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DEFENSE PROGRAMS BENCHMARKING IN CHICAGO, APRIL 1994

Identifying Best Practices in the Pollution Prevention Programs of Selected Private Industries

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ACRONYMS

AEC	Atomic Energy Act
ABS	Acrylonitrite butadiene styrene
ALCOA	Aluminum Company of America
ARAR	Applicable or Relevant and Appropriate Requirements
CAA	Clean Air Act
CAAA	Clean Air Act Amendments of 1990
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFC	Chlorofluorocarbon
CSO	Cognizant Secretarial Office
CWA	Clean Water Act
DoD	Department of Defense
DOE	Department of Energy
DP	Defense Programs
DP-34	Defense Programs Office of Environmental Support
EEC	Executive Environmental Council
EH-24	Office of Environmental Audit
EH&S	Environmental Health and Safety
EIT	Environmental Impact Team
EM	Office of Environmental Management
EO	Executive Order
EPA	Environmental Protection Agency
EPAct	Energy Policy Act of 1992
EPCRA	Emergency Planning and Community Right to Know Act
EPIC	Pollution Prevention Information Clearinghouse
ER	Office of Energy Research
GREEN	Get Reductions in Environmental Emissions at Navistar
HSWA	Hazardous and Solid Waste Amendments of 1984
IFI	Industries of the Future Initiative
KRA	Key Result Area
MIC	Micro-integrated circuits
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act of 1969
NCII	National Clean Industry Initiative
NGD	Smokeless Diesel Engine
NICE³	National Industrial Competitiveness through Energy, Environment, and Economics
NPDES	National Pollutant Discharge Elimination System
NPI	New Product Introduction
ODC	Ozone Depleting Compound
OFPP	Office of Federal Procurement Policy

OTA	Office of Technology Assessment
P2IG	Pollution Prevention Implementation Group
POTW	Publicly-Owned Treatment Works
PRP	Potentially Responsible Party
PWB	Printed Wiring Board
RCRA	Resource Conservation and Recovery Act
ROI	Return On Investment
SARA	Superfund Amendments and Reauthorization Act of 1986
SERDP	Strategic Environmental Research and Development Program
SNM	Special Nuclear Material
TQM	Total Quality Management
TRI	Toxic Release Inventory
TRP	Technology Reinvestment Project
TSD	Treatment, Storage and Disposal
VOC	Volatile Organic Compounds
WERC	Waste-Management Education and Research Consortium
WMMG	Waste Minimization Management Group
WRSC	Waste Reduction Steering Committee

DEFENSE PROGRAMS BENCHMARKING IN CHICAGO, APRIL 1994: IDENTIFYING BEST PRACTICES IN THE POLLUTION PREVENTION PROGRAMS OF SELECTED PRIVATE INDUSTRIES

"Initiate pollution prevention programs that will avoid future waste management costs and therefore pay for themselves."

(Secretary Hazel O'Leary: Departmental goal as stated in the official Performance Agreement between the President and the Secretary of Energy, 1995)

EXECUTIVE SUMMARY

The Office of Defense Programs (DP) was the first U.S. Department of Energy (DOE) Cognizant Secretarial Office (CSO) to attempt to benchmark private industries for best-in-class practices in the field of pollution prevention. Defense Programs' intent in this effort is to identify and bring to DOE field offices strategic and technological tools that have helped private companies minimize waste and prevent pollution.

Defense Programs' premier benchmarking study, *Benchmarking the Private Sector*, published March 1993, focused on business practices and process improvements used to implement exceptional pollution prevention programs in each of four privately owned companies: Aluminum Company of America (ALCOA), Rohm & Haas Chemical Company, Imperial Chemical Industries, and Delmarva Power Company. All of the programs were found to have certain practices or elements in common, and each company was found to excel at some particular phase of implementation of their program.

The current interest in implementing partnerships information exchange, and technology transfer with the private sector prompted DP to continue to seek best practices in the area of pollution prevention through a second benchmarking endeavor in May 1994. This report presents the results of that effort. The decision was made to select host facilities that own processes similar to those at DOE plants and laboratories, that have programs that have been recognized on a local or national level, that have an interest in partnering with the Department on an information-sharing basis, and that are located in proximity to each other.

The DP benchmarking team assessed the pollution prevention programs of five companies in the Chicago area--GE Plastics, Navistar, Northrop Corporation, Sundstrand and Caterpillar. At all facilities visited, Ozone Depleting Compounds (ODCs), hazardous wastes, releases under the Superfund Amendments and Reauthorization Act (SARA), waste water and non-hazardous wastes are being eliminated, replaced, reduced, recycled and reused whenever practicable. Toxic Release Inventory (TRI) releases have been

reduced, pollution has been prevented, money has been saved and operations continue to improve.

Risk control, environmental laws, market factors, cost savings, corporate structure and individual personalities have all provided shape and momentum to the five host company pollution prevention programs. Corporate and facility resource allocation in response to these drivers is focused, dynamic and based on sound economics.

1.0 INTRODUCTION

As with most other U.S. industries, the Department of Energy's activities have promoted one of the most material-intensive economies in the world. According to the April, 1994 issue of the National Center for Manufacturing Sciences' newsletter, *Focus*, the U.S. extracts more than 10 tons of material annually per person from U.S. territories. The article states that, of the quantity of active materials extracted as food, fuel, forestry products, ores and non-metallics, only 6 percent becomes durable goods. The remaining 94 percent is turned into waste within months of extraction.

The mission of the DOE nuclear weapons complex has changed from producing weapons systems to the integration of existing and new technologies for the prevention and minimization of the wastes resulting from its past and present activities. The Department is still responsible for not only the nuclear weapons stockpile stewardship and maintenance but also the waste by-products from 50 years of weapons production. Of particular concern are the wastes from the dismantling of retired weapons systems, the disposition of excess Special Nuclear Material (SNM) and other legacy wastes, the cleanup and decommissioning of its facilities, and continuing operations based on energy efficiency and resource conservation.

Along with other Federal agencies, DOE is becoming aware of its roles and responsibilities in stewardship of the environment. Recognizing that its current, innovative approaches to pollution prevention are applicable to commercial industries, DOE is aggressively pursuing partnerships and the exchange of technical information with the private sector, academia, and other Federal agencies. DOE, committed to being an industry leader, wants to share the wealth of its research, development, expertise and experience in pollution prevention and would like to apply and benefit from the successful programs of private companies.

To meet these objectives, DOE set out to identify the best pollution prevention programs and practices being employed by manufacturers, laboratories, and other industrial entities that produce wastes similar to those produced by DOE. In 1988, DP became the first DOE office to adopt a waste minimization policy for all its operations. As such, it has become the Department leader in reconfiguring DOE's mission for the next century.

Benchmarking is a formal method of identifying the best pollution prevention programs and choosing and implementing the most effective practices. This document reports on a benchmarking study of five Chicago industries by a Defense Programs team. Its objectives are to promote pollution prevention, waste minimization, the conservation of natural resources and good environmental stewardship through the transfer of technologies between DOE and private industry.

Defense Programs already has in place many of the elements identified in previous benchmarking activities as necessary components of best-in-class pollution prevention programs. This potential has significance far beyond the hallways of DOE's pollution prevention program or DOE's facilities—it points the way toward a future harmony between industry and the natural order.

Section 1 of this report examines pollution prevention policy and strategies within DOE, including the DP pollution prevention program, with looks at the roles of the DOE Pollution Prevention Executive Board and particular challenges and barriers to pollution prevention.

Section 2 continues this discussion with an in-depth review of the methodology of the Chicago benchmarking as an analytical tool for improving DOE operations.

Section 3 describes how the DP benchmarking team, which included a representative from the DOE Pollution Prevention Executive Board, applied this tool to five private sector industries in the Chicago area to meet the study's objectives. Described throughout as the "host" companies, the companies interviewed for this study were GE Plastics' Ottawa Site; Caterpillar Incorporated's East Peoria Track-Type Tractor Facility; the Navistar International Transportation Corporation's Melrose Park Facility; Northrop-Grumman Corporation's Electronic Systems Division, Rolling Meadows Site; and the Sundstrand Corporation. The section concludes with a description of various successful methods employed by the companies at waste minimization and pollution prevention.

Section 4 is an examination of the benchmarking activity itself. It examines host company pollution prevention plans and programs, focusing on such effective developments in corporate policy as the establishment of management-level positions with significant environmental program administrative responsibility; corporate goal-setting; and the establishment of incentives and strategies for personnel involvement. The section assesses issues ranging from technology transfer to public and internal relations and product design. A subsection on funding—waste stream costing and normalization, the indexed accounting of waste generation to rates of product production—demonstrates the importance of considering technical feasibility, effectiveness and economic justification in implementing pollution prevention measures. For example, at all five host facilities, low-cost pollution prevention measures could be implemented from regularly budgeted

environmental funds. Section 4 then goes on to prompt consideration of the value of performing pollution prevention opportunity assessments and inventories, crucial steps in identifying and prioritizing pollution prevention opportunities at the host facilities.

Section 5 summarizes the results of the Chicago benchmarking study and draws some conclusions about how the practices and programs shared with the DP team can be applied to the broader objectives of the nuclear weapons complex and DOE's mission for a new century. For example, the characteristics of a best-in-class pollution prevention program that the DP team deemed most effective were establishing top managerial support; efficiently analyzed waste generation and waste management costs; periodic waste minimization assessments; a cost allocation system; technology transfers; and motivated staff, particularly within the context of corporate needs and workplace culture.

The appendix of *DP: Benchmarking In Chicago* itemizes the regulatory drivers and Departmental initiatives behind pollution prevention, including technology transfer, and includes biographical information on the benchmarking team members.

1.1 Pollution Prevention Policy and Strategies within DOE

Benchmarking the private sector is only one component of DOE's Department-wide attempt to integrate pollution prevention into every aspect of daily operations at its production facilities, laboratories and Headquarters. As a vital first step, DOE has shown its commitment to pollution prevention at the highest levels of its organization.

During Fiscal Year 1995 budget allocations, Secretary O'Leary said that "high priority should be placed on waste minimization and pollution prevention within the DOE. ... This is one area where, with a modest, relative investment now, we can significantly impact future cost to the Department for waste treatment, storage, and disposal." The Energy Secretary continued by saying "all DOE programs that are waste generators should have well-developed programs and request adequate resources consistent with the desire to make near-term investments for long-term savings."

O'Leary's statements, published in the *Internal Review of Budget Guidance*, are being supported through DOE's development of plans, programs and participation in Federal initiatives. For example, the DOE *Strategic Plan, Fueling a Competitive Economy*, issued April 1994, sets forth a vision that DOE will be a leader in the areas of energy resources, industrial competitiveness, science and technology, national security, and environmental quality. Implicit in the plan's approach is the ongoing effort and forethought required in employing natural and financial resources so less is wasted.

The *Strategic Plan* states that the Department must minimize and prevent pollution from its on-going activities in order to become a leader in preserving environmental quality.

Further, it stipulates that "the Department has an urgent need to embrace the best management practices to improve processes and customer satisfaction, prevent defects, and eliminate waste." The plan also indicates that DOE wants to be viewed as best-in-class in its management practices, ensuring that those management practices are the best exhibited by its best public and private sector counterparts. A key strategy in developing these practices is to use total quality management and DOE-wide benchmarking "to reengineer and integrate management practices for continuous improvement."

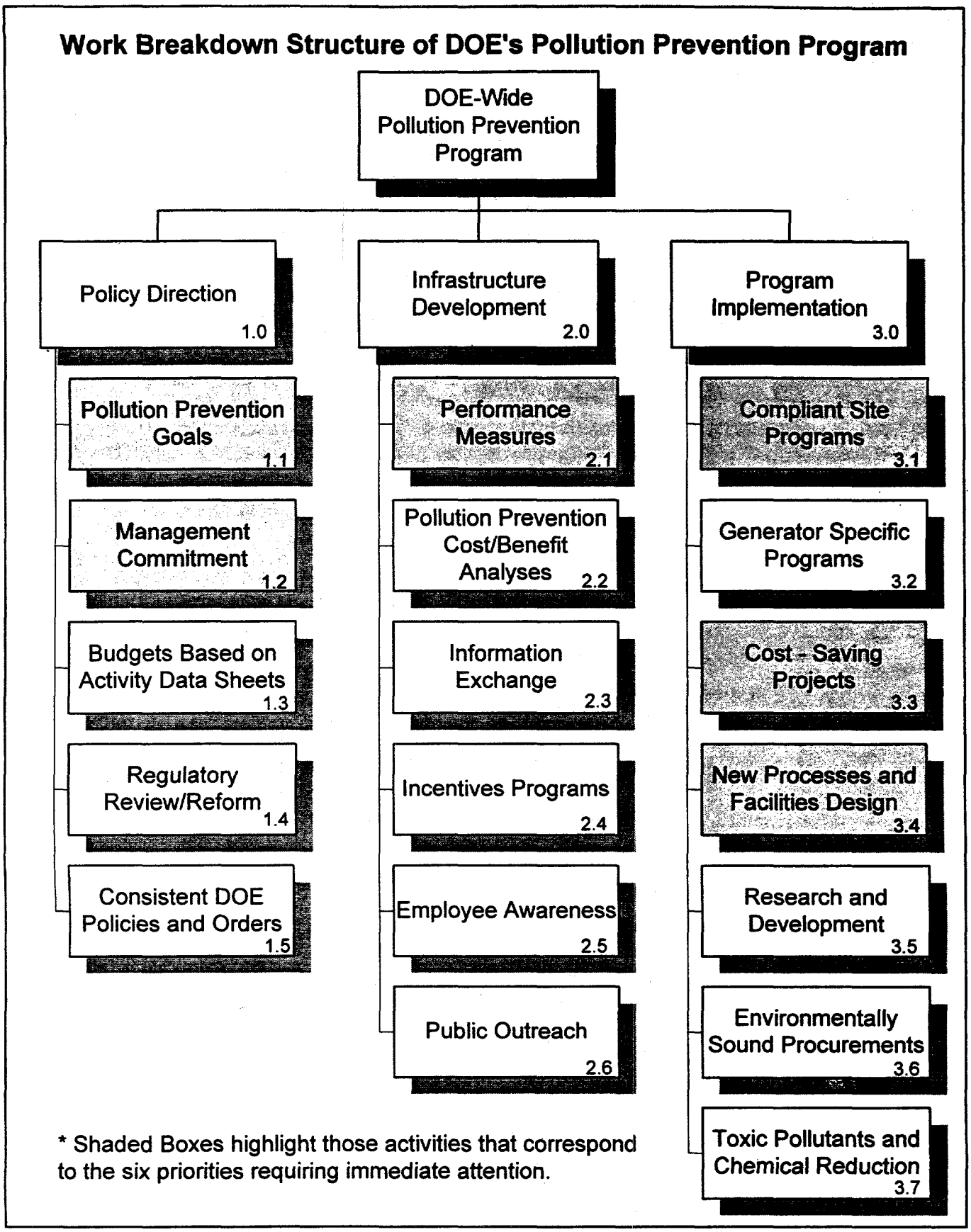
Along with the *Strategic Plan*, DOE's annually updated *Waste Minimization/Pollution Prevention Crosscut Plan* is a principal planning document for DOE's pollution prevention program. It is directed toward achieving the *Strategic Plan*'s core value to "respect the environment" by reducing or eliminating the generation of pollutants and waste at the source. The *Crosscut Plan* outlines specific roles and responsibilities for waste reduction within each office, listing several key activities to minimize waste and prevent pollution. It also commits DOE to halving its total releases of toxic chemicals by the end of 1999 and requires the establishment of site-specific waste reduction goals by then as well. The work breakdown structure of DOE's pollution prevention program as outlined in the (draft) 1995 *Crosscut Plan* is shown in Figure 1.1.

The DOE *Crosscut Plan* recognizes the Pollution Prevention Executive Board, comprised of senior managers from each CSO, as the primary responsible party for establishing policy and strategic direction for the Department's program.

1.2 Pollution Prevention Executive Board

In its overall objective to transfer to industry DOE technologies and expertise in pollution prevention, the Pollution Prevention Executive Board has three targets. It must identify 1) existing technologies within DOE that can be transferred immediately; 2) DOE's research and development activities and areas of scientific expertise that can assist industry in finding solutions to pollution prevention problems and 3) existing resources within DOE that can be shared with industry to help solve pollution prevention problems.

In meeting these objectives, the Board provides oversight for many Departmental pollution prevention programs. The Board is also in the position to approve the expenditure of funds for pollution prevention projects that have an estimated high return on investment (ROI). In April 1994, the Board approved a total of 20 ROI projects for three CSOs in DP, Energy Research (ER) and Environmental Management (EM). The total projected cost to implement the 1994 ROI projects was $2.8 million while the net annual savings was projected to be $7.4 million. In November 1995, 22 projects requesting $6.4 million with projected savings of $20.3 million annually, in which EM was


Work Breakdown Structure of DOE's Pollution Prevention Program
DOE-Wide Pollution Prevention Program
Policy Direction 1.0
Infrastructure Development 2.0
Program Implementation 3.0
Pollution Prevention Goals 1.1
Management Commitment 1.2
Budgets Based on Activity Data Sheets 1.3
Regulatory Review/Reform 1.4
Consistent DOE Policies and Orders 1.5
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Generator Specific Programs 3.2
Cost - Saving Projects 3.3
New Processes and Facilities Design 3.4
Research and Development 3.5
Environmentally Sound Procurements 3.6
Toxic Pollutants and Chemical Reduction 3.7
* Shaded Boxes highlight those activities that correspond to the six priorities requiring immediate attention.

Figure 1.1

the primary beneficiary, were recommended for funding by EM. Eight of the 22 projects requesting $1.5 million with annual savings of over $1.4 million were recommended for funding, in part, by DP.

In June 1994, another proposed DOE strategic program, the "Industries of the Future Initiative" (IFI) was presented by a cross-Departmental CSO group to the Pollution Prevention Executive Board. CSO representatives form a team promoting this initiative, with representatives from DP as well as the Offices of the Deputy Secretary; Energy Efficiency and Renewable Energy; Environmental Management; Energy Research; and Policy, Planning and Program Evaluation. IFI's mission is to "employ the resources of the DOE Complex in collaboration with the Industrial Sectors to develop and implement the basic and applied science of pollution prevention to improve DOE operations and to enhance the economic competitiveness of the U.S. Industrial Sectors." IFI facilitates partnerships among government agencies, the major industrial sectors, and other important stakeholders using the DOE complex as a test bed for collaborative activities.

The guiding principles behind the IFI are:

- regulation of whole facilities
- simultaneous protection of all media (soil, air, and water)
- integration of environmental and economic objectives through pollution prevention administrative flexibility
- promoting congruency among regulatory, fiscal and technology policies
- including all stakeholders in the process

IFI intends to start with a partnership oil industry called "Refineries of the Future," expanding later to similar programs in the chemical, aluminum, steel, pulp and paper, metal casting and glass industries.

The Board also sponsored the "Airlie House Initiative," which established pilot projects for waste streams and processes that overlap with industry at major DOE sites. DOE's Chicago Operations Office has the lead on this initiative that focuses the projects on microscale chemistry, vehicle maintenance, municipal refuse and recycling, and machining.

In 1991, implementing a memorandum of agreement between EM and DP, DOE initiated a formal waste minimization program for the minimization of wastes from activities associated with nuclear defense components and systems. A group of technologists known previously as the Waste Minimization Management Group (WMMG) concentrated on technical solutions to specific environmental problems and the transfer of those technologies to the private sector. This waste minimization technology developed around eight waste streams which included radioactive and toxic materials. Many of the accomplishments of this group are documented in the *Department of Energy Defense Programs Integrated Contractors Waste Minimization Program Accomplishments (Fiscal*

Years 1990, 1991 & 1992), a booklet that has become widely known as the "Return on Investment Document." The developments described briefly therein fall under the following general topic areas:

- sensors and process monitors
- recovery, recycle, and reuse
- novel unit processes
- systems analysis
- source or hazard reduction
- materials substitution
- automated systems
- engineering controls

The Waste Minimization Management Group is now being reorganized as the DOE Clean Technologies for Design and Manufacturing Group, with management and oversight provided by the Pollution Prevention Executive Board. The group's planning and implementation will be provided by a steering committee composed of representatives from major DOE offices, design laboratories, production plants and operations offices. There will also be an Industry Pollution Prevention Executive Advisory Board with representatives from small businesses and major industries to provide strategic direction. The Implementation Group will also include pollution prevention technology coordinators with expertise in these fields:

- pollution prevention training, awareness, and information
- special nuclear material (SNM)
- radioactive material (non-SNM)
- mixed waste
- energetic materials
- chemicals and metals
- products and manufacturing process design
- energy efficiency and conservation
- regulatory technology needs
- material procurement process

A recent pollution prevention project, spearheaded by DP and other Headquarters offices and in conjunction with the U.S. Environmental Protection Agency (EPA), helps publicize current and future trends in DOE's pollution prevention initiatives as well as promote the development of joint Federal/private alliances to address common pollution-related issues. This project is a videoconference series first broadcast in the summer of 1995 through the University of New Mexico's National Environmental Technology Network Waste-Management Education and Research Consortium (WERC). The program includes topics such as sustainable development, design for the future, opportunity assessments, total quality management, and other management tools and strategies. The program discusses

the availability, transferability, and usefulness of existing technologies with an emphasis on the applicability of established and innovative approaches to specific industries such as chemical manufacturers and users and refineries.

Additionally, DP sponsors biannual technology workshops which help participants benchmark the DOE sites' pollution prevention programs. The workshops also provide the opportunity to benchmark DOE's efforts against standards being set by pollution prevention experts in the private sector and in other Federal agencies.

1.3 Departmental Challenges and Barriers to Pollution Prevention

The Department's employees and contractors have noticed and commented on deficiencies or problem areas in DOE's pollution prevention program. One of their concerns was addressed in a May 1994 memo from then-Deputy Secretary of Energy Bill White to senior management of CSOs. The concern was that middle management at DOE field offices and contractor-operated sites were not getting the message regarding the importance of pollution prevention. Employees and contractors suggested that top management deliver the message to middle management and make effectiveness in implementing pollution prevention initiatives a measure of performance for management positions. An objective evaluation of DOE's pollution prevention programs highlighted other areas for improvement.

Office of Technology Assessment (OTA) Report, *Industry, Technology and the Environment-Competitive Challenges and Business Opportunities*, issued in November 1993, described three main factors limiting the effectiveness of the DOE waste minimization program. These were 1) a lack of cooperative involvement with industry consortia; 2) an emphasis on energy savings that may cause some highly toxic but low-volume waste to be overlooked; and 3) the lack of coordination between waste minimization programs in private industry and Federal weapons facilities.

OTA's report also commented on the high visibility of laboratory waste programs within DOE compared to the production facilities' waste reduction efforts.

In response to these and other concerns, the Department began conducting its own review of its pollution prevention program in 1993. The following year, the Office of Environmental Audit (EH-24) issued the *Draft Report of the Special Issue Review of Pollution Prevention Management Within DOE.*

This EH-24 assessment covered pollution prevention activities at the Headquarters level, at selected operations and site offices and within contracting organizations. The EH-24 assessment team looked at program strategies, infrastructure, management systems and implementation issues. The EH audit team found that many initiatives are in place to

develop and support a DOE pollution prevention program, but the team also discovered many challenges and barriers that remain to be addressed.

Additionally, the EH-24 assessment listed the following goals for DOE's pollution prevention program:

- Promote awareness and understanding of the potential benefits of pollution prevention.
- Encourage management commitment.
- Address organizational issues, such as coordinating all programs to meet DOE goals, bridging the gap between Waste Minimization Division development and line program implementation and strengthening the coordination between headquarters, operations offices and field sites.
- Develop financial incentives and disincentives.
- Establish pollution prevention funding priorities that focus on long-term benefits rather than short-term risks.
- Integrate pollution prevention into environmental restoration and decontamination and decommissioning activities.
- Provide technical assistance in methodologies, tools and techniques for pollution prevention implementation.
- Solve the problem of the moratorium on off-site shipment of waste.

On the positive side, the EH-24 team said that DOE Headquarters has in place a strategic plan and top level support for tackling these problem areas. The team distinguished, however, between top-level support and management commitment. The report noted that commitment means allocation of sufficient human and financial resources and the establishment of reporting and accounting systems.

The EH team also saw much variability in the implementation of pollution prevention programs at individual sites. Sometimes the success of a program depended on whether there was someone at the site to "champion" the cause of pollution prevention, the general level of awareness at a facility on ways to apply pollution prevention principles, and recognition of the benefits of pollution prevention. As a concept, pollution prevention was not well integrated into other environmental programs like water and air pollution control, remediation or National Environmental Policy Act of 1969 (NEPA), or into other business processes such as procurement, engineering and production.

The problem of decreased availability of funding for most CSOs in general has delayed or postponed indefinitely some pollution prevention efforts at the site level, according to the EH-24 *Draft Report*. Site successes have often been the result of strong grassroots efforts and low- to no-cost projects.

1.4 Office of Defense Programs Pollution Prevention Program

Defense Programs, in 1988, was the first DOE office to adopt a waste minimization policy. Although it now includes representatives from several CSOs and is chaired by an EM representative, the Waste Reduction Steering Committee (WRSC) was born of this policy, and was originally made up of representatives from various DP sites. This section describes the elements and status of the DP pollution prevention program as the DOE standard with which to compare the programs and strategies of the companies benchmarked for this report.

In April 1992, DP published the first version of its *Pollution Prevention Strategic Plan*. The current version describes ongoing DP projects and plans and outlines the objectives and strategies designed to address key, complex-wide pollution prevention issues. It is the basis of each DP site's implementation plan for pollution prevention. The key issues and objectives of the DP plan provide the framework for the benchmarking effort described in this report. The information gathered by the benchmarking team from the private sector supports DP sites in the development of their own pollution prevention programs.

The DP plan states that the mission of DP's pollution prevention program is to "address all forms of waste by developing and implementing cost-effective pollution prevention technologies, practices, and policies, in conjunction with partners in government and industry; and to conduct DP operations in a safe, compliant, and environmentally sound manner. DP is also committed to studying the methodologies and results of pollution prevention programs that are being implemented by other government agencies and private companies in order to "learn from the best."

Besides publishing the current *Strategic Plan*, DP in 1993 also issued the second edition of a guidance document for the performance of pollution prevention opportunity assessments. This version of the guidance incorporates a flexible approach to conducting the assessments, a direct response to the needs of DOE's diverse collection of manufacturing and research facilities. The latest version of the Pollution Prevention Opportunity Assessment Guidance document issued in December 1995 incorporates energy conservation area for analysis. Another document, *Prioritization of Pollution Prevention Options Using a Value Engineering Approach*, was also published in 1993 to provide the field with guidance in how to use limited funds for the greatest good in implementing pollution prevention opportunities. These documents provided the DP benchmarking team with a perspective that is readily recognized by companies operating under the economic laws that rule the private sector—"improve the bottom line!"

2.0 BENCHMARKING AS A TOOL FOR IMPROVING DOE OPERATIONS

The process of benchmarking includes identifying best practices—those that ensure effectiveness and superiority for a process owner—then evaluating the metrics of the superior practices and quantifying the effects of implementing those practices. The benchmarking team's goal is similar to the goal of general total quality environmental management, that is, to modify processes and products using these best practices in ways that improve environmental quality. According to *Benchmarking: The Primer*, a manual published by the Global Environmental Management Initiative, process improvement in an organization is generally motivated by these factors: 1) changing or emerging customer needs; 2) government regulatory requirements; 3) a shift in strategic direction; 4) newly recognized business problems and 5) dissatisfaction with current conditions.

These five elements motivating change all describe current trends within DOE. DOE's customers' and the Federal government's needs are changing from production of sophisticated weapons systems to cleaner products and technologies that support economically feasible, sustainable development. Environmental regulations are becoming more global in scope and are extending to cover all media (soil, air and water) and job functions (procurement, design, materials handling and waste disposal). Regulatory requirements now support a more focused approach to improving DOE processes as source reduction becomes the recognized guiding principle in pollution prevention.

Regulatory initiatives encourage or mandate the establishment of partnerships between Federal agencies and private industries for the purpose of addressing the environmental concerns of U.S. citizens. This shift in strategic direction for Federal agencies is indicated by the many new interagency technology transfer initiatives (See Appendix A). Among today's environmental challenges is the number of small businesses that cannot afford the refitting called for to comply with environmental regulatory requirements. Some of the Federal initiatives are designed specifically to assist small businesses in addressing issues of this sort.

Thus, there is regulatory motivation for the Department to seek "best practices" in industry approaches to pollution prevention and to incorporate them into its own operations, as well as disseminating them to other Federal agencies and the private sector. Benchmarking the private sector is the means to these ends.

2.1 Previous Efforts

Defense Programs' Environmental Support Group (DP-45) carefully monitors the pollution prevention-related successes of the private sector. In March 1993, the support group (then designated DP-64, Office of Production Facilities) published *Benchmarking the Private Sector*, DP's first study of the pollution prevention programs of two major

chemical industries, one metal fabricating plant, and a utility (ALCOA, Rohm & Haas Chemical Company, Imperial Chemical Industries, and Delmarva Power Company). The study demonstrated that certain elements seem to be essential to the planning and the implementation of a successful pollution prevention program. Some of the key program elements that were identified in DP's 1993 benchmarking report are listed in the November 1993 edition of the *Defense Programs Pollution Prevention Program Strategic Plan*, and are listed here as a reference:

- top-level management commitment, indicated by formal, written policy statements
- well-defined goals and objectives for all levels of activity, from administrative staff to line worker personnel
- open and effective communication, throughout the line organization, regarding all aspects of the pollution prevention program
- clear, concise guidelines and procedures for implementation of the established policy
- personal accountability and incentives for pollution prevention program development
- continued program support throughout both program planning and implementation phases
- extensive public relations campaigns to promote pollution prevention activities
- effective technology transfer between various corporate locations to avoid duplication of effort and to provide a catalyst for pollution prevention development

Another standard-setting pollution prevention benchmarking was conducted and reported by AT&T Bell Laboratory's QUEST Organization, a group that has developed extensive expertise in benchmarking private industries, for The Business Roundtable. The Business Roundtable study benchmarked six chemical manufacturers and their customers and identified both the common and unique elements of their successful, facility-level pollution prevention programs. The facilities the AT&T team identified as being "among the best-in-class" and selected for benchmarking were Proctor & Gamble, Intel, Du Pont, Monsanto, 3M, and Martin Marietta. DP has presented the results of the Business Roundtable report at its biannual technology workshops.

2.2 Current Benchmarking Efforts

Defense Programs is committed to benchmarking as a valuable total quality management tool. DP-45 management knows that it is imperative for DOE to track pollution prevention successes both in private industry and within the Department. The procedure used for setting up the benchmarking effort that is the subject of this report is similar to

the method used by AT&T's QUEST organization in the Business Roundtable benchmarking and closely follows the original approach used by DP in its earlier benchmarking activities.

3.0 HOST FACILITIES

Staffing at DP facilities ranges from around 1,000 to more than 24,000 employees. The facilities are operated by a variety of contractors with numerous organizational approaches for carrying out a broad spectrum of research, development and industrial activities associated with the development, manufacture, maintenance and dismantling of nuclear weapons. There are DP facilities in every EPA region, some within air quality nonattainment zones, some operating waste storage or treatment facilities, and others not.

All five host facilities for the Chicago benchmarking study fit a predetermined profile. Corporate headquarters, manufacturing and assembly host facilities were selected for to their eagerness to form partnerships for improvement and their track records in pollution prevention. The host facilities also have similarities to DP facilities in size, organization, processes, and compliance burden (See Sections 3.1-5).

Logistical concerns for the traveling benchmarking team also factored into the final selection of companies to benchmark. For example, Chicago was viewed favorably because its metropolitan area offered an enormous array of private industries within a convenient distance (Figure 3.1). EPA Region 5 Headquarters personnel offered guidance and direction on the selection of local leaders in pollution prevention. The Hazardous Waste Research and Information Center at the University of Illinois-Champagne provided support, including contact names and their telephone numbers. The DP team also explored existing professional relationships between DOE and local private-sector contacts. Screening potential host sites took the team approximately two weeks.

3.1 GE Plastics—Ottawa Site

"... We will continually focus on reducing the volume and associated concerns of generated wastes, by involving every Ottawa Site employee in idea-sharing exercises and action plans to Reduce, Reuse, and Recycle as appropriate...."

Peter R. Walker
Ottawa Site General Manager

Located in LaSalle County, Illinois, the GE Plastics Ottawa Site manufactures acrylonitrite butadiene styrene (ABS) thermoplastics resins and pellets. Thermoplastics are an important constituent of computer housings, automobile parts and components, and major household appliances.

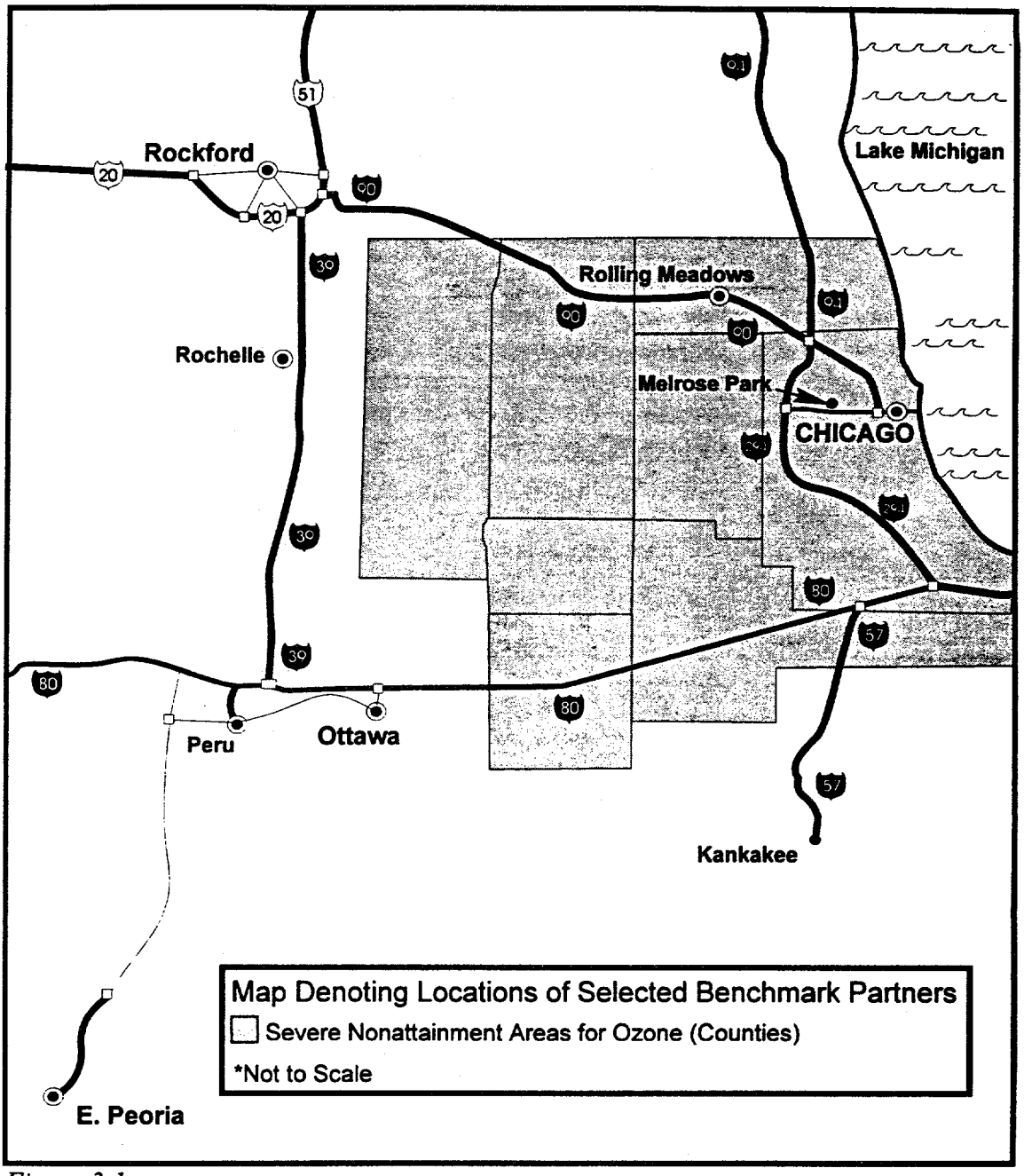

Rockford
Lake Michigan
Rolling Meadows
Rochelle
Melrose Park
CHICAGO
Peru
Ottawa
Kankakee
E. Peoria
Map Denoting Locations of Selected Benchmark Partners
Severe Nonattainment Areas for Ozone (Counties)
*Not to Scale

Figure 3.1

The site employs 410 people. With an annual production exceeding 300 million pounds, it is the world's largest manufacturer of ABS plastic. Energy costs the Ottawa site approximately $2.4 million annually.

Twice the recipient of the Illinois Governor's Pollution Prevention Award, the Ottawa Site is a pacesetter in GE's corporate environmental program. Particularly noteworthy are the site's air pollution prevention efforts. Product substitutions and process modifications have resulted in a 92 percent reduction in volatile organic compound (VOC) emissions measured against the baseline year 1987. Other Ottawa Site accomplishments include:

- solid waste reductions of 700,000 pounds per year
- reducing hazardous waste generation by 47,000 gallons via development of separation process

Nine facility-level professionals in environmental and health and safety disciplines at the Ottawa Site interact regularly with their counterparts at GE corporate headquarters, with state and regional environmental officials, and with local stakeholders. Compliance burdens at the facility include TRI reporting, 45 air permits, one permitted National Pollutant Discharge Elimination System (NPDES) outfall, nine Resource Conservation and Recovery Act (RCRA) satellite hazardous waste accumulation points and one RCRA 90-day hazardous waste accumulation area.

3.2 Caterpillar Incorporated—East Peoria Track-Type Tractor Facility

"...we will...develop and apply technologies and processes that prevent pollution and minimize all forms of waste, especially hazardous waste..."

Caterpillar Code of Worldwide Business Conduct and Operating Principles

One of the largest of all Caterpillar manufacturing facilities, the East Peoria Track-Type Tractor facility makes tractors, pipelayers, power shift transmissions and undercarriages. The facility began making tractors in 1925 and now is one of 45 Caterpillar plants worldwide. The East Peoria Track-Type Tractor plant is one of six Caterpillar facilities around Peoria, Illinois. Covering 607 acres with more than 7.5 million square feet under roof, it employs more than 5,000 people. The United Auto Workers and the United Plant Guard Workers of America are represented on-site.

Eight manufacturing commodity groups are housed in four separate building complexes within the East Peoria facility. Machining, fabrication, testing, and assembly of components, modules and fully functional tractors are in operation at East Peoria. Winner of the 1990 Illinois Governor's Pollution Prevention award and 1994 Certificate of Recognition for continuous improvement from the Governor's office, the East Peoria

facility reflects the site's and the company's commitment to pollution prevention with its achievements.

Significant accomplishments include:

- reducing ammonia emissions by more than 60 percent, based on the 1988 baseline
- eliminating 93 percent of chlorinated and fluorinated solvent usage

The East Peoria Facility has the equivalent of four full-time environmental staff members. Three standing environmental committees staffed on an as-needed basis by representatives from all major organizational units expedite all environmental programs on the site. Corporate oversight and the direction taken in environmental affairs come from a four-person Corporate Environmental Affairs staff. The environmental compliance burden on the East Peoria facility includes several air permits, TRI reporting, a permitted RCRA storage facility undergoing closure, an industrial waste water treatment facility with an NPDES outfall permit and a facility stormwater permit. All sanitary waste from the East Peoria Facility is channeled to the East Peoria public owned treatment works (POTW).

3.3 Navistar International Transportation Corporation—Melrose Park Facility

"...it is the policy of Navistar to ... exercise innovation in our manufacturing processes and our end products to minimize or prevent the generation of waste and the discharge of contaminants into the environment."

Navistar International Environmental Protection Policy and Management Program

Based in Chicago, Navistar International operates five facilities worldwide, including the Navistar International facility in Melrose Park, Illinois. The Melrose Park Engine Plant manufactures diesel engines for medium- and heavy-duty trucks and buses. It employs nearly 1,000 workers and has 2 million square feet under roof. There are three unions present: the United Auto Workers, the Teamsters and Stationary Engineers.

Strong adherents of total quality management (TQM), the Melrose operation is divided into seven business teams. Component machining and engine assembly and testing are performed daily, with an average production of about 200 engines per day.

Navistar's corporate GREEN (Get Reductions in Environmental Emissions at Navistar) program has produced highly competitive pollution prevention programs in all five of its plants. The Melrose Park facility won the 1992 Illinois Governor's Pollution Prevention Award and Navistar facilities in Ohio and Canada are serious contenders in their respective competitions. Other significant accomplishments at the Melrose Park facility include source reduction measures in 1991 that:

- eliminated Toxics Release Inventory (TRI) Form R reporting requirements
- reduced a 1.6 million pound/year sludge waste stream from grinding operations to approximately 600,000 pounds per year, without a negative impact on production

The Melrose Park facility has a three-person staff dedicated to environmental tasks. A Source Reduction Committee, staffed from all seven business teams, operates under the continuous improvement team concept and meets regularly to discuss pollution prevention issues. Corporate oversight and direction of pollution prevention activities is provided by a three-person Corporate Pollution Prevention Process Team. Environmental compliance burdens include numerous air permits, an NPDES stormwater discharge permit, SARA reporting, and RCRA hazardous waste accumulation point management. Navistar operates in the Chicago-Gary-Lake county severe non-attainment area for ozone.

3.4 Northrop-Grumman Corporation—Electronic Systems Division—Rolling Meadows Site

Northrop-Grumman Corporation manufactures electronic countermeasures equipment for military aircraft applications at its Rolling Meadows, Illinois site. More than 2,500 people are employed in design, development, production and repair functions for the AN-ALQ 135 radar-jamming system. Approximately 700 are "touch" employees, actually involved in production, assembly or testing. The remainder provide administrative, research-and-development and financial support.

Micro-integrated circuits (MIC) and printed wiring board (PWB) manufacturing, component assembly, product testing and other activities are compartmentalized for security within three buildings totaling over 1 million square feet. Employee access to security areas is based on level of security clearance and "need-to-know."

A voluntary member of EPA's Industrial Toxics Program, the Northrop Rolling Meadows site has achieved dramatic reductions in waste and emissions. Examples include:

- reducing hazardous waste generation by 93 percent, based on 1989 disposal data
- cutting back the use of ozone depleting compounds (ODCs) by 60 percent, an annual emission reduction of more than 50 tons
- elimination of a $900 K/year copper plating waste stream

Ten facility professionals in environmental, health, and safety disciplines coordinate and administer the Northrop corporate environmental plans and programs while performing their other duties.

The compliance burden at the Rolling Meadows site includes six air permits for 54 pieces of process equipment and a "bubble" permit regulating the entire facility, fully regulated RCRA hazardous waste generator status, SARA Title III reporting, and operation of one NPDES-permitted waste water treatment facility. Located within the boundaries of the Chicago-Gary-Lake County severe ozone non-attainment area, the Rolling Meadows site must also respond to an aggressive regional air-quality improvement program. For example, site environmental managers are currently formalizing a plan to increase their employee's average vehicle passenger occupancy, essentially eliminating the use of 452 employee-owned vehicles for transportation to and from work. Finally, a dynamic but aggressive Department of Defense (DoD) ODC phaseout campaign provides a very real set of constraints and timelines for ODC usage and phaseout in weapons system manufacturing.

3.5 Sundstrand Corporation

The Rockford, Illinois-based Sundstrand Corporation is a consortium of six business units dedicated to the development and production of proprietary, technology-based sub-systems and components. Sundstrand employs more than 12,500 at 33 manufacturing locations worldwide. Some facilities are unionized. Sundstrand is organized into two distinct business segments, the Industrial Group and the Aerospace Group.

Sundstrand's Aerospace's product array includes electric power generating systems, gas turbine engines, emergency and secondary power systems, and environmental control systems. Some 12 Aerospace Group facilities in the U.S. and overseas provide components and systems for a market that includes commercial airframe manufacturers and airlines; military aircraft; helicopters; business jets; missiles; and space and governmental agencies. Military sales constitute approximately 40 percent of Sundstrand Aerospace's market activities. The company carried out $50 million worth of contract research and development in 1993, work that it does principally for the Federal government.

Sundstrand's corporate commitment to waste minimization/pollution prevention is shown by these examples:

- With 1993 annual sales in excess of $1 billion, Sundstrand Aerospace spent approximately $2 million on waste disposal, most of which was non-hazardous. Aerospace's 1993 Annual Report states "the costs associated with environmental matters as they relate to day-to-day activities were not material and such costs for 1994 are not expected to be material."
- Only three out of 11 of Aerospace's stateside manufacturing facilities continues to report under TRI.

- Closure of all company-owned RCRA hazardous waste treatment, storage and disposal (TSD) facilities is either complete or ongoing.

Environmental staffing levels vary among Aerospace facilities according to the compliance burden, but all have at least one environmental, health and safety coordinator.

4.0 BENCHMARK PRACTICES

Even among the most successful programs, private industry approaches to pollution prevention vary tremendously. In general, all five host companies had processes, procedures, or plans in place that support pollution prevention objectives similar to those outlined in DP's Strategic Plan. The mechanics of these approaches are presented here as benchmark practices, which vary widely in their potential for transfer to Federal facilities. However, these benchmark practices make useful reference points for Federal environmental managers to compare elements of their programs. They should be equally useful as points-of-departure in the design, redesign, or implementation of facility, programmatic and Departmental pollution prevention programs.

Benchmark practices for this study were grouped into topic areas corresponding broadly to the key objectives outlined in the *Defense Programs Pollution Prevention Strategic Plan*. The major topic areas in which data was sought during the interviews were:

- pollution prevention plans and programs
- technology transfer and information exchange
- funding
- opportunity assessments and implementation
- pollution prevention in design, development and production
- public relations

For these broad topic areas, it was not feasible or even desirable to reach the same level of detail in each participant interview. Instead, the interviews were aimed at discovering the particular aspects of the hosts' pollution prevention programs that represent best practices in a given topic area. Information on corporate and facility-level successes was sought. In this way, by utilizing the composite results for all five facility studies, the team was able to identify the optimal characteristics of a superior pollution prevention program.

Some benchmark practices, by necessity, cross organizational boundaries. In these cases, this report provides sufficient background information to enable the reader to extrapolate the practices to comparable situations in any organization. Other benchmark practices reported by the DP team were stand-alone, site-specific, and well within broad guidance from higher level organizations. In these cases, no background information is provided.

Unique and particularly innovative benchmark practices observed by the benchmarking team as well as industry-standard approaches and trends in pollution prevention are discussed in Section 4. The chronological order of the site references does not indicate best-of-class within any particular industry. Rather, it provides a sampling of tools, techniques and management approaches that work in particular situations. Individuals involved in DP pollution prevention efforts can evaluate the relevance of the particular private industry approaches reported here and make comparisons with their own programs as appropriate. In some cases, existing DOE, DP, or facility-level approaches may already achieve results equivalent to or beyond the results discussed in the sections below. In other cases, adaptation of one or more of the reported benchmark practices to fit specific circumstances could make existing programs better.

4.1 Benchmarking the Chicago Host Companies—Methodology

The overall goal of the DP Chicago benchmarking study was to identify the essential elements of successful industrial pollution prevention programs' benchmark practices. In order to accomplish this, the benchmarking team obtained relevant data from each of the five host companies. Team members obtained data primarily through comprehensive interviews of key employees at each host company. To assure that the interviews were focused on salient issues related to effective pollution prevention programs, the team prepared and forwarded a questionnaire to the key personnel well before the site visit . This provided advance guidance to the host companies on the issues that the team would want to discuss at length during the on-site interviews.

All five plant interviews were conducted by three members of DP's technical support contractor's pollution prevention team directed and accompanied by John Marchetti, DOE-DP. The host companies assumed responsibility for identifying key individuals to represent them in the interviews. In all cases, the individuals interviewed were found to have major administrative responsibilities and knowledge about the plants' pollution prevention programs. Typically, the interviewees included a plant-level manager of environmental affairs and one or more additional personnel with experience in the implementation of pollution prevention programs and specific pollution prevention measures at the plant level.

The format of the on-site interviews was free-flowing, with the interview team guiding the discussions to key issues identified in the questionnaire. Lines of discussion initiated by company hosts were often pursued at length. This approach was found to be particularly useful in elucidating the key features of program success as seen from the perspectives of key personnel.

The duration of interviews varied from three to four hours. During the interviews, the host companies distributed selected materials illustrating characteristics of their successful

pollution prevention efforts to the interview team members. The team later reviewed these documents to obtain information on the various topic areas discussed below. In three cases--Navistar, Northrop and Caterpillar--the host company allotted time for a brief tour of its facilities so the team could inspect selected plant operations where there had been pollution prevention successes.

4.2 Host Company Pollution Prevention Plans and Programs

In the corporate setting, pollution prevention is often part of the broader issue of environmental management. Pollution prevention on the corporate level may be managed by health and safety officers, facility engineers, senior managers, union officials, process specialists, chemical and environmental engineers, and/or certified hazardous materials managers or other program champions . Often, environmental management is administratively coupled with other areas, especially industrial hygiene and safety. That pollution prevention is directly related to the type of risk management generally associated in private industry with industrial hygiene and safety is evidenced by the titles of two host company interviewees--Manager of Environmental Health (GE) and Director of Environmental, Health and Safety (Sundstrand). In general, however, private industry has begun to recognize the importance of environmental issues as a discrete administrative realm. This is reflected in the titles of the other host company interviewees, such as Manager of Environmental Affairs (Caterpillar), Environmental Control Manager (Navistar) and Director of Environmental Protection (Northrop).

For each host company, pollution prevention was a multi-media program. In each, a growing concern with environmental issues led to the establishment of organizational entities that have the specific responsibility for developing and achieving the companies' goals. At some host companies, outdated waste minimization terminology persists in these organizations; in others, it has been augmented with TQM terms and practices. The level of program development differs among the host companies. Most managers claim that the most easily attained goals, the so-called "low-hanging fruit," have been reached. Likewise, early RCRA (waste reduction) successes are followed by sucesses in reducing air and water emissions but at a higher cost and involving more planning.

Although there are significant variations from company to company, host facilities' environmental programs typically evolved over a period of several years. During this period of evolution, environmental issues were given increasingly more attention and visibility, upper management personnel became involved often with the setting of corporate-level environmental goals, formal action plans were developed, incentives for the involvement of workers were established and plans were implemented that mandated continuous improvement. Examples of these evolving environmental program components are described in the following sections.

4.2.1 Development of corporate policy

All five of the interviewed companies have developed a written corporate environmental policy statement. For example, Navistar's corporate environmental protection policy, originally drafted in 1988, is published and distributed to environmental managers as part of their *Environmental Policies and Procedures Manual,* which contains 18 specific procedures. This policy statement, shown in Figure 4.1, is issued by Navistar's Chief Executive Officer and outlines Navistar's corporate environmental policy and management approach.

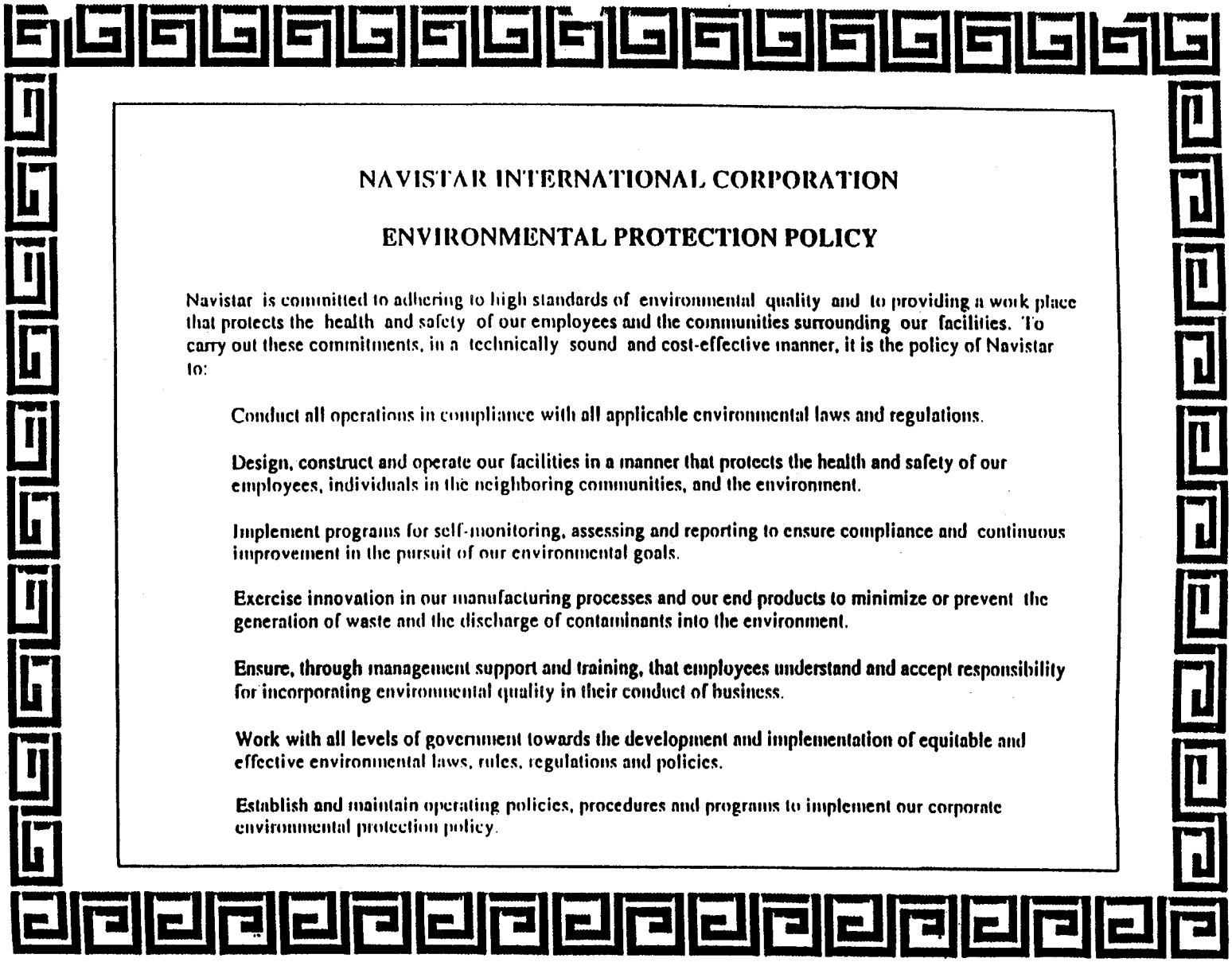
The environmental management policy at Navistar is linked at the facility level to a comprehensive business plan through common key result areas (KRAs). KRAs are the major elements of the Navistar environmental management program. A 2-year business plan established objectives, goals and action plans for seven of these areas: (1) environmental organization, (2) public policy, (3) compliance, (4) pollution prevention, (5) products, (6) risk reduction, and (7) environmental planning and resources.

Figure 4.2 summarizes Navistar's Melrose Park 1994-1996 Environmental Business Plan, which addresses 5-year capital and operating costs and action plans, including the seven KRAs.

KRAs at all major Navistar facilities are audited internally once a year and externally every three years. Internal audits make large use of checklists; action plans to resolve findings are submitted to corporate headquarters within 30 days. Findings are reviewed annually by the CEO.

4.2.2 Corporate goal-setting

As an example of corporate goal-setting, the CEO of Northrop said his company has a goal of zero discharge by the year 2000. Additionally, the *Northrop Environmental Management Manual* includes the written goals of a 90 percent reduction in hazardous waste generation and reportable releases of TRI chemicals by Dec. 31, 1996. GE Plastics has a corporate mandate to achieve a 50 percent reduction in waste disposal costs per pound of product by 1996. Similarly, Navistar has published 1996 waste generation reduction goals of 35 percent in hazardous waste, 20 percent in non-hazardous waste and 30 percent in toxic emissions. While such goal-setting is not uncommon and can be useful as an upper management-generated incentive to pollution prevention, specification of percentage goals, as Caterpillar indicated, may meet resistance. Numerical goals must be set carefully. At the division level, there is often resistance due to cost concerns and technical difficulties in achieving the set goals. This is especially true when new pollution prevention measures must be funded from the existing operational level budget. At Sundstrand, if and when numerical targets are achieved, there is the question of what the next pollution prevention objectives should be.



NAVISTAR INTERNATIONAL CORPORATION

ENVIRONMENTAL PROTECTION POLICY

Navistar is committed to adhering to high standards of environmental quality and to providing a work place that protects the health and safety of our employees and the communities surrounding our facilities. To carry out these commitments, in a technically sound and cost-effective manner, it is the policy of Navistar to:

Conduct all operations in compliance with all applicable environmental laws and regulations.

Design, construct and operate our facilities in a manner that protects the health and safety of our employees, individuals in the neighboring communities, and the environment.

Implement programs for self-monitoring, assessing and reporting to ensure compliance and continuous improvement in the pursuit of our environmental goals.

Exercise innovation in our manufacturing processes and our end products to minimize or prevent the generation of waste and the discharge of contaminants into the environment.

Ensure, through management support and training, that employees understand and accept responsibility for incorporating environmental quality in their conduct of business.

Work with all levels of government towards the development and implementation of equitable and effective environmental laws, rules, regulations and policies.

Establish and maintain operating policies, procedures and programs to implement our corporate environmental protection policy.

Figure 4.1

Figure 4.2

1995 - 1997 Navistar Environmental Business Plan, Melrose Park Plant

External Analysis

- Regulatory Requirements
- Financial Liabilities
- Environmental Groups
- Neighbors

Internal Analysis

- Env. Commitment
- Env. Policy & Procedures
- Professional Env. Staff
- Env. Integration

Mission

Navistar Environmental Protection Policy

KRAs

Key Result Areas are the major elements of the Navistar Environmental Management Program

Key Issues

- Enforcement
- Superfund
- SARA Title III
- Cost Control

Environmental Expenditures

($ 000)

	1995	1996	1997	Total
Capital and Non-Capital	804	196	925	1925
Operating Cost	411	394	396	1201
Total	1215	590	1321	3126

KRA 1 Environmental Organization

Objectives

1. Regulations monitored & complied with
2. Melrose Park management (M.P. & Corp.) informed

Goals

1. Review & summarize Env. regulations
2. Audit facilities
3. Annual status report & report to Board of Directors

Action Plans

1. Regulations Tracking
2. Audit Process
3. Pollution Prevention

KRA 2 Public Policy

Objectives

1. Minimize Emissions
2. Provide chemical exposure information

Goals

1. Identify emissions
2. Contain and clean up spills
3. Update MSDS files

Action Plans

1. Inventory all emissions
2. Prepare SPCC plan
3. Keep current all MSDS books

KRA 3 Compliance

Objectives

1. Meet all regulatory requirements
2. Resolve any N.O.V.'s

Goals

1. Understand and Comply with all regulatory requirements
2. Reduce VOC

Action Plans

1. Identify all environmental requirements
2. Renew air permit

KRA 4 Pollution Prevention

Objectives

1. Reduce volume and toxicity of wastes
2. Reduce disposal costs and liabilities

Goals

1. Develop pollution prevention programs
2. 25% reduction by 1994 and 50 % by 2000

Action Plans

1. Implement pollution prevention programs
2. Identify all Navistar waste handlers & disposal sites
3. Dispose of all wastes safely & responsibly
4. Reduce costs

KRA 5 Products

Objectives

1. Support development of N.G.D. products
2. Utilize energy efficient equipment and processes

Goals

1. Communicate with product development group
2. Change to energy efficient design and equipment
3. Smokeless Diesel Engine

Action Plans

1. Understand our products
2. Conduct energy studies
3. N.G.D. - Gov. Award

KRA 6 Risk Reduction

Objectives

1. Reduce environmental risks
2. Reduce liabilities in property transactions
3. Manage Superfund issues

Goals

1. AST compliance
2. Manage PCB & asbestos
3. Conduct environmental assessment
4. Minimize Superfund liabilities

Action Plans

1. Inspect & maintain AST
2. Annual review of PCB & asbestos

KRA 7 Environmental Planning & Resources

Objectives

1. Conduct environmental business planning
2. Environmental training

Goals

1. Identify environmental budget
2. Identify training needs

Action Plans

1. Monitor environmental expenditures monthly
2. Identify training attended
3. Develop training plan

4.2.3 Establishment of incentives

At the corporate level, there is a desire to widely publicize environmental successes. Facility and plant environmental managers value rewards related to documented success in pollution prevention. Making the public aware of these successes is an incentive for both corporate and facility management. Particularly noteworthy vehicles for public recognition are the state and governor's awards for outstanding success in environmental achievement. In Illinois, Navistar won such an award in 1992, as did GE Plastics the following year.

At Sundstrand, management support is sought by environmental staff by the use of data which demonstrates that, in many cases, pollution prevention is a good way to achieve substantial monetary savings for relatively little expenditure. In the Sundstrand Environmental Steering Committee, consideration has been given to the establishment of employee rewards for good pollution prevention work. Even though Sundstrand's corporate culture precludes monetary awards, visiting company executives make a point of complimenting good work by plant employees. Good work is also publicized internally through articles on pollution prevention successes in company newsletters at Sundstrand and Navistar.

Plant recycling programs are used at many plants to build environmental awareness and get individuals involved in pollution prevention. For example, at GE Plastics, a recycling center built from recycled plastic was placed where employees could deposit aluminum, glass, paper and cardboard for recycling. Northrop reported that employee recycling of paper, scrap metal, and wooden pallets raised $50,000 a year for charitable donations. Caterpillar established a similar on-site program for recycling metal scrap, wood, cardboard and plastic.

Incentives may even be attached to environmental compliance. Environmental team members may be rewarded at GE Plastics if, within a specified time period, there are no violations of regulations and if there are reductions in releases of SARA chemicals.

4.2.4 Strategies for personnel involvement

At the corporate and plant management levels, awareness of environmental risk and potential liability and the true cost of environmental law compliance is usually sufficient to guarantee substantial commitment to pollution prevention programs. But below the level of top management, committees are needed to guarantee wide employee involvement and to specify meaningful action plans. As pointed out by Navistar, it helps to get key individuals involved if a confrontational situation might arise. Caterpillar's experience is that several members from each of the operating units must buy into the on-site pollution prevention groups. GE Plastics has a cross-section of plant workers, particularly hourly

personnel, on its Green Teams to maximize involvement at the plant floor level. GE offers dinners to employees in exchange for presentations of pollution prevention best practices.

4.2.5 Response to Regulations

Northrop Corporation cites pollution prevention as the most effective response to increasingly stringent regulatory challenges and increasing public concerns. Stability of the business climate, cost avoidance, risk reduction and corporate image are other pollution prevention drivers identified in the *Northrop Environmental Management Manual*. Existing corporate reduction goals are structured to minimize the compliance burdens found under RCRA for hazardous waste and SARA Title III for reportable releases.

As pointed out by GE Plastics, the public reporting of TRI releases embarrassed U.S. industry and brought to the attention of upper management the importance of good environmental citizenship. Also, as related by Sundstrand, since at least the time of the establishment of requirements for SARA reporting, corporate environmental policy was expanded beyond current compliance with environmental law to include the control of future liability--risk control--and the enhancement of public image which, if distinctly negative, could have notable adverse affects on business activities. Northrop related that its environmental program is based primarily on risk assessment. All of the interviewed companies confirmed that during the late 1980s, most had established corporate-level responsibility for environmental issues.

Regulation of ODCs in particular has been recognized by the host companies as a threat to business stability. For example, Northrop's goal of process ODC phase-out by 1994 reflected market uncertainties, potential supply interruptions and dynamic customer and regulatory climates. Northrop set further goals to reduce chemical releases under the EPA's Industrial Toxics Program.

Northrop's Rolling Meadows Site has met or exceeded existing corporate goals; hence, facility-level drivers for pollution prevention are slightly different. Local CAA compliance and short- and long-term employee risk reduction are the primary motivational forces. For example, by taking steps to reach a self-imposed VOC reduction goal, the Rolling Meadows site could be classified as a minor source within the metropolitan Chicago non-attainment zone. Such a status change would significantly reduce their CAA compliance burden and reduce worker exposure to potentially harmful substances.

At Sundstrand, reductions in long-term liability under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), operating costs, and compliance burden drive Sundstrand's commitment to pollution prevention. Projects which may achieve reductions in any of these areas stand a very reasonable chance of funding, implementation and transfer.

As laws have changed and despite a long term policy of full compliance, Sundstrand has been identified as a potentially responsible party (PRP) at 25 Superfund sites, 23 of which will likely be resolved on a *de minimis* basis. Three other sites currently under active investigation or remediation offer hard data for managers to evaluate during cost avoidance scenarios. As a result, pollution prevention efforts that offer a significant reduction in future risk can successfully compete against capital expenditures that have a greater ROI. Through avoided management and disposal costs, ROI is calculated along with less tangible cost/benefits of compliance burden reduction. Pollution prevention opportunities that offer immediate or timely payback or that offer a quantum decrease in regulation stand the greatest chance of being funded.

4.2.6 Corporate and Management Commitment

For organizational pollution prevention efforts to receive continuing attention and necessary financial support, there must be a clear relationship between the individuals who are responsible for pollution prevention and all operational units. The level of corporate commitment to pollution prevention often is reflected directly in the placement of environmental program administration in the corporate organizational chart. At each of the interviewed plants, the DP team learned that the oversight of environmental programs includes both corporate- and plant-level management. For example, Caterpillar has established the position of Manager of Corporate Environmental Affairs, who reports through one superior to a group vice president. At the plant visited, Caterpillar has also appointed a Plant Environmental Coordinator. This position supervises a 50-percent level effort for pollution prevention of a staff of eight, including a full-time engineer for hazardous waste management.

Similarly, Sundstrand has established the position of Director of Environmental Health and Safety (EH&S), who reports to a divisional chief operating officer and administers both day-to-day and strategic environmental affairs. Under the EH&S Director, a four-person corporate staff coordinates safety and environmental compliance and restoration activities among all corporate facilities. Facility environmental staffs are used as resources according to site-specific needs.

Sundstrand's Aerospace Environmental Committee is the key corporate pollution prevention organization. Chaired by the Vice President of Manufacturing, this steering committee provides vision, momentum and resources for Sundstrand's pollution prevention efforts. Membership includes corporate directors of EH&S, manufacturing, facilities, assembly and testing, the comptroller and a legal representative. The committee meets approximately four times per year.

Two standing Sundstrand organizations, the Environmental Impact Team and the Waste Minimization Committee, provide facility and process level pollution prevention support. The Environmental Impact Team consists of nine people, and is charged with "design for

the environment" research for new products. Waste Minimization Committee membership includes all facility representatives and provides leadership and staffing for *ad hoc* pollution prevention efforts. Seventeen subcommittees are currently pursuing, implementing or managing facility-specific and corporate-wide initiatives. Sundstrand's corporate facility environmental organization and its aerospace environmental committee are depicted in Figures 4.3 and 4.4.

At Northrop, the Corporate Vice President and Chief Human Resources and Administrative Officer serves as the company's chief environmental officer. He chairs the Executive Environmental Council (EEC), and in conjunction with the Corporate Office of Environmental Management, initiates action and provides direction to company operating elements for the achievement of corporate pollution prevention goals.

The Northrop EEC meets annually or on an as-needed basis, generally limiting its meetings to members only. Established to foster environmental stewardship and preventive environmental management practices, the council evaluates environmental strategies, reviews the business implications of environmental requirements, shares information, and develops recommendations for management consideration. The Corporate Office of Environmental Management establishes corporate pollution prevention goals, monitors site progress towards achievement of those goals, and provides funding for all environmental activities including pollution prevention.

At the Northrop Rolling Meadows Site, environmental efforts are administered by the Senior Director of Human Resources. The Director of the Office of Environmental, Health and Safety Management and his staff of 10 professionals provide programmatic and daily management of all EH&S efforts at the site. The director estimates that approximately 50 percent of his time is spent on environmental issues. Of that amount, roughly 75 percent is spent on pollution prevention and the remainder on compliance. A site EH&S Committee consisting of nine standing subcommittees and an *ad hoc* pollution prevention subcommittee meet monthly in support of both corporate and site-specific environmental programs.

Work-area and process-level pollution prevention activities are the responsibility of the Rolling Meadows Pollution Prevention Subcommittee. This committee consists of appointed members from engineering, procurement, operations, quality, product support, environmental health and safety, and facilities, and is charged with the systematic review of all site areas and processes. Funded by the EH&S Committee and augmented by work area and process specialists as necessary, this subcommittee seeks to identify suitable target processes and chemicals for pollution prevention initiatives, and to develop recommended approaches. Northrop's corporate organization and the organization chart for the Electronic Systems Division/Rolling Meadows Site appear in Figures 4.5 and 4.6.

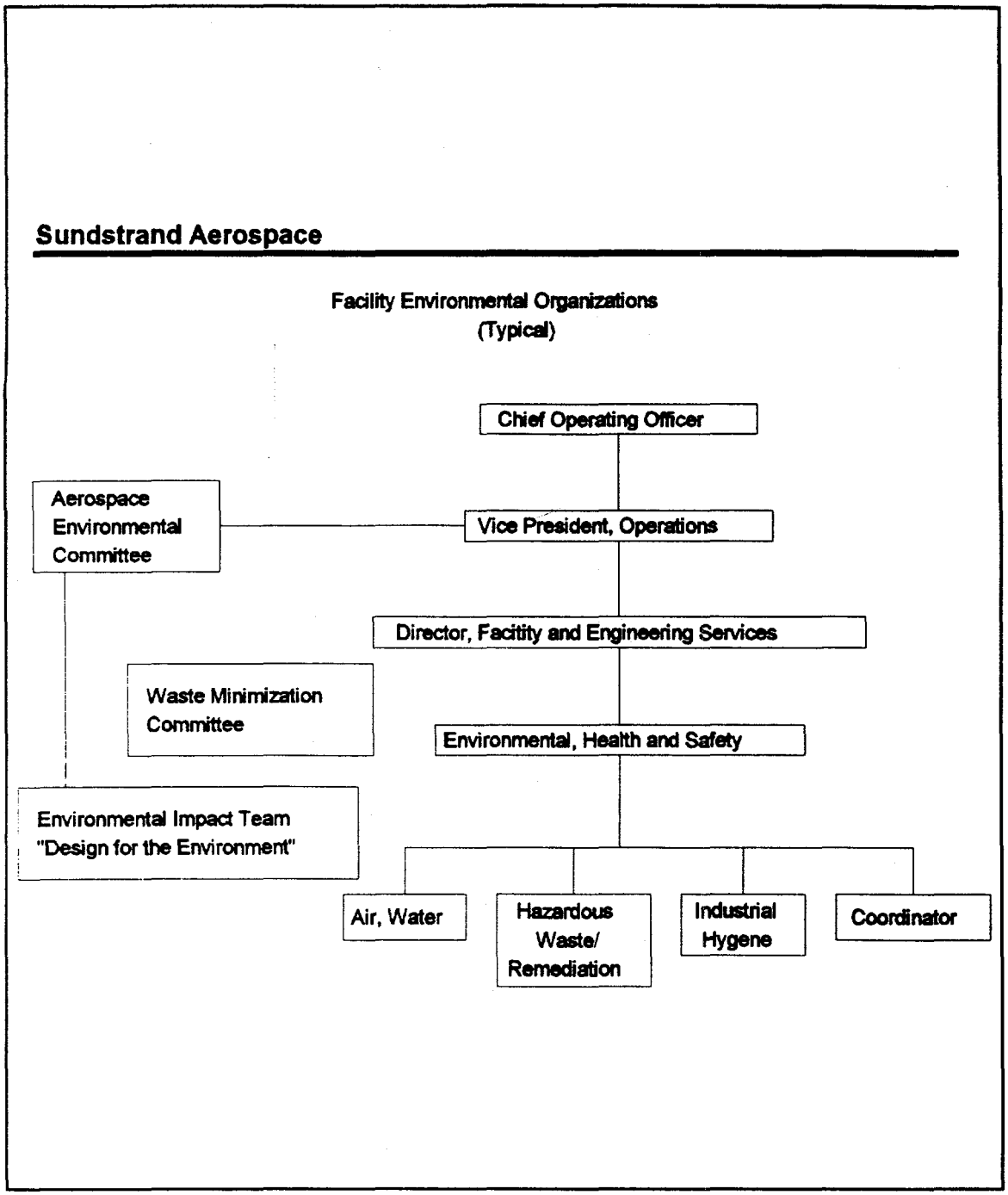

Sundstrand Aerospace
Facility Environmental Organizations
(Typical)
Chief Operating Officer
Aerospace Environmental Committee
Vice President, Operations
Director, Facility and Engineering Services
Waste Minimization Committee
Environmental, Health and Safety
Environmental Impact Team "Design for the Environment"
Air, Water
Hazardous Waste/ Remediation
Industrial Hygene
Coordinator

Figure 4.3

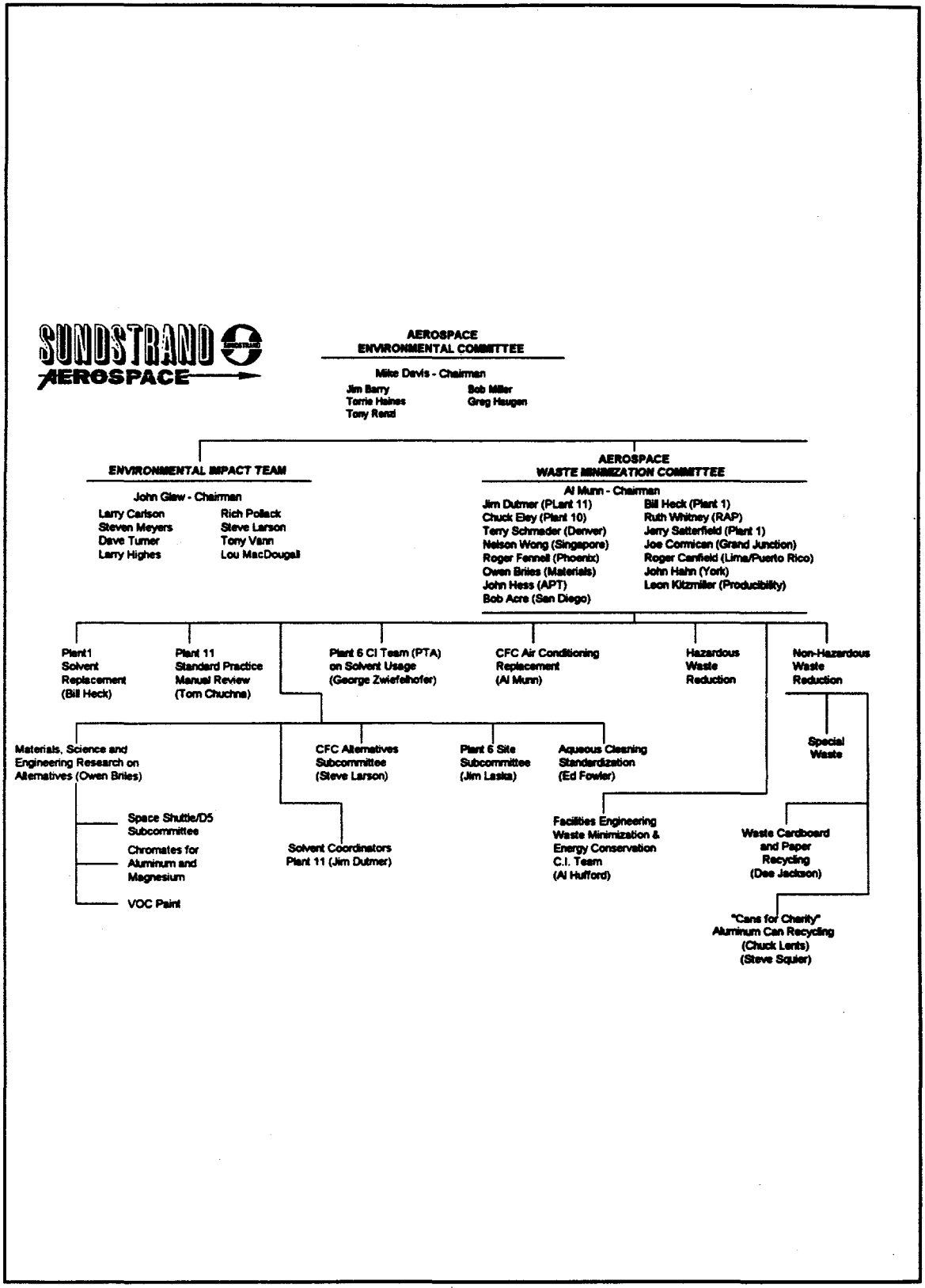

SUNDSTRAND AEROSPACE
AEROSPACE ENVIRONMENTAL COMMITTEE
Mike Davis - Chairman
Jim Barry
Torrie Haines
Tony Renzi
Bob Miller
Greg Haugen
ENVIRONMENTAL IMPACT TEAM
John Glaw - Chairman
Larry Carlson
Steven Meyers
Dave Turner
Larry Highes
Rich Pollack
Steve Larson
Tony Vann
Lou MacDougall
AEROSPACE WASTE MINIMIZATION COMMITTEE
Al Munn - Chairman
Jim Dutmer (PLant 11)
Chuck Eley (Plant 10)
Terry Schmader (Denver)
Nelson Wong (Singapore)
Roger Fennell (Phoenix)
Owen Briles (Materials)
John Hess (APT)
Bob Acre (San Diego)
Bill Heck (Plant 1)
Ruth Whitney (RAP)
Jerry Satterfield (Plant 1)
Joe Cormican (Grand Junction)
Roger Canfield (Lima/Puerto Rico)
John Hahn (York)
Leon Kitzmiller (Producibility)
Plant1 Solvent Replacement (Bill Heck)
Plant 11 Standard Practice Manual Review (Tom Chuchna)
Plant 6 CI Team (PTA) on Solvent Usage (George Zwiefelhofer)
CFC Air Conditioning Replacement (Al Munn)
Hazardous Waste Reduction
Non-Hazardous Waste Reduction
Materials, Science and Engineering Research on Alternatives (Owen Briles)
CFC Alternatives Subcommittee (Steve Larson)
Plant 6 Site Subcommittee (Jim Laska)
Aqueous Cleaning Standardization (Ed Fowler)
Special Waste
Space Shuttle/D5 Subcommittee
Chromates for Aluminum and Magnesium
VOC Paint
Solvent Coordinators Plant 11 (Jim Dutmer)
Facilities Engineering Waste Minimization & Energy Conservation C.I. Team (Al Hufford)
Waste Cardboard and Paper Recycling (Dee Jackson)
"Cans for Charity" Aluminum Can Recycling (Chuck Lents) (Steve Squier)

Figure 4.4

Northrop Corporation

Roles	Responsibilities
Chairman, President, and Chief Executive Officer	• Establishes corporate policy and vision • Defines and assigns management responsibilities
Corporate Vice-President and Chief Human Resources and Administrative Officer	• Chairs Execute Environmental Council • Approves changes and additions to environmental corporate policy
Corporate Director, Environmental Management Office	• Develops, coordinates and administers corporate wide environmental management programs and polices • Establishes corporate pollution prevention goals • Monitors facility progress towards pollution prevention goal achievement
ESD-Rolling Meadows Site, Director, Environmental, Health and Safety Management	• Implements P^2 program methodologies designed to meet or exceed corporate P^2 goals • Develops and implements P^2 strategies to address facility-specific environmental concerns not addressed at the corporate level • Chairs Environmental Health & Safety Committee • Funds all waste disposal activities
Environmental Health and Safety Committee	• Provides technical assistance to P^2 subcommittee • Provides funding for P^2 subcommittee • Coordinates activities of nine operational subcommittees • Approval authority for P^2 subcommittee recommendations • Provides awareness training
Pollution Prevention Subcommittee	• Plans, schedules and coordinates systematic reviews of all work areas • Conducts work area and process reviews of all areas and processes in conjunction with area managers and supervisors • Identifies target processes and chemicals for pollution prevention activities • Develops and reports pollution prevention recommendations
Area Managers	• Review, plan and implement process and procedural changes in response to P^2 subcommittee recommendations • Provide temporary member to P^2 subcommittee during work area and process reviews • Track and report pollution prevention progress made on targeted processes and chemicals
Employees	• Make pollution prevention recommendations either through management or the employee suggestion program

Figure 4.5

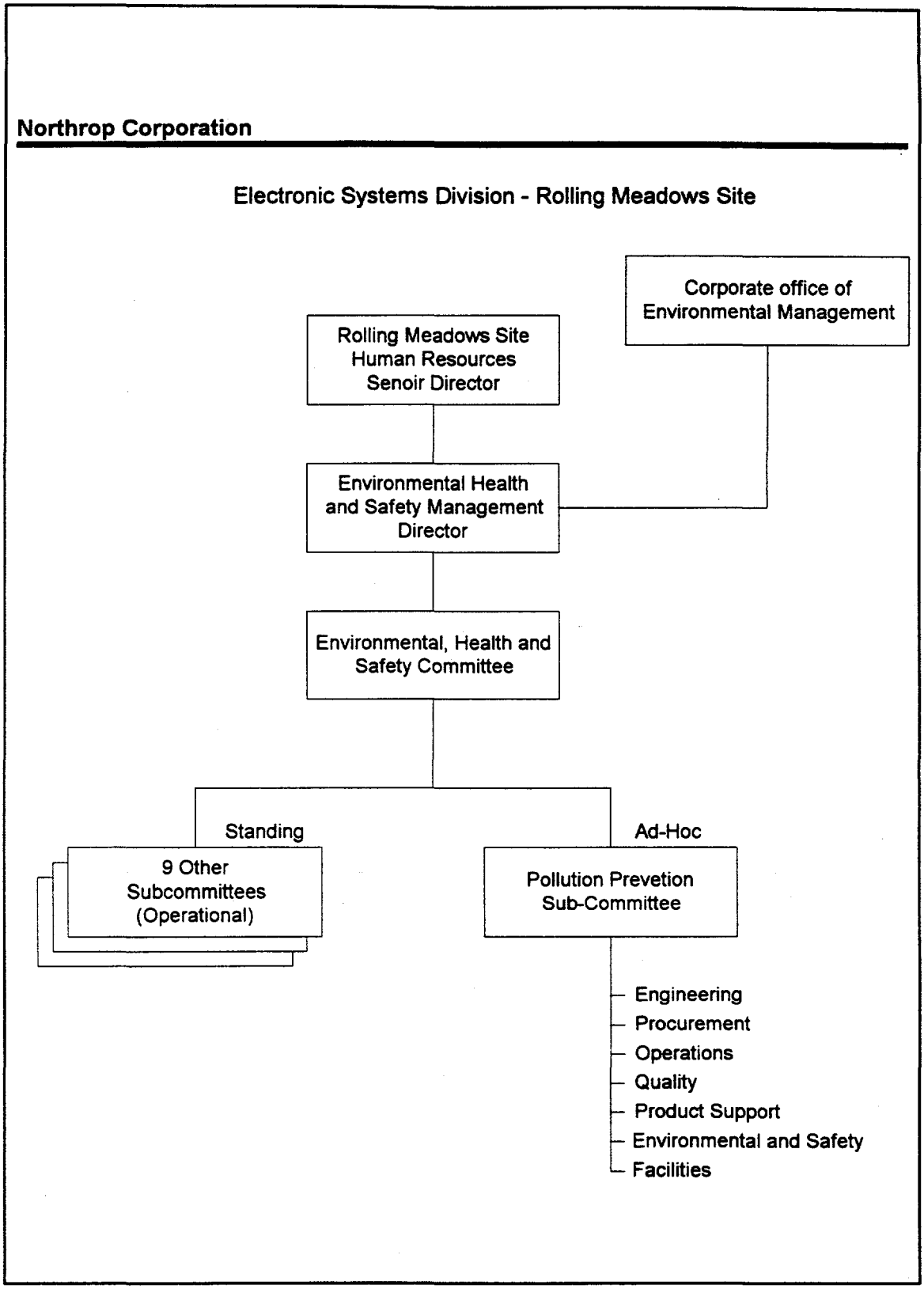

Northrop Corporation
Electronic Systems Division - Rolling Meadows Site
Corporate office of Environmental Management
Rolling Meadows Site Human Resources Senoir Director
Environmental Health and Safety Management Director
Environmental, Health and Safety Committee
Standing
Ad-Hoc
9 Other Subcommittees (Operational)
Pollution Prevetion Sub-Committee
Engineering
Procurement
Operations
Quality
Product Support
Environmental and Safety
Facilities

Figure 4.6

Another characteristic of all successful programs at the observed plants was that pollution prevention was most effectively implemented when committees were established that included not only pollution prevention managers but also a wide variety of other employees, ranging from technical experts—scientists and engineers—to floor workers. At GE Plastics, for example, the Manager of Environment and Health attends weekly staff meetings at which the plant's general manager is present. These regular meetings allow pollution prevention issues to be raised and discussed in the context of other plant-level issues of importance. Caterpillar has established several interrelated committees which deal with current environmental issues. In 1988, an Environmental Steering Committee was established which includes the site general manager, the department heads of technical, human and business resources, and representatives from individual site management, chemical engineering, environmental coordination and specific production groups. This primary environmental committee meets monthly to define environmental policy and action plans. In addition, in 1992, Caterpillar established Environmental Compliance and Environmental Impact Committees. In all of the surveyed organizations, regular committee meetings concerned solely with environmental issues or providing a forum for discussion of environmental issues greatly enhances the vitality of pollution prevention programs.

All of the host facilities' environmental managers were knowledgeable in plant manufacturing operations and environmental issues. Their ability to formulate acceptable programs related to the level of knowledge of manufacturing processes and their personal relationships with other plant employees, in particular, floor-level workers. All surveyed plants confirmed that to integrate pollution prevention into corporate philosophy, all workers had to be convinced of its importance and relevance to the company's mission.

The DP Team found a good example at Navistar, where the Environmental Control Manager has over 20 years of service in manufacturing operations before heading the plant environmental program. His long years of plant work experience gave him a worker-level appreciation for the factors affecting waste generation. Additionally, the manager had personal relationships with most of the plant workers, many of whom are longtime employees. In this way, Navistar's Environmental Control Manager has been able to work effectively with plant area personnel in a non-threatening way to try new processes and procedures to achieve pollution prevention.

A final important point related to the development of successful pollution prevention programs concerns the qualifications and experience of key environmental managers.

4.3 Information Exchange and Technology Transfer

Pollution prevention in complex organizations like the host companies must involve people throughout the hierarchy. Corporate managers must receive information on

environmental issues and interact with their subordinates to establish environmental policy and establish funding mechanisms for the implementation of pollution prevention.

Facility-level managers must interact with each other and their subordinates to determine and prioritize pollution prevention ideas and develop implementation plans. They must also establish the technological means to achieve each pollution prevention objective, which can be facilitated by the interchange of ideas among organizational entities with related experience and information. Corporate responsibility to the public requires that successful pollution prevention programs and implemented technologies be widely publicized to benefit national and international environmental objectives. For these reasons, this section examines how the host companies have utilized communication schemes to enhance the success of their pollution prevention programs.

The sharing of lessons learned and the exchange of process technology among corporate facilities offers private sector organizations opportunities for cost savings and expedites implementation of pollution prevention programs. While no two host companies approached technology transfer in exactly the same way or with the same degree of formality, trends were observed by the benchmarking team.

To begin with, employee training is central to developing a work force that understands and accepts environmental responsibility and pollution prevention within a particular facility. The host companies rely on word-of-mouth, newsletters, conference calls, meetings and presentations to spread pollution prevention information and technology within their organization. State and Federally funded cooperative arrangements with academia for training, research and development, and programmatic support are the primary external sources of pollution prevention information and technology. Occasionally, corporations may share information or cooperate on mutually beneficial pollution prevention initiatives.

The following sections discuss examples of host company approaches to technology transfer and employee training and awareness.

4.3.1 Examples of Information Exchange and Technology Transfer Mechanisms

All the host companies maintain contacts with outside agencies, including public service organizations. Navistar is involved in cooperative efforts with an Illinois university and Sundstrand engages in research and development with the University of Illinois to eliminate or replace a chromate-based metal coating application. The host companies also interact with product vendors and community representatives. The main avenue for important information flow, however, is among operating units within the corporation.

For example, GE Plastics' Manager of Environment and Health consults on a regular basis with other manufacturers to keep abreast of technology developments and regulatory

trends. To maintain these contacts, GE is an active member in the Chemical Manufacturers of America Association; the GE EH&S group distributes best practices information sheets describing effectively implemented measures. At Caterpillar's East Peoria facility, the Environmental Steering Committee, in addition to handling policy issues, deals directly with waste minimization techniques and implementation plans that may be used in one or more production areas of the facility.

As an example of effective information transfer within an organization, Navistar's Environmental Control Manager initiates a monthly conference call among the environmental managers to share policy and technical information. Through the Local Emergency Planning Committee, Air and Waste Management Association, Citizens Advisory committee, and P2 Presentations at the Annual HazMat Central Show, Navistar also networks with other manufacturers on pollution prevention.

At the Melrose Park facility, Navistar set up a cooperative information exchange with the coolant supplier in the development of diethanolamine-free coolant, coolant polishing equipment and recycling equipment. The arrangement led to a mutually beneficial coolant and equipment leasing contract and elimination of a major waste stream.

Corporate and site newsletters are also key media for disseminating pollution prevention information within all the surveyed organizations.

4.3.2 Employee Training and Awareness

At GE Plastics, the facility recycling center promotes pollution prevention as a teamwork endeavor involving all employees. The company spent $30,000 on the recycle center, to which employees bring glass, aluminum cans, milk bottles, newspaper and cardboard from office and home. The recycle center is itself a product of recycling, its plastic outer wall being made of recycled milk jugs. The roof is made of Shangles®, a building product made of recycled computer housings.

Within the GE Plastics manufacturing areas, scrap plastic, cardboard and pallets are recycled. The mowing and trash-hauling group volunteered to refurbish pallets and have rebuilt more than 10,000 since 1990. These recycling activities fostered GE's nomination for the Illinois Governor's Award.

Pollution prevention training at GE Plastics is part of the RCRA training for all employees. For the benefit of all its employees, GE has a library well-stocked with company waste management publications, *the Environmental Reporter, the Federal Register* and numerous other environmental reference works. GE Plastics' library displays an "environmental performance screen" featuring company successes in pollution prevention. Helping to build employee enthusiasm for corporate environmental programs as well as improving environmental performance, GE's Green Team holds one- to two-hour

conference calls each month. This pollution prevention team, consisting of environmental coordinators from all GE manufacturing sites, focuses on the transfer of best management practices. The Green Team meets formally twice a year with team members presenting best management practices from their site which are written up and distributed throughout the company.

In addition to such varied mechanisms of effective information exchange, the host companies use formal employee training to foster employee awareness and knowledge in pollution prevention methods. For example, at the Navistar plant, all plant employees were trained in early 1994 for hazardous materials, RCRA waste and pollution prevention issues. Topics and sponsors for environmental training conducted at the Navistar Melrose Park facility during 1993 are shown in Figure 4.7.

Figure 4.7

Topic	Sponsor
Clean Air Act	Illinois EPA
Hazard Communication and Employee-Right-to-Know	Navistar
Pollution Prevention	Hazardous Waste Research Center, University of Illinois at Champaign
Emission Report Training	Illinois EPA
DOT Training	Navistar
RCRA Hazardous Waste Training	Navistar
Employee Commute Options Training	Illinois Chamber

4.4 Funding

The benchmarking team discovered a common sentiment among the host facilities: 'With more money, we could prevent more pollution.'

Effective industrial environmental management programs require not only the efforts of key management and line individuals but also the financial resources to implement specific pollution prevention measures. The logic behind the way a corporation allocates funds is

determined by its philosophies on how budgets are prepared, how spending priorities are set and how funds are appropriated to operating units for specific purposes. Accounting methods for salaries of key individuals and waste disposal costs greatly affect the organization's incentive for pollution prevention. Therefore, it is important to consider how budgets are designed to include salaried positions, ongoing waste management expenses and capital needed for the implementation of pollution prevention measures.

Without exception, adequate funding is available to meet all compliance requirements at each host facility. Pollution prevention activities that offer collateral benefits of reduced compliance burden and/or cost savings through avoidance or enhanced efficiency generally are funded. Most host facilities had implemented at least one low- to medium-cost pollution prevention activity without regard to ROI.

Differences in private-sector financing versus governmental funding mechanisms necessarily limit the scope of the host facilities' benchmarking practices applicable to DOE in the economic area. However, there are common problems. Waste-stream costing and normalization are economic obstacles for both the DOE and the private sector. Economic justification through cost-benefit analyses, particularly the requirement for pollution prevention projects to clear ROI threshold values, tend to further disadvantage both private and government pollution prevention efforts. Neither DOE nor private industry has unlimited sources of funding for pollution prevention.

The following sections explore private-sector approaches to the following budgetary topics:

- waste-stream cost accounting
- reasons for and approaches to normalization
- ROI hurdle clearance and life-cycle costing
- mechanisms for funding implementation
- actual ROI

4.4.1 Waste Stream Costing

Waste streams generated during production operations must be managed continuously until they are recycled or disposed of off-site. The components of a waste-management budget include staff salaries for administration and waste handling, costs of on-site pre-treatment and final disposal costs. At each of the five host companies, one or more waste streams were actually composite wastes generated at several distinct point sources.

A specific example is the production of waste water in more than one plant process. The Caterpillar plant operates as three business units composed of eight commodities, including products and processes such as rollers, final drives, forging, links, chains, fabrications, transmissions, painting and assembly. The plant does not meter water use

within these specific commodity-use areas. Initial distribution of waste water treatment costs was uniform across all commodity-use areas based on square feet of building allocation. Caterpillar's policy is changing from spreading waste costs across all commodity groups to allocating waste costs to specific waste-generating groups. Commodity managers now pay for the disposal of wastes they generate. Refinements in cost distribution are made as commodity (products and services) managers take advantage of opportunities to lower overhead costs due to low-use, no-use, or pollution prevention.

Caterpillar's commodities are bought and sold among three on-site business units. The painting group may contract to paint D-6 bulldozers for the medium track-type tractor business unit. Funding for the disposal of paint-related wastes is provided by the painting commodity manager. Similarly, operational and maintenance costs for the on-site waste water treatment facility are recovered through chargeback to the commodity manager at a rate based on building spare footage or metered consumption. Costing for entire processes, from procurement to use, handling and disposal is now being assessed. Most process improvements are paid for out of the operations budget in which projects compete for capital funds.

At Northrop, the benchmarking team found that the total costs for hazardous waste disposal at the Rolling Meadows plant were relatively modest. If they were distributed among the operating units, little incentive would remain to pursue pollution prevention. On the other hand, Northrop's composite costs for waste disposal are significant and, if managed as a total liability, more likely to result in management attention and action. However, group-level attention to total waste costs was more likely when raw materials replacement costs were considered. Similarly, GE Plastics representatives told the benchmarking team the plant currently was not generating much hazardous waste, so GE's waste disposal costs are appropriated from the plant-area budget.

Sundstrand has mechanisms in place to capture or calculate many of the environmental costs of its waste streams. Generally, hard costs for raw materials, waste disposal, resource management, such as labor and other direct charges costs, and reporting are determined and charged back to the generator. Small group generators' waste management costs are paid from the centralized waste management budget. When appropriate to the measurement and relevant to Sundstrand's experience, the company estimates future liabilities. Sundstrand's recently formed Environmental Impact Team incorporates design for the environment plans in its life-cycle cost studies for new products.

At Navistar, upper management has a history of real commitment to pollution prevention. This is substantiated by the fact that they approve all justifiable requests for environmental appropriations even when dollars are scarce.

4.4.2 Normalization

If sufficient accounting data is available, waste management program administrators should ideally quantitatively relate the rates of generation of waste to product production rates. Indexed or normalized accounting of waste generation is important to demonstrate the continuing effectiveness of pollution prevention efforts when production rates vary. For example, Sundstrand normalizes waste production as pounds per year of waste generated ratioed to direct labor hours per year. However, Sundstrand reported to the benchmarking team that some waste streams normalized in this manner demonstrated an increased ratio to labor hours per year as Sundstrand maintained production during periods of decreasing employment. Examples of other host facility approaches to normalization follow.

Commodity managers at Caterpillar track and report some waste disposal costs per unit of production or machine-hour. At this level, visibility of waste streams and the management opportunities provided by this visibility ensure that processes are optimized to keep disposal costs down and profits up. Making waste generators accountable at this level, a relatively new strategy at Caterpillar, has had positive results. For example, source reduction measures in the seals commodity group halved disposal costs for each seal from $1.60 to 80 cents apiece.

Navistar facilities have established production units for measurement of pollution prevention results. The number of trucks produced at the Springfield Assembly Plant, the number of engines produced at the Melrose Park Plant, the tons of casting produced at the Indianapolis and Waukesah foundries, the number of items shipped at the parts distribution centers, and the number of employees at the Fort Wayne Navistar Technical Center are examples of using production units to gauge the effectiveness of process improvement. Waste disposal volumes and Form R toxic releases for each Navistar site are normalized by dividing by the number of production units. Comparison of the results of this equation against baseline year data from 1989 allows Navistar to calculate meaningful reduction percentages at facility and corporate levels.

GE's Ottawa Site environmental managers face a daunting task as they proceed as directed toward a 50-percent reduction in waste disposal costs per pound of product by 1996, utilizing 1992 as a baseline year. They say the only way to meet such an aggressive goal is to "step outside of the box." One approach is to increase production so that unavoidable costs of basic operations can be spread over more units of product. The environmental managers also noted how such program approaches can invite lulls in activity, often leading to a lack of continuing improvement after goals were met.

At Sundstrand's manufacturing facilities, both hazardous and non-hazardous production wastes are normalized. The "low-hanging fruit'" of early programmatic reductions skewed comparisons of dollars spent versus benefits received, and production-based ratios tended

to invert during periods of low production. Currently, calculating pounds of waste generated per direct labor hour provides Sundstrand managers with a useful means of measuring pollution prevention progress, although there are limitations in the interpretation of such data.

4.4.3 Economic Justification

Following the identification of specific pollution prevention measures, managers must decide which if any of those measures should be implemented. Such decisions are based primarily on assessments of technical feasibility and economic justification. Even in organizations with substantial environmental program budgets, such as those with funding for several salaried positions, pollution prevention measures that require substantial capital for implementation must generally compete for available funds.

The benchmarking team found that environmental projects at all host facilities enjoy special consideration during economic analysis. Though compliance-driven activities are consistently funded, pollution prevention support varies. Some companies use a simple economic index to assess project economic feasibility. For instance, Caterpillar requires a hurdle rate ROI be met unless the project is compliance-oriented. Furthermore, Caterpillar has begun to evaluate pollution prevention projects on the basis of life-cycle costs with which waste problems are framed for consideration based on "what is worth managing" rather than on specific costs for a single waste stream.

GE Plastics reported a need to achieve an ROI of 30 percent, unless other factors including community relations and compliance exist. GE Plastics noted, however, that earlier in the pollution prevention era, it was relatively easy to get approval to proceed with pollution prevention measures which were usually inexpensive, easy to implement and which resulted in a short payback—"low-hanging fruit." Today, it is more difficult to sell measures with longer paybacks. Sundstrand, while not specifying a hurdle rate, reported that pollution prevention projects have a lower ROI threshold than do other capital projects. Navistar does not have an ROI threshold, preferring to consider any project that reduces risk.

4.4.4 Implementation

As might be expected, low-cost measures in all five host facilities can usually be implemented from regularly budgeted environmental funds if the overall budget is substantial. Similarly, Northrop normally can fund simple low-cost pollution prevention measures from its environmental management budget of just over $1 million. In environmentally proactive organizations, funds are likely to be found for reasonably attractive measures. Navistar's Environmental Control Manager said he had never been turned down by plant management for funds for sensible environmental projects. Unfortunately, it is more common that there are threshold costs above which pollution

prevention actions must have special consideration and careful approval before funds are made available. This was the case at GE Plastics, where measures calling for more than $150,000 required strenuous justification for funding.

4.5 Opportunity Assessments

Opportunity assessments are an integral part of all host facility programs. Known variously as waste stream reviews, pollution prevention reviews and the like, opportunity assessments proceeded in a stepwise fashion at all host facilities. To management at the host facilities, in the context of limited time and resources, it is of prime importance to identify opportunities for waste minimization that impact the most hazardous or otherwise environmentally troublesome wastes. Ideally, management should generate and archive a list of measures for consideration on a continuing basis to maintain momentum in pollution prevention and to establish a timely attack on new waste streams or on those with changing generation rates.

It is important for management to maintain a database of pollution prevention options that are introduced during any opportunity assessment. Those that may not be economically or technically feasible today may be more practical in the future.

At all host facilities, results of initial facility-wide, screening-level assessments provide environmental managers with sufficient information to prioritize pollution prevention measures. Prioritization schemes vary but tend to reflect facility-specific drivers. In-depth review of priority waste streams and process are conducted by standing or *ad hoc* teams, depending upon the facility.

The following sections explore the host facilities' approaches to waste stream inventories and prioritization.

4.5.1 Identifying and Prioritizing Pollution Prevention Opportunities

At all the host facilities, the usual method of generating pollution prevention proposals is to establish committees of employees charged with the regular development of new ideas for consideration. The starting point for all host facilities is the establishment and continuous updating of a comprehensive listing of all the significant waste streams generated in the plant. (See next section) With the types and amounts of generated waste cataloged, an appropriate team can propose pollution prevention measures.

Caterpillar told the benchmarking team that each commodity group generates its own list of proposed waste minimization measures. In general, however, facility-level waste minimization and pollution prevention efforts are prioritized using Pareto analysis according to toxicity, cost and volume. The Caterpillar East Peoria Facility SARA 313

Report provides toxicity and volume data; life-cycle costs are derived from purchase and disposal records. The following table summarizes the six priority waste streams at the Caterpillar facility.

Waste Stream	Pollution Prevention Driver
Ammonia	3rd on SARA 313 Report (1988)
Aluminum Oxide	1st on SARA 313 Report (1988)
Dunnage	Large Volume
Waste Oil	Very large volume, cost
Chlorinated/Fluorinated Solvents	2nd on SARA 313 Report (1988)
Paint Sludge	Volume

At Sundstrand, the highly organized environmental management hierarchy includes a corporate-level committee with division-level employee members who meet quarterly to review environmental status and to formerly consider new measures for pollution prevention. At Navistar, a source reduction committee periodically considers selected waste streams for attention. Based on monthly "housekeeping" (environmental) audits—not full assessments—plant areas and processes needing remedial action are identified. A corporate group visits facilities annually to conduct more comprehensive waste assessments.

The prioritization of pollution prevention opportunities requires the establishment of a set of decision criteria. At Caterpillar, environmental staff discuss how to prioritize pollution prevention actions for implementation. While Caterpillar personnel said there is no easy way to establish firm criteria, factors to be considered include the volume, toxicity and management costs of particular waste streams. Caterpillar further reported that following this process, some streams emerged as high priority projects. Similarly, at Northrop, waste streams are ranked primarily by production amounts and associated costs.

At GE Plastics, the Green Team, mostly hourly workers from 10 plant areas, meets quarterly to perform a low-level opportunity assessment. A list of good pollution prevention ideas is maintained and reviewed in case changing circumstances make them more feasible.

In summary, the benchmarking team found that a clear accounting of waste generation rates was a tremendous aid for plant employees who met routinely to work on the development of pollution prevention ideas.

4.5.2 Inventories and Assessments

As previously indicated, pollution prevention must start with concise and up-to-date accounting of all significant plant waste streams. All five of the host facilities prepared some kind of listing of major waste streams. In most cases, summary listings of plant waste streams were incorporated into presentations geared toward internal waste management programs as well as external groups.

GE Plastics' Green Team completed an "initial scrub" opportunity assessment of all areas of the Ottawa Site. Nineteen waste streams were identified in addition to known air- and waterborne releases. This waste stream inventory is maintained and tracked on computer.

Commodity managers at Caterpillar's East Peoria Facility completed an initial comprehensive waste stream inventory. Accomplished by checklist (Figure 4.8), this effort focuses on identifying users of six priority chemicals and types of waste generated by each commodity. Ad hoc waste minimization teams for specific wastes thoroughly investigate the prioritized waste streams. The teams are staffed and funded by commodity managers with vested interests in particular waste streams.

Most of the methods for tracking waste reported by the host companies were based on a combination of manual and computerized methods. Northrop noted that, while waste stream tracking is done both manually and with computer spreadsheets, efforts are underway to improve the timeliness and accuracy of tracking.

4.5.3 Intensity of Assessment Efforts

As mentioned above, all host facilities had corporate and in-plant teams meeting periodically to consider their facility's environmental status and to plan for future pollution prevention activities. At facilities with vigorous environmental programs, the groups met monthly. However, after an initial period of program expansion and the implementation of a number of first-priority pollution prevention measures, environmental team meetings tended to revert to quarterly. This is consistent with the finding that after easy-to-implement, short-payback opportunities are explored, it becomes considerably more difficult to identify feasible and affordable waste minimization opportunities.

4.6 Pollution Prevention In Design, Development and Production

It is widely accepted in industry that the best approach to future environmental management is to incorporate pollution prevention into the design of products and production methods. Although most of the host facilities have pursued waste reduction primarily in terms of the modification of existing product and process designs, pollution prevention is a guiding principle in the current design of new products and processes.

CATERPILLAR'S EAST PEORIA FACILITY

ENVIRONMENTAL WASTE STREAM REVIEW
COMMODITY CHECKLIST

We are required by the United States Pollution Prevention Act and Corporate Policy to have, within our Plant, a waste minimization plan in effect. Waste minimization is driven by three factors:

1. Cost of disposal
2. Toxicity of hazardous waste
3. Volume of waste

Please answer the following questions pertaining to your commodity:

Has your commodity implemented a waste minimization plan?

Who may we contact in your commodity on the plan and follow-up?

Which of the waste streams below does your commodity generate?

- ☐ A.A.O.
- ☐ Coolant
- ☐ Packaging/Cardboard
- ☐ Dunnage
- ☐ Grinding/Machining Fines
- ☐ Lapping Sludge
- ☐ Millwater
- ☐ Oil
- ☐ Paint/Solvents
- ☐ Miscellaneous Maintenance/Solvents
- ☐ Refrigerant Oils
- ☐ Empty Drums

Note: We are interested in only those processes that generate wastes. Waste Streams do not include scrap parts, clean chips and used tooling which are already recycled.

What is a typical production measure for your commodity in a calendar month (such as: Machine Hours, Tractors Shipped, Piece Parts, etc.)?

We have provided a Process Flowchart, a Waste Stream Chart and Questionnaire to be filled out by your Div/Section Surveyor. You may modify the forms/questions to your commodity needs.

A list of products that contain six target chemicals will be provided to each commodity. Please call Ron Runyan at 5-3986 with all Div/Section #s for your area. Include these products in the Waste Stream Review. The six target chemicals are:

1. Ammonia
2. Chrome
3. Diethanolamine (DEA)
4. Glycol Ethers
5. Trichloroethane
6. Xylene

Figure 4.8

4.6.1 Design for the Environment

"We will incorporate environmental considerations into design ... and manufacture products that comply with environmental regulations ... and apply new technology when economically practical to minimize any potentially harmful impact of our products on the environment."
Caterpillar: 1992 Business Conduct Code

All of the host facilities have policies and ongoing procedures for the incorporation of pollution prevention into product modifications and new product design.

To achieve these goals, Caterpillar directed new product development teams to determine the best ways to incorporate pollution prevention into design activities. Caterpillar claims that although personnel in the business of design, engineering, planning and production are all physically located in the same area, these functions represent autonomous groups. In this context, "process" people have more readily implemented pollution prevention strategies than have the "product" people. To remedy this imbalance, there are now new product introduction (NPI) teams to consider product differentiation and the discriminating customer. The NPI teams are currently trying to determine long-term strategies in order to make serious, far-reaching decisions.

"Navistar will pursue opportunities to develop and sell products which have minimal adverse environmental impacts during their production and use. We will support efforts to develop products that can be recycled or safely disposed of at the end of their useful lives."
Navistar: Environmental Protection Policy

One of the seven KRAs in Navistar's current environmental business plan addresses product issues. Specific goals include communication with product development groups to assure the incorporation of environmental considerations into product design. In 1992 Navistar began marketing its new generation, smokeless diesel engine (NGD) which was designed to meet or exceed the CAA 1994 emission limits. In 1989, Navistar began an relationship with Castrol™ whereby Castrol™ maintains personnel at Navistar to provide all vehicle fluid maintenance. The agreement returned $38,000 to Navistar in 1993 and precluded the use and therefore the treatment and/or disposal of numerous gallons of vehicle fluids.

Northrop's current environmental business plan describes the integration of "environmental quality into all aspects of the design, manufacture, and servicing of aerospace products."

Sundstrand's 9-member Environmental Impact Team (See Figure 4.4) is assigned to new product design for the environment, and existing product redesign. The team performs

up-front pollution prevention opportunity assessments on all new products, and evaluates their life-cycle cost elements. An example of a specific measure taken to enhance product environmental quality was explained to the benchmarking team by a Sundstrand representative. He explained how the repeated need to paint a certain plastic pump cover had been eliminated--along with the concomitant waste--by purchasing a colored plastic part for the pump.

GE Plastics reported that product design teams are working with customers on concepts for environmentally friendly products. GE Plastics is considering how to make products easy to disassemble so the components can be recycled at the end of a product's useful life.

4.6.2 Environmentally Conscious Manufacturing

The development of effective environmental management plans at all of the host facilities incorporates the need to examine manufacturing operations for environmental impact. Such introspection has led to a continuing assessment of production methods to minimize waste production and environmental impact. The environmental management plan for the Caterpillar facility states "we will incorporate environmental considerations into manufacturing processes (and) develop and apply technologies and processes that prevent pollution."

Navistar's environmental protection policy states the company will "operate our facilities in a manner that protects the environment" and "exercise innovation in our manufacturing processes to minimize or prevent the generation of waste and the discharge of contaminants into the environment." Navistar's environmental protection policy and management program assert the company will "investigate and pursue process modifications which prevent pollution and result in waste reduction."

Northrop's environmental management manual includes a statement that each operating element shall "conduct research and development of materials and manufacturing processes in order to ensure continued pollution reduction."

As mentioned earlier, Design for Dismantlement is GE Plastics' goal for products made of ABS plastic. GE Plastics is working with its customers, which include manufacturers of appliances, computer housings, furniture, telephones and automotive parts, to minimize obstacles to recycling by developing and designing user-dismantleable products.

4.7 Public Relations

Effective pollution prevention programs can enhance a company's image in the community. Pollution prevention outreach efforts, stand-alone or in combination with other more general public relations activities, were a part of all host facility programs.

While it is difficult to distinguish between cultivated public relations and the good will resulting simply from doing good pollution prevention work, there appeared to be an art and business of inducing public and employee goodwill.

Host facilities focused their outreach efforts in different ways on various stakeholders. Employees, the public, local environmental committees and governing bodies, environmental groups, local and state regulators, and academic institutions participated in one or more host facility outreach activities. Pollution prevention awareness, responsibility, efforts and successes, and positive attitude were common themes in written and other media efforts for internal and external distribution. Displays, plant tours and open houses often included a mention of pollution prevention efforts and sometimes it was the sole focus of the event.

The following sections describe significant outreach efforts by host facilities. These observations are classified into internal and external efforts, the former referring to employee awareness and participation; the latter to all other stakeholders. There is some overlap and, in some cases, enhanced public image was the serendipitous result of ongoing pollution prevention activities.

4.7.1 Internal Public Relations

Public relations is vital both within and without organizational boundaries. Employee public relations efforts can include several types of interaction, such as employee membership on environmental committees, encouraging workers to get involved in projects such as the construction of a materials recycling center, and employee participation in pollution prevention seminars and training courses. Internal, site-specific newsletters like Navistar's *The Communicator* connect employees to in-house environmental programs and other issues affecting the company.

4.7.2 External Public Relations

Navistar's public information department responded quickly to the pollution prevention benchmarking team's request to partner in its benchmarking effort, and eagerly followed up the initial contact with a press packet of background information and news clippings about awards and noteworthy programs.

The benchmarking team discovered that concern for environmental issues among Navistar product purchasers and users was addressed in corporate literature about the NGD engine, *Engine News*, a newsletter for dealers, and articles about pollution prevention success in local newspapers.

Navistar has long recognized the importance of a good neighbor policy. Members of the community and others are frequently invited on tours of the Melrose Park plant, and

neighbors with environmental concerns receive prompt, courteous and individual attention and are given a name and number to call in the future. Navistar's imaginative approach to external public relations is epitomized by the arrangements it made for an elderly neighbor's lawn to be mowed.

Navistar seems committed to EPA's voluntary 33/50 and WasteWise programs. Recycle logos appear on corporate materials such as business cards and internal memoranda. Navistar engine salesmen are provided with printed material detailing the company's position on mobile-source CAA emissions requirements. As a spokesman for a local chapter of Citizens for a Better Environment put it, "It's an excellent success story. We'd like to see more companies do what Navistar is doing."

Navistar's regular contacts with regulatory groups keep the facility abreast of changing regulations and help establish a positive image. Among other means of stimulating dialogue, the Melrose Park Plant publishes the *Green Report*, a periodical said to drive the Navistar pollution prevention program, which is distributed widely to other company plants and to state and Federal regulatory agencies.

GE Plastics maintains a proactive public relations program which regularly interacts with a community advisory panel representing local environmental groups. GE Plastics annually hosts "Community Days," an event in which up to 100 community leaders are invited to receive general updates on facility activities as well as hear an environmental pitch that focuses on improved compliance and reduced environmental impact from site operations.

5.0 BEST-IN-CLASS POLLUTION PREVENTION PROGRAM CHARACTERISTICS

At first glance, it may seem a straightforward task to bring about a pollution prevention organization like those discussed in this report. It is actually a serious challenge to develop a coordinated, highly organized program with sufficient commitment to achieve long-term results. Yet, as the "best-in-class" industrial facilities like those in Section 4.0 demonstrate, significant pollution prevention *can* be achieved in diverse manufacturing settings.

Section 4.1 elaborated on how governmental organizations, and in particular DOE-DP, are challenged by limited manpower and budgets, a wide diversity in products and production rates, and large distances between operations. Despite these limitations, it appears certain, based on the case study successes described in this report, that DP can set ambitious goals, optimize personnel and budgets, and invigorate its pollution prevention programs to achieve the desired results. In this final section, observations and recommendations are summarized that may help DP administrators increase the effectiveness of their own pollution prevention programs.

5.1 Establish Top Management Support

It is a widely held belief that an organizational pollution prevention program has little chance of long-term success without the support of top-level management. It is also held that, in many instances, it is not a simple task to enlist the support of top-level managers.

In this regard, each of the five companies surveyed in this benchmarking effort founded their pollution prevention programs on organizational concern about environmental regulations and emissions reporting. Managers at all levels appreciate the need for effective pollution prevention when faced with the disruption of operations by regulators and organizational and individual legal liability. Over time, the sensibility of pollution prevention becomes obvious and environmental programs can be directed towards prevention of waste rather than its management.

Organizations having success with pollution prevention tend to assign overall responsibility to high-level management. At Caterpillar, a General Manager and Vice President had direct involvement in environmental program development and implementation. However, all of the companies surveyed exhibited an important management commitment at operational levels as well. This multi-level commitment ensures that daily management of the environmental program falls under the direction of one or more individuals having a full-time position in this area of operations.

The level of top management support determines budgeting at a level sufficient to support a significant pollution prevention program. It was noted that all five of the surveyed companies had annual environmental budgets of at least $1 million and substantially more in some cases.

5.2 Characterize Waste Generation and Waste Management Costs

Clearly, the starting point for waste management activities is a careful and complete inventory of waste generating processes and specific waste streams. It is imperative to establish a reliable method of quantifying all significant waste streams to track the results of pollution prevention efforts. It should also be a primary objective to gain a complete understanding of plant processes that produce waste streams so that waste problems can be attacked at the source.

Most of the incentives for industrial pollution prevention have an obvious financial basis, such as reduction in costs of raw materials, administration, handling and shipping, waste disposal, and compliance burden. Discussions with representatives of the host facilities made it clear that documenting the true financial effect of waste generation and

management is an important way to maximize the company's economic incentive to establish a serious program of pollution prevention.

In the case of DP organizations, profit may not be a primary objective. However, even in such cases, the reduction of waste-related overhead costs can free up substantial funds for use in meeting primary organizational objectives. Thus it is important to identify all relevant categories of waste-related costs to establish the economic incentive for pollution prevention. Occasionally overlooked are costs such as administrative costs of support employees, recurring permit fees, periodic sampling costs, expenses of on-site handling, storage and treatment costs (including utilities), and the costs of legal counsel with regard to environmental actions. All such costs must be identified and carefully quantified to show a clear understanding of the financial impact of waste management activities on the DP organization's overall financial performance.

5.3 Perform Periodic Waste Minimization Assessments

Without doubt, successful pollution prevention programs are responsive to changing needs and priority situations. As several of the host facility interviews indicated, all such programs progress through a series of phases to the implementation of progressively more complex pollution prevention measures. After all of the so-called "low-hanging fruit" have been plucked, further progress requires a revitalized effort to identify additional waste reduction opportunities for all remaining streams.

It is necessary to establish a policy for regular facility assessments in order to maintain a program's momentum. Best are limited assessments done weekly or monthly by plant teams. Follow-ups should consist of more extensive, several-day assessments by teams that include key floor workers, line managers and the director of the pollution prevention program.

5.4 Establish a Cost Allocation System

For effective pollution prevention, it is necessary to provide motivation for action at all levels in an organization. While the overall costs and liabilities associated with waste management are important factors in motivating top management to commit to pollution prevention as a corporate goal, it is sometimes more challenging to motivate managers of the operating groups. Assigning waste-related costs to the generating units is a very effective way to get the attention of mid-level unit managers. The appropriate allocation of costs can only be accomplished through the performance of periodic facility waste assessments so that costs can be assigned based on current area or unit waste production rates. These rates should be adjusted from time to time as the result of ongoing pollution prevention efforts.

5.5 Encourage Technology Transfer

Once an organization's pollution prevention program moves beyond the low-hanging fruit level, it is necessary to find waste-problem solutions which are matched to a specific set of plant conditions. Although this can always be done by a time-consuming, systematic survey of pollution prevention information sources, the process can be simplified by establishing mechanisms for the regular transfer of relevant technology. It is always beneficial to communicate with other like organizations. Particularly useful is the evaluation of the technical and economic feasibility of a proposed waste minimization measure based on the past experience of a similar facility.

A number of databases with proven usefulness in pollution prevention work have been established—for example, DOE's Pollution Prevention Information Clearinghouse (EPIC), [HTTP://146.138.5.107/EPIC.HTM]—for general information and technology transfer. Manufacturing organizations may also establish mechanisms for technical information exchange with vendors to keep abreast of new low- or no-pollution products and processes. Additionally, industrial manufacturers gain a distinct advantage by actively participating in manufacturers' associations where process improvements and efficiency are discussed.

Technology transfer should always be viewed as a two-way street. A plant's pollution prevention program can be enhanced through the good neighbor image that results from sharing information on waste minimization strategies which have been found to be effective.

5.6 Implement and Evaluate Program

Once a comprehensive pollution prevention program has been designed and responsible staff are brought aboard, the program must be implemented. During implementation, continued improvement necessitates regular evaluation to monitor success in waste reduction. Evaluation of pollution prevention efforts can be incorporated as one aspect of routine assessments of manufacturing operations. Evaluation must be quantitative and based on the developed waste-tracking system.

5.7 Carefully Match Program Structure to Specific Organizational Needs

Based on information from the benchmarking team's plant visits, it is clear that formal, regular meetings of pollution prevention committees should be established. The appropriate number of committees should be determined based on organizational complexity and the relative magnitude of the plant's waste problems. All committees should include plant floor workers who are familiar with the actual production processes

used in each waste-producing work area. For companies with more than one plant, at least one committee should be at the corporate level to ensure technology transfer between plants and the regular participation of top-level facility management.

Overall, the experience of the host companies strongly suggests that the direct day-to-day management of site waste reduction efforts should be overseen by a full-time, mid-level manager whose sole responsibility is pollution prevention.

Finally, all of the assessed corporate and plant pollution prevention programs were built on a proactive philosophy. Successful programs are not achieved when the primary strategy is to react or accommodate environmental regulation. The best policy involves setting broad goals that include becoming best-in-class with regard to waste reduction.

5.8 Carefully Choose Key Environmental Staff

The collective experience of the host companies suggests that day-to-day enthusiasm for pollution prevention is essential for the leaders of the program. Those charged with the daily operation of the organization's pollution prevention program should be chosen for their professionalism, energy level and personal dedication to environmental improvement.

In some cases, companies faced with the need to appoint environmental managers try to pick someone from the current staff to fill this role. Sometimes, the current staff yields an excellent candidate—at Navistar, someone with more than 20 years' experience, including a substantial amount of time on the plant floor, was named Environmental Control Manager. It is more typical, however, that an ideal candidate cannot be found within the organization. Management must then attract and hire an outsider who has the necessary experience and personal characteristics to drive a challenging pollution prevention program.

5.9 Provide Continuing and Substantial Staff Motivation

While it is not at all a straightforward matter to design and implement a comprehensive pollution prevention program for a complex organization, it is often even more challenging to maintain a high level of long-term motivation for the program to continue and succeed. Many factors, such as economic downturns, create drag on motivation. Lack of direction after the immediate, large-scale waste problems have been solved can be another factor, and other situations may give the pollution prevention program a low-priority status.

Based on the successes of the host companies, there are various strategies for maintaining motivation. The pollution prevention manager's position can be established at a highly visible, well-compensated level and imbued with real authority for decision-making. All

employees should be empowered to get involved in the organization's environmental program. Participation in state and national award programs should be promoted. The pollution prevention program can be strengthened by publicizing its successes, thereby generating competition with other outside agencies as well as encouraging interactions with other groups in business, government and academia.

APPENDIX A

A.1.0 Regulatory Drivers for Pollution Prevention

This section of the appendix is an overview of laws and regulations, executive orders, and prominent Federal initiatives factoring into DOE's strategic plans for pollution prevention.

A.1.1 First Tier Environmental Statutes

Major environmental laws that have been in place for decades continue to be the matrix for today's more refined and demanding Federal regulations, most of which have been tied into the central theme of pollution prevention.

The Resource Conservation and Recovery Act of 1976 (RCRA) and associated Hazardous and Solid Waste Amendments of 1984 (HSWA) established a national policy of minimizing waste generation. These laws specifically required were certification of minimization efforts to reduce volume and toxicity of waste, as well as signed certification on hazardous wastes manifests that a waste minimization program existed and that there was certification of minimization by treatment, storage and disposal facilities.

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) established the Superfund, among other legal instruments, for cleaning up inactive waste sites, accidental spills and releases. The Superfund Amendments and Reauthorization Act of 1986 included Title III, the Emergency Planning and Community Right to Know Act (EPCRA), which required owners and operators of applicable facilities to annually submit toxic chemical release inventories to the Environmental Protection Agency (EPA).

The Clean Air Act (CAA) and Clean Water Act (CWA) are older, media-specific laws, updated periodically, that provide standards for cleanup as applicable or relevant and appropriate requirements (ARARs). They also set out restrictions on releases and mitigate the results of past practices.

A.1.2 Second Tier Environmental Laws

The 1990s ushered in a new wave of actual and proposed amendments to some of the older laws. Many of these statutes built on or implemented aspects of the previous legislation.

The Pollution Prevention Act of 1990 established as a national policy a hierarchy of pollution prevention practices. Waste generators were to reduce at the source, recycle

when feasible, treat what cannot be prevented or recycled, and to dispose of whatever is left only as a last resort. The Pollution Prevention Act made a requirement of what was an option for businesses under EPCRA, to report source reduction and recycling data in annual TRI reports. Also, the Pollution Prevention Act requires EPA to provide Congress with biennial reports on pollution prevention activities and results.

The Clean Air Act Amendments of 1990 (CAAA) addressed 1) nonattainment of national ambient air quality standards; 2) pollution from mobile sources; 3) hazardous air pollutants from area and major sources; 4)control of pollutants from utilities; 5) emissions monitoring, reporting and permitting; 6) ozone-depleting substances; and 7) effective enforcement of the regulations. The CAAA provided numerous incentives to eliminate the use of hazardous substances whenever possible.

The Water Pollution Prevention and Control Act of 1991, a comprehensive CWA reauthorization bill, was introduced to the Senate but wasn't approved by the 102nd Congress. In 1993, a bipartisan Senate bill to amend and reauthorize the statute was introduced, authorizing EPA to mandate technology changes and eliminate discharge of toxic pollutants whenever possible. Effluent limitation guidelines would be required to reflect source reduction requirements and to limit cross-media transfer of pollution where achievable.

The Clean Water Amendments of 1995, if passed, will amend the Clean Water Act to add national goal and policy provisions with respect to water quality programs. Section 102 authorizes the Administrator of the Environmental Protection Agency, in carrying out national water pollution prevention programs, to: (1) conduct and promote comprehensive programs of basic water pollution research; and (2) make grants to local governments for carrying out water pollution prevention research, investigations, training, and information programs.

Section 302 revises provisions regarding the extension of the deadline for point source compliance to encourage the development and use of an innovative pollution prevention technology.

Section 316 revises provisions regarding water pollution control at Federal facilities to waive the sovereign immunity of the United States with respect to any requirement, administrative authority, or sanctions that may be imposed for violations. It provides that Federal employees may be subject to criminal sanctions, but exempts Federal agencies from such sanctions. It also authorizes the Administrator to commence administrative enforcement actions against Federal agencies under this Act.

The proposed legislation is currently before the Environmental Public Works Committee of the Senate.

The Energy Policy Act of 1992 (EPAct) drives many of the energy conservation and technology transfer initiatives designed to achieve pollution prevention objectives.

The following is from *Opportunities for Energy-Efficient, Pollution-Prevention Technology Demonstrations*, a report by the Sandia National Laboratories Vital Issues Panel in Washington, D.C. on June 8, 1993:

> Pursuant to Section 2108 of the Energy Policy Act of 1992 (EPAct), the Secretary of the U.S. Department of Energy, in consultation with the Administrator of the U.S. Environmental Protection Agency, was authorized to conduct programs designed to improve the energy efficiency and cost effectiveness of pollution-prevention technologies and processes, including source reduction and waste minimization technologies and processes. Presumably, these technologies and processes would be capable of increasing industrial productivity, while simultaneously reducing the consumption of energy and material resources and the production of wastes. Specifically in Section 2108(b), the Secretary, in consultation with the Administrator, was directed to identify opportunities for the demonstration of energy-efficient, pollution-prevention technologies and processes. A report containing this information was required to be submitted to the U.S. Congress within nine months after the enactment of the Act.

The Sandia panel succeeded in developing a working definition of technology demonstrations and ranking and weighting criteria for use by subsequent panels addressing technologies within selected industrial sectors. About a month later, the panel produced the Industrial Waste Reduction Program-sponsored report *Energy-Efficient, Pollution-Prevention Technology Demonstrations in the Petroleum Industry*. This study found that the petroleum industry may manage more water than it does petroleum, and that technology demonstrations focused on waste water management and six other broad technology areas could significantly benefit that industry. The other categories with strong potential demonstration opportunities were:

- toxic gaseous emissions
- advanced geophysical diagnostics
- locating orphan wells
- spent catalyst reuse
- oil/water emulsion breaking by chemical additives
- dry hydrogen sulfide adsorption.

An amendment to RCRA, the Federal Facility Compliance Act of 1992 waived sovereign immunity for Federal facilities. Federal facilities are now treated, with certain exceptions, just like any other generators of RCRA waste and can be reached by a wide range of

enforcement actions and provisions that subject Federal facilities to all Federal, state, interstate, and local requirements of RCRA.

A.1.3 White House Focus on Federal Facilities—Executive Orders

To emphasize the current Administration's belief that Federal agencies, as exemplary environmental stewards, should be leading the nation to less-polluting, sustainable development, numerous Executive Orders (EOs) have been issued that emphasize aspects of these statutes and regulations. Some of these are reviewed in the following paragraphs.

EO 12759 - April 17, 1991 - *Federal Energy Management*

This order includes sections requiring Federal energy efficiency goals for buildings and other facilities to be achieved by the year 2000, minimization of petroleum use in Federal facilities, implementation strategies, procurement of energy efficient goods and products, participation in demand side management services, vehicle fuel efficiency outreach programs, Federal vehicle fuel efficiency, and procurement of alternative fueled vehicles.

EO 12843 - April 21, 1993 - *Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances*

Federal agencies shall maximize the use of safe alternatives to ozone-depleting substances, revise their procurement practices, implement cost-effective programs and, to the extent that it is economically practicable, modify specifications and contracts that require the use of ozone-depleting substances. Federal agencies also shall exercise leadership, develop exemplary practices, and disseminate information on successful efforts in phasing out ozone-depleting substances.

EO 12844 - April 21, 1993 - *Alternative Fuels Vehicle Purchase by Federal Government Requirements*

This Executive Order commits the Federal government to exceed by 50 percent the 1993-95 alternatively fueled vehicles purchase requirements established by the EPAct. This objective should be pursued through the purchase of thousands more U.S.-made vehicles that use domestic fuels; natural gas, ethanol, methanol and electric power. Each Federal agency is to report annually to the Energy Secretary on progress under this order. The Secretary is to prepare for the President and Congress a consolidated annual report that includes an itemized evaluation of the efficiency of using these vehicles.

EO 12845 - April 21, 1993 - *Energy-Efficient Computer Purchase by Federal Government Requirements*

This order requires the Federal government to purchase personal computers, microcomputers, monitors and printers equipped with the energy efficient low power standby feature as defined by the EPA Energy Star computer program.

EO 12856 - Aug. 3, 1993 - *Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements*

This order establishes the principles that the Federal government should become the leader in pollution prevention through the management of its facilities and that it should provide the public with information on the storage and handling of extremely hazardous substances and toxic chemicals at Federal facilities. The order's provisions stipulate the development of a voluntary goal to reduce total releases of toxic pollutants by 50 percent by the end of 1999, Federal agency compliance with EPCRA, and the elimination or reduction of the acquisition or use of products that contain extremely hazardous substances or toxic chemicals. Numerous guidance documents have been distributed throughout DOE CSOs to assist the field in the interpretation and implementation of this order.

EO 12873 - Oct. 20, 1993 - *Federal Acquisition, Recycling, and Waste Prevention*

Extracted from the preamble, some of the specifics of EO 12873 are presented below.

Section 101. Consistent with the demands of efficiency and cost effectiveness, the head of each Executive agency shall incorporate waste prevention and recycling in the agency's daily operations and work to increase and expand markets for recovered materials through greater Federal preference and demand for such products.

Section 102. Consistent with policies established by Office of Federal Procurement Policy (OFPP) Policy Letter 92-4, agencies shall comply with executive branch policies for the acquisition and use of environmentally preferable products and services and implement cost-effective procurement preference programs favoring the purchase of these products and services.

Section 103 This order creates a Federal Environmental Executive and establishes high-level Environmental Executive positions within each agency to be responsible for expediting the implementation of this order and statutes that pertain to this order.

Section 502, *Designation of Items that Contain Recovered Materials*, includes specific requirements for printing and writing paper, for example, the minimum standard for high speed copiers and computer print-out paper shall be no less than 20 percent post-consumer materials beginning Dec. 31, 1994. This minimum content standard is to increase to 30 percent beginning Dec. 31, 1998. Other uncoated printing and writing paper, such as writing and office paper, book paper, cotton fiber paper, and cover stock shall include 20 percent post-consumer materials as of Dec. 31, 1994. This standard shall be increased to 30 percent on Dec. 31, 1998.

Section 601, *Goals for Waste Reduction* requires each agency to establish goals for solid waste prevention and recycling to be achieved by the year 1995.

Section 705, *Recycling Program* specifies that each executive agency shall initiate a program to promote cost-effective waste prevention and recycling of reusable materials in all of its facilities.

DOE now requires the use of recycled papers containing post-consumer waste and the use of soy- or other vegetable-based inks in its products printed on offset presses. In the early 1990s, recycled copier paper containing 10 percent post-consumer waste was used throughout Headquarters and was available to field offices. In April 1994, one hundred percent recycled paper (with 50 percent post-consumer waste) was performance-tested by the Printing and Graphics Division. Since the end of May 1994, the paper has been used for at least 90 percent of the copying at Headquarters.

EO 12898 - Feb. 11, 1994 - *Executive Order on Environmental Justice*

"All Americans have a right to be protected from pollution—not just those who can afford to live in the cleanest, safest communities."
—President Clinton

This order is intended to create new hazardous material clean-up projects in the nation's lowest income areas. The order is expected to have a sweeping impact on lead removal in public housing, pollution control in urban rivers, and exposure of farm workers to dangerous pesticides.

EO 12902 - March 8, 1994 - *Energy Efficiency and Water Conservation at Federal Facilities*

This order directs Federal agencies to install energy-saving light bulbs and alternatively fueled electric systems and to take other measures that would reduce

energy consumption 30 percent from 1985 levels by the year 2005. Former President Bush issued a similar executive order, EO 12759, which required a reduction of 20 percent from 1985 levels by the year 2000. Little effort was made to enforce it. Other requirements: Minimize use of petroleum products at Federal facilities by switching to less polluting alternative energy sources; significantly increase the use of solar and other renewable energy sources; design and construct new faclities to minimize life-cycle cost through energy efficiency and water conservation technologies; and utilize passive solar design and active solar technologies wherever cost-effective.

Mark Ginsberg, a senior Energy Department official, stated in the March 9, 1994 issue of the *Washington Post* that Federal officials were expected to invest an estimated $250 million in energy efficient technologies a year, and to reap two to three times that amount in saved energy costs. By switching from conventional computers to an energy saving variety the Federal government would cut the annual cost of computer use by 50 percent, now estimated at $125 million a year, Ginsberg said.

A.1.4 Federally Mandated Technology Transfer Initiatives

In addition to the numerous requirements mandated by these statutes and Executive Orders, there is a plethora of Federal initiatives under which Federal agencies are teaming with U.S. industries to research and develop new waste minimization and pollution prevention technologies. Some of these are described here to provide some insight into the magnitude of the effort to develop partnerships and technology transfers between Federal agencies and the private sector. All the initiatives listed here are supported directly or indirectly by DOE. Many other initiatives are described in *Federal Activities to Develop and Transfer Advanced Industrial Technology*, a February 1994 document from the Associate Deputy Assistant Secretary, Office of Industrial Technologies, Office of Energy Efficiency and Renewable Energy.

The National Clean Industry Initiative (NCII) was forwarded to the White House in May 1993 as a DOE Reinvention Laboratory under the National Performance Review. The Initiative represents a broad-based effort to accelerate the development and application of industrial technologies that are cleaner, more energy-efficient, and less expensive than conventional technologies. It focuses on modernizing equipment and processes within small- and medium-sized companies by improving the way government works with industry. The Initiative embraces a balanced approach that seeks to greatly accelerate the adoption of advanced clean technologies by industry while ensuring the development of a steady stream of technological innovation. It builds on traditional U.S. strength in technology development while correcting deficiencies in our ability to transform technological innovation into commercial successes.

This initiative directly supports one of the Administration's three major technology policy goals, that of promoting "long-term growth that creates jobs and protects the environment," as specified by President Clinton and Vice President Gore in *Technology for America's Economic Growth, A New Direction to Build Strategic Strength*, February 22, 1993. The ultimate goals of the NCII are to increase energy efficiency, reduce waste, and prevent pollution in U.S. industry.

The National Industrial Competitiveness through Energy, Environment, and Economics, ($NICE^3$) Program began in 1990 as a cooperative agreement between EPA and DOE, each of which initially contributed $1 million. The $NICE^3$ Program fits within the Industrial Waste Reduction Program whose goal is to improve the energy efficiency and competitiveness of private industry by cost-effectively reducing waste. $NICE^3$ goals are:

(1) Promote technology innovations that simultaneously improve energy efficiency, reduce waste production, increase economic competitiveness, improve productivity, preserve and increase jobs.

(2) Improve cooperation at the regional and state levels among DOE, EPA, states, and the Department of Commerce.

The 17 projects presently underway cost DOE $4.4 million and will result in, by the year 2010:

Energy savings
- 91 trillion BTUs per year

Economic savings
- $2 billion

Waste savings
- 64,000 tons of waste solvents, CFCs and other volatile organics
- 4.7 million tons of carbon dioxide from reduced energy use
- 35,000 tons of sulfur dioxide from reduced energy use
- 17,000 tons of nitrogen oxides from energy reduction
- 4 million tons of hazardous wastes
- 11 million tons of nonhazardous wastes
- 12 billion tons of waste water

Job savings
- 2,500 employee/years

The $NICE^3$ program has sponsored the transfer to the private sector of two technologies. $NICE^3$-funded technologies have created an estimated 140 jobs for each $1 million invested.

Another Federal initiative, the Technology Reinvestment Project (TRP), was developed to execute the programs authorized under the Defense Conversion, Reinvestment, and Transition Assistance Act of Fiscal Year 1993 and other legislation. The TRP is chaired by the Advanced Research Projects Agency of the Department of Defense (DoD), the DOE DP, the Department of Commerce's National Institute of Standards and Technology, the National Science Foundation, and the National Aeronautics and Space Administration (NASA).

TRP programs are structured to expand high-quality employment opportunities in commercial and dual-use U.S. industries and demonstrably enhance national competitiveness. One of the specific areas of interest in the TRP's technology development activity is Environmentally Conscious Electronic Systems Manufacturing. The *Program Information Package for the Defense Technology Conversion Investment and Transition Assistance* explains that the electronics and computer industry is the largest manufacturing employer in the world. According to this document, "Manufacturing by-products of the electronics industry and the disposition of electronic products are raising increasingly important technical and financial issues, and there is a need to improve processes, materials, and manufacturing equipment to control production of hazardous waste material and to be able to recycle the products."

The Strategic Environmental Research and Development Program (SERDP) was established by Congress in Public Law 101-510 (Title 10, U.S.C., Sect.2901-2904) to focus the nation's research and development infrastructure on environmental challenges caused by years of neglect. The purposes of the program are to:

(1) Address environmental matters of concern to the DoD and DOE through support for basic and applied research and development of technologies that can enhance the capabilities of the departments to meet their environmental obligations.

(2) Identify research, technologies, and other information developed by DoD and DOE for national defense purposes that would be useful to governmental and private organizations involved in the development of energy technologies and of technologies to address environmental restoration, waste minimization, hazardous waste substitution, and other environmental concerns, and to share such research, technologies, and the information with such governmental and private organizations.

(3) Furnish other governmental organizations and private organizations with data, enhanced data collection capabilities, and enhanced analytical capabilities for use by such organizations in the conduct of environmental research, including research concerning global environmental change.

(4) Identify technologies developed by the private sector that are useful for DoD and DOE defense activities concerning environmental restoration, hazardous and solid waste minimization and prevention, hazardous material substitution, and provide for the use of such technologies in the conduct of such activities.

One SERDP objective is to provide for the identification and support of programs of basic and applied research, development and demonstration in technologies that will minimize waste generation, including reduction at the source.

A.2.0 Department of Energy Compliance with Environmental Regulations and Executive Orders

Statutes and Executive Orders are incorporated into DOE's fundamental way of doing business through the formulation and adoption of policies and strategies. They are then translated into action through the development and implementation of formal Departmental initiatives and/or DOE Orders.

A.2.1 Pertinent DOE Orders

The existence of a waste minimization program has been a requirement since 1988 under DOE Order 5400.1, *General Environmental Protection*. The Order also requires each site to submit an Annual Waste Reduction Report.

DOE Order 5820.2A, *Radioactive Waste Management*, includes waste minimization requirements for the management of high level, transuranic, and low-level radioactive waste. The Order requires the preparation of a waste management plan for each site that generates, treats, stores or disposes of DOE wastes. The plan stipulates actions to minimize the generation of hazardous wastes.

APPENDIX B

Biographical Information On Chicago Benchmarking Team Members

John Anthony Marchetti is the Executive Officer for the Department of Energy Office of Defense Programs pollution prevention program. He is responsible for the overall coordination and implementation of the program within the nuclear weapons complex.

Richard J. Jendrucko is a professor in the Department of Engineering Science and Mechanics at the University of Tennessee, Knoxville. He currently serves as the Director of the EPA-supported University of Tennessee Waste Minimization Assessment Center.

Elizabeth McPherson is the owner and manager of McPherson Environmental Resources (MER), a professional consulting firm that provides engineering support, benchmarking studies, training, conference organizing, and publishing in the field of pollution prevention and waste minimization.

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