Education

If, in fact, furthering the goals of pollution prevention depends on individual decisionmaking and knowledge and use of new technology and new approaches to industrial and personal needs, then a continuing need for education is ardent. We also need to create effective channels to communicate the vision raised by the Conference and the technological approaches and solutions identified by the types of research activities discussed.

One effective channel is the professional community, which could benefit from frequent and vigorous technology transfer initiatives. Another channel is the general populace, which would welcome an opportunity to hear a clear, comprehensible, and unambiguous message about environmental needs, imperatives, visions, and their individual and collective roles in addressing them.

5.8 Research and Development Responsibilities

In a very real sense, the realization of the vision outlined at the Conference will require new decisions, new procedures, and new actions by all people and by the groups they work through. Research and development in the sense of searching for new ideas and trying new things and new approaches can be carried out by each individual. Such exploration should be encouraged and supported by meaningful and understandable information and clear explanations of the anticipated beneficial results of various changes and of their impacts on the environment. Providing people and organizations with the needed information and with the tools to explore modifications of their procedures, practices, and technological relationships would seem to be a most effective course of action.

6. FUTURE OF THE VISION: WHERE DO WE GO FROM HERE?

The dynamic nature of the conference resulted in the organization of a continuing Engineering Foundation Conference on Pollution Prevention. The 1992 conference , "Pollution Prevention – Making It Happen!," will be held January 26 - 31, 1992, in Santa Barbara, California. This conference will continue the tradition of the 1991 conference with an emphasis on the role of small group discussions. Subjects will be specific to the implementation of pollution prevention at the facility and firm level.

The final conference report will be distributed to key decisionmakers within industry, state government, federal government, universities, and public interest groups. Its purpose is not to supplant those R&D analyses that have already been done but rather to foster additional discussion on the role of pollution prevention. Especially critical for effecting R&D will be the understanding of the importance of looking at pollution prevention within a larger societal context rather than as another program for controlling pollution. To accomplish this will require a paradigm shift for all of us, both engineers and the general public.

SESSION 3E

CFC PRODUCT SUBSTITUTION

Chairpersons

Mr. Bill Goins
U.S. Department of Defense
Washington, D.C.

Mr. John Hoffman
Director, Global Change Division
U.S. Environmental Protection Agency
Washington, D.C.
The Importance of Pollution Prevention in the Transition from Chloroflurocarbons

Speakers

Mr. Bill Goins
U.S. Department of Defense
CFC Product Substitution (Part 1)

Mr. David Bergman
Director of Technical Programs, IPC
The Status of AdHoc Solvents Working Groups
CFC Alternatives Test Programs

Mr. Steve Nourie
American Metalwash, Inc.
Aqueous Cleaning Does Work

Prof. Paul R. Kleindorfer
Department of Decision Sciences
The Wharton School, University of Pennsylvania
Philadelphia, PA 19104

Mr. Carmen DiGiandomenico
Chief, Environmental Assessment Office
U.S. Army Materiel Command
Pollution Prevention in Weapon Systems Acquisition

Session Abstracts

CFC Product Substitution

CFCs greatly contribute to global warming and ozone depletion. In order to substitute CFCs, government and industry must pool their resources to research, develop, and test potential alternatives. IPC has developed a standard procedure for testing potential CFC substitutes. Incentives and funding may be needed to promote and facilitate the transfer of alternative technologies to developing countries. Policy makers and industry will face tough choices and challenges when evaluating the options to replace CFCs.

The Department of Defense (DoD) is running several government-industry programs to phase out the military use of ozone depleting chemicals and to resolve the complicated issues associated with defense procurement. Significant research is underway to develop alternative processes and solvents (e.g. aqueous cleaners) that would replace the CFCs now used for electronics and metal degreasing.

The Status of AdHoc Solvents Working Groups CFC Alternatives Test Programs

The Institute for Interconnecting and Packaging Electronic Circuits (IPC) has been involved in a 2 1/2 year test program for evaluating alternatives to the use of CFCs for cleaning printed board assemblies.

Phase 1 evaluated the cleaning performance of existing CFC-113 materials, and established the benchmark criteria against which other materials would be compared.

Phase 2 evaluated the cleaning performance of alternative cleaning agents. To date, seven alternatives have gone through phase 2 testing. All seven have been approved by the AdHoc Solvents Working Group as cleaning as well as or better than the CFC-113.

Phase 3 is intended to look at alternative technologies through the use of CFC cleaning. These include alternative fluxes, alternative soldering methods, etc. To date, three test plans are currently under development. These include water soluble fluxes, no clean fluxes, and inert atmosphere soldering.

Testing on Phase 3 water-soluble fluxes is currently underway at the Naval Avionics Center in Indianapolis. The current status of the three phase program will be discussed, with alternatives being identified as appropriate.

The Importance of Pollution Prevention in the Transition from Chloroflourocarbons

Title VI of the Clean Air Act Amendments of 1990 require the Environmental Protection Agency to promulgate rules and regulations to phase out chlorofluorocarbons and other fully halogenated chemicals by 2000. The consequences of the decisions that EPA, industry, and consumers will be making in the next few years are likely to be quite large, in both economic and environmental impacts. "Smart Pollution Prevention" is a strategy for easing current problems, and improving future economic and environmental performance.

"Smart Pollution Prevention" can take many forms. EPA's recently developed "GREEN LIGHTS" program encourages major U.S. corporations to install energy-efficient lighting technologies in their facilities. Aside from being profitable and preventing combustion related pollution, GREEN LIGHTS can reduce the cost of transition from CFCs in commercial cooling by easing the transition from CFC-11 to HCFC-123.

HCFC-123 will result in a 10 to 20 percent reduction in chiller capacity. Energy efficient lighting can reduce the cooling load, making up the difference in cooling capacity. This would enable a building owner to limit the transition costs from CFCs. Without efficient flighting, may chillers would need to be retrofitted with a larger compressor — at roughly half the cost of a new chiller. The results of this "Smart Pollution Prevention" strategy are lower transition costs, future profits, and less environmental damage.

CFC Reduction and Substitution in Developing Countries

The signing of the Montreal Protocol for Chlorofluorocarbon (CFC) reduction has led to the creation of a Global Environmental Fund (GEF) and subsidiary Ozone Defense Fund (ODF) to be managed by the World Bank, which would provide funds for environmental projects in developing countries, especially in the area of CFC reduction. Since these projects are likely to be perceived as being of greater benefit to the donor countries, they are significantly different from conventional lending programs of the Bank. Furthermore, the success of these projects depends critically on the cooperation of multinational corporations which operate under a set of goals which are likely to be different from those of either developing or donor countries. These features raise a series of issues which relate to:

- The development of appropriate incentive structures and policy initiatives which would create effective incentives within developing countries and industry to successfully implement these projects.
- The provisions and objectives of the Protocol itself as these relate to the timing of achieving phase-out of CFC's and tradeoffs between ozone depletion, global warming and other health, safety, environmental and economic consequences of projects directed toward CFC reduction.
- Evaluating alternative CFC-related projects by the World Bank, in terms of national effectiveness of programs as well as contribution to achieving the overall global objectives.

This presentation will address these three topics and describe ongoing research of a theoretical nature on various approaches to these topics and their likely consequences in achieving the goals of international cooperative agreements such as the Montreal Protocol.

Pollution Prevention in Weapon System Acquisition

The briefing will describe the efforts within DoD to infuse proactive environmental considerations into Weapon System Acquisition. These efforts are in contrast to the traditional pollution control which is typically "end-of-the-pipe" clean-up, remediation, and waste treatment. Pollution Prevention encompasses the "up-front" considerations of material selection and processes which eliminate or mitigate the downstream waste. Included in the briefing will be an overview of the draft DoD response to Congress on Environment in Weapon System Acquisition, and examples of on-going and planned pollution prevention work within DoD. These examples include the environmental manufacturing technology program, the CFC metal cleaning working group and other DoD and service programs.

THE PHASE OUT OF CFCs IPC's ROLE

DAVID W. BERGMAN
Director of Technical Programs
The Institute for Interconnecting and Packaging Electronic Circuits

THE PHASE OUT OF CFCs - IPC'S ROLE

David W. Bergman
Director of Technical Programs
The Institute For Interconnecting and Packaging Electronic Circuits

ABSTRACT

The Institute for Interconnecting and Packaging Electronic Circuits is participating in a three phase test program for identifying and approving alternatives to the use of Chlorofluorocarbons (CFCs) to clean printed wiring assemblies. The three phase test plan establishes the cleaning capability of existing CFC materials (Benchmark) and evaluates if alternative materials and alternative technologies can clean as well as or better than the existing CFC materials. IPC is also working with the military services to facilitate the usage of these new materials.

EXECUTIVE OVERVIEW

IPC an international trade association representing the printed wiring board industry is participating in a Three Phase EPA/DoD/IPC Cleaning and Cleanliness Test Program. This program is intended to evaluate and approve alternatives to the use of chlorofluorocarbons (CFCs) for cleaning purposes. Phase 1 (Benchmark) establishes the cleaning capability of existing CFC materials. Phase 2 of the program evaluates alternative cleaning agents and compares cleaning performance to the Phase 1 results. Numerous alternatives apparently exist. To date seven alternative materials have been evaluated. All seven materials have been shown to clean as well or better than CFC materials and have been recommended to the military services as replacements. At least four additional alternatives should be tested in 1991.

In addition, programs for evaluating alternative technologies that will eliminate the need for CFC cleaning are also underway. These test programs make up Phase 3 of the EPA/DoD/IPC Cleaning and Cleanliness Test Program. The test program for water soluble fluxes is already written and testing started in February 1991. Test plans for evaluating No-clean fluxes and Inert atmosphere soldering are now being written with testing expected 4th Quarter of 1991.

IPC members have participated and played a key role working with Naval Air Engineering Center to develop MIL-STD-2000A "Standard Requirements for Soldered Electrical and Electronic Assemblies". IPC is also working with Electronic Industries Association (EIA) and representatives from the DoD to develop and industry replacement document to 2000A which is designated NTL-STD-SOLD, "Requirements for Soldered Electrical and Electronic Assemblies". These efforts are providing military contractors with the flexibility to use alternatives to CFC cleaning.

In addition IPC members are working with the Defense General Supply Center (DGSC) which is the preparing activity of QQ-S-571E "Solder, Tin Alloy: Tin-Lead Alloy; and Lead Alloy", to update this specification and combine information from other IPC, DoD and international specifications to achieve an all-encompassing document covering electronic solders, solder paste, and fluxes. This effort will facilitate the military use of alternative fluxes being evaluated in the Phase 3 program.

The critical step now is to aid and facilitate the military contractors switch over to the new alternatives. EPA, DoD and IPC will develop teams to oversee and participate in this effort. As successes are seen in this effort they will be publicized, and switch-overs by other contractors should proceed more rapidly.

THE MILITARY PHASE OUT OF CFCs - IPC'S ROLE

BACKGROUND

For many years, CFC-113 and its azeotropic blends have been the solvents of choice for cleaning of metal parts and printed board assemblies in the electronic industries. CFCs are stable, have relatively low toxicity, and leave little or no post-cleaning residue.

The Montreal Protocol on substances that deplete the ozone layer was signed by 24 nations on 6 September 1987. Today, countries throughout the world continue to sign and ratify this accord. Already, countries representing over two-thirds of global CFC production have ratified the protocol, which went into effect 1 January 1989. The accord calls for a 20% reduction in the production of CFCs in 1989, a further 20% reduction by 1993, and a further 30% reduction by 1998. Further tightening of this timetable is exhibited in the U.S. Clean Air Act which brings additional solvents under regulation.

IPC - The Institute For Interconnecting and Packaging Electronic Circuits is an international trade association representing printed wiring board (PWB) manufacturers, military contractors, assemblers, cleaning material suppliers and cleaning equipment supplies among others. As many IPC members were affected by the Montreal Protocol, it was only natural that the IPC would have an interest in participating in the phase-out.

JOINT EPA/DOD/INDUSTRY AD HOC SOLVENTS WORKING GROUP

The Ad hoc Solvents Working Group got started in two areas. In October of 1987, at the request of the EIA/IPC Surface Mount Council, an IPC Task Group began discussing "How Clean is Clean" for surface mount assemblies. A meeting was held in December, 1987 to discuss programs for evaluating surface cleanliness.

In March of 1988, the EPA called an Ad hoc Solvents Group meeting at the request of Dr. Stephen Andersen, Chief of the Technology and Economics Branch, Global Change Division, to begin discussing alternative cleaning agents to CFC-113. The IPC and EPA efforts were merged to develop the Joint EPA/DOD/Industry Adhoc Solvents Working Group. The mission of the working group was to develop a uniform and timely procedure for evaluating alternative cleaning materials to reduce CFCs usage in electronic assembly cleaning.

Shown below are some of the 250 companies that are now represented in the Ad hoc Solvents Working Group.

AD HOC SOLVENTS WORKING GROUP

Solvent/Alternative Chemical Producers

- Advanced Chemical Technology
- Allied-Signal
- Alpha Metals
- By-Pas of Toledo
- Chem-Tech International
- Dow Chemical
- Dubois Chemicals
- Dynachem
- Envirosolv
- Envirosphere
- Exxon Chemical
- GAF Chemical
- Hurri-Kleen
- ICI Chemicals
- London Chemical
- Kester Solder
- Martin Marietta Labs
- Mirachem
- Modern Chemical
- Orange-Sol
- Pennwalt Corporation
- Petroferm
- Unitech International
- Van Waters & Rogers

Flux/Equipment Mfgrs

- Accel Technologies
- Alpha Metals
- Baron Blakeslee
- Branson
- Detrex
- Electronic Cntrls Dsgn
- Electrovert
- Forward Technologies
- Gram Corporation
- Hollis Automation
- Kester Solder
- London Chemical
- Stoelting
- Unique Industries
- Vichem

Defense Contractors

- Allied Signal Aerospace
- Boeing
- General Dynamics
- General Electric
- Grumman Aerospace
- Honeywell
- Hughes Aircraft
- IBM
- Litton
- Lockheed
- Magnavox
- Martin Marietta
- Motorola
- McDonnell Aircraft
- Raytheon
- Sunstrand
- Texas Instruments
- TRW

Commercial Manufacturers

- Apple Computer
- AT&T
- Cincinatti Electronics
- Control Data
- Convex Computer
- Delco
- Digital Equipment
- Eldec
- Ericsson Telecom
- Ford
- Hewlett Packard
- Northern Telecom
- Unisys

Government Agencies/Other

- Air Force RADC
- Air Force Kelly AFB
- Air Force Andrews AFB
- Army Materials Command
- Army Missile Command
- DESC
- Defense Product Standardization Office
- DOD
- EPA
- NASA
- Naval Avionics Center (NAC)
- Naval Sea Systems Command
- Naval Weapons Center - China Lake
- Naval Weapons Support Center - Crane
- Navy - Electronics Manufacturing Productivity Facility (EMPF)
- Sandia National Laboratories

Industry Associations

- Industrial Technology Research Institute - Taiwan
- Institute for Interconnecting and Packaging Electronic Circuits (IPC)
- Haloginated Solvent Industry Association (HSIA)
- Semiconductor Industry Association (SIA)

Other Interested Parties

City of Irvine
Georgia Institute of Technology
Greenpeace
International Conservation Center Foundation (ICF)
Pollution Prevention International
Robisan Laboratories
Solvent Recoverers (SRRP)
Underwriters Laboratories

No interested party is excluded from this activity. IPC maintains a mailing list for the Ad Hoc Solvents Working Group and continues to add interested companies. The Working Group has both international and domestic representatives.

The Ad hoc Solvent Working Group recognized that the major obstacle for changing to alternative cleaning agents was the military specifications. Because many military documents, such as DOD-STD-2000, have become widely used throughout the industry as well as the world, these documents are now de facto world standards. Approximately 10-50% of current CFC usage for printed board cleaning is due to the United States military specifications. Members of the Ad hoc Group sought involvement and cooperation with the U.S. Department of Defense (DOD) in order to see if military specifications can be changed.

In conjunction with this effort, the working group has also developed the following three phase procedure, for evaluating alternative cleaning material:

Phase 1 Development of a test vehicle and test plan (assembly parameters and test). Selection and Benchmark testing of a presently acceptable cleaning material (CFC-113).

Phase 2 Evaluate materials to identify ones as good as or better than the Benchmark Solvent (CFC-113).

Phase 3 Evaluate other technologies that would eliminate CFC cleaning (fluxing options, inert atmosphere soldering).

In order to obtain an international exposure, IPC circulated the test program that was developed to all of the IPC member companies. Comments were solicited from all companies and a working group reviewed and resolved all issues. Therefore in addition to the exposure, the IPC achieved an international consensus on the test plan.

TEST VEHICLE

A standard test assembly, IPC-B-36, (Figure 1) was designed to generate data for evaluating both through-hole and surface mount technologies. The board is configured on 1.5mm (0.060 inch) thick FR-4 laminate with overall dimensions of 100 x 100 mm (4 x 4 inches). The board is divided into four quadrants. Each quadrant has a land pattern site for a 68 I/O chip carrier. Via holes are included on all four quadrants to allow flux to flow up underneath the components during wave soldering. Quadrants C & D have 60 via holes and are intended to simulate present through-hole technologies.

Quadrants A and B are intended to represent surface mount cleaning challenges. Surface insulation resistance measurements can be taken using a daisy-chained through-hole pattern, Y patterns, and comb patterns.

The test boards were assembled in two quadrants with two 68 I/O leadless chip carriers without internal circuitry. The chip carriers are on 1.3 mm (0.050 inch) pitch. A solder mask standoff on top of a copper land yields a total standoff height of .13 mm (0.005 inches) over the laminate. A rosin activated wave solder flux (RA) and RA solder paste were used in order to assure a high level of contamination on the test board. The leadless surface mount component was also used to obtain a rigorous cleaning test, one that would be relevant to military activities.

BENCHMARK TESTING

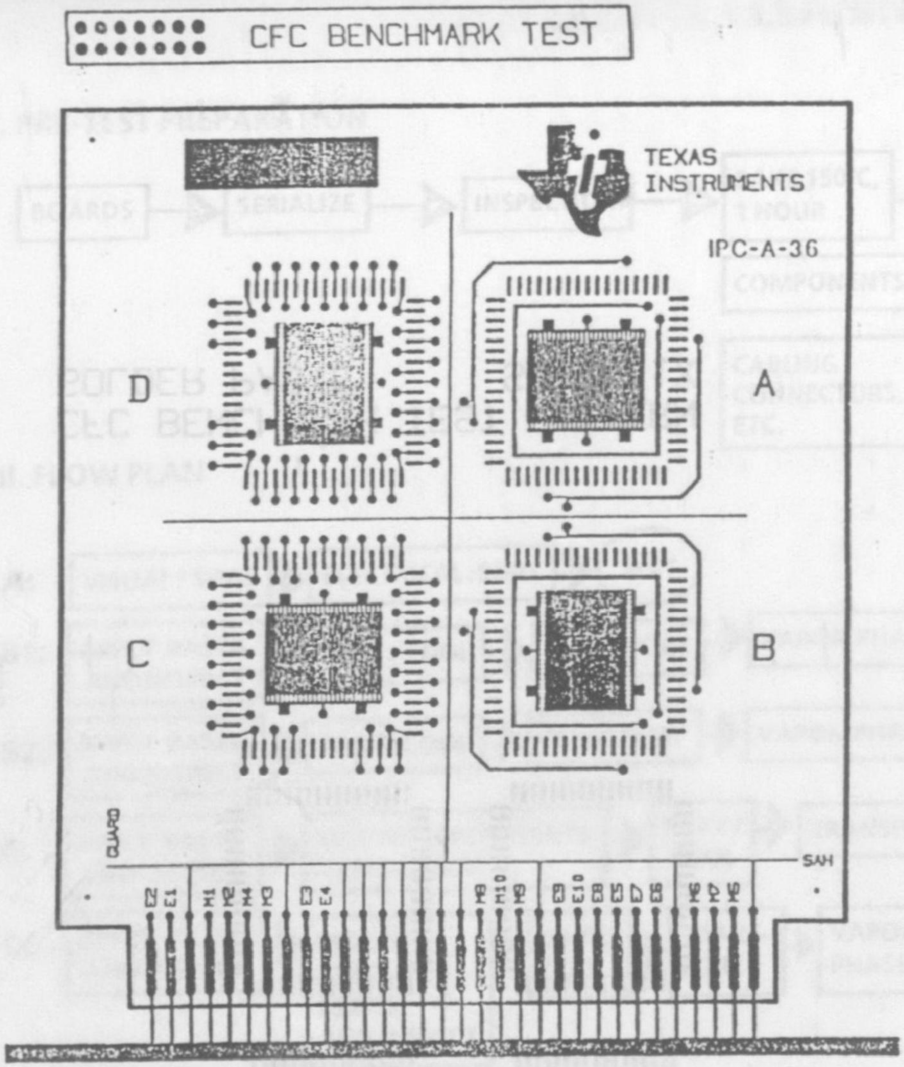
In order to have a frame of reference against which alternative cleaning agents can be compared the test program first called for a benchmark test cleaning with CFC-113.

Benchmark Testing using the standard assembly was performed by two military laboratories:

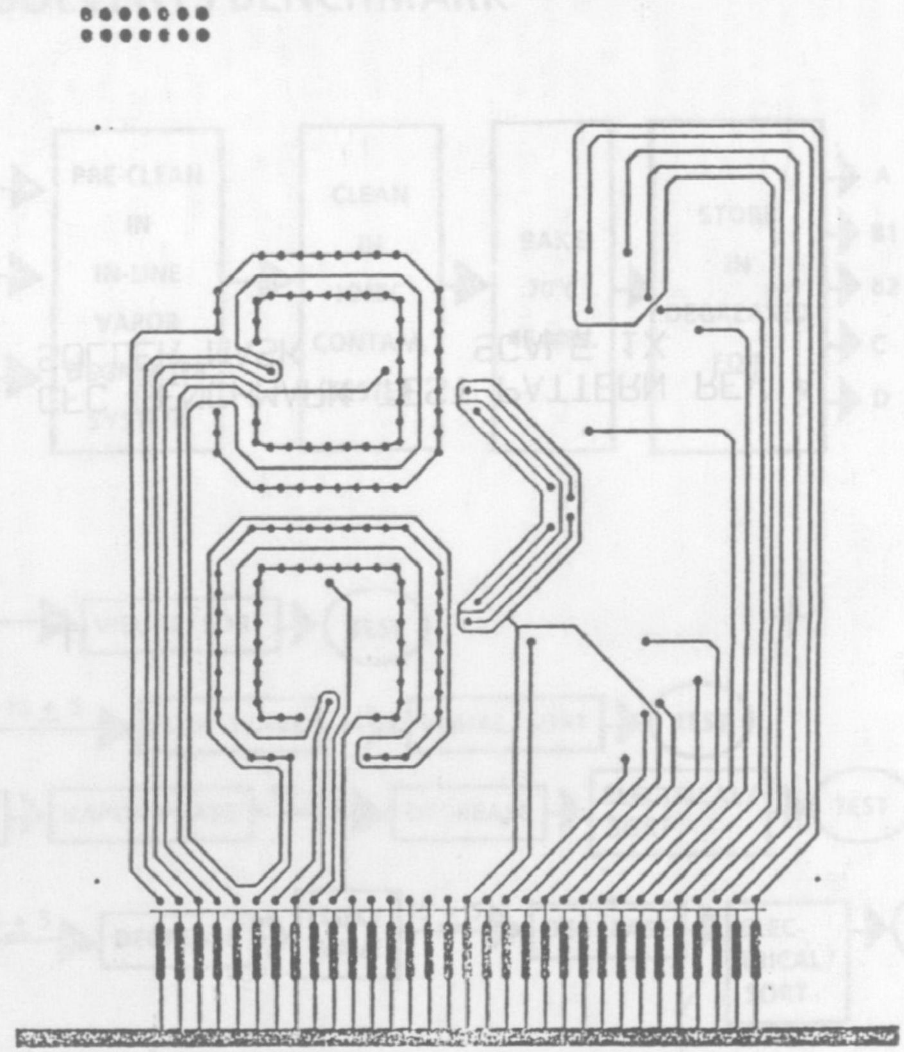
- Electronic Manufacturing Productivity Facility (EMPF), Ridgecrest, CA
- Naval Avionics Center (NAC), Indianapolis, IN

The two laboratories evaluated the cleaning capability benchmark using CFC-113 in the test sequences shown in (Figure 2.)

Process sequence A is the "control" specimen boards only seeing a cleaning step. B1 is the process sequence evaluating the contamination contributed by the solder paste and vapor phase process. B2 is the maximum contamination of the board with flux from the solder paste as well as the wave soldering. The B1 and B2 boards are tested without cleaning. Process sequence C measures the capability of the cleaning agent to remove the contamination by the solder paste (which can be compared to B1). Process sequence D represents the capability of the cleaning agent to clean contamination from both solder paste as well as wave soldering (can be compared to process sequence B2). The Assembly Cleanliness was evaluated using four test procedures:

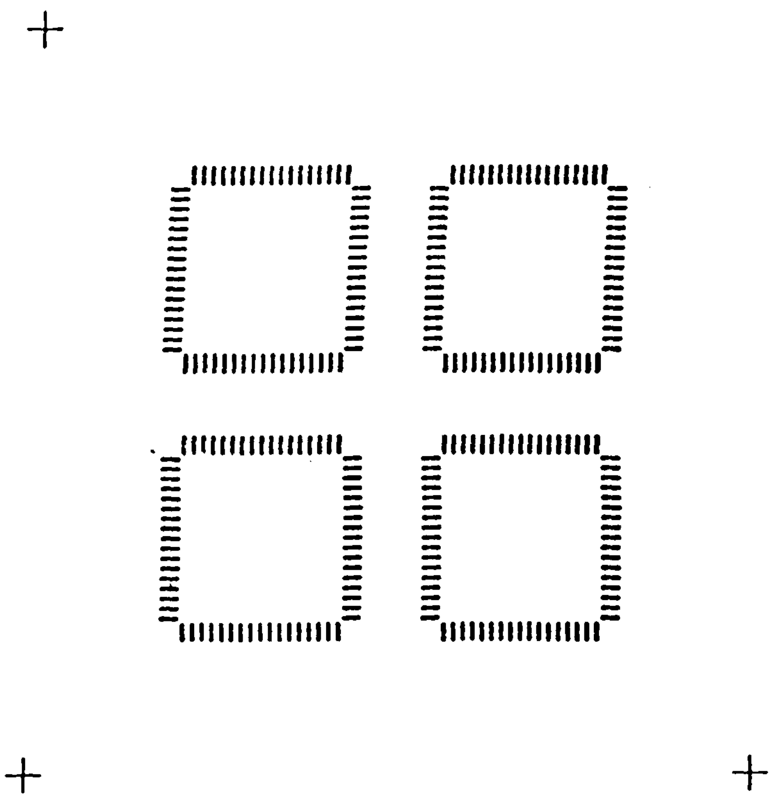


CFC BENCHMARK TEST PATTERN REV A
LAYER 1 SCALE 1X

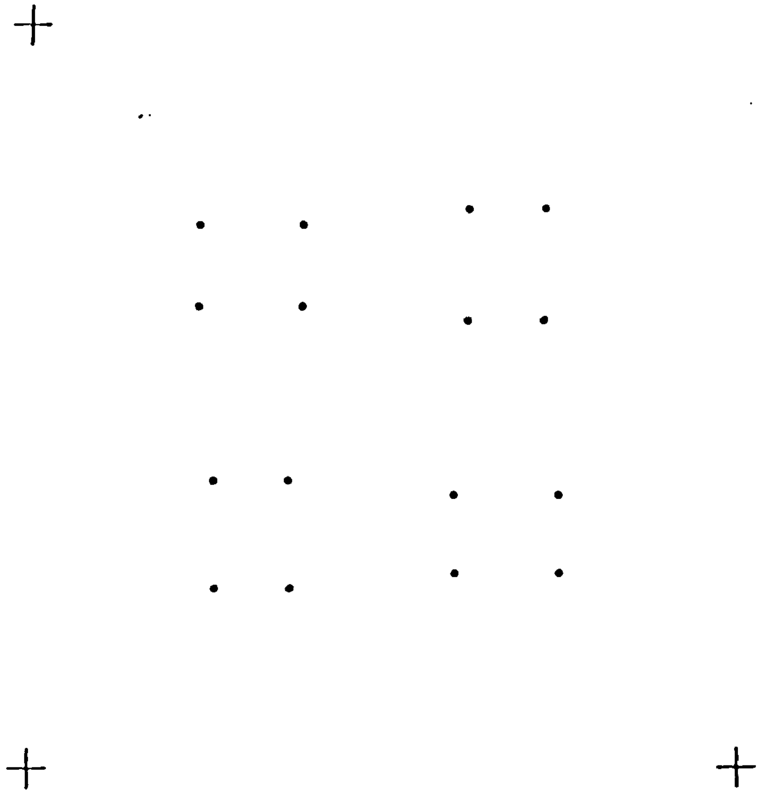


CFC BENCHMARK TEST PATTERN REV A
LAYER 2 SCALE 1X

Figure 1



CFC BENCHMARK TEST PATTERN
SOLDER PASTE SCALE 1X

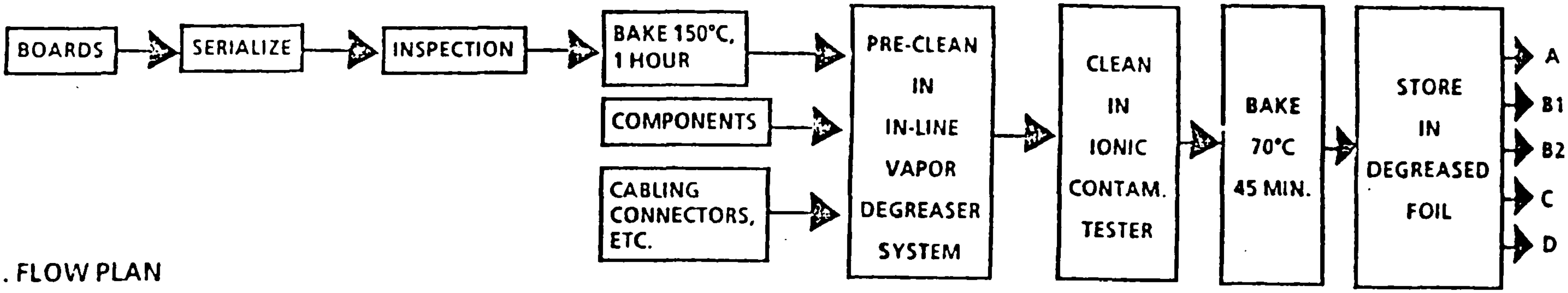


CFC BENCHMARK TEST PATTERN REV A
SOLDER MASK SCALE 1X

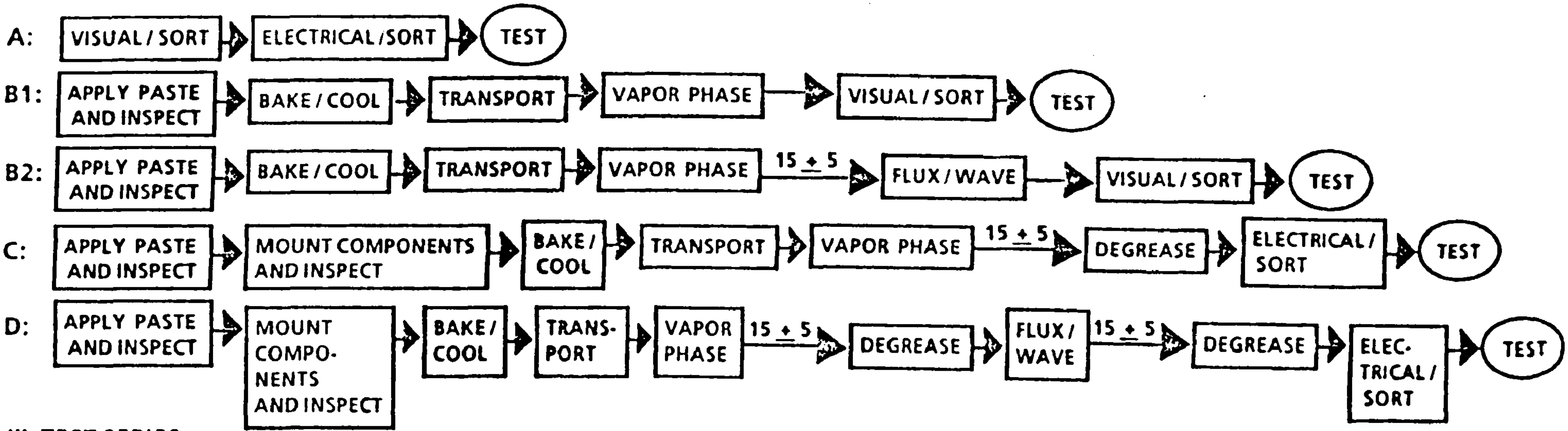
Figure 1

ALTERNATE CLEANING SOLVENTS BENCHMARK

I. PRE-TEST PREPARATION



II. FLOW PLAN



III. TEST SERIES

1: IONIC CONTAMINATION

2: SIR (168 HR, 85/85, 50V BIAS, 100V TEST)

3: ROSIN TEST BY UV/VIS

4: HONEYWELL / ORGANICS BY HPLC

Figure 2

1. Ionic Testing by Omegameter
2. Residual Rosin by U.V. Spectrophotometry
3. Surface Insulation Resistance
4. Quantification/Characterization of Residual Organics by HPLC

The Benchmark Test, which was completed in April, generated over 2500 SIR measurements 100 ionics readings, and 100 residual rosin data points.

The results were presented on 27 April 1989 at the IPC meeting in Orlando, Florida. The final report was published in October designated IPC-TR-580.

TEST MONITORING AND VALIDATION COMMITTEE

In order to prevent backlogs and delays at the two benchmark laboratories, the Adhoc Solvents Working Group agreed that alternate test sites can be used. A Test Monitoring and Validation Committee (TMVC) was established to oversee benchmark and alternative cleaning evaluation at these alternative sites. The function of the TMVC is to approve and monitor each alternative test site during assembly and testing.

The TMVC observed the benchmark (Phase 1) as well as alternative cleaning agent (Phase 2) testing. The function of the TMVC is to approve and monitor each test site during assembly and testing.

The TMVC is made up of five groups including commercial users, military users, the U.S. Department of Defense, material suppliers and equipment suppliers.

The TMVC is chaired by Dr. Leslie Guth of AT&T. The balance of the TMVC come from volunteer members of the ADHOC Solvents Working Group. Members of the TMVC are shown as follows:

TEST VERIFICATION AND MONITORING COMMITTEE

Chairman - Leslie Guth, AT&T
Industry Liason - David Bergman, IPC
EPA Liaison - Stephen Andersen
U.L. Liaison - Harlan Bratvold/Joe Allen

Service Representation

Army - Missile Command - Carl Buchanan
Air Force - RADC - Luke Lorang
Navy - EMPF - Tim Crawford/Bill Vuono
Navy - NAC - Robin Sellers/Doug Pauls
NASA - Dick Weinstein

Commercial

AT&T - Leslie Guth
Ford - Peter Sinkunas
General Electric Les Hymes
Northern Telecom - Dick Szymanowski

Military Contractors

Boeing - Ron Jannott
IBM - Phil Schuessler
Honeywell - Heather Getty/Tom Barrett/Jenny Mathias
Magnavox - Phil Wittmer/Beth Boomer
Texas Instruments - Joe Felty/Carol Ellenberger/Barbara Waller/Bob Buress

Supplier Representation

Chemicals
Allied - Kirk Bonner/Jerry Gozner
Alpha - Al Schneider/Jack Brous
DuPont - Bill Kenyon/Caroll Smiley
ICI - David Hey
Kester Solder - Brian Deram
Martin Marietta - Maher Tadros/Tushar Shah
Petroferm - Mike Hayes/Christine Fouts

Equipment
BBI - Carl Koenig
ECD - Steve Glass/Rex Breunsbach
Electrovert - Don Elliot
Hexacon Electric - Kathi Johnson

PHASE 2: CLEANING ALTERNATIVE TESTING

Phase 2 testing evaluates the cleaning capability of alternative materials. The Benchmark Test Plan for CFC-113 (Phase 1) gives very specific process parameters for the assembly, soldering, cleaning and testing operations. For Phase 2, the procedure in the benchmark test plan must be followed as closely as possible with the obvious exception of the cleaning process. The sponsor must provide with a test plan which includes the process details for the alternate cleaning agent. Sponsors of alternative cleaning agents are also responsible for arranging for the testing of their cleaning agent.

Representatives of the TMVC volunteer to review the test plan provided by the material sponsor. A minimum of five members of the TMVC representing the five interest groups (military, commercial, supplier, etc.) form a team that will monitor the test. This team will also review all data and the final report provided by the materials sponsor.

The Ad Hoc Solvents Working Group agreed that any material that clean as well as or better that the existing CFC-113 bench mark would be recommended to the military as a candidate for use as a replacement. After review of the test data and the report, the TMVC issues an approval notice that the material has passed. An example is shown in Appendix 1. The cleaning process used in the Phase 2 test is detailed on the approval notice so that the user may compare the performance to in-house operations. The members of the TMVC that were present at the test sign the approval notice.

As of February 1991 approval notices have been issued for the following Phase 2 alternatives.

<u>APPROVED</u>

Company	Material	Telephone	Type
Allied Signal	Genesolv 2004	(708) 450-3880	HCFC
Allied Signal	Genesolv 2010	(708) 450-3880	HCFC
E.I. DuPont	Freon SMT	(302) 999-2889	Dil. CFC
E.I. DuPont	Axarel 38	(302) 999-2889	S/A
E.I. DuPont	KCD 9434	(302) 999-2889	HCFC
Martin Marietta Labs	Marclean	(301) 247-0700	S/A
Petroferm Inc.	Bioact-EC7	(904)261-8286	Terpene

S/A = Semi-Aqueous
HCFC = Hydrofluorocarbon

In addition the following companies have expressed an interest in the Phase 2 program but have not organized their testing to date.

Company	Material	Telephone	Type
Advanced Chemical Tech.	ACT-100	(215) 861-6925	S/A
Alpha Metals	Alpha 2110	(201) 434-6778	Aqueous
Alpha Metals	Alpha 565	(201) 434-6778	MC
By Pas of Toledo	By Pas	(419) 865-6094	Aqueous
Chem-Tech International	CT-23, CT-24	(407) 734-3335	Aqueous
Dow Chemical	Chlorothene* SM	(517) 636-8325	MC
Dubois Chemicals	Hi-Tron L-4000	(513) 762-6839	Aqueous
Envirosolv	Re-Entry	(904) 724-1990	Terpene
GAF Chemical	M-Pyrol	(201) 628-3847	S/A
Hurri Kleen Corp.	HURRI SAFE	(703) 764-0034	Aqueous
ICI Chemicals	Propaklone	(092) 851-2556	MC
Kester Solder	Kester 5121	(708) 297-1600	MC
Kester Solder	Kester 5769	(708) 297-1600	Aqueous
Kyzen Corp.	IONOX LC	(615) 244-5798	S/A
Lonco	Prelete	(708) 766-5902	MC
Lonco	Loncoterge 520,530	(708) 766-5902	Aqueous
Mirachem	Mirachem 100	(602) 966-3030	Aqueous
Orange-Sol Inc.	Orange-Sol	(602) 961-0975	Terpene
Pennwalt Corporation	Isotron 141B	(215) 587-7000	HCFC
Unitech International	Unitech CV-250	(305) 255-9447	Aqueous
Van Waters & Rogers	Van De Flux 1600	(612) 774-9400	MC

MC = Methyl Chloroform
S/A = Semi-aqueous
HCFC = Hydrochlorofluorocarbon

PHASE 3 TESTING

At this point in time, IPC is beginning activity on Phase 3 of the test program which is intended to evaluate alternative technologies. Dr. Laura Turbini of the Georgia Institute of Technology is Chairing this activity. Phase 3 tests are being developed to evaluate:

- o Water Soluble Fluxes (WSF)
- o No-Clean Fluxes
- o Inert Atmosphere Soldering.

The test plan for the Water Soluble Fluxes is furthest along. It has undergone the IPC international review, and testing is now under way. Test plans for No-Clean Fluxes and Inert Atmosphere Soldering are in draft form.

Phase 3 - WSF

Naval Avionics Center in Indianapolis is the test site for the Phase 3 WSF test. Mike Hook and Doug Pauls of NAC are spearheading the Phase 3 effort.

Because of the large number of fluxes and pastes being provided to the industry the task group agreed on a strategy to "Prove the technology" as opposed to approving each flux. In order to achieve this the Phase 3 WSF test was broken into 2 stages. Stage 1 evaluates three water soluble fluxes and three solder pastes containing water soluble fluxes on a single sided board (Figure 3). The intent of this portion of the program is to evaluate the interaction of the board material with the solder paste and flux material. Stage 1 will use SIR and Ionic testing to evaluate the materials. A test flow is shown in Figure 4.

Following the Stage 1 test the flux and the paste that performs best will be use on the IPC-B-36 test assembly to gather data that will be used to compare to the benchmark (Phase 1) results.

SPECIFICATION ACTIVITY

IPC has been working with two military preparing activities which can directly effect the military phase out of CFC's. These are as follows:

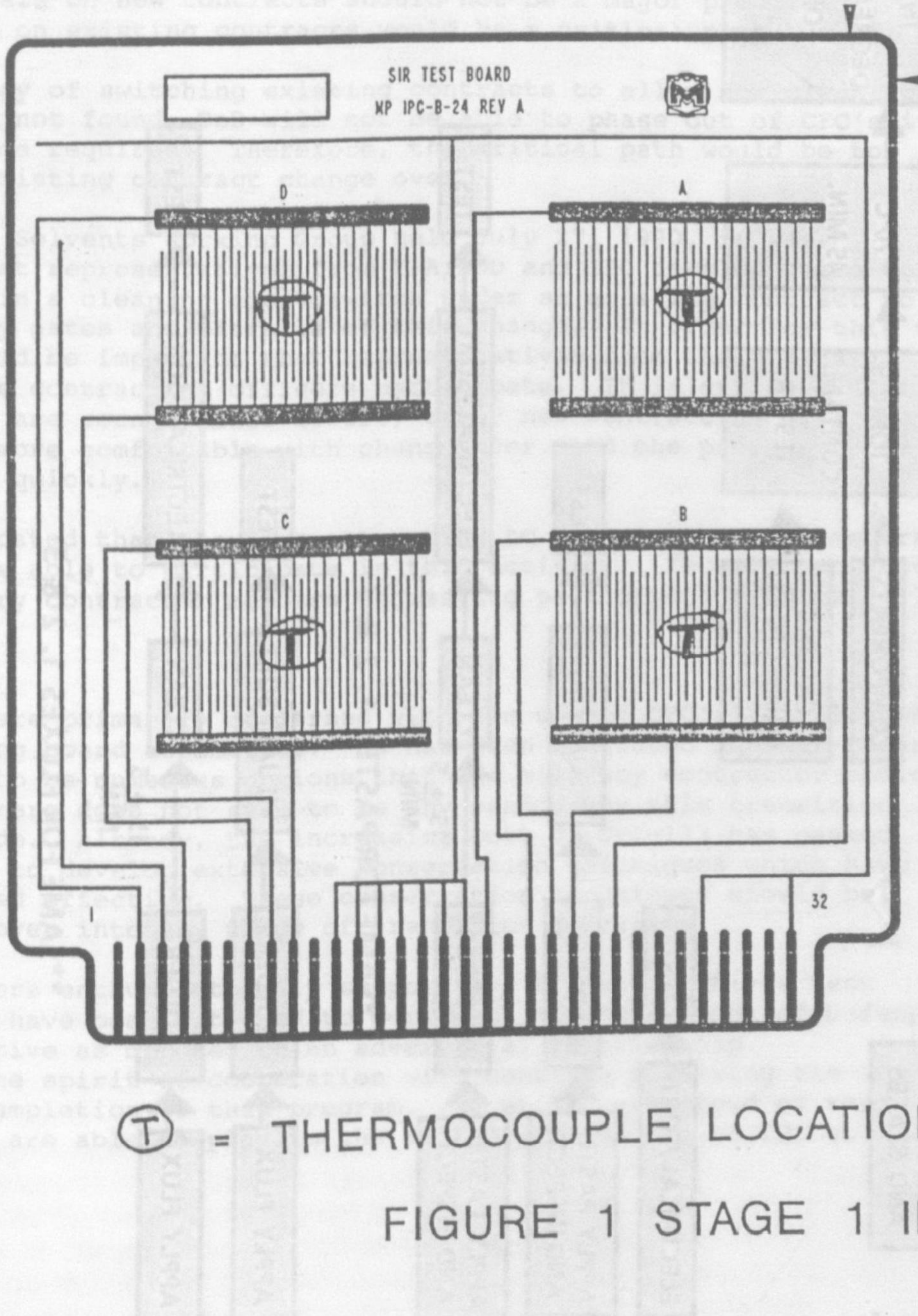
- MIL-STD-2000 - Preparing Activity Naval Air Engineering Center "Standard Requirements for Soldered Electrical and Electronic Assemblies"
- QQ-S-571 - Preparing Activity Defense General Supply Center "Solder, Tin Alloy: Tin Lead Alloy; and Lead Alloy"

The MIL-STD-2000 is probably the document of most concern to the military contractors of IPC. In the past, specific cleaning materials including CFC-113 have been called out as the cleaning materials of choice for this specification. Changes in philosophy are already taking place, and the preparing activity and the IPC committee members have made strides towards allowing other cleaning options.

QQ-S-571 currently allows only the use of rosin fluxes. This inhibits military usage of other possibilities including water soluble fluxes. Representatives from IPC and the International Institute of Welding (IIW) have been meeting to write a replacement for QQ-S-571 which will address solder paste, solder alloy, soldering fluxes and soldering wire and preforms. This document should be completed by the end of 1991 and will lay the ground work for the approval of the use of alternative fluxes.

Finally, IPC is working with the Electronic Industries Association (EIA) at the request of the Department of Defense to prepare an industry equivalent/replacement to the MIL-STD-2000. The document is currently designated: NTL-STD-SOLD, "Requirements for Soldered Electrical and Electronic Assemblies". At least six extensive meetings have been held. The committee is building on the MIL-STD-2000A effort and will hopefully have a document available for coordination by second quarter in 1991.

Figure 3

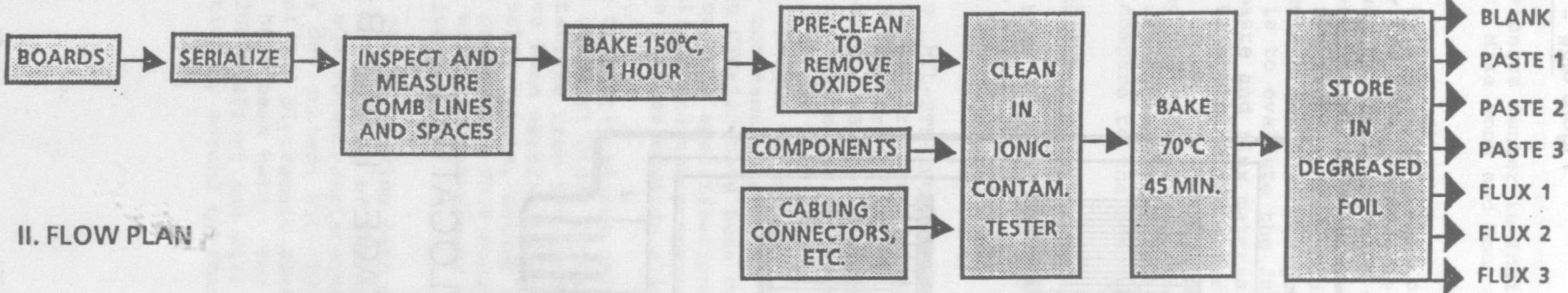


Ⓣ = THERMOCOUPLE LOCATION

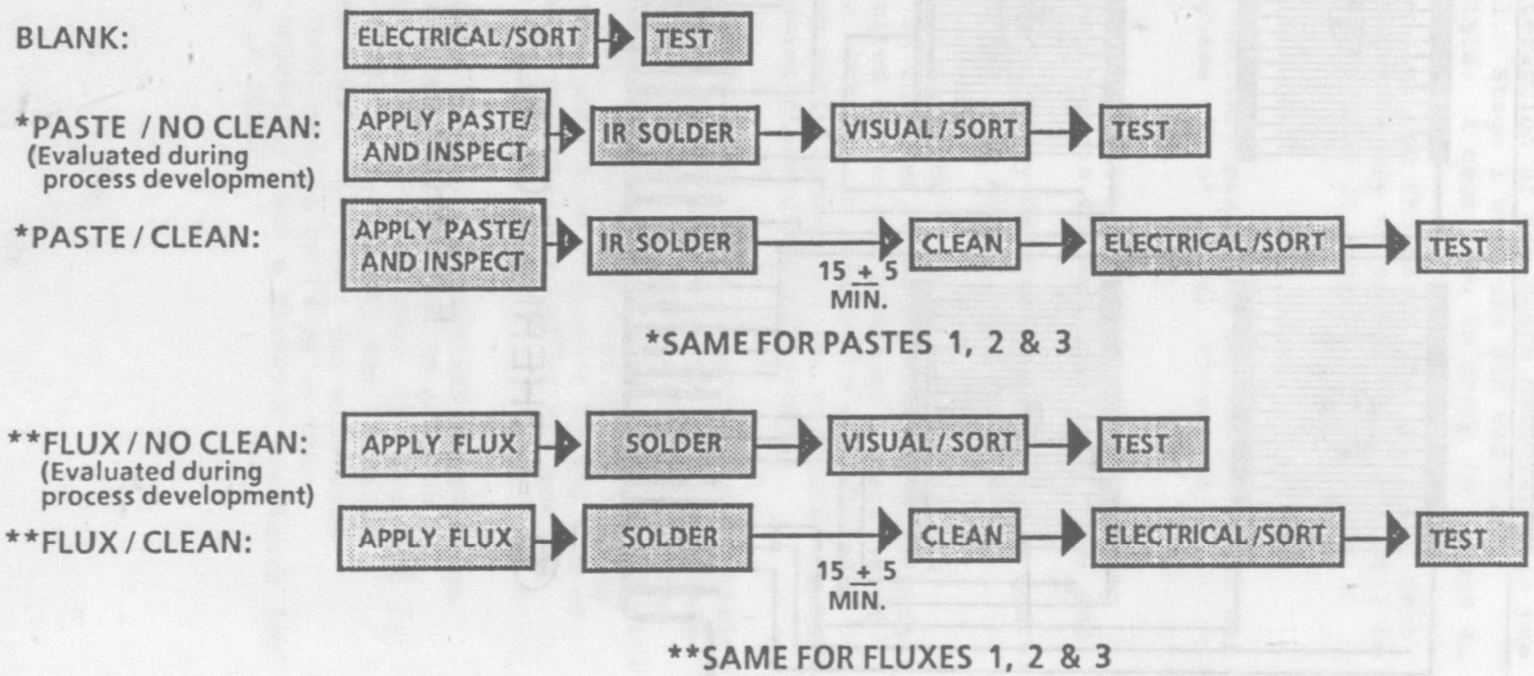
FIGURE 1 STAGE 1 IPC-B-24

PHASE III TEST PROGRAM / EVALUATION OF WSF INTERACTION WITH SUBSTRATE AND METAL

I. PRE-TEST PREPARATION



II. FLOW PLAN



III. TEST SERIES

1: IONIC CONTAMINATION BY OMEGAMETER

2: IONIC CONTAMINATION BY ION CHROMATOGRAPHY

3: SIR (28 DAY, 85°C /85% RH)

4: ORGANIC CONTAMINATION BY HPLC

Figure 4

STAGE 1 IPC-B-24

CRITICAL PATH

At this point, there seems to be numerous cleaning agents available to be considered as replacement. Seven alternatives will be approved by the Test Monitoring and Validation Committee and will be recommended to the military for consideration. The Military Electronics Technology Advisory Group (METAG) has indicated support for the Phase 2 materials and recommends their availability for use. The use of these materials on new contracts should not be a major problem. However, use on existing contracts would be a critical path.

If an easy way of switching existing contracts to allow new cleaning materials is not found, DoD will not be able to phase out of CFC's in the time frame required. Therefore, the critical path would be to facilitate existing contract change over.

At the AdHoc Solvents Working Group held July 27, 1990, it was suggested that representatives from EPA/DoD and IPC develop teams to participate in a cleaning agent switch under an existing contract to determine key gates and pitfalls of this change. In order for this to work, it would be important that representatives from the military including the contracting officers participate. It is expected that as successes are seen by this effort, other new contracting officers should feel more comfortable with change-over, and the process could proceed more quickly.

EPA has indicated that they are attempting to coordinate team members that would be able to participate in this activity. IPC will contact their military contractor members requesting participation as well.

IN SUMMARY

IPC members are primarily concerned with the use of CFC's for cleaning printed wiring board assemblies. As has been indicated in this paper, there seems to be numerous options that the military contractor could consider. There does not seem to be any reason why this transition cannot be made. Already, the increasing cost of CFC-113 has caused the industry to develop extensive conservation techniques which have already proved effective. These conservation techniques should be transferred over into any usage of transition materials.

The IPC members enthusiastically support the CFC alternatives test program, and have been enthused to work with the Department of Defense in a cooperative as opposed to an adversarial relationship. Hopefully, the spirit of cooperation will continue following the successful completion of this program. We at IPC are proud of the part that we are able to play in the military phase out of CFC's.

"CFC Reduction and Substitution in Developing Countries"[1]

Paul R. Kleindorfer
Department of Decision Sciences
The Wharton School
University of Pennsylvania
Philadelphia, PA 19104

The increasing threat to stratospheric ozone levels as a result of emissions of ozone depleting substances (ODSs) such as chlorofluorocarbons (CFCs) led to the Montreal Protocol in 1987 (see Morrisette [1989] for historical background). As amended in the 2nd meeting of the parties to the Protocol in London in June, 1990 (see UNEP [1990]), Protocol signers have committed themselves to a complete phase-out of ODSs in Developed Countries by the year 2000 and in Less Developed Countries (LDCs) by the year 2010. The Protocol also stipulates that the Developed Countries will pay for the "incremental costs" required for the LDCs to achieve the phase-out. To provide financing to the LDCs for phase-out projects, the parties to the Protocol have created the Interim Multilateral Fund (IMLF). Disbursements from the IMLF will be managed by the World Bank in collaboration with UNDP and UNEP. Pilot funding for the OMLF 1991-93 is to be $160 million, with another $80 million to be added if China and India sign the Protocol.

Disbursements from the IMLF will be guided by the recognition that most of the benefits of these phase-out projects accrue to the larger global community whereas the country undertaking the measures bears the cost.[2] These projects, therefore, are significantly different from the conventional lending activities of the Bank and involve a range of new issues which require the creation of appropriate incentives for cooperation by private and public sector participants in both developed and developing countries. The primary actors in this problem nexus, and some of their concerns, are listed below.

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[1] Paper to be presented at the Global Pollution Prevention Conference, April 3-5, 1991, Washington, D.C. This research was supported by the World Bank under a grant from the Division of Environmental Policy and Research. Helpful comments on a previous version of the paper by Stephanie R. Olen and Isadore Rosenthal are acknowledged. However, the views expressed here are the sole responsibility of the author.

[2] Thus, financing decisions for global environmental activities will be guided by criteria beyond the usual cost-benefit and efficiency criteria of environmental economics, including criteria such as affordability and fairness. See Munasinghe [1990] for a discussion.

Developing Countries

The participation and cooperation of the LDCs is, of course, fundamental to the success of this program. The primary concerns relative to LDCs are that they utilize the IMLF funds efficiently and effectively to meet the objectives of the Protocol for complete phase-out of ozone depleting substances by 2010 or earlier. As noted below, the implementation of the Protocol may have strong effects on the incentives which LDCs perceive for various types of projects.

Developed Countries

The participation and funding of the program by developed countries is likely to be driven by the perceived national benefits of global ODS reduction. It should be noted in this regard that a molecule of an ODS released to the stratosphere will have roughly the same effect on human health no matter where it comes from on the planet. So it is in the developed countries' interest to see LDCs phase-out CFC's and other halons.

Multinational Corporations

Given their ownership of the relevant technologies (both ODS substitute production technologies and end-use technologies) and investment capability in ODS substitution projects, multinational corporations (MNCs) will play a critical role in this program. In many LDCs, the MNCs presently supply the ODSs and influence the nature of the ODS-using equipment, either through direct supply or local manufacture. They will have an even stronger impact in the ODS substitute market and end-use equipment since these will involve major product and process innovations requiring substantial amounts of capital and expertise.

Non-Governmental Organizations

Given the significance of the Montreal Protocol in its own right and in setting precedents for future international environmental initiatives, it is not surprising that a number of national and international NGOs consider this an area of importance for their own agendas. They are interested in an open and participative discussion which allows them access to the policy debates surrounding implementation of the Protocol.

Intermediaries

Intermediaries (including The World Bank, UNEP, and UNDP) will act as agents of the coalition of member countries at one level (setting standards, priorities etc.) and the donor countries at another level (funding). The role of the intermediaries will be critical to the successful implementation of the Protocol.

Global Coalition

The Global Coalition consists of the parties to the Montreal Protocol. This coalition is driven by a collective set of objectives which may not be fully consistent with the objectives of individual countries, given the vast differences in per capita GNP, resources and technology among these countries.

Certain basic principles must underly any reasonable unification of the diverse interests of these players in a successful ODS phase-out program, including:

1) Respect for national sovereignty;

2) Commitment to global improvement and equitable burden sharing;

3) Respect for the jurisdictional and intellectual property rights pertaining to ownership of technology and plants.

4) Compatibility with the realities and contraints of the structure of international markets and trading and with the multiple cultural contexts involved.

While it would be interesting to consider the merits of various institutional approaches to implementing the Montreal Protocol embodying these principles, the outlines of the actual institutional arrangements and policies for implementation are already rather plain on the basis of actions undertaken thus far by the parties involved (see UNEP [1990]). What is going to happen is this. LDCs will be asked to submit country plans, containing a number of specific projects, to the World Bank. The Bank, together with UNEP and UNDP, will evaluate these projects, refine them to accord with best available practice, and then approve selected projects to be funded at a level corresponding to the "incremental costs" of these projects. This process in the LDCs must mesh with on-going market-driven new product developments in the developed countries.

Developed countries and MNC's will lead the way to a new ODS-free era by actively developing substitute technology and products. Together with the entry of these new products into the market, old products based on ODSs will be phased out as the demand for them gradually dies out. Scale economies are likely to speed up this process significantly. Given the heavy dependence of LDCs on the developed countries for technology and products, the diffusion of these new products into the LDCs is inevitable. The gradual elimination of demand for ODS-based products in the developed countries will increase the price of residual production to meet LDC needs. Except possibly in those LDCs where sufficient demand exists for within country scale economies to allow continuing operations of ODS production, normal price and demand erosion will ultimately lead to the point where substitution is economical even from the LDC standpoint.

The essence of the ODS phase-out problem for the principal intermediaries (The World Bank, UNEP and UNDP) is to speed up the natural process of diffusion of new products and processes which use environmentally safer substances than ODSs and to do so in a cost-effective and efficient manner. This gives rise to an interesting institutional design problem in implementing the Protocol. To highlight some of the important issues associated with this design problem, let us consider two "stylized" implementation procedures for funding phase-out projects by LDCs.

> The Global Auction--LDCs submit bids to the World Bank for funds from the IMLF by indicating (bidding) their lowest incremental cost option (in $/kg).[3] Projects would be undertaken, i.e. funded, across all LDCs in order of increasing incremental cost until funding for a given time period was exhausted. The Global Auction is essentially the institutionalization of the Maximum Bang per Buck criteria, subject to a time-indexed set of period budgets.
>
> Country Allocations--LDCs submit country plans, which are time-indexed sets of projects, to the World Bank. These plans are feasible relative to the time-bound obligations of the Protocol for achieving phase-out of ODSs and the plans contain good faith estimates (e.g., as jointly developed with UNDP) of the incremental costs of phase-out projects. The Bank (i.e., the Global Coalition) funds each plan at the full incremental cost level, leaving implementation to the individual LDCs, but requiring the continuing achievement of the plan's ODS total use time trajectory in order for funding to be continued.

The above two implementation scenarios can of course be refined to account for traditional investment banking evaluation criteria such as commercial viability of the technologies used, assuring that certain key projects are in any country portfolio/plan (e.g., obvious payoff areas such as recycling in indusrtrial commercial refrigeration), riskiness of projects, track records of the implementors, etc., most of these matters are clear to experienced development planning organizations like the World Bank and UNDP and we will not pursue them further here. However, these alternative implementation scenarios do indicate a few key

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[3] For comparability, the price per kilo of various ODSs would be weighted by the ozone depletion potential (ODP) of these ODSs.

points which will need to be recognized and/or resolved in implementing the Protocol.

First, monitoring at the country level of ODS production, imports, exports and consumption is essential to any reasonable implementation of the Protocol.

Second, alternative institutions for implementating the Protocol, including alternative funding scenarios, will have different implications for the nature and timing of projects funded and, ultimately, for the amount of ODSs which end up in the stratosphere for the next century. The timing issue is especially important since benefits from CFC removal clearly increase with the total amount of CFCs and other ODSs removed. Given the long-lived nature of ODSs in the stratosphere and current projections for continuing damage to the ozone layer even if the Protocol time-bound obligations are met, the impact of alternative implementation methods on the timing of ODS removal may be the most critical issue in deciding how to implement the Protocol. Resolving this issue will require a clear definition of the benefits of removing a kilogram of ODS from the stratosphere and not just a focus on the incremental cost of meeting the time-bound obligations of Protocol phase-out.

Third, because alternative implementations will affect which projects are proposed and funded, they will also influence the health, safety and global warming externalities associated with achieving the ODS objectives of the Protocol. Resolving this issue will require a clear definition of how these externalities are to treated. One approach will be to set standards for health and safety requirements and to evaluate global warming impacts (positive or negative) of ODS phase-out projects as a separate dimension of project evaluation (ultimately, to be traded off against the time-phased reduction of ODS).

Fourth, efficiency, fairness and cost-effectiveness (all of which are objectives of the Protocol implementation as per UNEP [1990]) will be affected by the institution selected. Indeed, there are going to be tradeoffs among various criteria for institutional design of implementation of the Protocol. For example, arguably the Global Auction will provide a more efficient outcome than the Country Allocation arrangement, but perhaps with much higher transactions costs and perceptions of inequity in funding.[4]

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[4] Of course, eventually all countries should receive necessary, incremental cost funding, but they may have to wait under the Global Auction for a number of years before their projects become cost-effective, leading to perceptions of inequity. The tradeoffs in the design of alternative institutions can be analyzed as in Crew and Kleindorfer [1986], but the choices here

The above issues point to some of the challenges which will have to be resolved to assure the effective implementation of the Montreal Protocol. We may expect similar issues to arise in the context of the much more complex global warming problem. What should motivate us in these important areas of international cooperative activity is a clear focus on the objectives of achieving sustainable development policies, compatible with a preservation of the global commons, and relying on established principles of environmental economics and the institutions of the international market place.

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along efficiency and fairness dimensions will not be easy.

SESSION 3F

CFC SUBSTITUTES IN REFRIGERATION

Chairperson

Mr. Mark Stanga
Litton Industry

Speakers

Mr. Mark Stanga
Litton Industry
L'Enfant Plaza, Washington, D.C.

Mr. Kent Anderson
Executive Director, International Institute of Ammonia Refrigeration
Chairperson, ASHRAE CFC Advisory Committee
Doing Without CFCs In Refrigeration and Air Conditioning

Mr. Jean Lupinacci-Rausch
Chief, Technology & Substitutes
Division of Global Change, US EPA
The Potential of Ammonia as a Substitute for CFC Refrigerants

Mr. Bruce Siebert
Trane Commercial Systems
CFC Management

Mr. Hoyt B. Wilder
Vice President, ARPI
President, IG-LO, Inc.
Transition to Ozone-Safe /Automotive Refrigerants

Session Abstracts

Introduction

Refrigeration and air conditioning systems present special challenges to the task of substituting CFCs. Various industries, trade associations, and other groups have been researching substitute refrigerants for commercial and residential units. Ammonia has the potential to capture several markets as an alternative refrigerant, but it also poses several problems (e.g., toxicity and flammability) that must be resolved. Recovery and recycling of CFCs is playing an important role for owners of existing systems during the phaseout of CFCs. Progress also is being made to replace the CFC-12 used in mobile air-conditioners (MACs) with HFC-134a, which has no ozone depleting potential.

Doing Without CFCs in Refrigeration and Air Conditioning

The phase-out of CFC refrigerants by the year 2000, and the likely elimination of HCFC refrigerants such as R-22, presents the air conditioning and refrigeration industry with a daunting challenge. This presentation will provide an overview of the issues and challenges facing the industry in eliminating the use of CFC/HCFC. The presentation will include an update on activities and research on substitutes, material compatibility and lubricants. The potential for pollution prevention through emission reduction, recycling and recovery will be reviewed, with a status report on standards, guidelines and regulations.

The Potential of Ammonia as a Substitute for CFC Refrigerants

Due to the increasing price and year 2000 phase-out of chlorofluorocarbons (CFCs), ammonia may be used as a substitute for CFCs in many refrigeration applications. The four potential markets for ammonia as a refrigerant replacement include: cold storage, chillers, process/industrial refrigeration systems, and retail food storage.

The development of other CFC substitutes, such as HCFCs and various health and safety issues related to ammonia will determine the use and viability of ammonia in refrigeration applications. The flammability and toxicity of ammonia may cause its use to be limited in several areas. Development of standard building codes and revisions in existing codes to allow the use of ammonia may be necessary before it can be used in large scale refrigeration systems.

With proper design, ammonia systems have been found to be as efficient as HCFC-22 in large water chillers and industrial refrigeration systems. Research is being done to find new designs for ammonia system that will improve safety, efficiency, and cost for cold storage, chillers and process/industrial refrigeration systems.

CFC Management

The commercial HVAC industry is facing two significant challenges relative to the environment; developing the technology and equipment to operate on alternative refrigerants, and helping their end user customers manage the existing inventory and deal with the declining supply of CFC refrigerants.

Alternatives such as HCFC 123 and HFC 134a, combined with HCFC 22, are the transition refrigerants and offer a variety of benefits. The correct balance between global warming, ozone depletion and energy use is the present challenge of chemical producers and HVAC manufacturers.

Containing CFC refrigerants and prolonging their useful life for heavy refrigeration machines will receive more emphasis in facility planning meetings. A culture, fostered by the low cost of refrigerant and lack of awareness of CFC's harmful effects on the atmosphere, must be modified. Refrigerant containment during equipment operation, while idle and while being serviced is critical. Final disposition of contaminated or retired refrigerant is slowly taking a salvage posture, resulting in a prolonged use of HVAC equipment designed for traditional refrigerants.

The following presentation will help end users, consulting engineers and service contractors understand the issues, establish a plan and evaluate resources to manage this challenging transition in our industry.

Transition to Ozone-Safe Automotive Refrigerants

Mobile air conditioning refrigerant (CFC-12) is a primary use for CFCs in the United States and internationally. In fact, nearly 40 percent of all domestic CFC production is used to cool automobiles. Therefore, the automotive industry faces a tremendous challenge to decrease its reliance on CFCs and make the transition to CFC substitutes by the end of the century, when CFC production will cease.

The transition process will include drastic changes to automotive air conditioning service practices, driven by the need to conserve and recycle refrigerants, in addition to concern for the environment. Cars currently using CFCs will rely on recycled CFC-12 and newly developed CFC blends in the future. Federal regulations are being implemented to govern service practices.

Though the desire and incentive to use substitutes exist, the transition is greatly complicated by the fact that no "drop-in" replacement has been developed for use in existing mobile air conditioning systems. Researchers have been working since the mid-1970s, yet have been unable to develop a chemical with all the attractive properties of CFC-12. However, an acceptable substitute has been identified, and is currently being implemented. This substitute, HFC-134a, will require air conditioning systems to be completely redesigned, with different compressors, hoses and lubricants. New air conditioning systems are coming on line from foreign and domestic manufacturers, but the transition in new cars is not expected to be completed until 1995 or 1996.

HFC-134a contains no chlorine and has an ozone depletion potential of zero. It does have a global warming potential of 0.3 (compared to CFC-12's 3.0). Because HFC-134a will cost considerably more than CFC-12, service technicians will have an incentive to recycle. It is likely that new refrigerants will be recycled, using equipment similar to that already in use for CFC-12 recycling.

Other relevant issues include: training and certification of automotive mechanics to properly handle CFC-12 and blends, retrofitting of existing CFC-12 MAC systems for HFC-134a and possible regulatory action on blends and replacements.

TRANE

Commercial Systems Group
The Trane Company

[illegible] Pammel Creek Road
La Crosse WI [illegible]
[illegible]

ENVIRONMENTAL SOLUTIONS: EXACTLY HOW TO CONTAIN CFC REFRIGERANTS, HOW TO CONVERT TO NEW REFRIGERANT

by: Bruce Siebert
Vice President and General Manager
Existing Building Services
The Trane Company
La Crosse, Wisconsin

The key equipment for air conditioning large commercial buildings is the centrifugal chiller. More than 80,000 of these chillers are in operation today in the U.S. and Canada.

Some reputable scientists have concluded, however, that the refrigerant used in most of these chillers, a chlorofluorocarbon (CFC) designated CFC-11, contributes to the degradation of the earth's protective ozone layer when it is emitted, rises into the upper atmosphere and decomposes. The evidence has spurred state, national and even international action to restrict CFCs. At conferences of the United Nations Environmental Programme, agreement has been reached on a worldwide ban of the production of CFCs by the year 2000 and severe limitations on their production before then. These include CFC-11 as well as CFC-12, used in some unitary air conditioning systems.

What happens now? Trane, a leader in air conditioning, manufactured more than half of the centrifugal chillers operating in the U.S. and Canada. Foreseeing the CFC ban, we recommend a choice of programs, the subject of this article. They permit either safe, continued use of present chillers and refrigerant or ease conversion to an ozone-friendly refrigerant in these same chillers and, later, a switch to new chiller equipment totally compatible with the new refrigerant. In the immediate future, it means prevention of CFC emissions into the atmosphere and, eventually, a carefully-prepared switchover to a new refrigerant by properly-engineered equipment modifications.

Responsible owners of chillers operating on CFC-11 will need to choose one of these options. Building owners and operators who choose the option of continuing with the current refrigerant -- and they may be in the majority because of the service life still remaining in their chillers -- should be interested in the following facts and figures.

Of the CFC-11 refrigerant used in U.S. chillers today, roughly 25 percent is lost to the atmosphere annually, from causes detailed later in this article. It is imperative that this loss be ended or drastically minimized.

Decreasing availability and fast-increasing price of CFC-11 must also be considered. In mid-1989, the price of one pound of CFC-11 was $3.00. Today, it's $5.50. Supply and demand may drive the price up even faster in the future as the total production ban goes into effect. And beyond price, there are U.S. Federal taxes, $1.37 per pound now and slated to rise to $4.90 a pound by 1999.

CONTAINING THE CURRENT REFRIGERANT

Leak Prevention. Conserving existing refrigerant inventory involves several practices. First and foremost is leak prevention, since about 40 percent of CFC-11 emissions derive from leakage in the chiller system. Chillers are thoroughly leak-tested in the factory, but wear as well as improper servicing and repair procedures can result in leaks. Leak prevention starts with inspection by service people experienced with the specific equipment. Detected leaks must be repaired; they're found most often in tubing, flanges, O-rings, and connections where components meet. Beyond this, there should be tightening of fittings, checking on welded joints, replacement of worn gaskets and seals, even attention to the anti-leak integrity of a chiller's outer shell.

Purging Leaks. Centrifugal chillers using CFC-11 operate below atmospheric pressure. As a result, one problem is air leaking into the unit rather than the refrigerant leaking out. Because air is non-condensible, it must be regularly removed (purged) from the unit to maintain operating efficiency. Poor purging equipment is responsible for 15 percent of refrigerant leaks. In response to this problem, Trane has developed a new, high-efficiency Purifier Purge that reduces CFC-11 emissions from purging by 90 percent compared to current purge systems.

A key advantage of the new purge is that it can operate whether the chiller is running or not. Heretofore, if a chiller was off for a period of time, and a large amount of air penetrated into the refrigerant, its start-up surge required venting of the refrigerant to lose this air. The new, self-contained purge system eliminates the need for refrigerant venting on chiller start-up.

Refrigerant Cleanliness. Besides air, other contaminants can penetrate the refrigerant. Oil can leak in from the complex lubrication system, moisture enters with air and via tubing holes, and acid can develop as moisture combines with wear metals in bearings and shafts. Emissions then occur as contaminated refrigerant is removed. Devices exist that sample the refrigerant in the liquid state and filter out these contaminants.

Care in Servicing. Refrigerant loss due to improper servicing may amount to 25 percent of CFC-11 emissions. Much chiller servicing is preceded by temporary removal of the refrigerant. Considering that a chiller can hold anywhere from 400 to 3,000 pounds of refrigerant (depending on chiller size) with 800 pounds the average, refrigerant removal should be performed by a method that doesn't cause loss. Too often in the past, when liquid refrigerant was removed for servicing, as much as 15 to 25 percent of the refrigerant was left in the chiller as gas, all of which was usually lost.

Here, too, we have a solution: a recycling/recovery system that is connected to the chiller pulls a high vacuum (29.8 inches mercury) on the system's containment tank, and pumps all liquid refrigerant into the tank. The pump then pulls 98.5 percent of the gas refrigerant out, liquefies it in a condenser and sends it into the containment tank. The service technician can then perform repairs, leak checks, and maintenance...after which the closed system returns all refrigerant (liquid and gas) to the chiller. It also presents an opportunity to clean the refrigerant by turning it into a gas, removing contaminants, liquefying it and returning it to the chiller.

It should be noted that, while the extra servicing care will increase maintenance cost from 50 to 100 percent a year, the savings generated by refrigerant conservation should more than offset this increased maintenance cost.

There is another recommended practice for effective refrigerant containment. If a chiller has been idle more than six months -- as during the fall/winter seasons, or because it's stand-by equipment -- before restarting it, remove the refrigerant into a system such as just described, to prevent refrigerant venting loss. If a chiller is to be idle less than six months, keep the chiller room temperature at less than the boiling point of the refrigerant (even one degree below). If the room's temperature is above that boiling point, refrigerant will boil and leak; if much below that boiling point, it will draw in air and moisture. If it isn't possible to control the ambient temperature in the chiller room, heat the refrigerant slightly to below its boiling point. Called pressure equalization, its goal is to keep the pressure of the chiller vessel equal to the atmospheric pressure.

Training. All of the aforementioned practices, in total detail, have been incorporated into our company's existing training programs. Building owners and operators can send staffs who operate and maintain chiller plants; mechanical contractors who install and service the equipment can also participate in such programs, given at our La Crosse, Wisconsin headquarters and in most Trane offices throughout the U.S.

Reclaiming Refrigerant. The containment approach is the key part of a good refrigerant management system. The other element is disposal when converting to a new refrigerant or removing a contaminated refrigerant. Trane is making arrangements with a national service, which would handle the refrigerant disposal procedure to prevent atmospheric emissions, and perform an intensive refrigerant cleaning and distilling process that preserves the material at a high quality level for further usage. Approximately 1,500 centrifugal chillers are replaced annually, for energy efficiency upgrade reasons apart from the CFC issue. Here, too, "retired" refrigerant can be reclaimed and emissions prevented. Thus, the fast-rising price of CFC-11 refrigerant, and its taxation, not only makes containment economically desirable, it also makes reclamation an economically-viable process and should help to stretch supplies and minimize future CFC-11 shortages.

CONVERTING TO THE NEW REFRIGERANT

HCFC-123. For those who wish to convert existing centrifugal chillers to another refrigerant...and those who would prefer to purchase a new chiller that uses a new refrigerant...the Trane-recommended new refrigerant is a hydrochlorofluorocarbon, HCFC-123. Possessing one-fiftieth the ozone depletion potential of CFC-11 -- it has built-in atmospheric instability, so it will break down in the lower atmosphere before it can reach the ozone layer -- HCFC-123 can be used in present chillers, although equipment modification must precede its adoption. An aggressive solvent, it will attack the elastomers used for seals and gaskets in previously-manufactured chillers, can dissolve the insulation used in the compressor motor windings, and harm other components. While many of its properties are similar to those of CFC-11, it does have some important differences. It is not quite as efficient as CFC-11, which results in a two to five percent reduction in efficiency, and it has greater mass, leading to a reduction of from 10 to 15 percent in capacity.

Converting Present Chillers. Anyone who believes that converting an existing chiller to accept HCFC-123 refrigerant is a simple matter of replacing a few gaskets and other components should be disabused of that notion immediately. To have a successful switchover with long-term operating performance efficiency requires an engineered conversion. We recommend that you contact the manufacturer of your equipment to discuss a program exactly suited to its model, age, operating status, etc. The conversion analysis should include comprehensive computer comparison of alternatives in relation to efficiency and economics. An engineered conversion permits knowing in advance what the resulting efficiency and capacity will be.

An optimum engineered conversion -- besides replacing seals, gaskets, bushings, diaphragms and motor insulation -- may also involve extensive re-engineering: improving the efficiency of heat exchange surfaces, improving compressor operation, changing orifice plates in the economizer, modifying and improving controls, etc.

To squeeze out more air conditioning tonnage capacity -- such as having an 850-ton converted chiller, but now needing 930 tons -- an ice storage system might be considered to gain that extra capacity. Here, ice is made by the chiller at night when electricity rates are cheapest, used for cooling during the day to provide the supplemental cooling.

Essentially, a chiller consists of condenser, evaporator, compressor and controls. Gaining more cooling capacity can also be accomplished by replacing the old compressor assembly with a more powerful, three-stage centrifugal compressor assembly, but keeping the existing condenser and evaporator.

Whatever the means, chiller conversion does work and Trane has proved it. Several months ago, we installed a modified hermetic centrifugal chiller, running on HCFC-123, in our 175,000-square-foot La Crosse administration building to cool the facility's 650 occupants. It has worked to everyone's satisfaction.

PURCHASING NEW EQUIPMENT

Similar Chillers. Perhaps the best way of announcing new equipment is to state that we are now shipping chillers, in capacities from 100 to 1,400 tons, with this label on them -- "CenTraVac Water Chiller Fully Compatible with Environmentally-Acceptable Refrigerant HCFC-123". Another option is purchase of remanufactured centrifugal equipment, a totally-rehabilitated old electric chiller modified to operate on HCFC-123 and costing 65 to 75 percent the price of a brand new chiller.

Still another alternative is the Trane Series R CentraVac chiller with helical rotary compressor, sizes 100 to 300 tons, in single or multiple units.

When should purchase of a new chiller be considered rather than converting an old chiller to HCFC-123? One answer is when a system operating on CFC-11 has marginal capacity, and converting to HCFC-123 may leave it seriously short of capacity or with poor efficiency. Higher refrigerant prices coupled with high maintenance costs may also dictate machine replacement, as would unavailability of more electrical power or higher electricity charges.

Different Equipment. The most obvious chiller replacement is with a like machine; an electric chiller for an electric chiller. However, there are other alternatives: steam and hot water absorption, direct-fired absorption, gas engine-driven chillers and combinations of cogeneration and heat-activation, helical rotary and scroll. Gas cooling is particularly attractive where electricity is expensive and subject to interruptions. Whatever the choices to be considered, we recommend a computerized analysis of each compared to the others, and projecting energy costs, efficiency and other factors important to a particular building.

To sum up, there are now solid alternatives that permit effective decisions on the refrigerant issue. The means are available for an orderly transition to refrigerant containment and/or conversion to the new refrigerant in present or new chiller equipment. Chiller manufacturers can provide the specific information which will result in the best choices for each situation.

MAKING THE TRANSITION

TO OZONE-SAFE REFRIGERANTS FOR MOBILE AIR CONDITIONERS

Hoyt B. Wilder
Chairman, Committee on Environmental Matters
Automotive Refrigeration Products Institute
President, IG-LO, Inc.
P.O. Box 14000
Lexington, KY 40512

Mobile air conditioning refrigerant (CFC-12) is a primary use for chlorofluorocarbons (CFCs) in the United States and internationally. In fact, nearly 40 percent of all domestic CFC production is used to cool automobiles. Therefore, the automotive industry faces a tremendous challenge to decrease its reliance on CFCs and make the transition to CFC substitutes by the end of the century, when CFC production will cease.

The transition process will include the development of new auto air conditioners that operate on non-CFC substitutes, and drastic changes in automotive air conditioning service practices, driven by the need to conserve and recycle refrigerants, concern for the environment and federal and state regulations.

Legislative Action on CFC-12

Prior to passage of the Federal Clean Air Act Amendments, a confusing and conflicting patchwork of state and local regulations on CFC-12 use was developing across the nation. Many states and localities considered restrictions varying from prohibitions on the venting of CFCs into the atmosphere during servicing, to Vermont's ban on the sale and registration of new automobiles with CFC air conditioners, starting with 1993 models.

The proliferation of varied sales and use restrictions on CFC-12 posed an enforcement and compliance "nightmare," with state agencies struggling to find ways to implement workable regulations, and many well-intentioned businesses becoming confused and unable to comply with the law, despite desires to do so. There was a glaring need for uniform national standards for responsible CFC use to govern the transition to alternative refrigerants. These standards arrived in the form of the Clean Air Act Amendments, and became law in November of 1990.

The new law requires the recapture and recycling of CFCs from mobile air conditioning systems and certification of mobile a/c service personnel, beginning January 1992. It also establishes a tight schedule for the phase-out of virtually all CFC production by the year 2000, and allows the sale of CFC-based automotive refrigerant in small cans (12 and 14 oz.) to service professionals only (effective November 1992).

The sales restriction on small cans will prohibit "do-it-yourselfers" from purchasing auto refrigerant, yet allows professionals to continue using cans. This is an important distinction, because the small can is the container of choice for the service sector and will serve an integral role in the distribution of alternative refrigerants.

The MAC Service Sector

The mobile air conditioning service sector, driven by economic forces, had begun to contemplate the transition away from CFCs well before the Clean Air Act became law. This process began when the U.S. Environmental Protection Agency issued regulations implementing the Montreal Protocol in 1988. The phase-down of CFC production stipulated in the Protocol, and later accelerated to phase out production by 2000, changed the service sector's perception of CFC-12.

Automotive service professionals are voluntarily changing their service habits to include the recovery and recycling of refrigerant. The value professionals associate with CFCs will ensure CFC-12 emissions are kept at a minimum. As CFC-based automotive refrigerant is phased out, it is becoming a precious commodity. In fact, CFC-12 prices have already increased noticeably in the past few years, partially due to a federal excise tax on CFC production that is designed to increase as production is phased down. For example, in 1999 the production tax on CFC-12 alone will be almost $5 per pound. Therefore, we can assume that virgin CFC-12 prices will continue to climb to reflect higher taxes and smaller supplies.

By recycling CFC-12, businesses will rely less on virgin refrigerant and immediately begin to recoup their expenses for recovery and recycling equipment. Another attractive aspect of recycled refrigerant is that it is not subject to the recently established CFC floor stocks tax. In addition to saving money by recycling refrigerant, businesses can potentially increase profits by marketing their recycling capabilities to environmentally conscious consumers.

CFC-12 Replacement

Though the desire and incentive to use substitutes exists, the transition has been impeded by scientists' inability to develop a "drop in" replacement for use in existing mobile air conditioning systems. Researchers have been working since the mid-1970s, yet have been unable to develop a chemical with all the attractive properties of CFC-12.

However, an acceptable substitute has been identified, and will provide significant environmental improvements. This substitute, HFC-134a, is significantly different than CFC-12 in most key properties and will require air conditioning systems to be completely redesigned, with different compressors, hoses and lubricants.

Significant differences between HFC-134a and CFC-12 include:

- HFC-134a contains no chlorine and has an ozone depletion potential of zero.

- HFC-134a has a much lower global warming potential than CFC-12 -- 0.3 compared to CFC-12's 3.0 -- due to its different chemical structure and a much shorter atmospheric lifetime (about 16 years).

- Heat transfer coefficients for HFC-134a are significantly better than those of CFC-12.

Thermodynamic properties for HFC-134a have been developed by a number of organizations, including the National Institute of Standards and Technology.

Implementation

Automotive manufacturers are in the process of developing new models that use HFC-134a air conditioning systems, but the testing process has been a slow one. Among other factors, the development of efficient lubricants and lubricating systems has been a significant challenge.

New MAC systems are coming on line from foreign and domestic manufacturers, but the transition in new cars is not expected to be completed until 1995 or 1996. Producers, including DuPont and Imperial Chemical Industries, have developed HFC-134a production capabilities and are making sales agreements with various automobile manufacturers.

Because HFC-134a will cost considerably more than CFC-12 currently does, service technicians will have an incentive to recycle it as well. It is likely that new refrigerants will be recycled, using equipment similar to that already in use for CFC-12 recycling.

The Challenge

The transition from CFC-12 to HFC-134a will not be a simple one, and will continue long past the CFC production phase-out scheduled for 2000. In the year 2000, it is estimated that of the 185 million vehicles using mobile air conditioning, 80 million will still rely on CFC-12 refrigerant. Some of these vehicles, with slight modifications to their systems, possibly could be serviced with HCFC blends or, with more extensive modifications, serviced with HFC-134a. However, it seems likely that many vehicles will rely solely on recycled CFCs.

Therefore, recycling CFC-12 is more than just a logical financial and environmental practice, it's the only way to make auto refrigerant supplies last into the next decade and beyond.

ARPI AUTOMOTIVE REFRIGERATION PRODUCTS INSTITUTE

CLEAN AIR ACT AMENDMENTS

CFC PROVISIONS AFFECTING THE AUTOMOTIVE INDUSTRY

The Clean Air Act Amendments of 1990 were approved by Congress on October 26, 1990, and signed into law by President Bush on November 15. The new law includes provisions for phasing out the use and emissions of ozone depleting chemicals, including chlorofluorocarbons (CFCs), and hydrochlorofluorocarbons (HCFCs). The Environmental Protection Agency will draft regulations to enforce these provisions.

Key CFC provisions of the Clean Air Act Amendments affecting the automotive industry include the following:

- Requires EPA to list CFCs, methyl chloroform and carbon tetrachloride as Class I substances and HCFCs as Class II substances within 60 days of enactment.

- Phases out the production of Class I substances by 2000, methyl chloroform by 2002 and Class II substances by 2030.

  EPA regulations to be promulgated immediately.
  First stage of phase-out begins January 1, 1991.

- Requires recapture and recycling of Class I substances during service and repair of mobile air conditioning systems.

  EPA regulations to be promulgated in November of 1991. Recycling mandate begins January 1, 1992. Centers that service 100 or fewer auto air conditioners annually have an additional year.

- Requires that all persons performing service on mobile air conditioners be properly trained and certified, effective January 1, 1992. Persons performing service at centers that service 100 or fewer cars annually have an additional year.

- Restricts the sale of Class I substances in containers smaller than 20 pounds to service professionals who recycle and are properly trained and certified. Restriction effective in November of 1992.

- Requires warning labels on containers of Class I substances.

  Effective May 1993, requires all CFC-12 containers to bear the label: "Warning, Contains clorofluorocarbon-12, a substance which harms public health and environment by destroying ozone in the upper atmosphere."

States have already and may continue to pass laws which are more stringent than these provisions, and the Clean Air Act Amendments do not preempt such laws. EPA staff have stated that it will be challenging to draft fair regulations by the required deadlines. ARPI will continue to inform and work with regulators and state legislators to design reasonable, enforceable regulations on the use of CFCs.

VEHICLES REQUIRING REFRIGERANT FOR SERVICE
(MILLIONS)

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
A/C VEHICLES ON ROAD	150	153	156	159	163	166	171	174	177	181	185
LESS 134A VEHICLES	0	0	0.7	5	14	28	43	59	73	90	105
VEHICLES REQUIRING R12 FOR SERVICE	150	153	155	154	149	138	128	115	104	91	80

Estimates by DuPont

CFC PHASE OUT
(% OF 1986 CONSUMPTION)

	Mont. Prot. (Jul '89)	Mont. Prot.– Rev. (Jan '91)	U.S. Clean Air Act (Jan '91)
1989	100%	–	–
1990	100%	–	–
1991	100%	100%	85%
1992	100%	100%	80%
1993	80%	80%	75%
1994	80%	80%	65%
1995	80%	50%	50%
1996	80%	50%	40%
1997	80%	15%	15%
1998	50%	15%	15%
1999	50%	15%	15%
2000	50%	0	0

SESSION 3G

INTERNATIONAL STRATEGIES FOR ENVIRONMENTALLY SUSTAINABLE ECONOMIES

Chairpersons

Rebecca Hanmer
Organization for Economic Cooperation and Development (OECD)

Jacqueline Aloisi de Larderel
Director, UNEP Industry and Environment Office

Speakers

Jacqueline Aloisi de Larerel
UNEP Industry and Environment Office

Paul de Jongh
Director for Strategic Planning
Ministry of Housing, Physical Planning and Environment
The Netherlands

Thomas Lindhqvist
Department of Industrial Environmental Economics
Lund University, Sweden

Ann Cronin-Cossett
First Secretary-Environment, Canadian Embassy

Rebecca Hanmer
Manager, OECD Programme on Technology and the Environment

(*Speaker to be announced*)
Chemical Industry Association of Mexico

Session Abstract

This session will explore examples of international strategies for environmental management towards "environmentally sustainable economies" and the role of pollution prevention in those overall strategies. While the session will focus on legislation, it will also address policies and instruments of implementation. Examples include: the National Environmental Policy Plan and the "Plus Plan" of the Netherlands, recent legislation introduced to the Swedish Parliament on environmental sustainability, Canada's "Green Plan," and strategic planning of UNEP's Cleaner Product Programme as well as OECD's Programme on Technology and Environment.

SESSION 4A

FRAMEWORK FOR POLLUTION PREVENTION (PART 1)

Chairperson

Ms. Ann Mason
Associate Director, Waste & Release Reduction Program
Chemical Manufacturers Association
Washington, D.C.

Speakers

Mr. John Salmela
Chevron, Chemical Company
(Representing the Chemical Manufacturers Association)
Improving the Chemical Industry—
CMA's Responsible Care Initiative

Mr. David Sand
Commonwealth Capital Partners
CERES–The Valdez Principles

Ms. Jacqueline Aloisi De Larderel
United Nations Environment Program
The United Nation's Cleaner Technologies Programme

Mr. Gary Hunt
North Carolina State
(Representing the North Carolina Office of Waste Reduction)
North Carolina's Integrated Approach

Session Abstract

In this session, speakers will identify the various conceptual frameworks for pollution prevention. Speakers will present the views of industry, government, and the public. Attendees to this session will learn about the variety of approaches to achieve pollution prevention within the various sectors both within the U.S. and internationally.

Speakers will present a summary of their organization's approach to pollution prevention; highlight the key topics of their tailored programs that are particularly important; and discuss some of their findings, outcomes or successes.

Speakers will entertain questions from the session attendees.

THE FRAMEWORK FOR POLLUTION PREVENTION IN THE CHEMICAL INDUSTRY

APRIL 1991

Mr. John Salmela
Chemical Manufacturers Association
2501 M St., N.W.
Washington, D.C. 20037

ABSTRACT

This paper describes the philosophicaland cultural approach that the chemical industry is using to improve performance in health, safety, and environmental protection. In particular, it describes the industry's framework to reduce wastes and releases and to manage wastes within the industry's broader Responsible Care® Initiative.

INTRODUCTION

Many challenges face the chemical industry in the 1990's and into the 21st century. The chemical industry's credibility with the public is at an all time low. There is an increased call for prescriptive state and federal regulations with stiff, punitive enforcement provisions. Inside the chemical industry, there is a growing belief that a new commitment to quality is essential for a competitive position in the global marketplace.

In response to these issues, the chemical industry has committed itself to improving its performance with the goal of continuous improvement in health, safety, and environmental protection.

The industry is resolved to address public concerns in a straightforward way. In 1988, the chemical industry launched an innovative new initiative, called Responsible Care ®. Responsible Care is designed to help companies continually respond to public concerns about health, safety, and environmental quality. In Responsible Care, the chemical industry welcomes, in fact, invites, the opinion and partnership of the public as we work to improve.

SCOPE OF THE PAPER

This paper describes the quiet revolution that the chemical industry is conducting within its own operations to improve its performance.

First, it describes the Responsible Care Initiative with its six Key Elements. Second, it details efforts intended to reduce the environmental impact of industry's operations on employees and the public through pollution prevention and environmental management.

IMPLEMENTING OPPORTUNITIES FOR WASTE AND RELEASE REDUCTION AND POLLUTION PREVENTION

Many challenges face the chemical industry as it implements waste and release reduction. This section explores a few of these challenges.

Changing the Corporate Culture.

Responsible Care represents a major shift in the way the chemical industry traditionally has approached its business. Historically, as with all businesses, the chemical industry focused on the "bottom line." Now, while manufacturing a product and making profits are still important, HOW the industry conducts itself is given equal status with the industry's traditional financial goals. For some companies, this represents a change in corporate perspective. For other companies, it represents only a minor adjustment of existing corporate policies.

Challenging Industry Employees to Own the Program.

Success of the Pollution Prevention Code demands that all chemical industry employees--manufacturers, researchers, planners, and association staff--adopt a reduction and prevention attitude. Most projects spring from simple, every-day actions, for example, turning off the continuous flow of water, recycling paper and plastics, running the production process at more optimal conditions, and performing preventive maintenance. While it is true that some improvements may be costly, employees can make important contributions to the reduction effort.

Education, clear goals, and motivation are all concepts that are easier to discuss than to achieve. An often used slogan of our environment-oriented times is, "Think Globally, Act Locally." This concept can serve as a guide.

RESPONSIBLE CARE--A FRAMEWORK FOR IMPROVED PERFORMANCE

The release in Bhopal, India, in 1985, prompted the chemical industry to accelerate its ongoing reexamination of its operations and has intensified industry efforts to improve overall performance. Between 1986 and 1989, many voluntary programs were developed by the Chemical Manufacturers Association (CMA) using CMA's consensus-building process.

In 1988, the U.S. chemical industry formally adopted Responsible Care ®. Many of the initiative's principles come from a similar program the Canadian chemical industry launched in 1984. Within CMA the Responsible Care program is an obligation of membership.

Under CMA's Responsible Care Initiative, the chemical industry commits to improve performance in health, safety, and environmental protection and to support that promise with tangible actions. The program has six Key Elements:

- Guiding Principles
- Obligation of Membership
- Codes of Management Practices
- Public Advisory Panel
- Self-Evaluation
- Executive Leadership Groups.

Guiding Principles--Obligation of Membership

To ensure a sound cornerstone for Responsible Care, CMA's chief executives developed and signed ten Guiding Principles that provide the framework for improving industry performance. (Table 1) The executives affirmed the importance of operating in conformance with these Guiding Principles by amending the CMA By-laws to require companies to adhere to these principles AS AN OBLIGATION OF MEMBERSHIP in CMA. This condition underscores the seriousness that the industry ascribes to the Responsible Care Initiative. In a sense, these ten Guiding Principles establish a contract between the public and CMA member companies as the basic framework for operating in the US.

Codes of Management Practices

Codes of Management Practices provide the framework for industry to implement the Guiding Principles. They delineate proper and acceptable practices in specific areas of industry operation that are intended to improve performance in health, safety, and the environment.

Currently, CMA's Responsible Care Initiative includes plans for six Codes of Management Practices. (Table 2) Each code covers a specific aspect of industry's operations and provides specific implementing guidance.

Table 2--Codes of Management Practices

Community Awareness and Emergency Response (CAER)--identifies and responds to community concerns.

Pollution Prevention--provides a framework for reducing and managing wastes and releases.

Worker Health and Safety--addresses the safety of the workplace.

Distribution--provides a framework for the safe transport and handling of chemicals.

Product Stewardship--addresses proper use and disposal of our products in the marketplace.

Public Advisory Panel

In CMA's Responsible Care Initiative, the public defines the term "responsible." A third party assembled an independent, diverse group of public opinion leaders to share public concerns about industry operations with CMA. The panel consists of independent thought leaders from across the United States and includes a doctor, a farmer, an ethicist, a futurist, an environmental leader, and a League of Women Voters leader.

The Public Advisory Panel provides direct input to the development of Responsible Care by reviewing and commenting on the Codes of Management

Responsible Care:®
A Public Commitment

GUIDING PRINCIPLES

Member companies of the Chemical Manufacturers Association are committed to support a continuing effort to improve the industry's responsible management of chemicals. They pledge to manage their businesses according to these principles:

- To recognize and respond to community concerns about chemicals and our operations.
- To develop and produce chemicals that can be manufactured, transported, used and disposed of safely.
- To make health, safety and environmental considerations a priority in our planning for all existing and new products and processes.
- To report promptly to officials, employees, customers and the public, information on chemical-related health or environmental hazards and to recommend protective measures.
- To counsel customers on the safe use, transportation and disposal of chemical products.
- To operate our plants and facilities in a manner that protects the environment and the health and safety of our employees and the public.
- To extend knowledge by conducting or supporting research on the health, safety and environmental effects of our products, processes and waste materials.
- To work with others to resolve problems created by past handling and disposal of hazardous substances.
- To participate with government and others in creating responsible laws, regulations and standards to safeguard the community, workplace and environment.
- To promote the principles and practices of Responsible Care by sharing experiences and offering assistance to others who produce, handle, use, transport or dispose of chemicals.

Practices. The Public Advisory Panel acts as a sounding board during the code drafting phase to assess whether the code adequately addresses public concerns.

Member Self-Evaluation

Inherent in any program is the need to measure and track implementation progress. Responsible Care requires that each company submit an annual progress report for each Code.

The Self-Evaluation Form serves as an internal management tool for CMA and companies to track progress. The ultimate measure will be improved industry performance.

Executive Leadership Groups

CMA's member company senior executives recognized that they must provide both top level commitment and adequate resources to ensure the successful implementation of Responsible Care. They developed regional groups, called Executive Leadership Groups, to provide a mechanism for companies to share experiences and progress with Responsible Care implementation.

Periodic regional meetings allow top company executives to meet with their peers to discuss corporate-wide Responsible Care implementation activities. Through the Executive Leadership Groups, leaders within the chemical industry have a mechanism to monitor industry commitment to the Responsible Care Initiative and to review industry's progress toward improved performance.

POLLUTION PREVENTION CODE--CHARTING NEW DIRECTIONS UNDER RESPONSIBLE CARE

Waste and release reduction forms one part of the two-part Code, Pollution Prevention, designed to improve industry efforts for environmental protection. This code combines and expands upon four existing CMA programs. One important expansion over previous CMA voluntary programs is that implementation of the Code is an obligation of CMA membership.

This first part, Waste and Release Reduction, moves beyond existing, voluntary industry programs by setting two far-reaching goals:

1. Ongoing, long-term reductions in the amount of all contaminants and pollutants released to the air, water, and land.

2. Ongoing reductions in the amount of wastes generated at facilities.

An important aspect of this Code is the definition of the term "waste." Based upon input from the Public Advisory Panel, CMA adopted a broad definition for waste.

> ***Waste***--*Any gas, liquid, or solid residual material at a facility, whether hazardous or non- hazardous, that is not used further in the production of a commercial product or provision of a service and which itself is not a commercial product.*

The second part of the Code will address managing the remaining materials left after implementation of the reduction projects. This part will address company wastes handled by both member companies and by their contractors, groundwater protection, and remediation of sites.

CMA member companies recognize that achieving ongoing, long-term reductions requires the commitment and expenditure of substantial human and financial resources. By adopting the Pollution Prevention Code, companies are charting a new course toward source reduction.

Providing a Framework for Pollution Prevention Progress.

The first ten management practices provide a framework for reducing waste generation and releases to the environment.

Practice 1--Commit the Organization.

> *A clear commitment by senior management through policy, communications, and resources, to ongoing reductions at each of the company's facilities, in releases to the air, water, and land and in the generation of wastes.*

Management commitment is the foundation for the entire Responsible Care Initiative and its reduction program. Company implementation will range from an informal verbal company policy to well-established written policy. Each company and/or facility must determine the best way to achieve the fundamental change in corporate culture and attitude required by the Responsible Care Initiative and its related Codes.

Practice 2--Inventory Wastes and Releases.

> *A quantitative inventory at each facility of wastes generated and releases to the air, water, and land, measured or estimated at the point of generation or release.*

Establishing an inventory is essential to identifying and understanding what reduction opportunities exist. Many companies in CMA are covered by the release reporting requirements of the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986, also called SARA Title III. Most of these companies will use these SARA inventories as the foundation for the inventory required by the Code. The Code encourages facilities to evaluate their inventories and expand them to cover all substances and wastes, whether hazardous or non-hazardous.

CMA, EPA, and others offer resource materials on methods to estimate or measure releases and wastes. Two areas in which CMA expended considerable effort include measuring equipment leaks (fugitive emissions) and estimating releases from ponds and spill areas (secondary emissions). CMA guidance documents are available for each of these release types. In addition, CMA experts developed a software package to capture the fugitive data (POSSEE) and developed a series of models for estimating secondary emissions (PAVE).

Practice 3--Evaluate Potential Impacts.

Evaluation, sufficient to assist in establishing reduction priorities, of the potential impact of releases on the environment and the health and safety of employees and the public.

Under this practice, facilities must evaluate the potential impact that wastes and releases may have on employees and the public. Many facilities may expand the occupational health evaluations conducted for employee protection to the public. Some facilities may choose to conduct testing in communities, using either a short-term survey or longer-term monitoring. Some facilities may choose to use modelling to estimate the impact of the facility on employees and the public. Ultimately, the concerns of employees and public will determine the type of evaluation.

Practice 4--Educate and Listen to Employees and the Public.

Education of, and dialogue with, employees and members of the public about the inventory, impact evaluation, and risks to the community.

Using the outreach mechanism established in the Community Awareness part of the CAER Code, companies must seek the input of employees and the public. Listening to their concerns is the key concept in this practice to gain input from employees and an informed public. Inherent in this practice is an educational process so that employees and the public can understand the technical terms and concepts used to describe plant operations, the inventory, evaluation of potential impacts, and the risks.

Companies that have established an outreach mechanism under the CAER Code and companies that have engaged the public in conversations about the SARA Title III releases know that establishing these public contacts are important. Sometimes both facilities and the public find that establishing open communication mechanisms is a daunting and challenging opportunity.

While there is no best way to establish an outreach mechanism, CMA offers many written resources and a support network for facilities.

Practice 5--Establish a Reduction Plan, Goal, and Priorities.

Establishment of priorities, goals and plans for waste and release reduction, taking into account both community concerns and the potential health, safety, and environmental impacts as determined under Practices 3 and 4.

Only after developing the inventory, performing the evaluation, and listening to the employees and public should a facility develop a reduction plan.

Each company/facility is beginning to implement the Code at a different point because many have been implementing reduction projects for a long time. In fact, some companies instituted a formal corporate or facility reduction program over ten years ago. Therefore, each company and/or facility must identify its own reduction opportunities, identify the concerns of its own public, determine their reduction priorities and goals, and develop and implement its own reduction plan.

Practice 6--Implement the Reduction Plan.

Ongoing reduction of wastes and releases, giving preference first to source reduction, second to recycle/reuse, and third to treatment. These techniques may be used separately or in combination with one another.

The U.S. Environmental Protection Agency has endorsed the hierarchy: source reduction, recycle/reuse, and treatment.

Each waste and release source must be evaluated for its reduction potential. This evaluation will help in setting the reduction priorities. Once identified, the hierarchy requires that facilities preferentially try to implement projects for source reduction before recycle/reuse or treatment programs.

Each company must identify its own priorities and implement a reduction plan to meet company or facility-set goals. Technical infeasibility is only one of several facility and/or waste specific criteria that can lead to selection of a reduction project involving recycle/reuse or treatment. When developing their reduction priorities, companies/facilities should consider other criteria including: risk/benefit mechanisms; public concern; size of the facility; economics; and other factors such as conservation of resources.

Practice 7--Measure Progress.

Measurement of progress at each facility in reducing the generation of wastes and in reducing releases to the air, water, and land, by updating the quantitative inventory at least annually.

Tracking and measuring progress are important features because facilities must have some mechanism to measure progress against the facility's reduction plan and its goal. Inherent in Pollution Prevention is the understanding that facilities will discuss general reduction techniques and assumptions as part of the public education and dialogue process.

Practice 8--Communicate Progress.

Ongoing dialogue with employees and members of the public regarding waste and release information, progress in achieving reductions, and future plans. This dialogue should be at a personal, face-to-face level, where possible, and should emphasize listening to others and discussing their concerns and ideas.

Practice 8 provides the feedback loop to employees and the public. Using the outreach mechanism established in the Community Awareness part of the CAER Code, facilities communicate actions and progress toward resolving concerns that were identified in Practice 4.

Practice 9--Integrate Reduction Concepts in Planning.

Inclusion of waste and release prevention objectives in research and in design of new or modified facilities, processes, and products.

Incorporating reduction concepts into the business planning process will steer progress toward source reduction. Business units considering new products, expansions, major modifications, or process retrofit are good candidates for source reduction. Hence, it is essential that those concerned with planning these activities know about the corporate reduction objectives.

Practice 10--Outreach.

An ongoing program for promotion and support of waste and release reduction by others.

Under this practice, companies have some flexibility in the types of activities they choose to conduct. Some examples of activities that represent industry outreach include:

a. Sharing technical information and experience with customers and suppliers;

b. Supporting efforts to develop improved waste and release reduction techniques;

c. Assisting in establishing regional air monitoring networks;

d. Participating in efforts to develop consensus approaches to evaluating environmental, health, and safety impacts of releases;

e. Providing educational workshops and training materials;

f. Assisting local governments and others in establishing waste reduction programs benefitting the general public.

PREVENTING AND MANAGING RESIDUALS

The second part of the Code includes four practices that address the management of the residual wastes remaining after prevention and reduction practices are in place.

Practice 11--Facility Assessment

Practice 12--Contractor Evaluation

Practice 13--Groundwater Protection

Practice 14--Prior Site Evaluation

CMA's members are currently reviewing the draft language for these four practices. CMA expects to approve the inclusion of these draft practices into the Pollution Prevention Code in the Fall of 1991.

MEASURING INDUSTRY-WIDE PROGRESS.

As part of the Pollution Prevention Code, companies are required to send a three-part report to CMA or its designated agent(s):

1. Self-Evaluation Form.

Each year companies must report the number of facilities in each of the six implementation stages. CMA will compile these data to determine industry-wide progress.

2. Release Trend Data.

Each year companies must send release data based upon the Toxic Release Inventory that most members submit to the Environmental Protection Agency under the Emergency, Planning and Community Right-to-Know Act (EPCRA) requirements.

3. Waste Data.

Beginning with the 1990 reporting year, members are required to complete a waste survey. (Previously, this survey was voluntary.)

ENCOURAGING POLLUTION PREVENTION

Industry alone cannot fully accomplish the goals of pollution prevention. All parts of society have a role to play. For example, regulators can play an extremely important role.

Challenging Regulators to Allow Source Reduction.

Regulators interested in promoting source reduction projects can help motivate industry by closely examining the permitting process and removing unnecessary barriers. The traditional approach to evaluating a permit application is to use a technology-driven approach. For optimum reductions, many projects require a process change rather than the addition of a pollution control unit. Applicants who propose source reduction strategies (often requiring change in the process) report that the permit process either slows or stops altogether. If a facility needs a permit to install source reduction practices and a permit is impossible to obtain when such a project is proposed, facilities may be less willing to propose source reduction projects.

When companies that aggressively search for ways to reduce releases earlier than regulations might require are thwarted from competing in the world market because a tightened permit could impede expansion, the permit becomes a disincentive for voluntary reductions.

Regulators, trying to create incentives for facilities to use source reductions or to go beyond the required control technologies, must recognize that the existing system has created some disincentives.

The chemical industry firmly believes that early reductions benefit society, respond to public concerns, and reduce the opportunity for exposure to pollutants.

SUMMARY

In this paper, we have provided a summary of the Responsible Care Initiative and presented a detailed overview of the Pollution Prevention Code of Management Practices.

Under this Code, the chemical industry embraces the goal of long-term reductions both in the amount of wastes generated and compounds released to the environment. It also clearly states its use of the full waste management hierarchy, giving preference to source reduction wherever technically possible and feasible.

Under Responsible Care the chemical industry has committed itself to a cultural change, to realign priorities, and to continually improve performance. In implementing the Initiative, we expect to be held accountable for our performance.

Improved performance will take time, money, and hard work. As we move down this road, we invite others to pick up the challenge and join us.

CERES & THE VALDEZ PRINCIPLES

The Coalition for Environmentally Responsible Economies (CERES) is a broad group of environmental and concerned investor organizations. In 1989 CERES issued the Valdez Principles, a ten point code of corporate environmental responsibility.

A major part of the work of CERES is the promotion of standardization of disclosure of environmental information. As part of the "Global Pollution Prevention '91" conference, David F. Sand, Valdez Principles Project Director, will be speaking on the Principles and environmental disclosure.

CERES may be contacted at:	711 Atlantic Ave. Boston, MA 02111 617-451-0927
Mr. Sand may be contacted at:	Commonwealth Capital Partners, Inc. 334 Broadway Cambridge, MA 02139 617-491-0988

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Guide to

THE VALDEZ PRINCIPLES

Statement of Intent

With these Principles, the Coalition for Environmentally Responsible Economies, or the CERES project of the Social Investment Forum, sets forth broad standards for evaluating activities by corporations that directly or indirectly impact the Earth's biosphere. The Valdez Principles are intended to help investors make informed decisions around environmental issues. As representatives of the investment and environmental communities, we are asking corporations to join with us by subscribing to these Principles.

Recognizing the complexity of issues contained in these broad Principles, CERES sees the Principles as a long term process rather than a static statement. CERES members hope that signatory companies will work with us on the elaboration of the specific requirements of these Principles. Our intent is to create a voluntary mechanism of corporate self-governance that will maintain business practices consistent with the goals of sustaining our fragile environment for future generations, within a culture that respects all life and honors its interdependence.

We ask for a long term commitment to the process of compliance with these Principles, and an additional commitment of assistance and cooperation in the further development of specific standards derived from each of these general Principles.

How to Sign

The following steps should be taken by companies wishing to be signatories:

1. Signatories should submit to CERES a letter signed by an authorized company representative that will include the "Introduction to the Principles" and the entire text of the Principles.

2. Accompanying the letter, a company should submit to CERES a check in the appropriate amount per the fee schedule in Section IV of this Guide.

3. Signatories will receive a copy of the CERES Report (see The CERES Report) before Labor Day of each year to be completed by March 1 of the following year. The report should be mailed to the CERES office where it will be summarized and made available to the public.

The Valdez Principles

Introduction

By adopting these Principles, we publicly affirm our belief that corporations and their shareholders have a direct responsibility for the environment. We believe that corporations must conduct their business as responsible stewards of the environment and seek profits only in a manner that leaves the Earth healthy and safe. We believe that corporations must not compromise the ability of future generations to sustain their needs.

We recognize this to be a long-term commitment to update our practices continually in light of advances in technology and new understandings in health and environmental science. We intend to make consistent, measurable progress in implementing these Principles and to apply them wherever we operate throughout the world.

The Valdez Principles

1. Protection of the Biosphere

We will minimize and strive to eliminate the release of any pollutant that may cause environmental damage to the air, water, or earth or its inhabitants. We will safeguard habitats in rivers, lakes, wetlands, coastal zones and oceans and will minimize contributing to the greenhouse effect, depletion of the ozone layer, acid rain, or smog.

2. Sustainable Use of Natural Resources

We will make sustainable use of renewable natural resources, such as water, soils and forests. We will conserve nonrenewable natural resources through efficient use and careful planning. We will protect wildlife habitat, open spaces and wilderness, while preserving biodiversity.

3. Reduction and Disposal of Waste

We will minimize the creation of waste, especially hazardous waste, and wherever possible recycle materials. We will dispose of all wastes through safe and responsible methods.

4. Wise Use of Energy

We will make every effort to use environmentally safe and sustainable energy sources to meet our needs. We will invest in improved energy efficiency and conservation in our operations. We will maximize the energy efficiency of products we produce and sell.

5. Risk Reduction
We will minimize the environmental, health and safety risks to our employees and the communities in which we operate by employing safe technologies and operating procedures and by being constantly prepared for emergencies.

6. Marketing of Safe Products and Services
We will sell products or services that minimize adverse environmental impacts and that are safe as consumers commonly use them. We will inform consumers of the environmental impacts of our products or services.

7. Damage Compensation
We will take responsibility for any harm we cause to the environment by making every effort to fully restore the environment and to compensate those persons who are adversely affected.

8. Disclosure
We will disclose to our employees and to the public incidents relating to our operations that cause environmental harm or pose health or safety hazards. We will disclose potential environmental, health or safety hazards posed by our operations, and we will not take any action against employees who report any condition that creates a danger to the environment or poses health and safety hazards.

9. Environmental Directors and Managers
We will commit management resources to implement the Valdez Principles, to monitor and report upon our implementation efforts, and to sustain a process to ensure that the Board of Directors and Chief Executive Officer are kept informed of and are fully responsible for all environmental matters. We will establish a Committee of the Board of Directors with responsibility for environmental affairs. At least one member of the Board of Directors will be a person qualified to represent environmental interests to come before the company.

10. Assessment and Annual Audit
We will conduct and make public an annual self-evaluation of our progress in implementing these Principles and in complying with applicable laws and regulations throughout our worldwide operations. We will work toward the timely creation of independent environmental audit procedures which we will complete annually and make available to the public.

Guidelines for Becoming a Signatory

Any business entity may become a signatory of the Valdez Principles by submitting a signed copy of the Principles and the statement of intent. Signing the Principles constitutes a continuing commitment to make measurable progress in implementing and abiding by the Principles, and to apply them to worldwide operations, subsidiaries, partnerships, and joint ventures. A signatory is expected to adhere to the Principles in its role as a consumer and in the production of its products and services.

Signatory companies are encouraged to make public the fact that they have signed the Valdez Principles. CERES and its members will acknowledge and seek to publicize the positive commitment implicit in signatory status. The name "Valdez Principles" is a servicemark of CERES, Inc. and signatories agree to use it and the CERES name in public statements only in accordance with guidelines issued by CERES or with specific advance permission. Signatory companies agree not to suggest or imply that they have a "seal of approval" from CERES or its members or that CERES has endorsed the company or its products.

A Corporate Advisory Committee of signatory companies will be established to work in consultation with CERES on those aspects of the process that require further amplification or clarification.

On or before Labor Day of each year CERES will release the format for the CERES Report. Companies signing the Principles agree to submit to the Coalition by March 1 their responses to the CERES Report (see The CERES Report).

SESSION 4B

SOURCE REDUCTION

Chairperson

Mr. Arnold L. Feldman
Olin Corporation
Charleston, TN

Speakers

Mr. Jerry Kotas
US Environmental Protection Agency

Ms. Carol Andress
Northwest-Midwest Institute
Washington, D.C.

Ms. Joanna D. Underwood
Inform

Mr. J. Lindsly
Dow Chemical Company

Mr. Stan Springer
Washington Department of Ecology

Session Abstract

The session will be a panel discussion directed toward consensus building on questions relating to source reduction. The questions will be both prepared and taken from the audience. Prior to the discussion, each panel member will be introduced followed by a 3-4 minute (maximum) opening statement.

The questions for discussion are listed below:

- Everyone wants "zero generation" or "zero discharge." Is this truly possible?
- Can legislative/regulatory mandate force source reduction? What are the economic implications?
- If closed loop process reuse of a stream is considered source reduction then:

Can source reduction include this stream if it is temporarily stored yet reused in the generating process? If not, why?

Using another process on-site?

- Realizing that this is a capitalistic society (business must make a profit) and the state of the economy, for those projects/ideas on source reduction that are not economically viable, what are the incentives to do them?
- Illinois uses the term "economically reasonably and technically feasible" (ERTF) and New York has adopted a similar term as its waste minimization law. What are economically reasonable and technically feasible? Who decides?

SESSION 4C

CASE STUDIES IN POLLUTION PREVENTION (PART 1)

Chairperson

Mr. Joe Lindsly
Dow Chemical Company
Midland, MI

Speakers

Ms. Stephanie Richardson
Program Manager
North Carolina Pollution Prevention Program
Raleigh, NC
The Low-Tech Approach—The Equity Story

Mr. Robert Lutz
Manager of Environment Affairs
Dow Chemical Canada, Inc.
Sarnia, Ontario
Application of Continuous Improvement in Dow Canada

Dr. Lowell Smith
Senior Fellow in the Waste Minimization Group
Technology Section, Roundup Division
Monsanto Agricultural Company
St. Louis, MO
Ion Exchange for Glyphosphate Recovery

Mr. Kevin Boyle
Technical Manager, Fina/Cos-Mar Company
Carville, LA
ALERT

Session Abstract

Case studies of new technologies, new approaches and real life industrial accomplishments will be presented by representatives of Government, Industry, and Academia. Topics range through the Computer Industry to the Chemical Industry; and from promising new technologies to recycle waste water, to a simpler re-visitation of accepted hazardous waste problems with new vision and energy to develop new solutions, that not only succeeded where previous efforts had failed but are now being applied in Europe and Japan.

LOW TECH WASTE REDUCTION - THE EQUITY STORY

by

STEPHANIE RICHARDSON
PROGRAM MANAGER
NORTH CAROLINA POLLUTION PREVENTION PROGRAM
OFFICE OF WASTE REDUCTION
NC DEPT. OF ENVIRONMENT, HEALTH AND NATURAL RESOURCES

prepared for presentation at

GLOBAL POLLUTION PREVENTION '91
Case Studies in Pollution Prevention (Pt.1)
April 3, 1991

LOW TECH WASTE REDUCTION - THE EQUITY STORY

by

STEPHANIE RICHARDSON
PROGRAM MANAGER
NC POLLUTION PREVENTION PROGRAM
NC DEPT. ENVIRONMENT, HEALTH AND NATURAL RESOURCES

ABSTRACT

The food processing industry is very diverse. The diversity of the industry is apparent not only by the vast array of final products but also by the waste generated. Food processing waste, though not considered to be a health hazard, can be formidable in the quantities generated. Even the smallest seasonal plant is capable of producing waste loads equivalent to a population of 15,000-25,000 people. Sludge generated from process wastewater treatment coupled with solid waste generation occurring during product handling and processing can result in wastes that are both difficult and expensive to handle.

The increased cost of end-of-pipe treatment technologies and solid waste disposal coupled with the negative public impact of environmental non-compliance has forced the food industry to investigate alternate approaches to their waste problem. The approach that has proven itself both financially and technically feasible is waste reduction. The food industry, more than any other industry, is fortunate in that low tech waste reduction is extremely effective in reducing waste generation, water usage and their associated costs.

This paper will present the steps which have been proven to be effective in reducing waste generation in food processing. This information will be validated by documented results from The Equity Group (Equity), a producer of breaded chicken nuggets, located in Reidsville, NC.

TYPES OF WASTE

Before an effective waste reduction program can be implemented, an understanding of what a waste is, and, how and where it originates is required. In food processing, waste can be broken into two categories; direct and indirect.

Direct wastes are those wastes that can be accounted for in the dumpster or inedible bins. These wastes occur as raw ingredients are stored, transferred and processed. Direct waste can be classified as intentional and unintentional.

Intentional wastes are wastes that are expected such as peelings and pits from vegetable processing; blood and bones from meat processing; bread and dough from bakeries; and wash down water from all processors. Unintentional waste are those waste resulting from poor inventory control, improper employee management and improper storage. Examples of unintentional wastes include losses attributable to spoilage while in storage; improperly supervised clean up; losses due to improper equipment maintenance, etc. Direct waste, whether intentional or unintentional, is comprised of lost product ingredients and semi or fully processed product.

Indirect waste is a result of direct waste lost down the drain. Product or raw ingredients lost down the drain results in wastewater which must be treated which leads to the formation of sludge.

Sludge generation is dependent on the type of food being processed, the type of wastewater treatment used and the amount of food lost down the drain. There is a direct correlation to food lost down the drain and wastewater strength and therefor the resulting sludge generation. One pound of Biochemical Oxygen Demand (BOD), the pollutant measure most used by municipalities, is equivalent to 0.89 pounds of fat, 1.03 pounds of protein and 0.65 pounds of carbohydrate.

IDENTIFYING REDUCTION OPPORTUNITIES

Inaccurate record keeping low waste disposal and treatment costs or lack of disposal problems have lulled management into thinking waste loads and water usage are within acceptable limits. As management realizes that efficiently run wet processing plants should only lose 2-5% of input ingredients, they become aware of the losses they are incurring. This coupled with increased wastewater treatment and solid waste disposal costs as well as public scrutiny have forced management to reevaluate operational procedures.

The best and quickest approach to identifying waste reduction opportunities is by conducting a waste audit or waste assessment. This approach can be performed in-house or by outside consultants. There are six basic steps to this process.

First and foremost is corporate commitment. Lack of corporate commitment is the most formidable obstacle to waste reduction. The establishment of a clear, concise corporate policy regarding waste is imperative. Employees have a sixth sense when it comes to the true level of corporate commitment and they will rise to or fall to the level that is expected of them.

Step two is choosing a team to conduct the audit or assessment. An audit or assessment can be conducted by an outside firm; however, plant employees know the facility better than anyone. Audits/assessments can be conducted by an individual; however, a team approach with members from every department will provide a better insight and broader base to work from. There should be representation from management, shipping/receiving, QA/QC, maintenance, process line, cleanup, engineering, etc.; and, they should all be treated as equals. Additionally, if there is "sister" plant it may be advisable to have a representative from that plant involved. This will allow someone who has knowledge of the process but isn't involved with it on a day to day basis to look at it with "fresh eyes". Often times daily procedures are taken for granted. Additionally it will provide for input from someone who has no fears (imaginary or otherwise) of repercussions.

The third step involves gathering of background information. This includes all available information from the following areas: production/processing, waste management, economic/financial and general(vendor information, previous studies etc.). This data should provide some correlations between waste produced, water usage per unit process or indicate what production activities resulted in significant waste generation. Further it should indicate if inventory control (spoilage) has been a problem in the past or if environmental noncompliance is chronic.

Assemblage of this data will result in a formidable collection of material which must be put in a usable form. Step four, with its two parts, allows the information to be used by establishing a flow chart which tracks ingredients from the receiving dock through processing to product or waste. The creation of a simple flow chart which shows each input and output per process directs the team toward opportunity areas as well as identifying data gaps. The second portion of this step is to go into the plant and observe all actual operations and perform any monitoring that is needed to fill data gaps. If there is questions about a process or procedure the team members should be free to talk with the line workers. Asking "why" or "why not" about given activities often reveals reasons of "because we've always done it this way" or "because I was told too." Sound technical reasoning will be lacking when wasteful practices are discovered. The worse, but frequently response, is "I told management about the problem (situation) and they did nothing about it so why should I care?"

Step five requires that information that was gleaned from the survey be inserted into the flow chart and that a mass balance be performed. As the term implies this is a "mass" balance. The desire here is not to account for every microbe of ingredient, product or waste; instead it is to get a feel for the amount of incoming ingredients vs. the amount of finished product with what is left over being waste. There are two basic mass balances that should be performed. The first is process by process. This will pin point individual processes are the most wasteful and water intensive. The second balance is and overall plant balance. This will evaluate activities which are not specific to an individual process such as cleanup, batch dumping, etc. This balance often identifies areas where a change in employee attitude is required.

Now that all the information on plant processes and waste generation has been assembled and the areas of concern have been identified it is time to move to the sixth and final step. This step consists of alternatives evaluation. Technical and economic evaluations are performed to determine the feasibility of waste reduction options. These options could include such approaches as chemical substitution, processes modification, on-site recycle programs, off-site recycle programs etc.

For the food industry one of the most effective approaches is training employees as to what a waste is, where it comes from and the effect it can have on the environment and their job, as well as retraining them in the area of proper dry cleanup activities. For all industries employee training should be the first option implemented with other approaches to follow. Employees are the first line of defense. Without their involvement any waste reduction plan is doomed to failure. Employee training programs, improved maintenance programs, water reduction programs, employee involvement programs are all vital ingredients in the low tech approach to waste reduction.

THE EQUITY STORY

Background

The Equity story began in June 1987 and is ongoing. Equity Group, located in Reidsville, NC was producing approximately 2.5 million breaded chicken nuggets daily. The process involved the grinding and blending of high quality chicken meat, formation of chicken nuggets which were then battered, breaded, rebattered with tempura, fried, frozen and packaged. The plant which employed 275 people on two production shifts and one cleanup shift operated five to six days a week. The operation was using approximately 200,000 gallons of water daily and discharging wastewater with a daily BOD (Biochemical Oxygen Demand) loading of 4,500 pounds. Even at these levels of discharge it was not until the implementation of a new sewer use ordinance, pretreatment limits and surcharge levels in June of 1987 that excess waste generation in the facility was recognized.

The Problem

The traditional approach to food processing was practiced by Equity. High production quality and sanitation standards translated into high water usage. Additionally the requirements of the U.S. Department of Agriculture (USDA) requiring all production lines to be free of any meat accumulation while in operation were interpreted as requiring all equipment to be hosed down three times per shift. The result was a tenfold increase in water usage and waste production. Since discharge of waste materials had not presented a problem in the past standard operating procedure was to flush waste food ingredients down the drain to the pretreatment plant. On an average, the per shift food loss to the drains was 55 pounds of chicken meat, 3 pounds of tempura and 15 pounds of dry batter per production line. There were 6 lines.

During this same period of time the City of Reidsville was fined for noncompliance with their wastewater discharge limits. Subsequent analysis revealed that the city's wastewater treatment plant was incapable of handling incoming wastewater at the loading levels that were being received. This resulted in a new sewer use ordinance being adopted by the City of Reidsville. The new ordinance established stringent pretreatment limits and heavy surcharge levels. Equity's BOD loadings were well above the established limits and therefor were very costly.

Initial Response

Upon notification of the city's wastewater treatment problem, the new discharge limits and the increased surcharges for BOD, Equity took immediate action. A committee was formed and charged with the task of investigating all approaches to reducing waste loadings that were being discharged to the city. The committee was chaired by the director of personnel who contacted the NC Pollution Prevention Program (PPP) and the Agricultural Extension Service (Ag. Extension). Use of the director of personnel in this capacity placed a people oriented person who had no preconceived ideas about what could and couldn't be done with regard to technical problems and waste treatment at the helm of the program. The lack of preconceived ideas coupled with the employee trust that he possessed proved to be very valuable assets.

Technical Assistance

In July and August of 1987 preliminary waste surveys were performed by specialist from PPP and Ag. Extension. It was at this point that the severity of the problem became apparent. A report outlining operational and cleanup procedures was submitted to Equity and a preliminary training program for selected managers and line supervisors was held.

This initial training program was used to acquaint attendees with wastewater terminology as well as inform them of the difficulties that Equity was having with their wastewater discharge. Additionally it pointed out that these wastewater problems were a result of hosing batter and meat into the drains, and, that a new policy of keeping the food off the floor and out of the drain would be implemented.

The traditional approach to waste management taken by Equity had been pretreatment. Since waste reduction and pollution prevention was a new approach they applied for and received a grant from NC PPP to establish and implement a waste reduction program.

Identification

Since a preliminary survey had been performed and managers and line supervisors had been informed of the problem and planned approach to that problem, they were prepared when a more detailed water and waste survey was conducted. This survey consisted of observing and photographing processing activities and cleanup activities. Photography included the use both still camera shots and video recording. Additionally, monitoring and testing was performed on water usage and waste generation by shift and during periodic points through the day.

This detailed survey revealed that solid waste such as fat, raw chicken bits, dry batter (breading) and processed nuggets were being washed down the drain. Liquid wastes finding their way to the drain included chicken blood and juice, and tempura batter.
Additionally, the survey showed that over half of the waste load resulted from the cleanup.

Closer examination of the problem revealed that solid waste was being washed down the drain because there was no alternate disposal option and because there were no containment (catch pans) facilities to capture crumbs, flour, oil, etc. that was lost during product transfer. It also became apparent that waste was being generated because of worn-out equipment, missing gaskets, misaligned conveyors, leaking valves and lines, and a general lack of routine maintenance.

The most serious problem was the lack of communication between management, the line workers, maintenance staff and the cleanup crew. The line workers were unaware that their actions could have a direct affect on wastewater problems. They had not been trained in dry cleanup practices. The maintenance approach was "if it ain't broke don't fix it", and, cleanup functioned under the misconception that more water used in cleanup translated into a better job done.

Dry Cleanup

The dry cleanup approach took two phases. The first portion was to provide containers for the collection and separation of solid and liquid waste. These containers included catch pans placed under equipment where product was lost during transfer as well as containers into which employees placed dry waste that accumulated on their equipment or was on the floor. Catch pans were also emptied into these containers. With containers in place supervisors instructed their employees as to proper dry cleanup methods which involve removing ALL dry ingredients from the floor and equipment prior to cleaning with water. Any wet ingredients were collected separately. The result was, that by 1988, this basic training had resulted in a 50 percent reduction of the BOD loading in the wastewater.

The effectiveness of dry cleanup was not only demonstrated in the BOD reduction but in the amount of solid waste which was being accumulated. The collected solid waste was, for the most part, carbohydrate and protein based and was therefor marketable. Over 5,000,000 pounds per year was being sent off site for use as animal feed with the remaining being sent to a rendered. This resulted in approximately 30 ton/week of solid waste being removed from the landfill in 1988.

The quantity of solid waste generated, which was previously hidden in the wastewater, resulted in the evaluation of the processes. This evaluation focused on the manner in which chicken blending took place, the quantities of batter formulated, and the manner in which ingredients were being used. This approach was used to reduce the actual generation of the waste.

The Program Continues

Even though the Grant from PPP ended in 1988, Equity's commitment to waste reduction continues. This is evident by their more recent efforts.

In October 1989 each and every employee at Equity was involved in an in-depth training program. Each shift was broken into half or thirds in order that production continue and group size be limited. Training was performed at a level and using terminology that did not intimidate or confuse the line workers but was upscaled for management. Separate presentations were made to production line workers, cleanup crew, supervisors, and management. A member of management attended each presentation to emphasize corporate commitment.

Employee training took place in the conference room using slides of actual plant activities. Employees were trained as to what a waste was; where it came from; the effect it could have on the environment; and, the effect that the increased sewer charges were having on profitability and how that could affect their job. All training was very positive. Employees were not condemned for previously accepted wasteful practices, instead the situation of how standards had changed was explained. With this explanation came training in dry cleanup and water saving procedures. Viewing a slide presentation of process and cleanup activities in a nice, comfortable surrounding made wasteful activities very apparent; however, with the positive nature of the training no one felt that they were being blamed or being made the scape goat. During this training they were told that management wanted to know what could be done to make their jobs easier and less wasteful, if there was any special equipment that would help or if they had any ideas on the subject.

When employees realized that food was in fact a waste once it hit the floor, and that their work ethics could have a positive impact on the environment they became enthusiastic participants in the waste reduction program. The effectiveness of this low cost, low tech approach is apparent by the reduction of wastewater pollutant loadings realized. In October 1989 TSS (Total Suspended Solids) and BOD (Biochemical Oxygen Demand) loadings in the wastewater were in the 2,500 mg/l range. Following the training they dropped to the 300 mg/l range. This translated to a $10,000 per month sewer surcharge savings.

With enthusiasm about the environment high and employee concern at a peak, Equity management made the decision to start an environmental employee involvement group. Thus, the Waste Awareness Program (WAP) was born. Initiated in October 1989 it was not until early 1990 real activity began. The WAP committee is composed of workers from a company departments and shifts. Employees are rotated on and off the committee periodically in order to insure total employee involvement and maintain fresh approaches to the complex waste issues. Committee members receive patches to wear on their uniforms. The effectiveness of the committee and its input is demonstrated by the continued decline in wastewater BOD loading.

Most recently Equity management noticed that water usage had begun to increase slightly. Management was determined to nip this in the bud early on and implemented a water reduction program as part of the WAP. Additionally new approaches to solid waste management have recently been tested utilizing equipment that had been removed from service. Initial results indicated this will result in batter becoming a marketable commodity without the current involved handling requirements.

The Last Step

Even with a waste reduction program that is as active as the Equity WAP, most food processing plants need some form of pretreatment. The very nature of their waste, totally organic, makes this a necessity. Equity is no different. They have in fact over the past several years invested money in the upgrading of their wastewater pretreatment facility which consists of an aeration basin, and air scrubber, a hydro-float system and a belt press. The unique part of this system is the fact that the solids residue that is produced by the pretreatment process is being sold to renderers.

The waste reduction approaches within the plant and resulted in reduced loading to the pretreatment facility which has resulted in less energy required for aeration and reduced pretreatment costs.

SUMMARY

The director of personnel for Equity, Jim Waynick, was the key ingredient in the initial and ongoing success of their waste reduction program. His people management skills coupled with his lack of preconceived ideas made him a champion of the cause. Mr. Waynick recently compared waste reduction to alcoholism. He referred to it as WASTEAHOLISM. As he so aptly put it "waste reduction is very much like alcoholism. First there is denial; no, I don't have a problem. Then comes admitting there might be a problem; well, maybe I have a problem but it is not that bad and it would be easy to fix. The comes acceptance, well yes I do have a problem and it is going to take some real effort to fix it." Mr. Waynick continued the analogy by saying that just like with alcoholism you are never cured of wasteaholism. It is always an ongoing cure and that if you ever let you guard down wasteful practices will reoccur and will ruin any progress that might have been made.

Low tech approaches to waste reduction are very effective but they do require a champion that believes it can work; corporate commitment; a change in attitude; and employees involvement. Each of these ingredients is critical to the success of a program; because, as Equity proved, it is not a one shot program, it must be an active, living program.

Remember start small, start simple, look for the basics. Low tech approaches to waste reduction can be understood and accepted by the employee. Low tech approaches to waste reduction can be implemented by the employee. Since the first line of defense against waste is the employee, low tech approaches are the logical choice.

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SESSION 4D

FRAMEWORK FOR POLLUTION PREVENTION (PART 2)

Chairperson

Ms. Ann Mason
Chemical Manufacturers Association

Speakers

Mr. R. W. Lutz
Dow Chemical Canada
(Representing the Canadian Producers Association)
The Canadian Chemical Industry's Responsible Care Initiative

(Representative to be determined)
American Petroleum Institute
API Environmental Excellence Program

Mr. Patrick Burt
Acteron Metal Finishers
(Representing the Metal Finishers Association)
Pollution Prevention in Small Business in the Surface Finishing Industry

Session Abstract

In this session, speakers will identify the various conceptual frameworks for pollution prevention. Speakers will present the views of industry, government, and the public. Attendees to this session will learn about the variety of approaches to achieve pollution prevention within the various sectors both within the U.S. and internationally.

Speakers will present a summary of their organization's approach to pollution prevention; highlight the key topics of their tailored programs that are particularly important; and discuss some of their findings, outcomes, or successes.

Speakers will entertain questions from session attendees.

SESSION 4E

POLLUTION PREVENTION THROUGH TRANSPORTATION

Chairperson

Mr. Kenneth L. Heitner
Electric & Hybrid Propulsion Division
Office of Transportation Technologies
U.S. Department of Energy
Washington, D.C.

Speakers

Dr. Mark A. DeLuchi
Center for Energy & Environmental Studies
Princeton University
Environmental Impacts of Advanced Alternative Transportation Fuels and Technologies
Mr. Phillip Haley
Allison Gas Turbine Division
General Motors Corporation
An Overview of the Automotive Gas Turbine And Its Potential For Reduced Emissions

Mr. Lawrence G. O'Connell
Senior Manager, Transportation Program
Electric Power Research Institute
The Electric Vehicle, The Clean Machine

Mr. Raymond Costello
Biofuels Systems Division
Office of Alternative Fuels
Transportation Technologies
U.S. Department of Energy
Overview of U.S. Department of Energy Biofuels Program

Dr. Alan C. Lloyd
Chief Scientist, Technology Advancement Office
South Coast Air Quality Management District
Attaining the Air Quality Standards in the South Coast Air Quality Management District, Opportunity for Advanced Technologies and Pollution Prevention

Session Abstract

Modern transportation technology has always been associated with a certain amount of pollution. Steam locomotives produced copious soot and ash. By contrast, the modern automobile in mid-century was viewed as clean. But in air basins with strong inversions and strong sunlight the automobile was found to be a significant contributor of photochemically active hydrocarbons and oxides of nitrogen. These emissions contribute to photochemical smog. More recently, we have also realized that the total energy utilized by automobiles as reflected in their carbon dioxide emissions has an effect on global warming.

Technology offers us three alternatives to these problems. The first is to improve the automobile engine by changing to the gas turbine. The second is to change to an alternative hydrocarbon fuel, potentially derived from a renewable source. The third alternative is to change to an electric vehicle, with both a different fuel and propulsion system.

This session addresses both the problems and the alternatives. The goal is to increase our understanding of the new problems, and the role of the alternatives in reducing global pollution from transportation.

SESSION 4F

CASE STUDIES IN POLLUTION PREVENTION (PART 2)

Chairperson

Mr. William Walsh
E. I. du Pont de Nemours & Company
Louviers Bldg.
Engineering Department
Wilmington, DE

Speakers

Mr. Paul Dickens
MEMC, Inc.
Spartansburg, SC
Waste Elimination—Challenge Of The 1990s

Mr. Larry E. Tolpi
Site Environmental Projects Manager
Assisted by the Kevlar Waste Minimization Team
E.I. du Pont de Nemours and Company, Inc.
Richmond, VA
Kevlar Manufacturing—Waste Minimization

Mr. Thomas R. Stanczyk
Senior Vice President
Recra Environmental, Inc.
Amherst, New York
Integrating an AC Electrocoagulator (ACE) In-Line with Product Waste Systems to Enhance Product Recovery and Reuse of Water

Mr. Paul E. Scheihing
Office of Industrial Technologies
U.S. Department of Energy, Washington, D.C.
Industrial Process Integration — A Cost Effective Approach to Preventing Pollution

Mr. Bill Bilkovich
Waste Reduction Program
Florida Department of Environmental Resources
Tallahassee, Florida
Focus on Success: The Florida Industrial Air Toxics Project

Session Abstract

The development of cleaner technologies, technical measures which reduce environmental, occupational and consumer risks by modifying the nature of the production process will be an important part of the U.S. Environmental Protection Agency's pollution prevention policies. This paper identifies and analyzes the existing impediments and incentives to the development and adoption of cleaner technologies in the regulated industry.

The paper is divided into three parts. It first examines EPA's historical, current and proposed approach to pollution prevention policy. This included a comparison of the various statutory approaches to toxic substances control, as well as analysis of economic incentives, technical and information assistance programs, consumer awareness programs and liability provisions.

Having established the pollution prevention policy context in the first part, the second part then identifies the major forces internal and external to industrial firms that could influence the development or adoption of cleaner technologies. Issues discussed include: the size of firms, maturity of the industry, technological flexibility, technological capabilities, economic position, competitive pressure, public pressure, market needs, organizational structure, and strategies for technological change.

Finally, existing impediments and incentives are identified and analyzed within the context and constraints discussed in the first two parts. The analysis suggests that there are three main categories of impediments: technical, economic and financial, and structural. Lessons to learn from international experience of other OECD countries in overcoming these barriers and developing and promoting cleaner industries are discussed.

WASTE ELIMINATION — CHALLENGE OF THE 1990s *

Paul S. Dickens, P.E.
Senior Environmental Engineer
MEMC Electronic Materials, Inc.
P.O. Box 5397
Spartanburg, South Carolina 29304

The 1980s changed forever the management of manufacturing industry. Companies that did not adopt a focus on product quality and customer service lost in the market place. The 1990s hold similar dramatic change. Environmental issues increasingly impact business decisions. Negative public perception and increasingly stringent environmental laws will put companies that generate chemical emissions and hazardous waste at a competitive disadvantage.

This paper describes the approach of MEMC Electronic Materials, Inc. to management of environmental issues. "Waste elimination" and "resource efficiency" are discussed as tools to improve the competitive advantage of manufacturing industry. These concepts not only address timely environmental issues, but can be an important internal source of company funds. An expanded role is defined for the environmental professional working in industry. Results of MEMC waste elimination projects are presented. The MEMC approach to environmental issues is a model for other companies considering waste elimination efforts.

WASTE MANAGEMENT AND ENVIRONMENTAL LAWS

The Resource Conservation and Recovery Act of 1976[1] (RCRA) established a hierarchy of waste management. Source reduction is the preferred waste management practice followed in order of preference by on-site waste recycling, off-site waste recycling, waste treatment, and land disposal. The 1984 Hazardous and Solid Waste Amendments[2] (HSWA) established new requirements that eliminate land disposal as an option for most chemical waste. The Land Ban provisions of HSWA[3] substantially increase the cost of managing hazardous waste. The Toxicity Characteristic Leaching Procedure promulgated in March 1990 is expected to increase three-fold the volume industrial waste defined as hazardous and subject to RCRA regulation.[4,5]

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Tables and figures follow text in order cited

Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA) requires public reporting of chemical use, chemical emissions, and hazardous waste generation by manufacturing industries.[6] The Community Right-To-Know provisions of SARA, more than any other environmental regulation, are driving industry to eliminate toxic chemical use. The Pollution Prevention Act of 1990[7] (PPA) requires public reporting by manufacturing industries of their effort towards chemical emission reduction and the reduction and recycling of hazardous waste. The first year for PPA waste reduction reporting is 1991.

Air Toxics Provisions of the 1990 Clean Air Act Amendments[8] (CAA Amendments) require "Maximum Achievable Control Technology" (MACT) for air emissions of 189 commonly used industrial chemicals. Requirements for volatile organic compound (VOC) emission control at industries in air quality non-attainment areas are strengthened. Enforcement of MACT and new VOC emission standards under the CAA Amendments will begin in 1995. The CAA Amendments also establish a nationwide permit system for air emission sources with substantial civil and criminal penalties for violation of air emission standards. Many industrial facilities previously exempt from air quality laws will require permits and air emission controls under the CAA Amendments.

The electronics industry is a large user of chlorofluorocarbons (CFCs) and methyl chloroform (1,1,1-trichloroethane). The 1990 Clean Air Act Amendments incorporate CFC and methyl chloroform phase out provisions of the Montreal Protocol on Substances that Deplete the Ozone Layer.[9] Worldwide production of CFCs will end by the year 2000. Worldwide production of methyl chloroform will end by the year 2005. Production of methyl chloroform in the United States is prohibited after 2002. Meanwhile, the cost of these chemicals has greatly increased.

The management of wastewaters and non-hazardous solid waste is also undergoing change. Implementation of the 1987 Clean Water Act Amendments[10] has forced many industries to install new and expanded wastewater treatment facilities. Having the greatest impact are toxicity testing of wastewater effluents and revision of state water quality standards for toxic chemical pollutants. These provisions are contained in Section 304(l) of the amended act. Some industrial operations will be seriously impacted by storm water discharge permits required in 1992.[11]

Most industries cannot operate without access to local sanitary landfills for disposal of trash and other non-hazardous solid waste. However, many communities face a severe shortage of landfill capacity.[12,13] Sanitary landfill rates are rapidly escalating. Proposed Federal standards for sanitary landfills will further increase the cost to dispose of non-hazardous solid waste.[14] Some communities have imposed landfill restrictions and surcharges on industrial non-hazardous waste. Federal laws to regulate industrial non-hazardous solid waste and to mandate solid waste recycling are proposed.[15, 16, 17] Similar laws are proposed or already in effect in some states and local communities.

Public awareness of environmental issues has grown, particularly at the state and local level. Manufacturing plants perceived as "dirty" are no longer tolerated despite the jobs they create. Land use and zoning laws are increasingly used to block new industries and industry expansion. Third-party legal challenges to wastewater, air, and hazardous waste permits are common. Citizen group monitoring of industry compliance with environmental laws is on the rise. Comprehensive environmental initiatives such as California's "Big Green"[18] and the Massachusetts Toxics Use Reduction Act[19,20] are gaining public support.

Annual expenditures on environmental protection in the United States increased from under $25 billion to $100 billion between 1972 and 1990, totaling 1.5 to 1.7 percent of the country's gross national product (GNP).[21] A large portion of this cost is borne by industry for waste management and end-of-pipe pollution controls. To fully implement existing laws, expenditures for environmental protection are expected to increase to 3.0 percent of GNP by the year 2000 with industry paying an ever larger share.

There are significant financial, regulatory, and public relation incentives for industry to adopt a proactive approach to environmental issues. Companies that eliminate chemical emissions and the generation of solid and hazardous waste obtain a market advantage. These companies are no longer hostage to changing environmental laws and negative public perception. These companies can devote capital to new products and improved product quality rather than waste management and end-of-pipe pollution controls. These companies make positive contribution to both economic growth and improved environmental protection.

WASTE ELIMINATION

"Waste elimination" is the elimination of chemical emissions and the elimination of solid and hazardous waste generation by changes in product design and manufacturing technology. Both product design and manufacturing are considered because the customer's cost to use a product (including the cost of disposal) is as important as the manufacturer's cost to produce it. Waste elimination goes by other names such as "waste minimization" and "pollution prevention." However, the term "waste elimination" is preferred, for it best describes the goal to be achieved: eliminate the generation of waste. Waste elimination is driven by the following ideas:

- Waste management is an unproductive drain on company resources. Waste management refers to end-of-pipe systems to treat air emissions, wastewater, and hazardous waste and to dispose of solid and hazardous waste residuals. As environmental regulations become more stringent, the drain of these unproductive waste management expenditures will increase. Because waste management requirements are driven by environmental laws, companies have little control over waste management cost.
- Waste elimination avoids waste management cost. As a result, waste elimination conserves company funds for productive investment in new products and improved product quality. Waste elimination is an internal source of company funds.
- Because it conserves company funds for productive investment, waste elimination is a necessity for competitive survival.

The relationship of waste elimination to a company's competitive position is illustrated with the concept of "resource efficiency." Resource efficiency is the ratio of the resource content of a manufactured good to the resources required to produce that good and to manage and dispose of waste from the manufacturing process. The goal of waste elimination is to improve resource efficiency. Resources include energy, labor, water, air, raw materials, manufacturing chemicals, and supplies. Waste includes heat, wastewater, air emissions, unused materials, spent chemicals, used packaging materials, and spent and unused supplies. Waste also includes the energy, labor, and materials expended for waste management and pollution control.

Resource efficiency is a direct measure a company's competitive strength. The generation of waste is at the expense of resource efficiency. Expenditures for waste management further decrease resource efficiency. In contrast, the benefits of waste elimination are two-fold: resources are not lost to waste, and resources are not expended to manage and dispose of that waste.

In the global market of the 1990s, only the most efficient manufacturing producers will survive. Waste must be viewed as evidence of lost resources. A fundamental requirement for any world-class company is to determine its resource efficiency and continuously improve it.

CULTURE CHANGE

There are many barriers to waste elimination within manufacturing industry. These include product specifications, capital resources, and environmental regulations that focus on pollution control. The greatest barrier, however, is management attitude.

Waste elimination requires movement away from reliance on end-of-pipe waste management systems to comply with environmental laws. Waste elimination requires a systems approach to manufacturing management that includes consideration of environmental issues at the front end of product and manufacturing technology design. It requires a commitment of resources normally devoted to production. Waste elimination requires questioning of product specifications that result in the generation of waste. It often results in a higher capital cost for manufacturing facilities. Waste elimination is a departure from traditional industry culture where marketing, research, and manufacturing groups have separate, vertically - integrated management structures.

The philosophy of waste elimination is similar to the philosophy of continuous quality improvement.[22] Like quality improvement, the power of waste elimination is in small changes that over time result in a large reduction in chemical emissions and the generation of solid and hazardous waste. Like quality improvement, the financial benefits of waste elimination may not be immediately evident but build over a period of years. The key to both is continuous change. Companies that have adopted the philosophy of continuous quality improvement will find that waste elimination is a natural extension of the quality management approach.

Waste elimination requires the ownership and commitment of all company employees. This ownership is the source of creative ideas for product design and manufacturing technology change. Waste elimination is a simple idea. However, its implementation within a manufacturing organization can be difficult. Everyone within a company must be convinced that waste elimination builds competitive advantage. Company management must show by example their honest support.

ROLE FOR THE ENVIRONMENTAL PROFESSIONAL

End-of-pipe waste management systems (and the staff to run them) evolved at most industries as environmental laws were established during the 1970s and 1980s. The "end-of-pipe" approach was the most expedient way to comply with changing laws. Every industry established an environmental control department to manage their regulatory compliance and waste management systems. These departments are staffed with environmental professionals: engineers and scientists with backgrounds in environmental science, pollution control technology, and environmental law. Unfortunately, these departments tend to communicate with manufacturing personnel only in response to problems or when needed to obtain environmental permits. They typically have little or no contact with marketing and research groups. The end-of-pipe approach to waste management also discourages "ownership" of waste elimination by marketing, manufacturing, and research personnel. The fact that "someone else handles it" is a barrier to their understanding of waste management problems and opportunities.

Progressive industries are dismantling their vertically-integrated marketing, research, and manufacturing groups in favor of horizontally integrated "teams". The team approach is an opportunity for the environmental professional to take an active role in promoting waste elimination efforts. These individuals have the best understanding of the sources of waste and of waste management cost. The challenge to the environmental professional is four-fold:

- Effectively communicate information on waste generation and waste management cost.
- Identify opportunities for waste elimination including the financial and environmental benefits to be gained.
- Participate in waste elimination project teams with manufacturing, research, and marketing personnel.
- Track and provide timely reporting of waste elimination results.

This role is one of educating, cheerleading, and keeping score. It requires developing a strong knowledge of manufacturing technology and product specifications. The ultimate goal of the environmental professional in industry is to eliminate the need for their job. That is, the goal is to fundamentally change a company's operations so there is no need for specialized staff to manage waste and compliance with environmental laws. This occurs when the priority given to resource efficiency is equal to that given issues of quality, customer service, and finance.

MEMC ELECTRONIC MATERIALS, INC.

MEMC Electronic Materials, Inc. manufactures polished and epitaxial silicon wafers. Silicon wafers are the substrate, or base, on which microelectronic circuits (microchips) are built. MEMC is a worldwide producer of silicon with manufacturing plants in the United States, Europe, and Asia. MEMC's customers are the manufacturers of logic and memory microchips. Logic and memory microchips are used in everything from computers and consumer electronics to automobiles and airplanes.

Proactive Waste Management Strategy

MEMC has evolved a proactive strategy for the management of chemical emissions and solid and hazardous wastes generated as a by-product of silicon manufacturing. The focus is on changes in manufacturing technology that reduce or eliminate these emissions and waste. The result of these changes over time is a large reduction in unproductive expenditures for waste management and pollution control.

The MEMC waste management strategy has several components. The company has established definitive environmental goals. These are:

- Reduce hazardous air emissions by 80 percent by year end 1994.
- Eliminate use of ozone depleting chemicals by year end 1995.
- Reduce generation of priority wastes by 50 percent by year end 1996. Priority wastes include hazardous waste and recyclable solid waste that is landfilled.

The base year for these goals is 1988. Where possible, the goals are to be achieved through investment in manufacturing process change rather than end-of-pipe waste management systems.

MEMC targets efforts towards waste elimination by establishing task groups with specific waste reduction goals and deadlines. These task groups include environmental, safety, manufacturing, engineering, and research personnel. MEMC encourages ownership of environmental goals by stressing the long-term cost benefit of waste elimination efforts. MEMC provides resource commitment for waste elimination by holding key managers accountable for progress towards the company environmental goals.

Results

The MEMC manufacturing plant in Spartanburg, South Carolina has made significant progress towards company environmental goals. The projects completed include process elimination, chemical substitution, substitution of mechanical for chemical methods, modification of equipment and maintenance procedures, yield improvement, and recycling. Details for several of these waste elimination projects are presented elsewhere.[23] The following highlights major results:

<u>Chromic Acid</u>. Prior to 1988, the only available structural etchants for the evaluation crystal structure in silicon were based on chromic acid. Chromic acid is a suspected human carcinogen.[24] In late 1988, MEMC developed a new structural etchant for silicon based on copper salts rather than chrome. The copper-based etchant does not create a hazardous waste when treated. MEMC also determined that a process called "Rod Etch", which accounted for 80 percent of chromic acid use, was unnecessary. Rod Etch was eliminated, and copper-based structural etchants were substituted for chrome-based etchants on all but one silicon product. An etchant with a reduced chrome content was substituted for the one product still requiring chrome. Results are outlined in Table 1.

During a period when manufacturing output increased 10 percent, 96 percent of chromic acid use was eliminated, and the volume of hazardous chrome treatment sludge was reduced by half. The $60,300 annual cost eliminated includes process chemicals not required, waste treatment chemicals not required, and hazardous waste disposal cost avoided. The copper-based silicon etchants are a significant breakthrough for the silicon industry. The development work for these etchants was done at the MEMC Spartanburg Plant. MEMC has published the results for other companies to use.[25]

In 1990, the technology for treating waste etchants containing copper and chrome was modified. These treatment modifications further reduced the generation of hazardous chrome sludge and avoided a large increase in sludge disposal cost due to EPA Third-Third Land Disposal Restrictions.[3] The overall reduction in chrome sludge generation is outlined in Table 2. Between 1988 and 1990, the MEMC Spartanburg Plant eliminated 53,800 lbs/year of chromium hydroxide sludge. This is an overall reduction of 81 percent. In addition, the chromium content of the remaining sludge was reduced tenfold from 47,000 parts per million (ppm) by weight as trivalent chromium to 6200 ppm. The annual cost savings outlined in Table 2 are in addition to those of Table 1.

<u>Acid Use and Air Emissions</u>. The Rod Etch process was a source of hydrogen fluoride (HF) and other acid air emissions. Its elimination and the substitution of mechanical methods for chemical processing of silicon slugs reduced overall process emissions of HF at the MEMC Spartanburg Plant by 32.5 percent. This result is included with data for acid use and associated air emissions in Tables 3 and 4. The Table 4 acid emission reductions were achieved solely by manufacturing technology change. No new air pollution control systems were installed. The mechanical methods developed for processing silicon slugs also produced a

substantial improvement in product yield. In late 1990, new technology for slicing silicon slugs was introduced. This new technology further increased product yield and reduced process-related HF air emissions by an additional 2 percent.

Ozone Depleting Chemicals. Freon 113 and methyl chloroform are ozone depleting chemicals. They are common solvents used in the electronics industry for critical cleaning of semi-conductor materials and packaging. At the MEMC Spartanburg Plant, Freon 113 was used to clean containers call "tote pans". These tote pans were used for temporary storage of polished silicon wafers between process steps. Freon 113 was also used to clean plastic cassettes. The plastic cassettes are a protective device used to carry silicon wafers between manufacturing steps. Methyl chloroform was used in one of several proprietary steps for cleaning raw materials associated with silicon crystal production.

Tote pan cleaning with Freon 113 was eliminated by switching to a "just-in-time" product flow. The need for solvent cleaning of cassettes was eliminated by changing the flow of cassettes through manufacturing steps. The cassettes are now cleaned with soap and water. The elimination of Tote Pan and Cassette Cleaning eliminated 40.6 percent of Freon 113 use and 42.0 percent of Freon 113 air emissions at the MEMC Spartanburg Plant. The reduction in Freon use eliminated $218,500/year in combined raw chemical and solvent waste disposal costs. These results are outlined in Table 5. Maintenance procedures and piping for MEMC's solvent vapor degreasers were changed in late 1989 to reduce the volume of solvent lost to waste when solvent stills and filters are cleaned. These changes avoided generation of an additional 6000 lbs/year of hazardous waste solvents containing Freon 113.

MEMC has developed special techniques for the clean handling of raw materials associated with silicon crystal production. MEMC engineers suspected that with these handling techniques, cleaning steps involving methyl chloroform were not required. A series of statistical tests were conducted to prove that chlorinated solvent cleaning of raw materials was not necessary. These tests were a success. The use of methyl chloroform in silicon crystal production was eliminated. An aqueous-based cleaner was substituted for the chlorinated solvent cleaning step. Results for the MEMC Spartanburg Plant are outlined in Table 6. The process change eliminated 12.5 percent of methyl chloroform use and 15.6 percent of methyl chloroform air emissions. The change eliminated more than $19,000/year in process chemical and solvent waste disposal cost.

Solid Waste Recycling. In 1990, the MEMC Spartanburg Plant undertook a solid waste study. The purpose of the study was two-fold:

- Establish a baseline generation rate and composition for non-hazardous solid waste.
- Identify opportunities to reduce the volume of non-hazardous solid waste landfilled.

The MEMC Solid Waste Study included a cardboard and office paper recycling trial. This trial was a great success. Results are illustrated in Figure 1. During the recycling trial, the MEMC Spartanburg Plant collected and recycled 85 percent of waste cardboard generated and 73 percent of waste office paper generated. At these collection rates, the reduction in the volume of plant trash generated and hauled to landfill disposal is 24 percent. The weight of cardboard collected and recycled is 70 tons/year. The weight of office paper collected and recycled is 38 tons/year.

Cardboard and office paper recycling is now permanently established at the MEMC Spartanburg Plant. Although revenue from the sale of recycled material amounts to only $1150/year, the recycling of cardboard and paper avoids more than $10,400/year in landfill disposal cost. The MEMC recycling trial results illustrate that landfill cost avoidance is the main economic benefit of solid waste recycling. In early 1991, the MEMC Spartanburg Plant implemented recycling of waste wood pallets, skids, and packaging crates. This reduced the volume of plant trash landfilled by an additional 8 percent. The landfill cost savings from waste pallet recycling is $9000/year.

New Technology

The waste elimination projects completed at the MEMC Spartanburg Plant are modifications to existing manufacturing technology. These projects are initial steps towards MEMC's company environmental goals. To achieve its environmental goals, MEMC is developing the next generation of silicon manufacturing technology. This development is a partnership between MEMC's major customers and suppliers. Requirements for the new technology include:

- Eliminate chlorinated solvent use, particularly use of ozone depleting chemicals.
- Eliminate or reduce process related emissions to air and water.
- Eliminate one-time-use product packaging.
- Improve first pass and total product yield.

SUMMARY

The 1990s require a change in the attitude of manufacturing industry towards waste. Generation of waste and associated management cost are a liability. Companies that eliminate waste conserve resources for productive investment in new products and improved product quality. These companies make positive contribution to both economic growth and improved environmental protection. The role of the environmental professional working in industry is to foster a waste elimination ethic. This occurs when the priority given to resource efficiency is equal to that given issues of quality, customer service, and finance.

MEMC Electronic Materials, Inc. is evolving a waste elimination ethic as part of its culture of quality and customer service. Since 1988, the MEMC plant in Spartanburg, South Carolina:

- Eliminated 96 percent of chromic acid use.
- Reduced generation of hazardous chrome treatment sludge by 81 percent.
- Reduced process air emissions of hydrogen fluoride by more than 32 percent.
- Eliminated 40 percent of Freon 113 use and 42 percent of Freon 113 air emissions.
- Eliminated 12 percent of methyl chloroform use and 15 percent of methyl chloroform air emissions.
- Reduced the volume of plant trash landfilled by 32 percent through waste cardboard, office paper, and wood pallet recycling.
- Eliminated more than $350,000/year in process chemical and waste management costs.
- Avoided a cost increase of more than $45,000/year due to EPA Land Disposal Restrictions for chrome treatment sludge.

These results have been a significant internal source of company funds and have gained positive recognition from the company's customers and peers. This recognition included the 1990 South Carolina Governor's Pollution Prevention Award. MEMC is developing the next generation of silicon manufacturing technology. Waste elimination is an important focus of this work. MEMC's success is a model for other companies considering waste elimination efforts.

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Table 1 - Chrome Use Reduction at MEMC Spartanburg, South Carolina Plant [a]

Item	1988	1989
Chromic acid use, lbs as CrO_3	5,490	210
Acid treatment sludge, lbs [b]	60,590	30,850
Manufacturing volume [c]	1.00	1.10
Chrome use eliminated, lbs as CrO_3 [d]		5,830
Acid treatment sludge eliminated, lbs [b,d]		35,800
Annual cost eliminated: [d]		
Process chemicals		$27,900
Personnel protective equipment [e]		16,800
Waste treatment chemicals		4,800
Sludge disposal		10,800
Total		$ 60,300

a - Elimination of Rod Etch process. Substitution of copper-based etchants for chromium-based etchants in the evaluation of silicon crystal structure.

b - Dewatered sludge resulting from chemical reduction, neutralization, and precipitation of chrome and copper-based etchants. The dewatered acid treatment sludge is a D007 hazardous waste.

c - Manufacturing capacity is proprietary. 1988 production assigned value of 1.00.

d - Escalated for 1989 manufacturing volume.

e - Acid gowns, gloves, face shields, and other expendable supplies required for Rod Etch process.

Table 2 - Cost Avoided by Chrome Sludge Elimination, MEMC Spartanburg Plant [a]

Item	Value
Chrome sludge eliminated[b]:	
Manufacturing technology change, drums/year	73
lbs/year	35,850
Waste treatment technology change, drums/year	42
lbs/year	17,950
Annual disposal cost avoided:	
Transportation and disposal[c]	$ 16,700
Treatment to meet Third-Third Land Ban[d]	25,900
Hazardous waste disposal tax[e]	3,000
Total	$ 45,600

a - Manufacturing and waste treatment technology changes made 1988 through 1990. Data based on 1989 Spartanburg Plant manufacturing volume.

b - Chrome sludge is the dewatered precipitate produced by reduction and neutralization treatment of waste acid etchants containing hexavalent chromium and divalent copper.

c - Increased rates charged by off-site, commercial hazardous waste management facility effective July, 1990.

d - Prior to landfill disposal, the dewatered sludge must be stabilized to meet treatment standards under EPA Third-Third Land Disposal Restrictions for hazardous waste effective August, 1990.

e - Alabama out-of-state hazardous waste tax effective July, 1990.

Table 3 - Mixed Acid (Nitric, Acetic, Hydrofluoric) Use Reduction at MEMC [a,b] Spartanburg, South Carolina Plant

Item	Value
Mixed Acid use eliminated:	
lbs/year	71,500
percent of process use [c]	31.9
percent of total plant use	3.4
Waste acid eliminated:	
lbs/year	69,800
Annual cost eliminated:	
Process chemicals	$ 37,600
Waste treatment chemicals	1,100
Total	$ 38,700

a - Substitution of mechanical slug polishing for chemical slug polishing in Crystal Evaluation Laboratory.

b - Data based on 1989 Spartanburg Plant manufacturing volume.

c - Crystal Evaluation Laboratory.

Table 4 - Acid Emission Reduction at MEMC Spartanburg, South Carolina Plant [a]

Item	Value
Acid air emissions eliminated:	
- Oxides of Nitrogen [b]	
lbs NOx/hr	1.53
percent of total plant process emission	12.5
- Acetic Acid [b]	
lbs CH_3COOH/hr	1.00
percent of total plant process emission	5.1
- Hydrogen Fluoride [b,c]	
lbs HF/hr	0.175
percent of total plant process emission	32.5

a - Data based on 1989 Spartanburg Plant manufacturing volume.

b - Substitution of mechanical slug polishing for chemical slug polishing in Crystal Evaluation Laboratory.

c - Elimination of Rod Etch process. Substitution of copper-based etchants for chrome-based etchants in the evaluation of silicon crystal structure.

Table 5 - Freon 113 (Trichlorotrifluoroethane) Use Reduction at MEMC [a,b] Spartanburg, South Carolina Plant

Item	Value
Freon 113 use eliminated:	
lbs/year	88,300
percent of total plant use	40.6
Freon 113 air emission eliminated:	
lbs/year	85,300
percent of total plant emission	42.0
Waste Freon 113 eliminated: [c]	
lbs/year	3,800
percent of total plant waste	23.6
Annual cost eliminated:	
Process chemicals	$ 121,000
Freon tax [d]	97,100
Waste solvent disposal [e]	400
Total	$ 218,500

a - Elimination of Tote Pan and Cassette Degreasing.

b - Data based on 1989 Spartanburg Plant manufacturing volume.

c - F001 hazardous waste from operations using Freon 113. Weight includes water and contaminates picked up in degreasing operations.

d - Federal excise tax on ozone depleting chemicals effective 1/1/90. For Freon 113, tax is $1.10/lb.

e - Waste solvent is recycled for credit. Disposal cost represents transportation to off-site recycling facility.

Table 6 - Methyl Chloroform (1,1,1-Trichloroethane) Use Reduction at MEMC Spartanburg, SC Plant[a,b]

Item	Value
Methyl Chloroform use eliminated:	
lbs/year	25,300
percent of total plant use	12.5
Methyl Chloroform air emission eliminated:	
lbs/year	23,700
percent of total plant emission	15.6
Waste Methyl Chloroform eliminated:[c]	
lbs/year	1,600
percent of total plant waste	9.0
Annual cost eliminated:	
Process chemicals	$15,400
Ozone depleting chemical tax[d]	3,400
Waste solvent disposal[e]	200
Total	$19,000

a - Elimination of chlorinated solvent degreasing of raw materials used for silicon crystal production.

b - Data based on 1989 Spartanburg Plant manufacturing volume.

c - F001 and U226 hazardous waste from operations using methyl chloroform. Weight includes corrosion inhibitors in solvent as well as water and contaminates picked up in degreasing operation.

d - Federal excise tax for ozone depleting chemicals. For methyl chloroform the tax became effective 1/1/91 and is $0.137/lb.

e - Waste solvent is recycled for credit. Disposal cost represents transportation cost to off-site recycling facility.

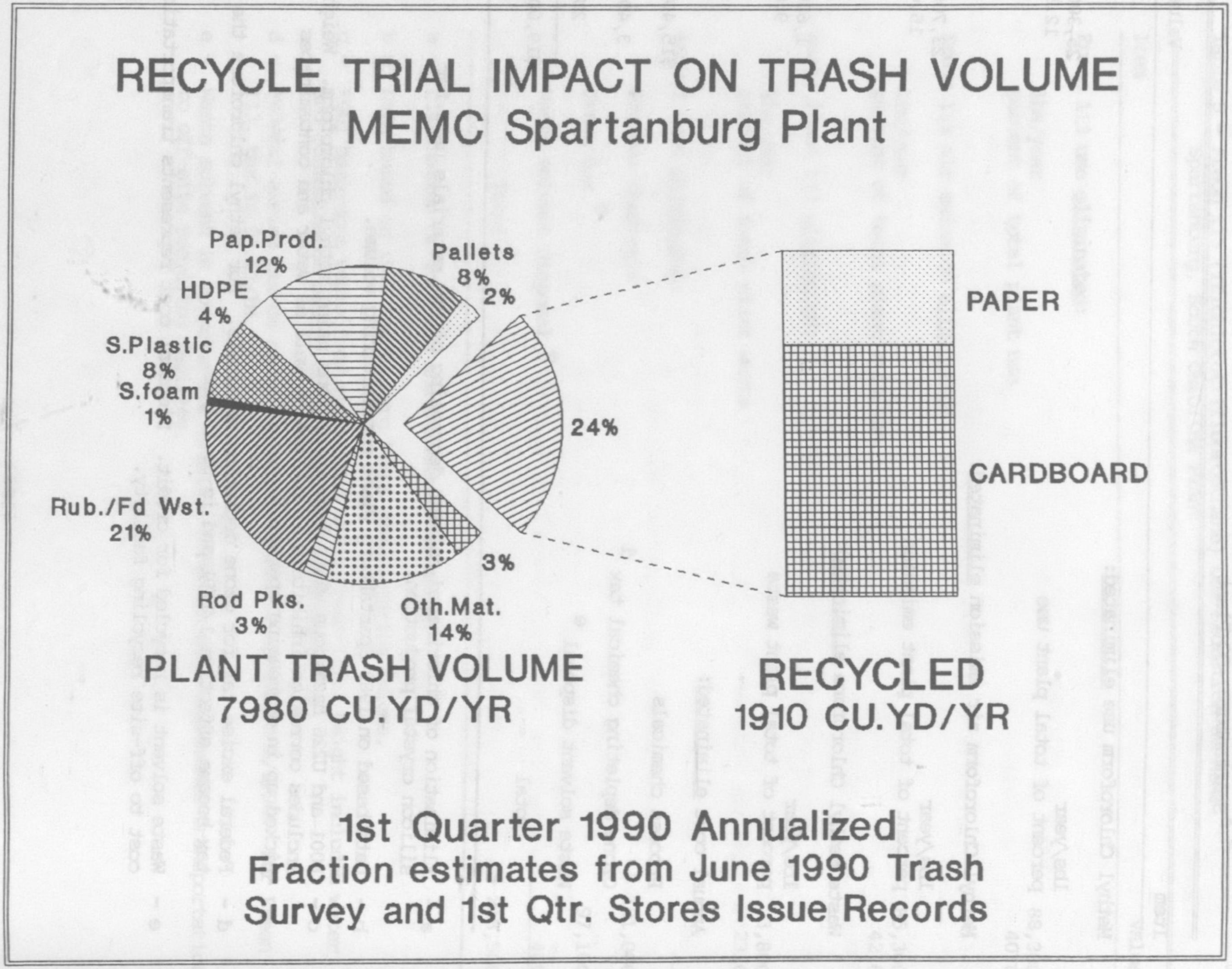

Figure 1 Recycle Trial Impact on Plant Trash Volume

CASE STUDY: KEVLAR* MANUFACTURING WASTE REDUCTION

Presented by Larry E. Tolpi, E. I. Du Pont De Nemours & Co., Inc.

to the GLOBAL POLLUTION PREVENTION '91 CONFERENCE April 3-5, 1991

The "KEVLAR" manufacturing team at Du Pont's Richmond, Virginia Spruance Plant has instituted a variety of environmental programs that have reduced process waste by over 80%. Initiatives included recovering most purged ingredients and reducing off-specification "KEVLAR" polymer. The "KEVLAR" team also reduced manufacturing-related chloroform emission by 70%. These improvements are saving the "KEVLAR" business several million dollars annually.

While new technology played an important role in these accomplishments, the key factors were renewed will and resolve to succeed where others had failed in the past. Many "KEVLAR" team members had been trained in creative-thinking concepts, which nurtured an innovative CAN DO attitude. Developing new paradigms that portray waste reduction as business opportunities rather than problems was more important than developing new technology.

"KEVLAR", Du Pont's super-strong fiber, is five times stronger than steel of equal weight. It is resistant to heat, flame and chemicals. The fiber is used in the aerospace, automotive, sporting goods, and marine industries and numerous ballistic-protection applications.

Environmental Significance of accomplishment: Over three million annual pounds of solid waste previously shipped to landfills have been eliminated by recovering most purged ingredients. Nearly one million annual pounds of liquid and solid waste previously incinerated or landfilled have been eliminated by reducing off-specification "KEVLAR" polymer at its source. The process waste reductions from these two programs eliminated about 75 tractor-trailer loads of liquid or solid waste from being shipped 1,200 miles to incinerators or landfills annually.

Chloroform emissions to the atmosphere have been reduced by greater than 125,000 pounds a year within the past 24 months. This is a 70% reduction of Spruance SARA III emissions for this category.

50% of our tetrachloroethylene solvent emissions have been eliminated through reduced vaporization in testing laboratories. Caustic/acid filters that were sent to hazardous waste landfills are now cleaned and disposed of locally. Approximately 125,000 gallons of used oil that was shipped off site each year is now burned as part of the Spruance power-plant operations. The energy value of this oil is equivalent to heating 150 homes for a year.

* Du Pont Registered Trademark

Impact on Du Pont associated businesses worldwide: We have instituted environmental initiatives that not only will have a positive impact on the "KEVLAR" business in the short term, but we feel we have averted what could have been a major concern over the generation of waste connected with "KEVLAR" process. In addition, process waste reduction programs created at Spruance are being applied to "KEVLAR" plants in Northern Ireland and Japan, which gives this effort a global environmental perspective. Many Du Pont employees worldwide contributed to these environmental accomplishments.

What is innovative and/or creative about this accomplishment?: One statement helps sum this up: many of the efforts undertaken by the "KEVLAR" team members were considered or attempted in the past without success. Many team members were exposed to creative-thinking concepts that enabled generating new approaches to overcoming obstacles. Renewed energy was generated and this team went and succeeded where others had tried and failed before. Also, an unique two-person environmental-advocacy team was established within the manufacturing plant, which inspired the organization from within, instead of being dictated to by others.

New technologies had to be developed. For example; a process had to be invented for transforming a solid process material into a useful liquid polymer solution that could yield high-quality products. Also, advanced computerized process controls had to be developed to enable the automatic start-up of the manufacturing process in order to eliminate process waste. By shifting the focus toward eliminating waste, rethinking the classification of intermediate reactants from waste to in-process ingredients, and collectively stretching our thinking, major changes in the manufacturing methods occurred with ensuing elimination of most waste material.

Why are these accomplishments outstanding?: Over its 18 year history of production, a certain amount of "waste" was considered a standard, unavoidable part of the "KEVLAR" manufacturing process. That operating philosophy has been changed within a matter of several years, while at the same time making a major positive impact on the environment and business profitability.

Du Pont's first annual worldwide Environmental Respect Award winners were selected in November 1990 and the "KEVLAR" Manufacturing Unit received one of only two Chairman's Awards. The two winners were chosen from a field of 200 group or individual applicants throughout the company. The Environmental Awards Committee selected the most significant achievements according to environmental significance, relevance to Du Pont's businesses or sites, and degree of innovation and creativity. In celebration of achieving the Chairman's award, "KEVLAR" donated $10,000 to Virginia's Maymont Foundation to refurbish their public Nature/Environmental Education Center,

Industrial Process Integration - A Cost-Effective Approach to Preventing Pollution

Paul E. Scheihing
Program Manager, U.S. Department of Energy
Office of Industrial Technologies, Washington, DC

Stephen Priebe
Engineering Specialist, Idaho National Engineering Laboratory
Conservation Programs, Idaho Falls, Idaho

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Abstract

The production of manufactured goods requires energy. Regardless of what type of energy is required, all energy that is consumed produces some form of pollution or waste. Making industrial processes more efficient with process integration will result in lower product energy intensity, will identify reduced cost approaches to expanding a process, and will cost effectively prevent or reduce pollution. By looking upstream in a process, unnecessary waste products can be avoided at the downstream end. This paper will review the benefits of industrial process integration, both on a national scale and to specific industry types to economically reduce gaseous emissions. A few of the process integration case studies that the U.S. Department of Energy's Office of Industrial Technologies(DOE/OIT) has sponsored throughout the U.S. will be used as examples to show how process integration can have significant benefits in preventing pollution. The projects to be described are presently in the equipment design stage. These success stories comprise four industrial sectors; petroleum refining(SIC 29), chemical processing(SIC 28), pulp and paper manufacturing(SIC 26), and food processing(SIC 20).

Introduction

The consumption of energy within U.S. industry has a significant impact on the U.S. economy. The total energy bill for U.S. industry in 1989 was $97 billion(1). This represents 1.9% of the 1989 Gross National Product($5,200 billion)(2). Since energy costs are a component of any company's operating cost, escalating energy prices will certainly effect U.S. industry's profitability and competitiveness compared to other manufacturers who may make similar products more energy efficiently. Pollution from industrial energy consumption is another concern. The type of energy that is used, and the way in which the energy is used, must be carefully scrutinized by process designers. With environmental regulations getting stricter, the life cycle costs of using a particular type of energy may someday be dominated by the cost of controlling the consumed energy's resultant waste stream compared to the cost of the raw energy itself. Also of concern, environmental policy makers should carefully consider the energy requirements of pollution control devices since if these devices are energy intensive they may generate a waste stream comparable in size to the one that is being controlled. Considering all of these factors, industrial process integration will need to be emphasized as a means to identify cost effective pollution reduction opportunities.

The amount of energy consumption in any process is governed by physical and chemical properties. For example, the production of chemicals requires some energy feedstock material and some heat energy to get the reactants to their activation energy level. How the process goes about getting to the energy level and what happens to the energy after the reaction, can be controlled by the process designer. The process designer can make the process more or less energy efficient depending upon the equipment he chooses. The choice is often a function of equipment availability and cost, relative to the energy savings and the avoided cost (capital and operating cost) of end-of-tailpipe pollution controls. Both the availability of better equipment and the cost of equipment relative to energy, continually undergo change. Once the process design is committed to hardware, the process immediately starts to become obsolete. The energy efficiency can be improved continually in the life of the process by utilizing process integration. Energy consumption per unit of product (i.e., energy intensity) can be markedly improved through proper analysis and corrective action. Process integration allows the plant to remain cost competitive with other producers of the same commodity. Process integration makes the product less susceptible to energy price fluctuation.

U.S. Industrial Energy Consumption and Air Emissions

A review of how, where, and what energy is used in U.S. industry is in order to properly quantify the magnitude of energy consumption that is targetable by process integration enhancements, and thus the level of air emissions that result from this energy consumption. (Although it is realized that energy consumption results in many types of waste streams that can be in solid, liquid, or gaseous states, this paper will focus on selected gaseous waste streams that are attributable to industrial fuel combustion, that is, oxides of nitrogen(NOx), oxides of sulfur(SOx), and carbon dioxide(CO_2)).

Table 1 shows a breakdown of industrial energy consumption by functional use within the industrial sector for the year 1985. Energy is consumed in three main areas: heat and power systems for the manufacturing sectors(IA.); feedstocks(IB.); and non-manufacturing energy for agriculture, mining, and construction(II.).

Table 1 - 1985 U.S. Industrial Energy Consumption
by Functional Use[1],[3],[4],[5],[6],[7],[8]
(Trillion BTU)

I. Manufacturing.......25,066
A. Heat and Power...........19,648
1. Electricity...................2,541
a. Motors............................1,773
i. Compressors, Pumps, & Fans..........721
ii. Materials processing................565
iii. Materials handling.................487
b. Process heating.....................207
c. Electrolytic........................346
d. Lighting............................215
2. Electrical generation losses...5,879
3. Boiler steam...................5,607
4. Furnace heat...................4,093
5. Cogeneration...................1,528
a. Steam...............................897
b. Electricity.........................325
c. Losses..............................306
B. Feedstocks................5,418
II. Non-Manufacturing....3,218
A. Fuel......................2,069
B. Electricity.................347
C. Electrical losses...........802
III. Total Industrial...28,284

Figure 1 illustrates the energy in U.S. industry that can potentially be impacted by process integration. The energy that can be impacted by process integration will henceforth be referred to as the "targetable" energy. Of course, only a portion of this energy can be conserved economically. The energy that is considered non-targetable is: the feedstock energy that is consumed to make a product and is not used as an energy source (i.e., it is not combusted);

the energy consumed in all of the non-manufacturing sector; and the electrical energy, including generation losses, that is used for non-process motors (e.g., conveyor systems, machinery, etc.) and lighting. (Since any process integration study involves the careful analysis of the mass and energy flow streams of a process, the feedstock energy that is used, and how it is used, will be an integral part of the study. However, it is assumed here that the conservation of the feedstock itself is minimal, but the heat and power energy required to react and process the feedstock energy is "targetable". Process integration could, however, be used to identify cost effective measures to reduce the attendant residual waste streams from feedstock processing, but this paper is only considering combustion related waste streams, and therefore, feedstocks have been excluded from the "targetable" energy).

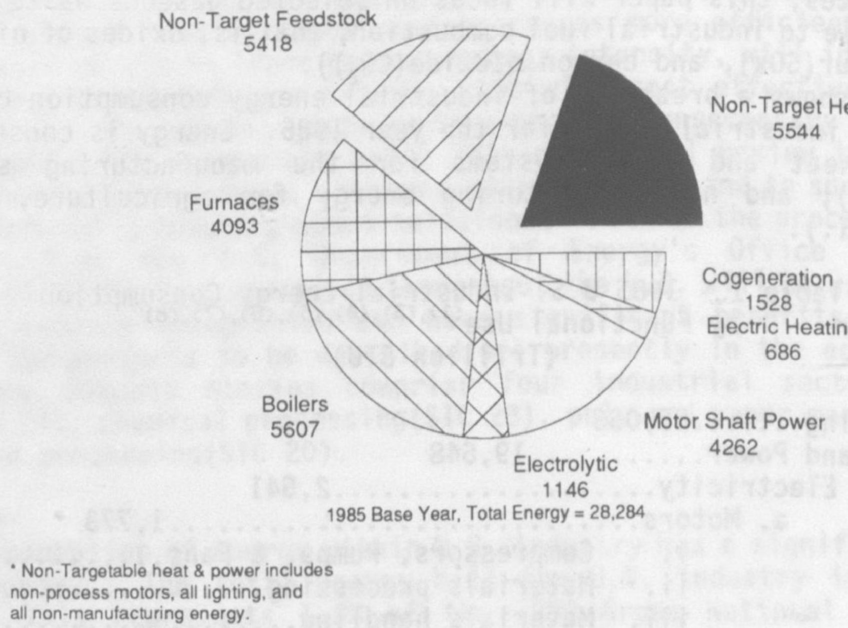

Figure 1 - Targetable U.S. Industrial Energy
(All figures in trillion BTU)

Figure 2 shows a breakdown of the fuels that are consumed to supply the "targetable" energy[(1),(3),(4),(5),(6),(7),(8)]. The generation and transmission energy losses of producing electric utility power and the breakdown of fuels used to generate utility power on a nationwide basis are included in these numbers.

Table 2[(9),(10)] shows the specific air emission indices on a weight basis from the burning or consumption of the fuels shown in Figure 2.

Table 2 - Gaseous Emissions Produced From Energy Supply Types
(Tons of Emission per Trillion BTU Energy)

	NOx[(10)]	SOx[(9)]	CO_2[(9)]
Natural Gas	200	Negligible	55,000
Coal	500	1000	100,000
Petroleum	300	Negligible	80,000
Nuclear	0	0	0
Hydro	0	0	0
Byproducts (wood chips)	300	0	65,000

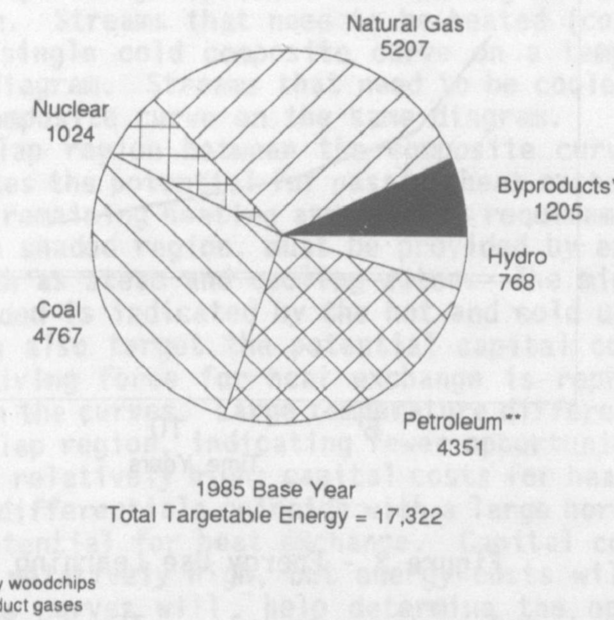

Figure 2 - Source Fuel Types Supplying the Targetable Energy
(All figures in trillion BTU)

Multiplying the absolute levels of the fuels consumed in Figure 2 (i.e., the "targetable" energy) by the specific air emission indices of Table 2 allows a projection of the U.S. gaseous emissions(in 1985) that are attributable to the "targetable" energy(Table 3). Therefore, it is a portion of these emissions that could be mitigated from industrial process integration enhancements. (Energy consumption in the industrial sector has grown from 28.2 quadrillion BTU in 1985 to 31.2 quadrillion BTU in 1990[1], therefore, the level of emissions should not have changed appreciably from 1985 to 1990).

Table 3 - Gaseous Emissions from "Targetable" U.S.
Industrial Energy (1985 Base Year)

NOx -	5.0 million tons
SOx -	4.8 million tons
CO_2 -	1190 million tons

Targeting Utility Requirements with Process Integration

Process integration involves combining all the unit operations in a given process plant to produce the required products in the most cost effective manner with the least environmental impact. To accomplish this, one must resolve a set of complex, often conflicting, requirements. These requirements include, minimizing capital and operating costs; maximizing product output, flexibility, and reliability; and resolving safety and environmental issues. Process integration has traditionally been, and to a large extent still is, performed by engineers who examine a new or existing process and develop an improved design. This has generally been done by intuition or experience, and has led to gradual, but steady, improvements in the energy use of a plant process. Figure 3 shows what this "learning curve" looks like, where energy intensity decreases with time.

As shown on the learning curve, improving energy use significantly by this method may require years. Indeed, the minimum energy use was not generally known, so engineers could not know how much improvement was possible. Beginning about 15 years ago, analysis techniques began to be developed based on

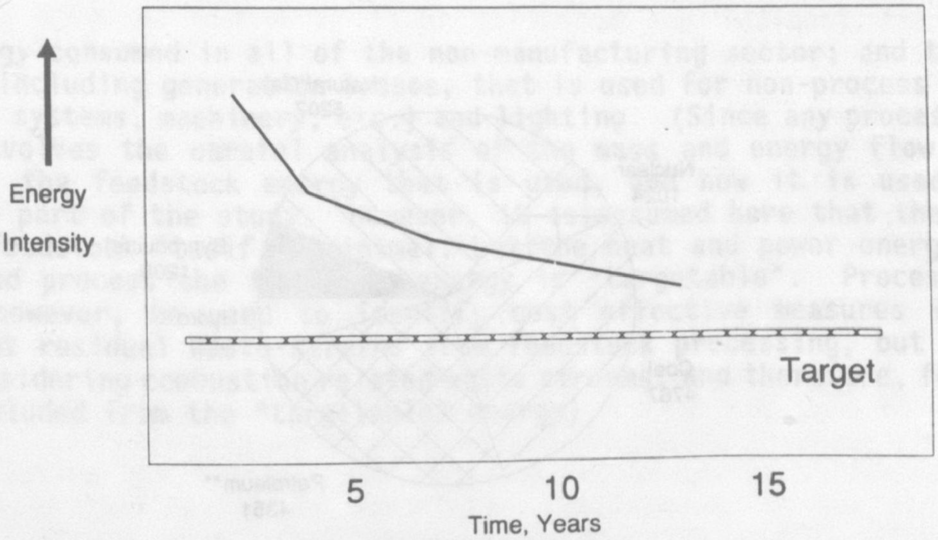

Figure 3 - Energy Use Learning Curve

thermodynamic and engineering principles. These techniques attempted to study a process as a whole, and then maximize the energy efficiency of the process. Most of the techniques involved complex mathematical equations and solutions, which tended to prevent their use except in specialized cases. One technique that evolved over that period, known as pinch technology, is based on relatively simple concepts.[(11),(12),(13),(14),(15),(16)] Using process flowsheets, and mass and energy balances, pinch technology can guide the process engineer through the integration and optimization of even complex process plants. Pinch technology can be used to identify both the minimum hot and cold utility requirements before any energy recovery network or utility systems are designed. The minimum utility requirements identified by a pinch study, called the hot and cold utility targets, may represent 25% to 40% energy savings.

"In industrial processes, streams of material are heated and cooled over a wide temperature range as raw materials are transformed into finished products.

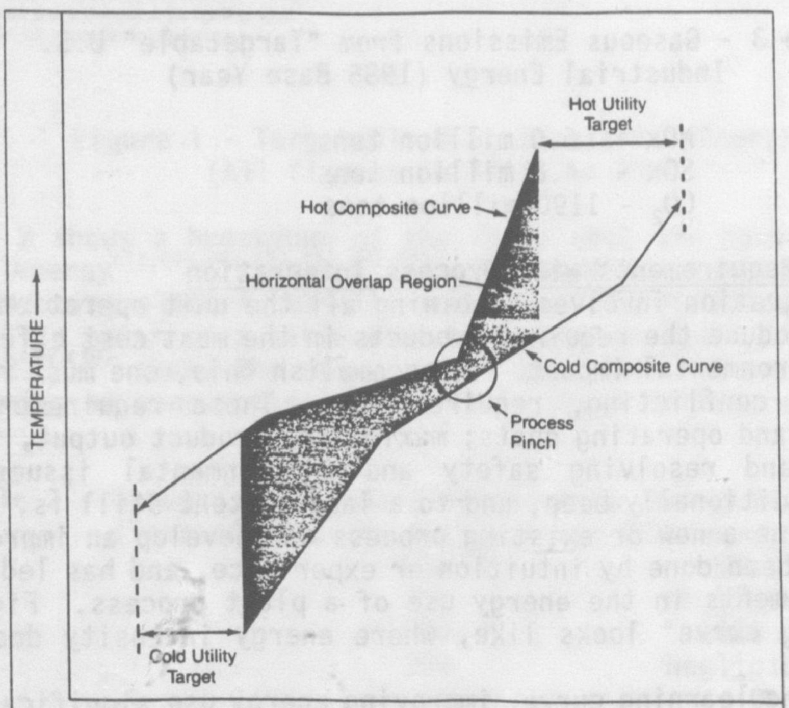

Figure 4 - Composite Curves

To determine the energy targets, these streams are combined into composite curves, Figure 4, which graphically represent the heating and cooling requirements of the system. Streams that need to be heated (cold streams) are combined together into a single cold composite curve on a temperature verses enthalpy(energy content) diagram. Streams that need to be cooled (hot streams) are combined into a hot composite curve on the same diagram.

The horizontal overlap region between the composite curves, the shaded region in Figure 4, indicates the potential for passive heat exchange between the hot and cold streams. The remaining heating and cooling requirements, indicated by the area outside of the shaded region, must be provided by external heating and cooling utilities, such as steam and cooling water. The minimum or target amount of each utility needed is indicated by the hot and cold utility targets.

The composite curves also target the potential capital cost of the heat exchange network. The driving force for heat exchange is represented by the vertical separation between the curves. Large temperature differentials coincide with small horizontal overlap region, indicating fewer opportunities to recover heat. Energy costs will be relatively high; capital costs for heat exchange will be low. Small temperature differentials coincide with a large horizontal overlap region, indicating good potential for heat exchange. Capital costs for a heat exchanger network will be relatively high, but energy costs will be low."[17] In this way, the composite curves will help determine the optimum tradeoff between energy costs and the capital investment of the heat exchange network.

Further "study of the composite curves identifies possible process modifications, such as changes in flow rates, temperatures, and pressures, that further reduce the energy targets. New composite curves incorporating these changes define the final energy targets."[17]

"The closest point between the hot and cold composites curves is called the process pinch. Shown in Figures 4 and 5, the pinch divides the system into two subsystems. The subsystem above the pinch requires only the process-to-process heat exchange and a minimum hot utility. The subsystem below the pinch requires only heat exchange and a minimum cold utility. Using excess hot utility, represented in the figure by X, causes the excess heat to cascade through the system and across the pinch, requiring excess cold utility to remove the

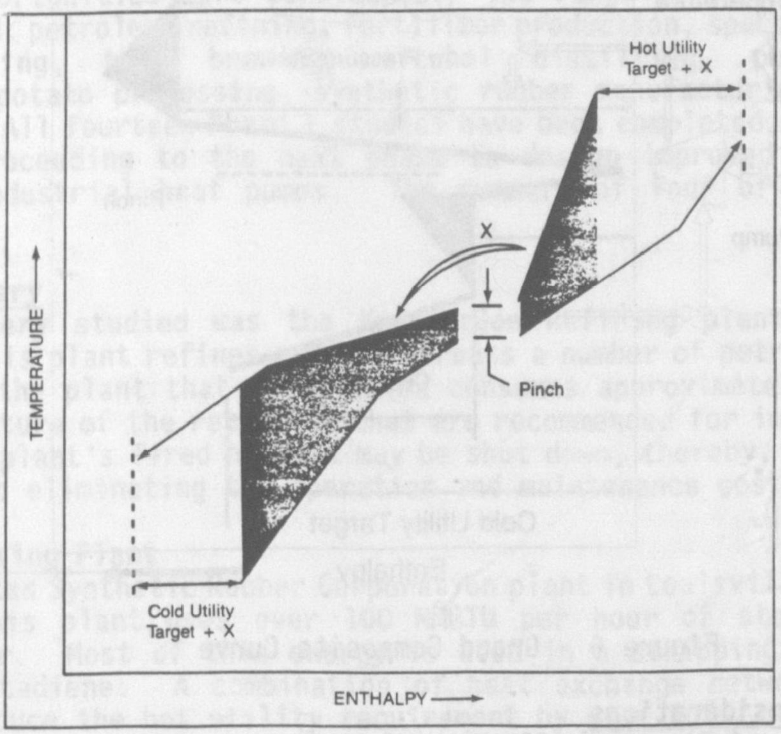

Figure 5 - The Pinch Principle

heat."[17] Therefore to meet the hot and cold utility targets a few basic rules need to be followed:

* No cold utilities are used above the pinch.
* No hot utilities are used below the pinch.
* Heat is not transferred from above the pinch to below it.

Heat and Power System Design

When a configuration for the process and heat exchange network is established, pinch technology can be used to guide the design of the heat and power system that will support the process. A useful aid to accomplish this is the grand composite curve(GCC). The GCC is generated as the difference in heat load between the hot and cold composite at each temperature. "The GCC, Figure 6, helps select the types and amounts of utilities recommended. Like the composite curves, the GCC shows the amount of heat that must be provided to and removed from the system, but it also reveals the temperature at which heat must be supplied and removed."[17]

Figure 6 shows what one heat and power system may look like. High pressure steam is required for the portion of the process at higher temperature. The remainder of the hot utility target could be supplied by low pressure steam. High pressure steam could be let down through a steam turbine to provide both the low pressure steam and electricity. A mechanical vapor recompression(MVR) heat pump can satisfy a portion of the heating and cooling utility. The heat pump recovers waste steam (i.e., waste heat) and recompresses the vapors to the level of the low pressure steam. The heat pump input energy, which is the electricity necessary to drive the compressor motor, could be less than a tenth of the heat that is recycled if the lift temperature of the heat pump is low enough (e.g., less than 30 degrees F).

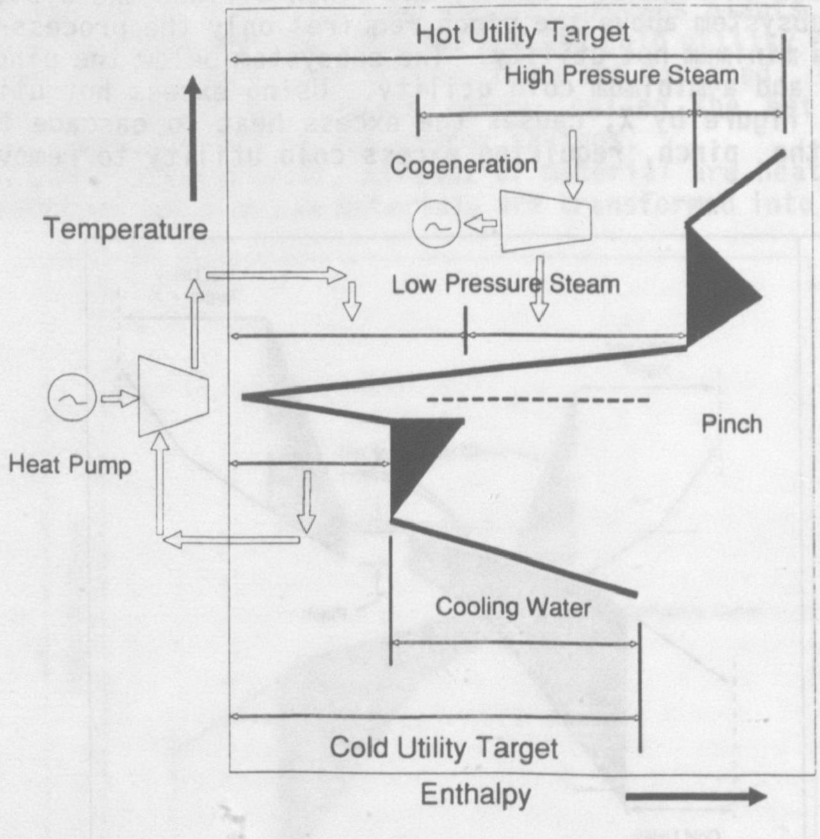

Figure 6 - Grand Composite Curve

Shaft Power Considerations

Table 1 and Figure 1 illustrated that a significant amount of energy in industry is consumed to supply electricity for motor drives that provide shaft power. While shaft power has not traditionally been a key element within a process integration study, the use of shaft power and the way it is supplied should be carefully scrutinized to ensure for an energy efficient process design. Most of the shaft power supplied for industrial processes is by electric motor drives(some shaft power is supplied by steam turbines and heat engines). Processes require numerous pumps, fans, and compressors to move fluids and gases within the processes. The amount of flow or energy supplied to various parts of the process may vary widely during the process operation duty cycle. A growing trend in industry is to use adjustable speed drives(ASDs) to efficiently accommodate the large swings in a process' flow and energy requirements. ASDs allow an electric motor drive to vary in speed, and therefore, supply only the shaft power that is actually needed by the process. Controlling the process by the motor speed and not by energy inefficient flow throttling can save a significant amount of energy. Since ASD motor drives are electrically driven, they may also provide a net reduction of on-site air emissions if they can cost-effectively replace a heat engine drive device, such as a steam turbine. On a global basis they may or may not have a positive environmental impact.

Summary of Process Integration Opportunities to Reduce Emissions

To summarize the opportunities afforded by process integration to conserve energy and thus reduce emissions, the following options are available:

* **Utility Targeting** - Identify the minimal practical target utility of the process and thus identify cost effective heat exchange network improvements, or process modifications.
* **Heat and Power Systems** - Design an integrated heat and power system by considering cogenerated power and heat pump systems.
* **Shaft Power Supply** - Design shaft power systems that supply the process power requirements efficiently. Consider using ASDs where they are cost effective to avoid on-site fuel burning for heat engine driven systems.

Process Integration Success Stories

In 1988 the Department of Energy/Office of Industrial Technologies initiated a series of cooperative agreements to study 14 various industrial processes. Although the studies performed were to specifically try to identify industrial heat pump opportunities using the pinch technology method, all possible process integration opportunities were considered. The range of processes that were studied included: petroleum refining, fertilizer production, specialty chemicals, cheese processing, beer brewing, alcohol distilling, pulp and paper manufacturing, potato processing, synthetic rubber manufacturing, and textile manufacturing. All fourteen Phase I studies have been completed. Eight of these projects are proceeding to the next phase to design improved heat exchanger networks and industrial heat pumps. The summary of four of these projects follows:

Petroleum Refinery

The refinery studied was the Kerr-McGee Refining plant in Wynnewood, Oklahoma.[18] This plant refines and hydrotreats a number of petroleum products. The portion of the plant that was studied consumes approximately 81 MMBTU per hour. A key feature of the retrofits that are recommended for implementation is that one of the plant's fired heaters may be shut down, thereby, not only saving energy, but also eliminating the operation and maintenance cost on the heater.

Chemical Processing Plant

The American Synthetic Rubber Corporation plant in Louisville, Kentucky was studied.[19] This plant uses over 100 MMBTU per hour of steam, to process synthetic rubber. Most of this energy is used in a stripping operation that produces polybutadiene. A combination of heat exchange networking and heat pumping will reduce the hot utility requirement by over 50%.

Pulp and Paper Plant

The Bowater Carolina pulp and paper plant in Catawba, South Carolina was studied.[20] This plant uses a large amount of energy in manufacturing market pulp, newsprint, and coated paper. Although, a large portion of their on-site combustion energy is from wood chips and black liquor, a significant amount of the energy the plant purchases is natural gas, which has a relatively high cost compared to the wood chips and black liquor. A heat integration opportunity was found whereby dirty low pressure atmospheric steam will heat boiler feed water in place of higher pressure steam. This frees up the higher pressure clean steam for economical heat pumping . The combination of the heat integration and heat pumping will save over 100 MMBTU/Hr of steam heat.

Food Processing Plant

The American Maize Products plant in Decatur, Alabama was studied.[21] This plant is a wet corn milling plant that makes various grades of high fructose corn syrup. The milling and refining portion of the plant were studied. An opportunity for a heat pump to recycle heat around the refinery's multiple effect evaporator was identified. This heat pump has already been installed. An increase in steam demand was needed on-site due to the expansion of the plant. The heat pump installation precluded the need to install additional boiler capacity(about 10MM BTU per hour) since the existing coal-fired boiler is operating near full capacity. Therefore, not only was energy saved, but capital expense was minimized to supply the additional steam.

Table 4 summarizes each plant's energy savings, economics, and emission reduction(using the national air emission indices quoted in Table 2). The investment cost includes the cost of the pinch study plus the engineering design which is approximately between $200,000 and $300,000.

Table 4 - Summary of Four Process Integration Success Stories

	Petrol. Refinery	Chemical Plant	Paper Plant	Food Plant
* Energy Scope(MMBTU/Hr)	81	133	369	135
* Hot Utility Target(MMBTU/Hr)	60	122	309	84
* Actual Savings(MMBTU/Hr)				
> Total	35	72	110	61
> Heat Integration	11	10	60	40
> Heat Pumping	24	62	50	21
* Fuel Type Saved, %				
> Coal	0	100	0	100
> Natural Gas	100	0	100	0
> Petroleum	0	0	0	0
* Heat Pump Energy (MMBTU/HR, Type)	2 Electric	8 Electric	3 Electric	10 Steam
* Net On-Site Fuel Burn Reduction				
(MMBTU/Hr)	35	72	110	51
(%)	43.2	54.1	29.8	37.8
* Net Cost Savings(K$/Yr), est.	500	1,500	1,400	750
* Investment(K$), est.	1,400	2,300	1,100	1,700
* Simple Payback(Yrs)	2.8	1.5	0.8	2.3
* On-Site Emissions Reduction				
> NOx (tons/yr)	61	295	193	214
> SOx (tons/yr)	0	590	0	428
> CO2 (tons/yr)	30,500	59,000	53,000	43,000

As Table 4 shows, the economics of less than a three year payback based on the energy savings alone is attractive. The reduced emissions are an added benefit that have not been factored into the economics.

Conclusions

Industrial process integration offers industry an approach to identify least cost methods to expanding processes, and to reduce operating cost, especially energy cost. As environmental regulations continue to get stricter, process integration will need to be used more aggressively to insure that both profitability and environmental compliance are mutually achieved. The Department of Energy plans to complete many of the host site demonstrations that are in progress so as to identify new and novel process integration approaches that U.S. industry can replicate effectively and expediently. If process integration methods being pursued presently by many companies are proliferated throughout U.S. industry, then a significant reduction of industrial waste will be eliminated cost effectively.

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* Available through the National Technical Information Service, Oak Ridge, TN.

SESSION 4G

CLIMATIC CHANGE

Chairperson

T. J. Glauthier
World Wildlife Fund and The Conservation Foundation
Washington, D.C.

Speakers

Mark Farber
Mobil Solar Energy Corporation

Konrad von Moltke
Dartmouth College and Senior Fellow at
World Wildlife Fund and The Conservation Foundation

John P. Hughes
Electricity Consumers Resource Council

William U. Chandler
Battelle Memorial Institute
Pacific Northwest Laboratories

Joseph VandenBerg
Edison Electric Institute

Session Abstract

Many of the actions needed to mitigate the rate of global warming are essentially "pollution prevention" actions. The central strategies for slowing the rate of carbon dioxide buildup, for example, involve finding ways to reduce the basic energy-intensity of the U.S. and worldwide economies. Programs to switch to alternate fuels or plant new forests simply cannot suffice, and more than the analog of switching to alternative materials solves basic pollution problems in other sectors.

The obstacles to progress in the climate change area, and the successful strategies to overcoming those obstacles, are instructive for those involved in traditional pollution prevention areas.

The objectives of this panel are:

- To explore market dynamics involving superior, but non-traditional technologies. How do companies overcome the obstacles to market acceptance of new, less polluting technologies? How do countries react to perceptions of international trade implications of climate change mitigation strategies?
- To discuss contrasting views on the expense and difficulty of implementing programs to reduce our energy intensity. Why are there such disparate views, and what is the appropriate way to evaluate such potential changes?

THURSDAY EVENING PRESENTATION

POLLUTION FREE BUSINESS DECISIONS AND PRACTICES

Co-Chair

Mr. Herbert B. Quinn, Jr., P.E.
Porterfield-Quinn Consultants
McLean, Virginia

Co-Chair

Lawrence Ross, Director
American Institute of Chemical Engineers/Center for Waste Reduction Technology
New York, NY

Speakers

Mr. Denny Beroiz (Industry)
Northrop Corporation
Poco Rivera, CA
Pollution Prevention in a Large Industrial Organization

Dr. Ramani Narayan (Academic)
Michigan State University
Michigan Biotechnological Institute
Lansing, MI
Environmentally Degradable Plastics and the Fast Food Industry

Mr. John Hunter (Industry)
3M Company
St. Paul, MN
Pollution Prevention Pays in Product Design

Ms. Terri Goldberg
NE Waste Management. Officials Association
Boston, MA
Cost and Savings Assessments for Pollution Prevention

Session Abstract

There are a number of organizations, including corporations and government installations, which have made top level commitments to manage their processes and programs in a "pollution free" manner. Without exception, success in this area requires a policy commitment to change ways of doing business and to institute pollution free practices throughout the organization. This session will present a review of policy, management and technical practices. The papers will review economic considerations, regulatory problems and employee training issues. The session will focus on practices and policies that could be successfully transferred to medium and small institutions.

POLLUTION FREE BUSINESS

DECISIONS

AND

PRACTICES

Denny J. Beroiz

Environmental Resource Management Director

Northrop Corporation, B-2 Division

Prepared for presentation at Global Pollution Prevention '91

Pollution Prevention and Total Quality Management Session

April 5, 1991

UNPUBLISHED

I wish to pose the argument that for American manufacturers, the engineering, scientific or technical developments have already provided the breakthroughs and commercializes products to reduce all pollution to 5% of the current total. I acknowledge that much work is needed to advance our position, in finding quicker, better, cheaper and more energy efficient ways - but the basics are on the shelf. The missing ingredient is leadership. The leadership that sets the difficult goal, musters the resources, ignites the people and conquers the obstacles.

When we look to find what the real issues are in pollution prevention, we find a bedrock of American social training and values that encourages each of us to be wasteful. Consider the case of an American manufacturer who employs U.S. workers and (without any effort to change their culture or values) expects them to be pollution preventers at work. Is it any wonder that pollution prevention has fallen short rather than exceeding the meager goals of control technology currently mandated by law and regulation? What other policy need be adopted by industry? What prevents industry from moving to a higher goal and thus the adoption of more aggressive programs using the off-the-shelf technology is regulation. Regulation by its mere existence, delivers mixed goals, drains resources, does not inspire risk taking and remains as a poor substitute for leadership inside an American company.

If there is any effort that needs to be more widespread it is that which addresses the behavioral and motivational aspect of our culture - our culture - with its predisposition toward waste and pollution in the quest for lifestyle and goals. The workplace should be the laboratory for this cultural shift, the Government can't accomplish it from outside the walls of that setting.

But where is the evidence for the path I describe as the correct one? Where are the case studies? Are they isolated? - non-existent? If they do exist, what can be gained by analysis of the facts surrounding the success? Is the leadership alternative producing results and is it transferrable?

In 1984, I was part of a scientific and engineering group who were brought together to rid a nine billion dollar company of its pollution. What took place from December 1984 to December 1989, challenged our training, shook our confidence and changed our understanding of pollution. We were told to eliminate hazardous waste and emissions in four years and to present that plan in 45 days. I have the results of the Pomona Division of General Dynamics for one media.

The first year result of nearly 50% reduction was accomplished by using no capital. The second year reduction was accomplished using less than $500,000 to support the Division's $1 billion sales position. From 1987-90 over $5 million in capital was used for pollution prevention changes. What made the remarkable improvement was not capital inprovements but rather a cultural shift. At Northrop Corporation's B-2 Division a vision of zero discharge of pollution was implemented in July 1990. The Company policy on hazardous waste reduction was published, followed by a broader charter for the B-2 Division to eliminate all forms of pollution by 1995. People must proclaim the goals and objectives, not regulations. Armed with this clear charter, the environmental professional must understand how to implement within the existing culture. Additionally, what cultural changes must be made first are important.

People in the workplace become the champions for this change. They will perform the extraordinary role for additional recognition of their contribution.

Northrop relies and depends on the spirit and innovation of these intrapreneurs...these champions. You find these champions by publicly announcing that it is alright not to make waste. You find more champions by openly soliciting their ownership in stopping waste generation. The startling results of the Northrop program is presented and by no surprise...it has had no capital spent in the first 10 months.

The concept that I wish to leave with you is that "waste reduction or pollution prevention starts between the ears". The leader must publish a clear and simple target and be committed to follow-up. People, in the form of champions will do the promotion and will achieve great success without capital or extensive research.

GENERAL DYNAMICS

Environmental Resource Management

Hazardous Waste

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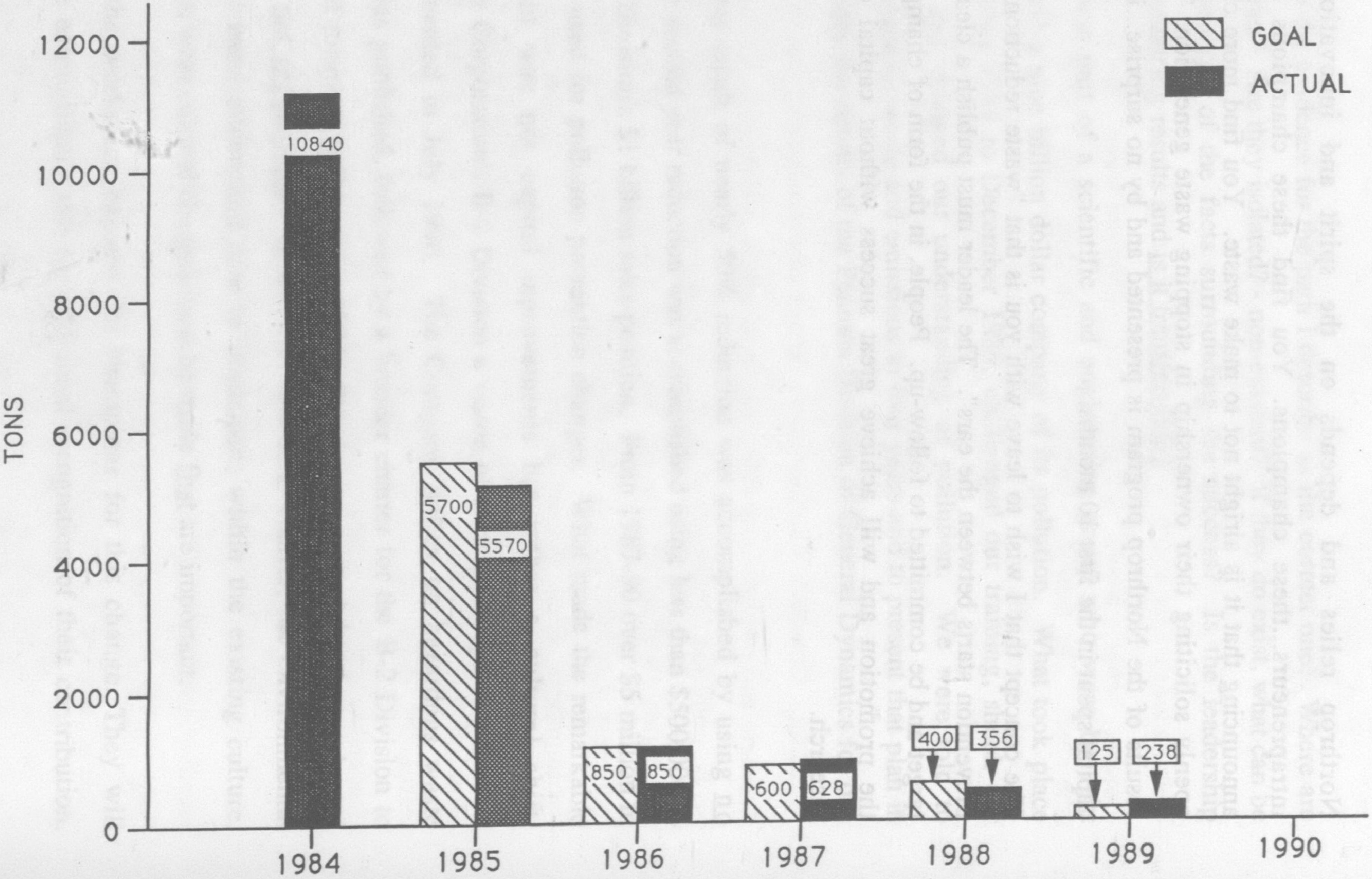


NORTHROP Corporate Announcement

CA 90-39

July 20, 1990

Northrop Corporation takes pride in its policy of conducting all of its operations in an environmentally responsible manner and in adhering to applicable environmental laws and regulations. Due to an expanding array of agencies and regulations coupled with bold initiatives by the American public to significantly reduce chemical emissions from manufacturing operations, adherence to this policy has become increasingly costly and complex.

214-1

The key to responding effectively to these regulatory challenges and public concerns is the reduction of hazardous wastes generated in manufacturing operations. There are also important business benefits associated with hazardous waste reduction. By substituting materials with less hazardous analogs, recycling materials, improving housekeeping techniques, and improving processes, Northrop will comply with waste minimization regulations. Other benefits include:

- Reduced employee exposure to chemicals
- Improved corporate image in the community and workplace
- Reduction in long-term liability for disposal site cleanup
- Improved efficiency in overall environmental compliance
- Avoidance of escalating hazardous waste disposal costs

To realize these benefits, I have directed the Corporate Environmental Management Office to implement an aggressive Waste Minimization Program. Our primary goal will be to achieve at least a 90% reduction in our hazardous waste stream by December 1996 and to ~~utilize~~ hazardous waste landfills only as a last resort.

Each operating element of the company will implement a waste minimization program within its operations which establishes milestones and methodologies to meet the company's reduction goals. The waste minimization plan of each operating element and its progress towards achieving our waste reduction objectives will be reviewed during quarterly business review meetings.

Kent Kresa
President and
Chief Executive Officer

Form CO 242 (R4 90) ISSUED BY CORPORATE INFORMATION SERVICES FOR ADDITIONAL COPIES CONTACT ORG 133/99 331-4859 REC'D IN REPRO 7/24

To: D. Beroiz, J. Diaz, M. McHugh, F. Lippon, W. Masterjohn, K. Berchtold, L. Israelitt, A. Myers, R. Silverstein, E. Smith, D. Suydam, C. Taylor

From: O.C. Boileau, President and General Manager

Subject: Environmental Resource Management

Date: October 29, 1990

B-2 Division Policy is very specific in regard to our responsibility in handling and disposing of waste and hazardous materials. This is not only a professional responsibility, but it must also be a personal one for every employee.

General policy requires that we comply with applicable government laws and regulations to provide a safe and healthy workplace; protect the environment from hazards inherent in our business; maintain standards that are more stringent than those required by environmental laws and regulations; pursue the use of least toxic materials; have participation and involvement by employees to identify, collect, store and dispose of hazardous waste; and reach a goal of zero discharge by 1995.

More specific requirements are made of senior managers. Specific functional responsibilities are:

Engineering must review and change, as necessary, new product designs and proposed modifications at each stage of development to reduce or eliminate the use of hazardous materials. Engineering must also take the lead in continuously reviewing and changing existing product designs, materials and manufacturing processes to reduce or eliminate the use of hazardous materials and the generation and discharge of hazardous wastes.

Manufacturing must consider environmental implications in current production processes and implement plans to reduce or eliminate the use of hazardous materials and the generation, discharge and disposal of hazardous wastes. Manufacturing must minimize hazardous wastes and emissions through conservation and recycling. It is Manufacturing's responsibility to point out to Engineering and Program Management, the product processes that generate hazardous waste and/or emissions.

Material Control and Distribution must identify and track hazardous materials; optimize use of surplus hazardous materials; and coordinate with Procurement to minimize amounts of hazardous materials. It is Material Control's responsibility to work with Engineering and Procurement to match packaging size with specific activity requirements and to purchase only in quantities necessary for the process.

Quality Assurance must analyze hazardous waste streams; review and suggest changes to any process specifications to minimize the discarding of process solutions prior to maximum life usage.

Facilities must oversee installations, maintenance and recharging of chemical processing facilities; provide for hazardous material storage and waste processing facilities; and provide support in control and clean-up of hazardous material spills.

Division Counsel must provide legal interpretation of environmental laws and regulations, and review settlement agreements, fines, and major incidents with Environmental Resource Management.

Health and Safety will coordinate the Chemical Material Control program; track chemicals using the Chemical Materials Management program; and conduct inspections and audits to ensure compliance with safety and environmental requirements.

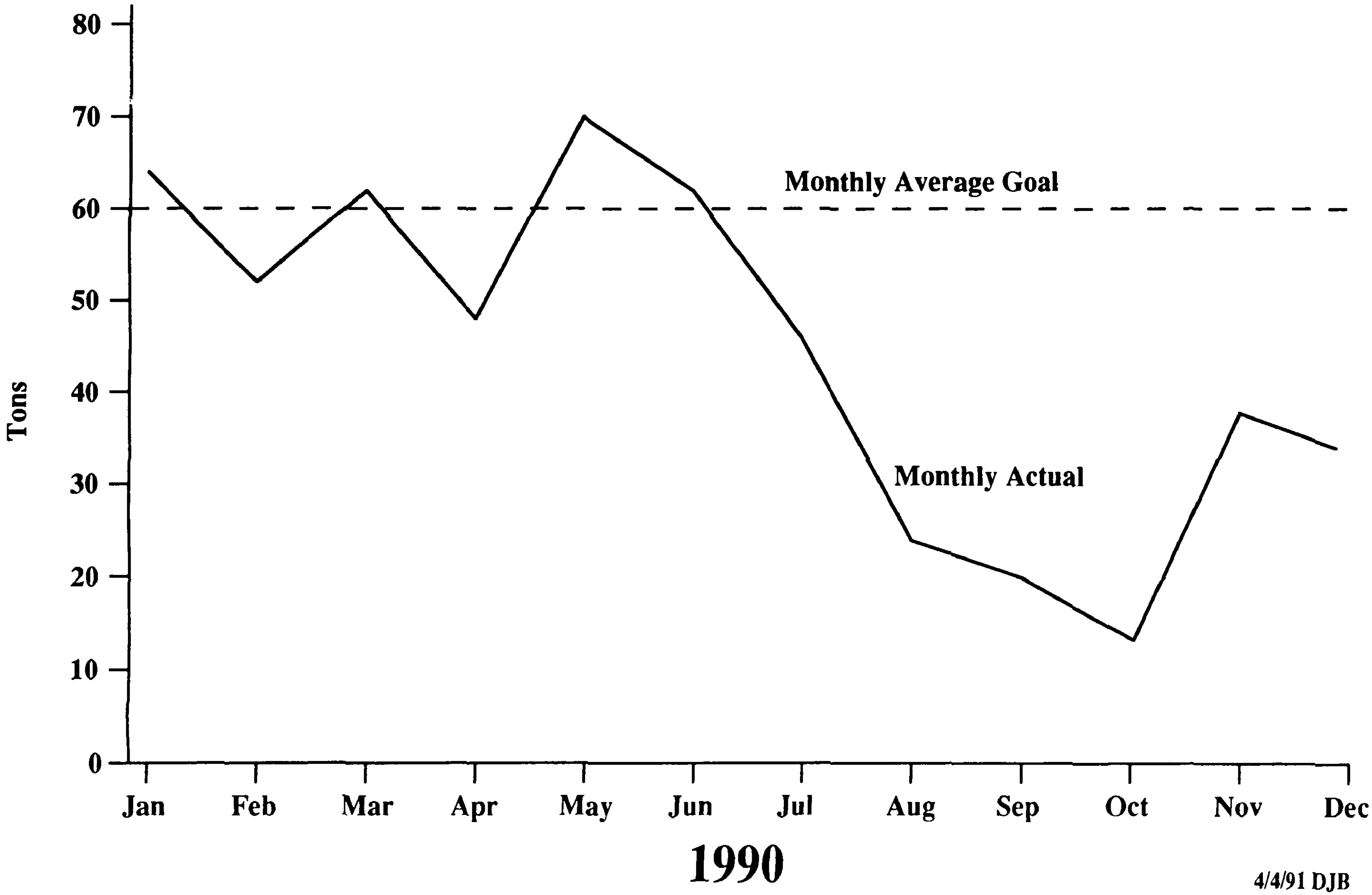
Procurement must coordinate order quantities of hazardous materials with Material Control to ensure surplus quantities are kept to a minimum, and ensure that suppliers are required to identify materials as hazardous and provide Material Safety Data Sheets along with container markings required by South Coast Air Quality Management District regulations.

Training will provide employee education and certification programs to inform employees of measures to be taken to maintain a safe work environment.

All B-2 Division employees must understand that our ultimate goal is to achieve zero discharge of hazardous waste and other hazardous emissions from all facilities.

O.C. Boileau
President and
General Manager

NORTHROP
B-2 Division
Monthly Hazardous Waste

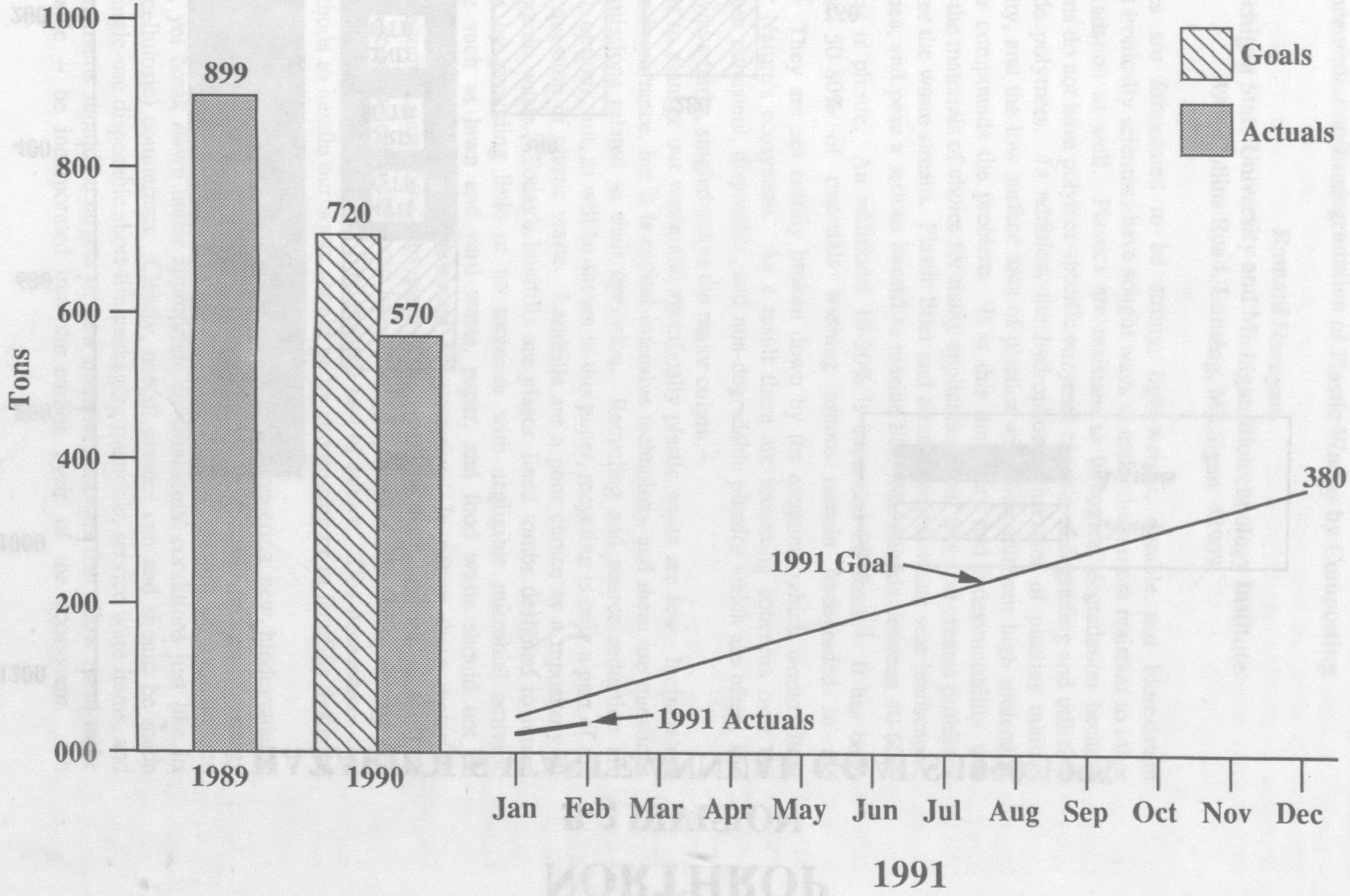


4/4/91 DJB

NORTHROP

B-2 Division

Total Hazardous Waste, Cumulative



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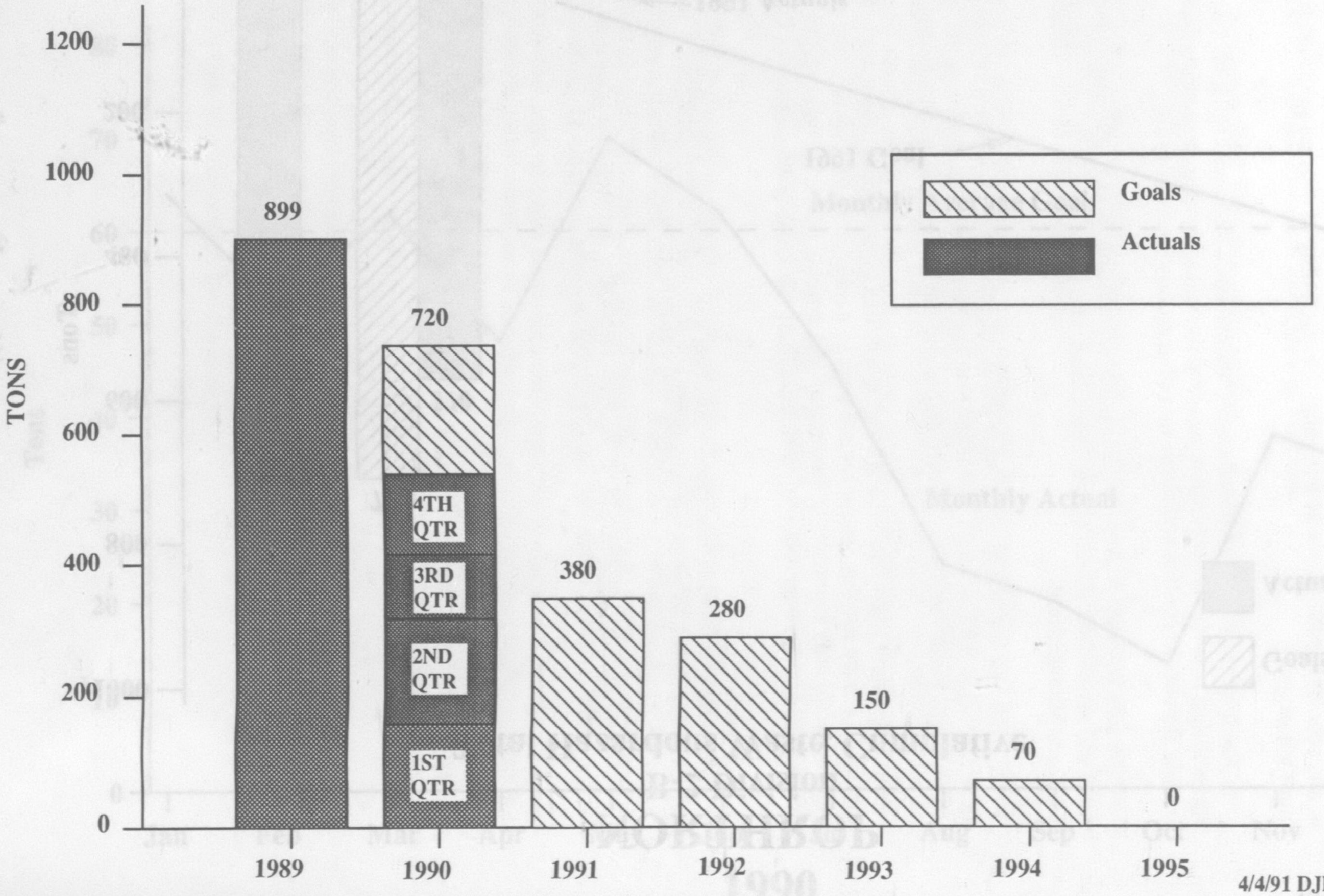
4/4/91 DJB

NORTHROP

B-2 DIVISION

HAZARDOUS WASTE ANNUAL GOALS 1990-1995



4/4/91 DJB

Bioremediation/Biodegradation of Plastic Wastes by Composting

Ramani Narayan
Michigan State University and Michigan Biotechnology Institute
3900 Collins Road, Lansing, Michigan 48909

Plastics are formulated to be strong, light-weight, durable and bioresistant materials, and ironically scientists have sought ways to make them more resistant to other kinds of degradation as well. Plastics are resistant to biological degradation because microorganisms do not have polymer-specific enzymes capable of degrading and utilizing most manmade polymers. In addition, the hydrophobic character of plastics inhibits enzyme activity, and the low surface area of plastics with their inherent high molecular weight further compounds the problem. It is this durability and indestructibility that make plastics the materials of choice for many applications, but this also creates problems when they enter the waste stream. Plastic litter and errant medical waste scar landscapes, foul our beaches, and pose a serious hazard to marine life. Nationwide between 40-60% of beach debris is plastic. An additional 10-20% is expanded PS foam.[1] It has been estimated that 50-80% of materials washing ashore remain undegraded in the environment.[1] They are not readily broken down by the elements which would allow them to enter Nature's ecosystem. As a result there are mounting concerns over the disposal of these persistent, disposable, and non-degradable plastics which are often, and perhaps not always fairly, singled out as the major culprit.[2]

Options to manage our waste and specifically plastic waste are few. Incinerators are growing in importance, but it is capital-intensive technology and there are questions about toxic emissions related to their operation. Recycling and source reduction are accepted viable options, but, as will be shown in this paper, recycling is only a part of the answer to the question of plastic waste. Landfills are a poor choice as a repository of plastic and organic waste. Today's landfills are plastic lined tombs designed to retard biodegradation by providing little or no moisture with negligible microbial activity. Organic waste such as lawn and yard waste, paper, and food waste should not be entombed in such landfills to be preserved for posterity. In nature these materials biodegrade to become a part of the ecosystem of the biosphere via the carbon cycle. This is the major bio-geochemical cycle of our biosphere. Any method adopted to manage our waste should take cognizance of this fundamental fact of nature. This necessitates that one of the methods to handle our waste should be by composting or in landfills designed to allow for accelerated degradation.

This leads us to the concept of designing and engineering new biodegradable materials -- materials that are plastics, i.e. strong, light-weight, easily processed, energy efficient, excellent barrier properties, disposable (mainly for reasons of hygiene and public health), yet break down under appropriate environmental conditions just like its organic (lignocellulosic) counterpart. Clearly, not all plastics can and should be made degradable. Single-use disposable short-life packaging materials, service ware items, and disposable nonwovens should be targets of new material concepts that allow them to be fully compostable -- be incorporated into the carbon cycle of the ecosystem. An estimated 30% of synthetic polymers totalling 16.5 billion pounds annually fall into this category. Marine plastics is another category that lends itself to degradable design concepts. These include fishing gear such as driftnet straps, and packaging material such as plastic sheets, strapping, shrinkwrap, polystyrene foam products and domestic trash such as plastic bags, bottles and beverage ring containers.

Rationale for Biodegradable Polymers - The Ecosystem and the Carbon Cycle[3,4]

Scientists and engineers have assembled the carbon units derived from natural resources to form complex polymeric structures (plastics) with specific and desirable properties. However, in the past little attention has been given to the disassembly of these molecules in an ecologically sound manner, nor was the ecological impact of these polymeric materials addressed when they entered the waste stream. In nature, on the other hand, polymeric materials have inherent degradability. Specifically, many carbon-based materials such as plants and trees are biodegradable, as well as all living creatures. The carbon is recycled via the carbon cycle of the ecosystem. Figure 1 illustrates the carbon cycle.

Green plants fix atmospheric carbon dioxide and grow. They are consumed by herbivores which in turn are consumed by carnivores. All respire to produce carbon dioxide and ultimately form dead organic matter. The dead organic matter is decomposed by microorganisms such as fungi and bacteria, resulting in humic material. This humic material is further decomposed by microorganisms to carbon compounds over a long period of time. Approximately 9000 Kg of carbon per hectare is returned to the soil which is assimilated by plants, trees and other vegetations, and the cycle continues. When plastics and other carbon-based materials are disposed of in the environment, they should be able to become an integral part of this carbon cycle.

As discussed earlier, manmade products such as plastics are, unfortunately, bioresistant. As a result, there is an irreversible build-up of these synthetic materials in nature which short circuits the ecosystem. Thus, the rationale is to design and engineer strong, lightweight, useful, disposable plastics that can break down under environmental conditions or in waste disposal systems to products that can be assimilated by the ecosystem (carbon cycle).

Degradability and Recycling

Recycling continues to receive considerable attention as a solution to the growing plastic waste problem and claims have been made that degradable products will impact negatively on plastic recycling efforts by contaminating recycled feedstock. Without a doubt, recyling is very important, but only where it is technically and economically feasible.

It has been argued that re-marketing 50 cts/lb plastics is not feasible since cleaning, reconverting and reshipping costs often exceed the virgin-resin cost. Thus, only a handful of large volume, easily collectable, single resin component materials such as PE milk containers and PET bottles can be recycled. Expensive engineering plastics and composites such as used in the automotive industry are collectable and economically viable for recycling. However, considerable technical difficulties have yet to be overcome relating to the poor compatibility of different types of polymers, or different grades of the same polymer.

Clearly non-woven personal care products such as diapers and feminine hygiene products, medical products such as surgical drapes, wraps, and face masks do not lend themselves to recycling concepts. These materials are contaminated with body fluids and are composed of multiple resin compositions. For example, the major component in a baby diaper is wood pulp, which is a degradable material itself. Typically, it has an inner polypropylene lining and an outer polyethylene backing. Recycling this material would be energy and labor intensive, requiring elaborate separation and cleaning.

There is a current trend to go back to cloth diapers as an environmentally responsible approach. This is far from true and, in fact, about three times as much energy is used and nine times as much air pollution results from the use of cloth diapers. Even more important is the question of hygiene and the potential for infection. In medical applications this is even more critical because the prime motivation in producing these single use disposable products is to operate in a safe, hygienic, and infection-free environment.

In the recycling process, following one or more reprocessing cycles, the properties of the plastic will ultimately drop off due to the additional heat history to make repeat use for the same application difficult. At that stage, the plastic will have to be discarded into the environment, which would require that degradability be built into the material system.

Landfill Practices

Today's sanitary landfills are quite heterogeneous environments unsuitable for the consistent degradation of plastic waste. Typically, landfills are huge plastic-lined tombs devoid of oxygen and moisture, and support little microbial activity. As a result the rate of degradation is extremely slow and even organic waste including food, paper, lawn and yard waste does not readily degrade. This lack of degradation of natural polymeric materials in landfills has been cited as the major reason why degradable plastics will not help in plastic waste management and more specifically in creating more landfill space.

Setting aside the question of degradable plastics for a moment, one has to wonder about the logic in packing our readily degradable material like food waste, paper, lawn and yard waste into nondegradable plastics bags. Hence, in an effort to protect and preserve Nature's ecosystem, progressive waste management strategies should include degradable materials (organic waste) capable of undergoing biodegradation to its natural elements -- CO_2 , water and humic materials (the carbon cycle). This leads us to the concept of composting or biocycling, and managed landfills where accelerated degradation occurs. The new degradable materials are in tune with these ecosystem concepts and would allow us to incorporate them into the carbon cycle.

Composting (Biocycling)

The time frames necessary for the natural ecosystems to operate cannot cope with the amount of solid waste we produce, and this includes both the plastic and the naturally degradable yard waste, paper, paperboard, etc. As a result processes must be designed to accelerate the degradation of these wastes within the scope of the carbon cycle and the ecosystem of the biosphere. Composting is such a process and is defined as "accelerated degradation of heterogeneous organic matter by a mixed microbial population in a moist, warm, aerobic environment under controlled conditions". This is practiced in other countries as a viable waste management approach. France has over 100 plants producing

800,000 tons of compost each year. Sweden composts one fourth of its solid waste. In the U.S. composting is also catching on. There are at least 12 mixed municipal solid waste composting facilities and numerous lawn and yard waste composting programs that are currently operating.

A conceptual composting scheme is shown in Figure 2, wherein one can control and monitor the whole composting operation. One can even inoculate the "compost bioreactor" with special hydrocarbon degraders to speed up hydrocarbon-based plastics' degradation. By composting our plastic, yard and paper waste, we can generate much-needed carbon-rich soil (humic material) which can redress the problem of sustainability of our agricultural system. Major problems of topsoil erosion resulting in poor water and nutrient retention and depletion in organic carbon matter is facing the agricultural community today. The problem of waste disposal could become the solution for this agricultural crisis.

MBI-GRANDMETROPOLITAN PLC PROGRAM

Today's single use, short-lived disposable fast food packaging materials is cartedf away to sanitary landfills to be entombed and preserved for posterity. Biologically degrading these materials via appropriate composting or accelerated degradation schemes would ensure that the polymeric carbon is recycled back to nature via the carbon cycle. Uncoated paperboard, cellophane (cellulosic film) was observed to readily biodegrade under composting conditions. With polyehtylene coated paperboard, the cellulosic component underwent biodegradation, however the polyethylene carbon was not degraded. This would mean that when the PE coated material was composted, a irreversible build up of a persistent non-biodegradable polymeric carbon would occur. The PE coating is used in fast food and other food packaging to provide for water and grease resistance (e.g. beverage cups)

We are developing corn protein based laminates and films, designed to have appropriate water and grease barrier properties to function as substitutes for polyethylene. These materials are readily degraded and assimilated by the microbial consortia. Once the process is developed and optimized, fast food packaging materials could be sent to lawn and yard waste composting facilities and turned in to useful mulch (recycling the carbon back to nature).

Plastics and organic waste should never end up in a landfill to be entombed for posterity. They should be reclaimed, recycled, composted (biodegraded), or incinerated. A proper mix of all these approaches is needed to effectively manage polymer waste. The technical, economic, geographical and local environmental factors will dictate the hierarchical order of the waste disposal approaches to be adopted. Figure 3 presents a conceptualized view of such an approach..

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1) Alaska Sea Grant Report No. 88-7 on "Workshop on Fisheries, Generated Marine Debris and Derelict Fishing Gear", February 9-11, 1988.
2) *Modern Plastics*, Waste Solutions, April, 1990.
3) R. Narayan, *Kunstoffe*, 79 (10), 1022, 1989.
4) R. Narayan, *INDA Nonwovens Res.*, 3 (1), 1991.

Figure 1
CARBON CYCLE

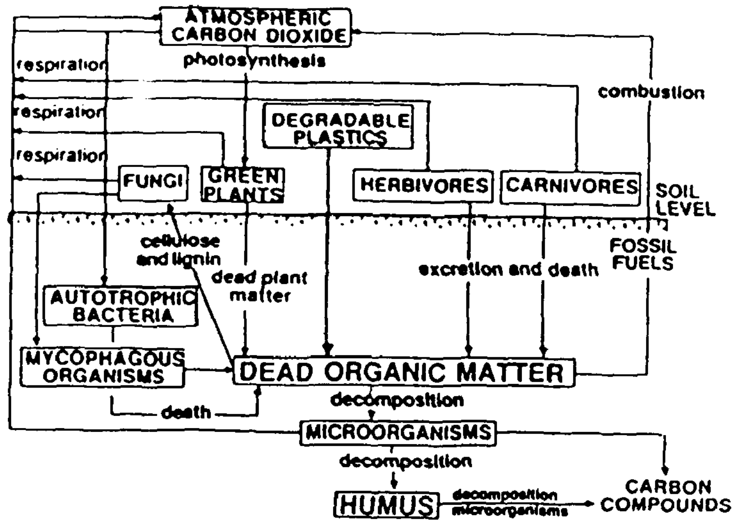


Figure 2
CONCEPTUAL COMPOSTING SCHEME

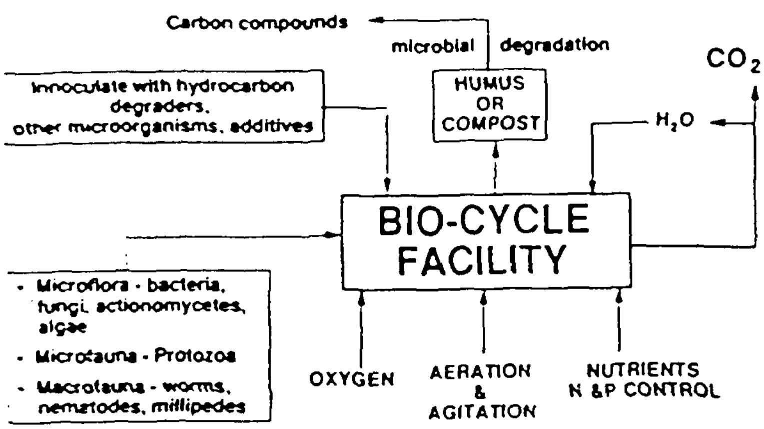
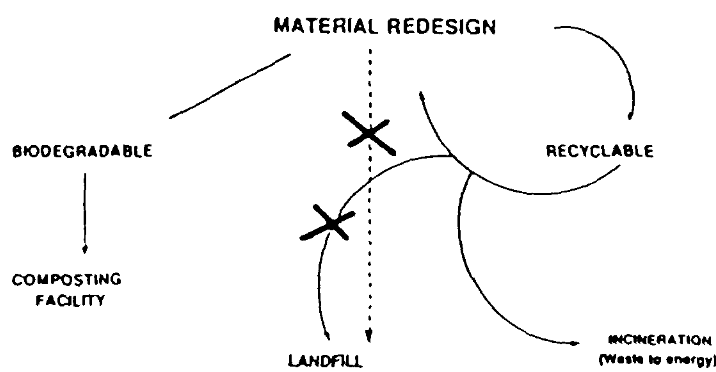


Figure 3
CRADLE TO GRAVE CONCEPT



INTEGRATION OF DESIGN CONCEPTS WITH DISPOSAL SCHEME

ABSTRACT

PREVENTING POLLUTION THROUGH PRODUCT DESIGN

It is 3M corporate policy to produce products with a minimum adverse impact on the environment. There has been a product development process within the company for several years that helps keep the product research laboratories focused on this environmental objective. This process has recently been expanded to more formally consider the complete life cycle of products and the materials from which they are made. The process will be described and some product examples will be presented that demonstrate the achievement of pollution prevention objectives.

AUTHOR: John S. Hunter, III
Senior Environmental Engineering Specialist
EE&PC
Bldg. 21-2W-05
3M Company
P.O. Box 33331
St. Paul, MN 55133

CLOSING SESSION

ROLE OF MEDIA IN POLLUTION PREVENTION

Chairperson/Moderator

Ms. Karen Doyne
Senior Vice President, Fleishman-Hillard, Inc.
Washington, D.C.

Speakers

Mr. Arthur E. Wiese
Vice President for Public Affairs
American Petroleum Institute
Former Journalist and
Past President of the National Press Club

Mr. Morris (Bud) Ward
Executive Director
Environmental Health Center
Former Editor and Reporter
Founder of ***The Environmental Forum***

Ms. Mary Hager
Environment and Science Writer
***Newsweek* magazine**

Session Abstract

The closing session will examine the role of the media in covering — and, some would say, encouraging—environmental action such as pollution prevention. How do reporters, former reporters and business spokespeople see the media's responsibilities in this area? Is coverage appropriate, fair, accurate? What is the relationship between the media, public opinion, and public policy.

The speakers for this session have extensive backgrounds in the environmental and media fields, and will offer varied analyses of media-related issues.