ENVIRONMENTAL COST ACCOUNTING FOR CHEMICAL & OIL COMPANIES : A BENCHMARKING STUDY

A Project of Institute for Corporate Environmental Management at the University of Houston in Partnership with the Business Council for Sustainable Development - Gulf of Mexico

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Purpose of This Report

This report summarizes an Environmental Cost Accounting Benchmarking Study of five major U.S. and Mexican companies currently involved in developing environmental accounting systems. The purpose of the benchmarking study, which was conducted from June 1995 through June 1996, was to compare environmental accounting approaches in oil and chemical companies whose activities have significant environmental impact.

This project was jointly facilitated by the Institute for Corporate Environmental Management of the University of Houston ("ICEM"), and by Pilko & Associates ("Pilko").

We would particularly like to thank the five participating companies for their exhaustive contributions to the study. Due to confidentiality agreements, two of the five companies are referred to using fictitious names, denoted by an asterisk (*) below:

- Celanese Mexicana
- Ciba-Geigy
- Grupo Primex
- International Refineries*
- Specialty Refiners*

The purpose of the study was not to identify a single best system for environmental cost accounting, since requirements of such systems vary with industry, location, corporate culture, and many other aspects of a company. Rather, the purpose was to allow the Partners to discuss the form and functions of the environmental cost accounting systems they are developing or using, as well as to discuss uses for the cost information yielded by such systems. This report summarizes the information shared in the Benchmarking.

For more information about basic Environmental Accounting concepts or EPA's Environmental Accounting Project, contact the Pollution Prevention Information Clearinghouse at 202 260-1023 to have an information packet sent to you, or visit the Environmental Accounting Project website at http:\\www.epa.gov.opptintr/acctg/

Acknowledgments

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Executive Summary

Over the past twenty years, responsible environmental management has become an important focus of companies throughout the world. During this period, many environmental regulations have been enacted, requiring management to consider the environmental implications of virtually every decision facing their companies. Governmental mandates for environmentally responsible behavior have been enacted in virtually all countries.

Recently, there has been a shift in environmental regulation from the "command and control" approach to environmental regulation to market driven forms, in which pollution prevention alternatives are replacing mandated end-of-pipe technologies. This movement is driven by the realization that it can be more efficient (and cost effective) to avoid pollution than it is to clean it up.

Determining the appropriate pollution prevention approach often leads to additional decisions that must be made by management. These decisions include selecting among proposed capital expenditures, and making better pricing and product mix decisions by uncovering the real costs (including environmental costs) of various products and processes. As markets for emissions' allowances develop, companies will want to determine whether it is more cost-beneficial to buy or sell these allowances, given the costs of avoiding the covered emissions. Finally, estimates of subsequent cleanup liability can change the relative attractiveness of acquiring or disposing of a facility.

These decisions require information about costs and benefits that have often not previously been collected. Environmental cost accounting information is useful in improving a number of business decisions. This document describes the process and results of a benchmarking effort conducted to define current practices in environmental cost accounting and future needs.

Project Background

In 1994, as part of on-going environmental accounting research, a benchmarking project was initiated at the Institute for Corporate Environmental Management (ICEM), University of Houston, to examine current practices in environmental accounting in industry. The team assembled included Miriam Heller from Industrial Engineering, David Shields from Accountancy and Taxation in the College of Business, and Beth Beloff from ICEM. The team chose the methodology described as *Cooperative Benchmarking*™ to develop this information. This methodology was created by Pilko & Associates to bring participating companies (Partners) together in small groups to discuss environmental issues/ problem areas and generate new ideas for improving environmental management practices.

At the same time, member companies of the Business Council for Sustainable Development - Gulf of Mexico (BCSD-GM) were developing projects to demonstrate the business opportunities arising from incorporating sustainable development concepts into business decisions. The development of a tool to assist in identifying economic opportunities in reduction of environmental impacts was of great appeal to the BCSD-GM. As a result, member companies from both the U.S. and Mexico were encouraged to participate in the benchmarking effort, and BCSD-GM became a valuable partner in the project. Two non-BCSD members also joined to form a group of five companies from the chemical and refining industries that participated in the

study. The companies were Celanese Mexicana, Ciba-Geigy, Grupo Primex, "International Refineries," and "Specialty Refiners."

The environmental cost accounting *Cooperative Benchmarking*™ process can be characterized by the following steps:

- Determination of Factors and Issues of most interest to the participating companies.
- Conversion of Factors and Issues into an in-depth questionnaire.
- Formation of cross-functional teams within companies to complete the questionnaires and prepare case studies highlighting specific applications of environmental accounting to corporate decisions.
- Implementation of two in-depth multi-day benchmarking sessions in which companies presented information developed for the questionnaire and case studies to the group.
- Facilitation of group discussions around issues presented and lessons learned.
- Distribution to participating of confidential reports summarizing results and review.
- Generation of the sanitized version of report to sponsoring organizations.

What are Environmental Costs?

Due to the importance of accurate cost information in making the decisions sketched out above, the term "environmental cost" has been introduced into the vocabulary of environmental managers. Environmental cost has been defined in various ways. During the benchmarking sessions, the term was often used to refer to costs incurred in order to comply with regulatory standards, costs which have been incurred in order to reduce or eliminate releases of hazardous substances, all other costs associated with corporate practices aimed at reducing environmental impacts, and costs associated with ***not*** addressing these issues. (More uses of the term can be found in the Environmental Protection Agency's *Introduction to Environmental Accounting As A Business Management Tool: Key Concepts and Terms*[1]*.)* Six observations emerge from the definition provided here:

1. Environmental costs are really a subset of the costs of operating a business. Formerly, when substances were released into the air, water or land, the resulting pollution would be considered a social cost, an externality. Regulation has resulted in internalization of some of these environmental externalities, through, for example, requirement of additional investment in equipment or training, or for fines and fees resulting from noncompliance.

2. As environmental externalities become internalized, new costs emerge. These new costs must be captured by the cost accounting system, so that product costs remain accurate enough to facilitate sound decision making. For example, how should the cost of improved waste treatment (wastewater plants, incinerators, etc.) be reflected in the costs of the products responsible for waste generation?

3. The magnitudes of environmental costs are greatly underestimated, and their impact on product or process costs is often obscured through inaccurate overhead accounting. Environmental costs are often hidden in overhead and underestimated. For instance, in another

[1] Environmental Protection Agency 742-R-95-001, June 1995, 39 pages.

effort, the Amoco Yorktown Refinery case study documented in "*Green Ledgers: Case Studies in Corporate Environmental Accounting,"* a large sample of employees estimated environmental costs to be 3% of non-crude operating expenses. After further investigation, those costs were found to be *at least* 22% of non-crude operating costs[2].

4. Environmental cost information, like all cost information, is useful only when there are decisions that are facilitated by knowing that information. Among the decisions that can be facilitated by environmental cost information is product costing. Product costing accuracy is not improved by defining costs already accurately assigned to products by the cost accounting system, regardless of whether they are ***called*** environmental. That is, the label "environmental" does not improve cost accuracy in this case but it may enable cost reduction of the product.

5. Many superior environmental projects are often not identified as environmental because they convey operating benefits as well (i.e., pollution prevention projects which increase yield). Sometimes, the best environmental projects are not identified as environmental at all. Conversely, end-of-pipe treatments are classified as environmental and are often given high priority by management, but may not represent the best solution to the problem. Thus, proactive environmental management often leads to higher "nonenvironmental" costs and lower environmental costs.

6. Despite the existence of fledgling environmental cost accounting systems, participating companies relied on techniques such as Life Cycle Assessment and materials balancing, which do not require financial data. They claim that, in many cases, environmental cost information is less useful than non-financial, real-time measures of performance. Participating companies had difficulty providing environmental cost data relating to various types of environmental activities.

Attitude Toward Environmental Stewardship

As is true with the development of any management initiative, the development of environmental cost accounting systems is dependent on the corporate culture, or attitudes, in place. Given favorable attitudes among top management, an internal champion, adequate funding, and follow-through that includes integration of the tool into everyday decision-making, the development of such a system is likely to succeed. Without such support, the system will not have an impact.

The degree of success experienced by the participant companies in establishing and using environmental accounting systems reflects this. Some participating companies appear to value environmental considerations as one of the primary keys to company success. Other companies supported voluntary environmental initiatives less enthusiastically. However, their agreement to participate in this study indicates a strong interest in responsible environmental management.

In the companies with cultures supporting high integration of environmental functions into the business processes, it was considered less important to differentiate between environmental and nonenvironmental costs, and emphasis was placed on allocating *all costs* to

[2] Ditz, D., Ranganathan, J., and Banks, D.(ed.). (1995). Green Ledgers: Case Studies in Corporate Environmental Accounting, World Resources Institute, Washington, DC.

product and processes. In those companies less well integrated, there were more reasons found to identify environmental costs separately from other costs.

Environmental Cost Accounting Systems

A supportive corporate culture forms the foundation for developing a successful environmental cost accounting system. Participating companies point to varying degrees of success:

International Refineries is addressing environmental cost accounting by identifying environmental costs through a coding system. Similarly, Ciba-Geigy describes the development of an environmental cost accounting system based on detailed overhead accounting; one which also incorporates standard cost variance analysis. This system will be useful in allocating environmental costs to the products and processes that cause them, and isolating nonstandard cost performance where it occurs.

Both International Refineries and Grupo Primex are approaching environmental costs by retrofitting to their existing accounting systems. International Refineries and Ciba-Geigy generate environmental cost data as part of the General Ledger systems. Grupo Primex and Specialty Refiners utilize free standing systems that access, but are not directly integrated with, other systems.

The categories defined for accumulating environmental costs may directly affect how environmental cost information is and can be used within an organization. Each company's "cuts" at the problem was a little different. For example:

- International Refineries' system tracks and defines all HSE related expenditure by category, media and line of business, yet has difficulty tracking environmental costs by location or sub-unit.
- International Refineries' focus on expense elements is consistent with their primary use of the system as an aid to capital budgeting for environmental projects
- International Refineries, Grupo Primex and Specialty Refiners have a strong focus on the environmental cost of a product. Accumulated costs in high level categories generally limited the degree to which such costs could be used for "what if" analyses.
- Ciba-Geigy accounts for environmental costs by product or as part of capital projects. These distributed environmental costs are difficult to accumulate by other categories.

No company was developing activity-based environmental accounting systems. Thus, there was no direct attempt to identify the relationship between managerial decisions and the costs of those decisions. At best, the focus was on improving how costs associated with environmental processes are allocated to product. In many cases, this entailed installing better measurement capability to improve cost allocation. For example, Ciba-Geigy has implemented a transfer pricing mechanism to provide appropriate internal economic signals.

No environmental cost system tracked intangible or less tangible costs. Specialty Refiners reported that historical liability was considered in their system but no details were given. Ciba-Geigy and International Refineries track remediation and liability costs using another system.

Some companies found value in defining synthetic performance measures over aggregate information: ecological management ratios (Grupo Primex) and cost per pound of waste (International Refineries). Ciba-Geigy believes that environmental costs cannot adequately indicate performance and that other methods, such as materials balancing and Life-Cycle Assessment is necessary complementary tools for environmental cost management.

Use of Environmental Cost Accounting in Managerial Decision Making.

A number of difficulties may hamper efforts to incorporate environmental cost accounting information into business decision making. For example, end-of-pipe projects are more easily identified as environmental than are pollution prevention projects. By prioritizing environmental projects which are required for compliance (which is done by all of the participating companies), there may be a bias toward acceptance of end-of-pipe projects at the expense of superior, pollution prevention projects. Indeed, the structure of environmental cost accounting information will have a profound effect on the decisions. Conversely, the corporate culture will directly affect decisions regarding the kind of environmental cost accounting information to be gathered.

All companies differentiated between environmental capital expenditures and environmental operating and maintenance costs. They reported systematic methods for evaluating capital expenditures for budgetary approval. Environmental operating and maintenance costs are tracked in most cases. However, these costs are not singled out for special management. They are used in the same way as nonenvironmental costs, to identify problem areas in cost performance (identification of significant deviations from budget), or to demonstrate the cost impact of process improvements.

A major issue identified by participants relates to circumstances in which environmental cost accounting information is more useful to managers than real-time nonfinancial information, such as waste stream metering and yield rates. In general, the participants felt that nonfinancial measures were superior to financial information for day-to-day management, but that financial information more effectively justified the need for intervention to top management.

Summary of Key Findings

		Ciba-Geigy	Grupo Primex	International Refineries	Specialty Refiners
I	**CULTURE**				
	(1) Approach Compiance- driven (2) Incentives	• Compliance as responsib. of line organization. • Highly integrated env.function • ISO 14001 expected • Sustainable development core value	• Compliance oriented • Decentralized EHS • ISO 14001 expected • Zero effluent corporate goal	• Compliance oriented • Decentralized EHS • No ISO 14001 decision • Management focus on cost benefits of environmental decisions	• Compliance oriented • Becoming more decentralized • ISO 14001 under study • Moving EHS management from tactical to strategic
II	**SYSTEM**				
	(1) Environ- mental Cost System Features	• Part of General Ledger • Cost elements detailed on product cost sheet • Transfer pricing • Remediation costs are not included • Only tangible costs addressed • Depreciation, R&D, etc. costs are pooled	• Stand-alone with intent to integrate with MIS • Use income statement categories: - variable (audits,RA,penalties) - maintenance (on env. assets) - fixed (env. personnel) • Only tangible costs addressed • Depreciation of environment equipment and assets commingled	• Appends prefixes to General Ledger expense codes • Defines 8 EHS product code categories: safety, air, water, solid/ hazwaste, remediation, spill cleanup, medical services, other • 30 product codes in all • Only tangible costs addressed • Everything is a "cost center"	• Store on manually generated spreadsheet with inputs from GL &Maintenance Mgmt. System • "Environmental" defined by API • EC analysis Ad hoc/as needed • Labor costs stored on payroll sys. • Only tangible costs addressed
	(2) Ancillary Systems	• Meters track material flows by building • Material balancing • LCA using pollution index	• Meters track effluent volume and loading at the unit level • Measure and report releases to water, air, and soil as well as water usage for env. compliance	• None specified	• Maintenance Management System • Payroll for labor costs • Capital projects database • Working toward meter capability
	(3) Decision Focus/ System Goal	• Product costing • Profit & inventory valuation • Total cost control and management	• Define EC contribution to conversion cost • Evaluate EC impact on profit • Enable performance measures based on ecological management ratios (lbs waste/lbs product)	• Improve reporting • Provide detailed EHS costs to management • Budgeting • Standardize EHS cost capture throughout divisions	• Define "point of generation" costs and assign to product lines • Unifying metric/communications tool for decentralized EHS
	(4) Users	• Line employees • Corporate Environmental affairs personnel • Accounting personnel maintain system		• Field and accounting personnel	• Waste management teams • Project managers justify expense • Environmental staff reporting • Accounting maintains GL • Maintenance maintains MMS • Corporate Info. technology group maintains interface

Summary of Key Findings

		Ciba-Geigy	Grupo Primex	International Refineries	Specialty Refiners
III	**DECISIONS**				
	(a) Operating	• Env. costs are tracked separately • Env. aspects of ongoing operation allocated to product	• Env. costs are tracked but not different from other costs.	• Env. costs are tracked to improve budgeting, find cost saving opp.(volume disc.) push cost resp. to business unit and better understand costs of alternate remediation.	• Product mix decisions incorp. environmental cost info, where price flexibility, pricing incorp. environmental costs. • Intangible, qualitative issues considered in envi. decisions.
	(b) Capital expenditure	• Capital projects must meet normal hurdle rates/unless mandated; if required for compliance approved	• Capital projects must meet normal hurdle rates/unless mandated; if required for compliance approved	• Capital projects must meet normal hurdle rates/unless mandated; if required for compliance approved	• Capital projects must meet normal hurdle rates/unless mandated; if required for compliance approved
IV	**OVERALL**	**SYSTEM**			
	(1) Strengths	• Product costing, profit, and inventories are more accurate • Clearly defines responsibility and accountability • Information is provided at appropriate, effective levels in the organization	• Well positioned to integrate with real-time data • Use MIS to relate environmental costs to financial information	• Simplicity and basis in current system makes use likely • Low incremental cost • Extensibility • Only as accurate as current cost codes • High availability of data	• Based on reliable General Ledger
	(2) Weak--nesses	• Environmental cost elements may not be labeled as such • System lacks flexibility to accumulate costs for some meaningful environmental decisions, e.g., technologies • Inflexibility hampers EC and and LCA integration	• Personnel resistance indicates lack of clearly defined respon-sibility	• Maintenance security • No distinction between recurring and non-recurring costs • Cannot trace cost to specific unit • No transfer pricing • Only captures labor costs associ-ated with "environmental unit"	• Politically difficult to set up new cost codes • High level systems directed at external reporting • Limited user training • Manpower intensive • Lack of low-level decision costing (spill, permitting)

Project Background

In the 1990's, the traditional command-and-control approach has given way to a more market-driven regulatory strategy. Today, businesses are encouraged to select technologies and methods to best meet environmental performance standards, taking cost-benefit relationships into account. Yet, the market-driven approach can only be successful if companies understand their cost structures, including environmental costs, and the economic benefits that arise from improved environmental performance. For assistance, environmental managers are seeking decision support tools to characterize the cost and benefit relationship of environmental activities. They need tools to bridge the communication gaps between environmental, financial and operations managers around these issues. Reliable environmental cost information and accounting models for allocating environmental costs to specific activities, processes, and products are essential for the market-driven approach, as well as for the broader integration of environment into the business, to succeed.

Over the last three years, the Institute for Corporate Environmental Management (ICEM) at the University of Houston, in response to requests from business, has been coordinating the development of an environmental accounting framework. This research has been directed by an interdisciplinary environmental accounting team, through grants from the University of Houston, National Science Foundation, Gulf Coast Hazardous Substance Research Center, US Environmental Protection Agency, and Management Institute for Environment and Business.

A major step toward building a foundation for a corporate system to account for environmental costs are to understand current practices of leading companies in similar industries. The ICEM team chose the methodology described as ***Cooperative Benchmarking***$_{SM}$ to develop this information. This methodology was created by Pilko & Associates to bring participating companies (Partners) together in small groups to discuss environmental issues / problem areas and generate new ideas for improving environmental management. ***Cooperative Benchmarking***$_{SM}$ is an attempt to produce results far exceeding those realized from traditional benchmarking methods. The benchmarking sessions are rigorous, with each session lasting two to three days.

In 1994, ICEM and Pilko & Associates initiated the Environmental Accounting Benchmarking Project to develop an understanding of environmental cost accounting through a benchmarking study of corporate practices. The project had the following objectives:

- To collect information on what companies in the chemical and refining industries are doing in accounting for environmental costs and how environmental accounting can provide decision makers with the information they need.
- To develop case studies from each participating company on how they are grappling with the issues of environmental management and cost accounting for environmental activities.
- To establish baseline environmental cost information as identified by all participating companies.
- To develop a framework for understanding the nature and uses of environmental accounting.

At the same time, member companies of the Business Council for Sustainable Development - Gulf of Mexico (BCSD-GM) were developing projects to demonstrate the business opportunities inherent in incorporating sustainable development approaches in business decisions. BCSD-GM recognizes the value of developing a tool to assist in identifying economic opportunities in reduction of environmental impacts. The BCSD-GM encouraged its U.S. and Mexican companies to participate in the environmental cost accounting benchmarking project. In addition, several companies outside of the BCSD membership were approached.

The Environmental Accounting Benchmarking Project was formed with the assistance of grants from various sources previously mentioned and a commitment from the companies to cover direct project expenses. The companies agreed to the participation of two corporate individuals representing three skill sets: environmental, operations and finance. David Shields from the University of Houston (ICEM) and Eric Dietert from Pilko agreed to co-facilitate the benchmarking sessions. Research assistants from the MBA, Industrial Engineering, and Chemical Engineering programs at the University of Houston were brought into the project. Confidentiality agreements were signed by the benchmarking team.

Company profiles and examples of each company's usage of environmental accounting can be found in Appendix A.

The Benchmarking Process

The benchmarking process has been organized into four parts: Defining Project Objectives from Factors and Issues, Data Collection through Questionnaires, Benchmarking Sessions, and Synthesis. The following diagram captures the flow of activities characterizing the entire effort[3]:

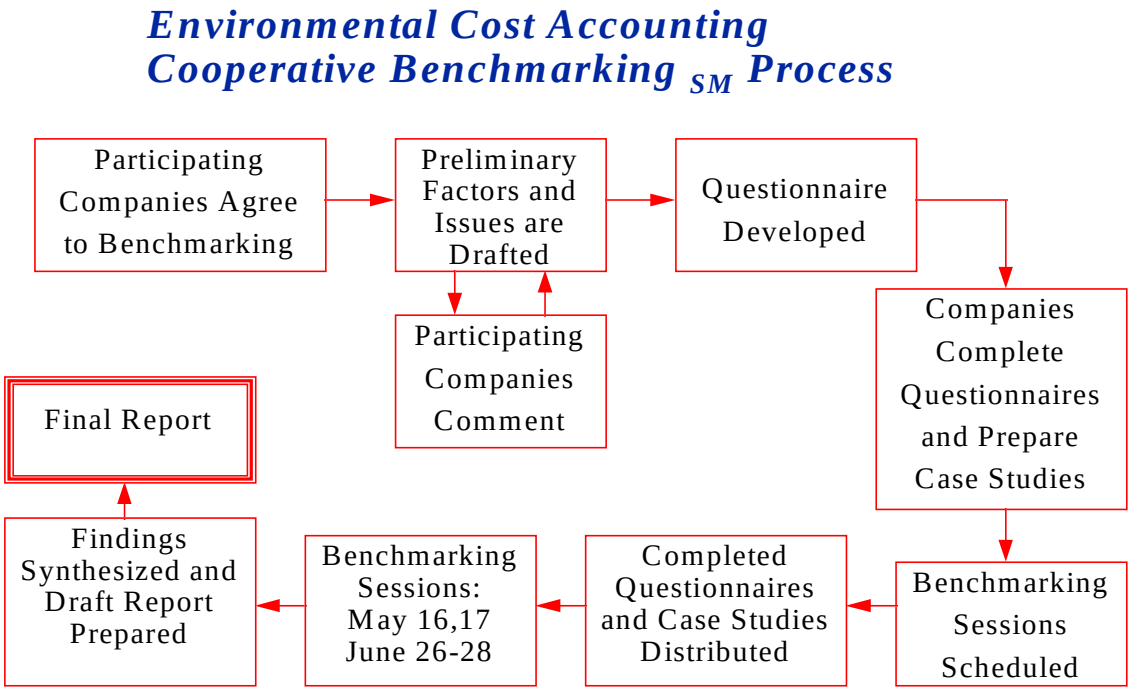

Figure 1: Environmental Cost Accounting *Cooperative Benchmarking*$_{SM}$ Process

Defining Project Objectives through Factors and Issues: In an effort to organize the project around environmental accounting factors and issues of greatest interest to the Partners, a list of eighteen factors was prepared. Definitions were discussed and Partners ranked the factors by greatest to least interest. This formed the basis for the organization of the Data Collection phase of the project. (Table A, *Ranking of Factors and Issues*)

Partners were most interested in 1) understanding how to monitor for environmental costs; 2) developing systems for cost accounting; 3) automating environmental accounting information systems; 4) and learning about methods to allocate environmental costs to product and process. They chose to emphasize the decision support aspects of the accounting developments: managerial control, budgeting, etc. Of least interest to participants were the impacts of North American Free Trade Agreement (NAFTA) on costs, and life cycle costing.

The underlying structure for the project (as depicted in Figure 2) became clearer during the discussions regarding factors and issues. It became apparent that corporate attitudes toward responsible environmental performance (corporate culture) were the primary factor in

[3] *Cooperative Benchmarking*$_{SM}$ *is a service mark of Pilko & Associates, Inc.*

determining the implementation and use of environmental cost accounting systems in decision making.

Data Collection: On the basis of the Factors and Issues work (refer to Table A), the ICEM/ Pilko team developed a *Questionnaire* to assist Partners in generating information about their operations and environmental cost structures. (See Appendix B) The information gleaned from the questionnaires was used to generate case studies which were presented to the other Partners during the benchmarking sessions.

The questionnaire was divided into five parts:

- Company Overview
- Attitude toward Environmental Stewardship/ Corporate Culture
- Environmental Cost Accounting Systems
- Environmental Costs & Non-Financial Performance Measures
- Cost Information for Decision Making

In addition, guidelines for case presentations by partner companies were distributed.

Benchmarking: Benchmarking was organized into two sessions over five days. Partners were given guidelines for presenting the information developed for the questionnaire. Presentations were organized to flow from company overview and culture, to environmental cost accounting systems, costs and other performance measures, and cost information for decision making. Case studies were interspersed throughout the five days and were often presented in conjunction with the related topic of discussion.

Discussion was guided by the ICEM/ Pilko team. Key issues and findings were noted periodically and summarized at the end of each session. All companies except Ciba-Geigy were represented in the first session; all companies except Celanese Mexicana were represented in the second session.

Synthesis: Results of the benchmarking sessions were summarized first in a draft report, and reviewed by the participants. When completed, this confidential report formed the basis for documentation and recommendation to the participating companies.

This report, sanitized of confidential information, was generated for use by outside sponsors of the study. The intent of this report is to provide generalized findings about corporate environmental cost accounting procedures and uses for the chemical manufacturing and petroleum refining industry.

Table A - Ranking of Factors and Issues

Factor*	***Rank***
Environmental cost monitoring	1
Full cost accounting	2
Environmental accounting info. systems	2
Capital Versus Operating	3
Management Control	3
Environmental cost allocations	3
ECA info. for decision support	3
Budgeting process	3
Future environmental liabilities	4
Compliance versus voluntary costs	5
Reporting Systems - Accounting systems	5
Remedial/clean-up costs	5
Other metrics	6
Life cycle cost accounting	6
EC info. for external-focused issues	7
Environmental cost drivers	7
Public financial disclosure statements	7
NAFTA	7

* Note: Working definitions are given in Appendix C

Environmental Accounting System Development Framework

The following framework illustrates the relationship between different management processes involved in environmental cost accounting. This framework was the basis for the questionnaire developed in conjunction with the Environmental Cost Accounting Benchmarking Project. Each of the elements in the framework was the subject of one or more discussion sessions during the Benchmarking Sessions.

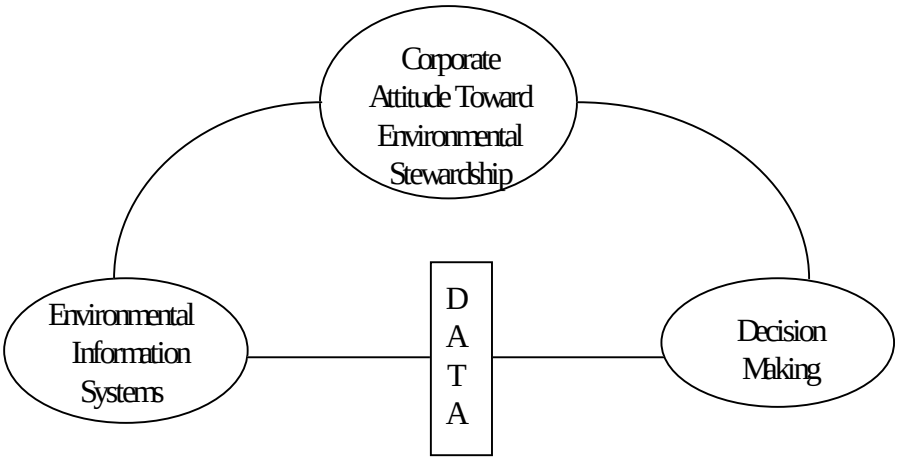

Figure 2 : Conceptual Level Framework for Environmental Cost Accounting

The framework reflects the interrelationship between corporate culture (attitude toward environmental stewardship) and the availability of resources for development of an environmental accounting system. Only companies with a clear desire to integrate environmental decision making into the normal business context is likely to make such an investment.

The environmental information system will generate data that would otherwise be unavailable to managers. This data may be cost-based or may consist of nonfinancial measures. Nonfinancial measures can be used to either generate financial measures with the addition of other data, or they may be used directly, as real-time data.

In either case, the data provide evidence relating to the decision to be made. Ultimately, the creation of better information systems generates better data that support better decision making. This, in turn, may have a feedback effect on the organizational learning and culture of the company. This culture change brings about conditions that could cause future changes in the organization's information systems as well as the kinds of decisions that management will make.

Attitude Toward Environmental Stewardship

During this project, it became clear that, for the five participating companies, an organization's attitude toward environmental stewardship is directly related to the company culture and, in fact, is a subset of the company culture. An example for assessing how these elements function together was offered by one Partner company. Ciba-Geigy has published its environmental policy: "Vision 2000" which describes a balance between the economic, social and environmental responsibilities that will ensure the prosperity of the business beyond the year 2000.

The Vision 2000 policy reflects the company culture at Ciba-Geigy, defining the nature of the organization and describing the core values that determine the actions of the company:

- **Economic Success:** This is ultimately the measure by which companies and their shareholders evaluate their success.

- **Social Responsibility:** Ciba-Geigy accepts responsibility for the effects of its actions on employees, the community, and other stakeholders.

- **Environmental Responsibility:** Ciba-Geigy strives to maintain a policy of sustainable development, including resource conservation and pollution prevention. The goal is to conduct business in a way that will not impede the ability of present and future generations to meet their needs.

This attitude toward environmental stewardship helps to define the organization through its culture because the culture represents the set of values, norms and procedures that serve as the foundation for any environmental project. The culture is affected by the dominant individuals in the organization, as well as by the industry and, perhaps, the nationality of the company. Nationality can be important due to differences in laws and regulations, socio-economic conditions, and cultural traditions.

The five Partners made presentations on the topic of attitude toward environmental stewardship. Although the topics discussed during this session varied with each Partner, most of the discussion centered around a few main areas. These areas include: the environmental organization and associated roles and responsibilities; environmental management systems, policies and procedures; environmental standards, compliance efforts and voluntary programs, and organizational changes.

Structure of the environmental organizations. All five Partners have some form of environmental organization. The roles and responsibilities of these environmental units vary among the Partners. Some companies organize their environmental group in a decentralized manner. In these cases, significant resources are placed at operating facilities while the corporate group provides an oversight and limited support role.

Other Partners allocate a greater share of resources to a centralized organization. The centralized environmental group provides proportionately more top-down support to the facilities. The amount and allocation of environmental resources provide an initial indicator of the company's attitude toward environmental stewardship. However, differences in

organizational demands for environmental services may also explain the different organizational structures and resource allocations.

U.S./Mexico Environmental Climate. Each Partner has developed environmental management systems, policies and procedures which reflect their national cultures, as well as their corporate cultures. All Partners, whether Mexican or U.S.-based, are concerned with compliance with applicable environmental rules and regulations.

The regulatory requirements in the U.S. and Mexico are generally similar, but there are also a number of differences. Many of the regulations created in the U.S. are subsequently issued in Mexico after a time lag of several years. Consequently, it may be easier for Mexican companies than for U.S. companies to accurately predict what future regulations will be.

The Mexican companies in this study claim that they face a more regulated environment than U.S. companies in the use of water. Water usage is taxed at a higher rate than in the U.S., and is taxed twice: once when it is extracted from groundwater wells, and a second time either as the cost of treating the water to standards or the costs of reinjecting water to water quality standards. This double taxation results in very conservative water usage policies by Mexican Partners.

The extent to which the Partners participate in voluntary environmental programs varies with the nationality of the company. The U.S. companies tend to have more voluntary program participation than do the Mexican companies. However, there are fewer voluntary programs in Mexico than in the U.S. The direction of causation is not clear: do voluntary programs generate interest among companies, or do companies provide the impetus for voluntary programs?

All the Partners have undergone or are in the process of undergoing significant environmental organizational changes. This phenomenon is not limited to the current wave of "re-engineering" which is occurring in many U.S. industries. Additional competitive pressures, brought on by dynamics such as the globalization of industry and political policy changes such as NAFTA, have caused the Mexican Partners to undergo significant organizational changes as well. (Recall that Partner companies ranked NAFTA-driven environmental changes as relatively uninteresting during the planning session.)

The following sketches out relevant aspects of the corporate culture of the participating companies:

Ciba-Geigy. Within Ciba-Geigy, compliance is the responsibility of the line organization. If the line organization requests assistance in determining compliance levels, or for related support, several groups are available to provide it. These include Environmental Affairs, Regulatory Affairs, Legal Department and Regulatory Networks. If local standards are below Ciba-Geigy's internal standards, they will comply with the higher standards.

Ciba-Geigy participates in a number of voluntary programs including ICC Charter for Sustainable Development, Responsible Care, ISO 14000 (site by site), EPA 33/50, Environmental Leadership and Green Lights. In general, all employees are responsible for both regulatory compliance and company internal standards. Environmental performance goals are part of the organization's objectives. Consequently, there is a corresponding impact on compensation. Adherence to these environmental regulations and standards is everyone's responsibility day in and day out.

Grupo Primex. Within Grupo Primex, compliance issues are a top priority. Compliance with effluent discharge limitations is currently under evaluation. The company plans to start up a wastewater treatment system to address chemical oxygen demand, suspended solids and oil and grease exceedences.

In addition to its membership in the BCSD-Gulf of Mexico, Grupo Primex participates in the Responsibilidad Integral: El Compromiso de la Industria Quimica (Integral Responsibility: The Commitment of the Chemical Industry). This voluntary program is analogous to the Responsible Care program in the United States. This program is aggressive as companies have agreed to full implementation in five years.

Grupo Primex reorganized and downsized during 1993. The company closed a plant and is now conducting all operations at a single complex. Upon completion of the reorganization, Grupo Primex began a program of paying employees who submit ideas that improve environmental performance, but only after the idea is implemented.

International Refineries. Within International Refineries, the operating unit is responsible for conformance with the environmental policy. International Refineries employs a decentralized staff, placing resources at operating locations. A lean and flat organization provides preventive support to the operating organization for ongoing efforts.

International Refineries' environmental policy is signed by the CEO and was last updated in 1990. The management systems emphasize preventive programs, and senior management supports efforts by the corporate environmental group to improve performance. As demonstrated in the case studies included in this report, International Refineries management sees value in better understanding its environmental costs.

International Refineries participates in a number of industry and government voluntary programs. These include Responsible Care, American Petroleum Institute's(API) STEP, EPA 33/50, Green Lights, Natural Gas STAR and Energy STAR. Incentives have been created for improvements in environmental performance. Individual performance review has an environmental element, and senior management performance review also includes an informal environmental element.

International Refineries has significantly changed its organization and asset structure from 1990 to 1995. Assets in the Exploration and Production and retail marketing areas have been rationalized. The upstream operations have been consolidated and new business units were created for the downstream and chemical operations. These changes have led to an approximate 30% decrease in headcount. During this period, the Health, Safety and Environmental (HSE) group has increased headcount and created a stable structure.

Specialty Refiners. Specialty Refiners conducts a compliance auditing program to evaluate the effectiveness of compliance efforts at the company's facilities. Specialty Refiners also requires annual assurance letters from facility management which certify compliance with regulations. Specialty Refiners also participates in a number of voluntary programs including: EPA 33/50, API STEP, Green Lights, Waste Wise and ISO 9000.

Specialty Refiners has been a leader in developing a used oil stewardship program in support of its car service business. Major efforts under the auspices of the API included the formation of a used oil coalition which consisted of 12 to 15 oil companies. Another effort was in the area of developing model laws and regulation for the used oil, mainly to prevent it from becoming a hazardous waste.

Specialty Refiners reorganized during 1995, effectively moving corporate resources out to operating facilities. The corporate group is currently responsible for regulatory matters and environmental policy. There are also two shared services groups. These are remediation and occupational health, both located within the marketing division. All other functions are within the operating divisions or at the facility. There are approximately 100 full time equivalents involved in the Environmental Safety and Health (ESH) group.

Environmental Cost Accounting System Development

In the sessions, each of the partner companies discussed their current system for generating environmental cost information. A variety of methods were used. Some systems were wholly integrated, or layered, onto the General Ledger. Other systems were in the fledgling stage, existing as ad hoc systems that access information from other established systems to fulfill decision making needs as they arise. Each system is described more fully in the following section.

Ciba-Geigy. Ciba-Geigy has identified two uses for environmental cost accounting. The first use is to assign the proper current cost to the correct product, for profit determination and inventory valuation. The second use is to provide management with support for controlling and managing costs. Ciba-Geigy recognizes the impact of misallocation of overhead costs, which often include environmental costs, to product. The system implemented by Ciba-Geigy addresses most issues regarding environmental costs by instituting an improved cost accounting system that accurately associates each cost with each product.

Ciba-Geigy generates environmental cost information as part of the General Ledger System. Each product has associated with it a detailed product cost sheet which defines all cost elements associated with the product. Given for each cost element is the unit of measure, consumption per 100 pounds of product, unit price and cost per 100 pounds of product (see Table B at the end of this section for a fictitious cost sheet.) The cost elements include raw material, direct labor, equipment, repair and maintenance, electricity, steam, analysis and quality control, wastewater, incinerated wastes broken down into solid, organic and aqueous types, general facilities, services, and overhead (general FS&O), and unit overhead.

While the cost sheets enable more accurate product costing, controlling and managing environmental costs are dealt with using transfer pricing mechanisms. Ciba-Geigy has weighed several methods for determining the appropriate rate for the transfer price. One method, using the ratio of the total cost to total capacity is easy to implement, provides a predetermined rate for the budget cycle, and it adequately reflects a lower cost for lower usage. However, since it is not normalized to reflect actual usage rather than total capacity there may be unallocated costs.

Another method, which defines the rate as the ratio of total cost to actual usage, shows the real cost of services but results in a rate that varies during the budget cycle. This method may not provide incentive to minimize wastes, since the environmental cost will depend on the interactive effects of all users of the service. For example, if all users reduce their use of the service by one half, none will realize a reduced rate for usage, as the corresponding unit rate will double.

Moreover, Ciba-Geigy recognizes limitations of purely financial information. Ciba-Geigy has developed another management tool for computerized reporting known as SEEP (Safety, Energy, and environmental Protection). The system requires all major production sites to input to SEEP data on safety, resource use and environmental releases, excluding those from the raw materials production and consumer use stages of the product life-cycle. Cost data are also manually entered by site. Aggregate and analytic forms of these data form the foundation of Ciba's Corporate Environmental Report. Also, these data fit directly into a limited Life-Cycle Assessment methodology currently under development to improve the cost-effectiveness of

environmental decision. (A more detailed description of the use of LCA is given in the Ciba-Geigy Case Study.)

System users and system maintenance. The system is used by line employees to manage ongoing environmental costs (as with other costs). Cost information is available throughout the organization and each operating unit knows product costs. Corporate Environmental Affairs is responsible for remediation costs, but these are not handled by the cost accounting system. They are dealt with in a fashion similar to how capital investment projects are handled. The maintenance of the systems rests with corporate, division, and plant accounting functions.

System strengths and weaknesses. The system clearly defines responsibilities and accountabilities. The objective is to try to account for environmental costs at the location and level where individuals are responsible for them and can make decisions to manage them.

A primary weakness of the system is that environmental costs are part of many cost centers. This leads to environmental costs being general and summary in nature. While charge back mechanisms should facilitate improvement, it is difficult to explicitly define environmental costs and accumulate them into meaningful categories. For instance, aggregating environmental cost information over multiple cost centers, as is required to be consistent with annual SEEP reporting needs, is very difficult.

Grupo Primex. In 1996, Grupo Primex began environmental cost monitoring. Goals for the environmental accounting system were established. First, the environmental cost accounting system was to be a sub-system from their existing management information system. Second, the system needed to assist Grupo Primex in determining the impact of an environmental cost on net profit and conversion (direct labor and overhead) cost. Finally, the system would have to enable performance measurement, at all levels in the company based on ecological management ratios. The ecological management ratio is an index which measures pounds of waste produced per pounds of product, i.e., it is a waste-focused yield measurement. The index is not yet widely used in the plants.

Grupo Primex focuses on environmental costs in certain income statement categories: variable costs, maintenance, and fixed expenses. Variable costs may fall into a general regulatory category, which includes environmental audits, risk assessment, penalties, remediation or research and development. Other variable costs are tracked by media. Variable costs associated with water may relate to duty payments for environmental permit exceedences not associated with audits, compliance fees for particular discharge conditions, utilities, electricity, water analysis, and labor costs. Water has double costs, since there is a fee to extract it from the ground as well as to dispose of it. Variable costs for air include monitoring and duty payments (fees and taxes). Currently, Mexico has nothing comparable to the Clean Air Act Amendments of 1990. Variable costs for hazardous materials may be associated with analysis, duty payments, treatment and disposal, transportation and labor cost. Finally, costs for soil analyses and duty payments are variable.

Measurement instrumentation enables Grupo Primex to track environmental costs at the unit level. For instance, the costs of the wastewater treatment plant are allocated to each product according to loading and volume.

Mexican companies report usage and emissions to the government to determine duty payments. Payment is made when emissions are reported. Water is reported quarterly; air emissions are reported once per year. Soil is reported periodically. Funds are escrowed, based on predicted duty payments. To facilitate reporting, Grupo Primex's General Ledger tracks metric

tons of production with costs. The financial and environmental management systems are reviewed on a monthly basis.

Maintenance costs include all expenses incurred as a result of preventive and corrective maintenance for ecological assets, e.g., the wastewater treatment plant. Fixed expenses are integrated by salaries and wages paid to ecology department personnel.

System strengths and weaknesses. Grupo Primex has begun separating environmental costs from operating costs. The system is free standing and does not directly access data from any other system. However, they have made strides in procuring measurement equipment that enables real-time data collection. Environmental costs can be related to financial information using their management information system.

One principle problem with the environmental accounting system is implementation. People resist what they perceive to be forced compliance or behavioral change. The company is trying to provide incentives through monetary recognition of individual initiatives once implemented.

Another issue to be resolved is the company's operating definition of environmental costs. This definition process is not complete, so not all potentially interesting information is being collected. For example, the current system does not attempt to track less tangible costs.

Depreciation costs of environmental equipment and production assets are commingled, i.e., environmentally-related depreciation is not separated from depreciation of nonenvironmental assets. This distinction is more important in Mexico than in the U.S., because, in Mexico, if a capital investment is for environmental assets, it can be fully depreciated in the first year, resulting in significant tax savings.

International Refineries. Four overarching goals led International Refineries to the decision to extend their accounting system to incorporate environmental costs. First, International Refineries would like to improve reporting capabilities for governmental, public and industry concerns. Second, the system would provide additional detail to management about Health, Safety and Environment (HSE) expenditures. Third, such a system would provide a standardized approach to capturing HSE data through divisions. Finally, International Refineries opted to "enhance" the system rather than risk disruption and change through the construction of an entirely new system.

Specific requirements for the system were internally generated. The system would be simple but would have the capability to 1) track and define all expenditures related to health, safety or environmental projects by category, media, location and line of business; 2) track penalties and fines imposed by regulatory agencies; and 3) spot errors. System development entailed three people working for seven months: two accountants and one environmental specialist.

The Enhanced Health, Safety and Environmental(HSE) Accounting System builds on the existing accounting system by defining HSE product codes. These HSE product codes are teamed (via prefix) with existing accounting, location, and expense codes. There are eight categories of HSE product codes: safety, air, water, solid and hazardous waste, remediation, spill cleanup, medical services and other (e.g., maintenance). Other categories correspond to those defined by the U.S. Census Bureau and the American Petroleum Institute (API) in their annual surveys.

HSE product codes for safety include compliance fines, monitoring, asbestos, safety equipment and safety supplies. HSE product codes for air include compliance fines, emissions

testing, and stack sampling. Solid waste product codes include compliance fines, hazardous waste, non-hazardous waste, and waste testing and analysis. Remediation codes include soil remediation, compliance fines, testing and analysis and site assessment. A last category (other) includes miscellaneous environmental expenses, e.g., bird cones for the stacks. About 30 expense codes are explicitly associated with HSE product codes. Examples of environmentally connected expense codes include environmental professional fees, public awareness programs, external analytical laboratory fees, and waste transportation.

Field personnel approve an invoice and select the correct product and expense codes. Accounting "load" forms are filled in using specific accounting codes assigned by location, product and expense codes. The accounting department pays invoices and enters coding into the General Ledger system. Therefore, any expense can be identified and selected according to any of these three codes. Utility costs can be listed in this format and one can even specify the utility according to whether it is electric, water, gas, etc.

Although environmental costs have been tracked to some degree for the last several years, only data after 1993 are accurate and comparable.

Strengths and weaknesses of the system. The system has many strengths. Its simplicity and the nature of its extension to the existing accounting system. Data is continuously and instantaneously available, so expenditures can be instantly tracked by category. By including environmental costs into the cost base of project accounting, individuals who are in the best position to manage environmental costs can give them full consideration. In turn, these individuals can be held responsible for their decisions. Extraordinary activities can be captured because the system is expandable through the simple addition of new account categories.

The ease with which new accounts can be added can also be risky, since it facilitates inappropriate changes as well as appropriate ones. New account classifications may be added, resulting in overlapping account codes. This inconsistency means that time series comparison of environmental costs will not be accurate. The system will reject codes of impossible formats, but no other checks are performed as the data are entered. Thus, classification accuracy will depend on the account assignment, as determined by an accounting clerk.

Another weakness of the system is its lack of distinction of recurring and non-recurring costs. Distinguishing between these costs could produce cost time series comparisons of higher fidelity, since non-recurring costs could be screened out.

Future improvements in the system include developing a procedure to routinely review product codes to delete redundant codes and ensure that new product codes are not included in the wrong categories.

The account classifications do not facilitate tracing costs arising from incidents, such as spills, back to a specific unit, since not all units have separate cost centers (e.g., the wastewater treatment plant). These systems are viewed as general overhead costs, without any chargeback mechanism. The system, therefore, does not currently support transfer pricing to all units. Additional metering capabilities, e.g., tracking volumes sent to flares, would provide measures of activity that could be used as a basis for transfer pricing.

International Refineries is aware that excessive reliance on profit maximization strategies using internal charge backs will inevitably cause internal arguments, and may not be good in the long run, since cost cutting may short-change safety. On the other hand, International Refineries believes charge back could contribute to improved operations management. A transfer pricing mechanism would help track line leaks or determine which unit ought to recycle.

The system has some limitations regarding labor costs. It does not capture personnel time by project, and only includes labor if it is associated directly with an "environmental unit," e.g., the desulfurization unit, or the wastewater treatment plant.

Specialty Refiners. Specialty Refiners' primary goal for an environmental cost accounting system is to provide "point of generation" environmental expenses assigned to product lines. Spills, disposal costs, over/under treating for lube oils, permitting, wastewater treatment, etc., would all be assigned relatively accurate costs. The cost information would be distributed to appropriate field personnel to demonstrate the cost of specific actions as well as inaction. Given Specialty Refiners' trend toward decentralized ESH, environmental costs could serve as a unifying metric and communication tool.

Specialty Refiners has begun examining environmental costs, although a separate environmental cost system is not in place. Environmental cost data are generated and analyzed on an ad hoc basis. Environmental cost data are generated using the mainframe General Ledger and the Maintenance Management System. Labor costs are not included since salary information is stored on the payroll system. Capital contractor work requests are maintained and accessed on a database. All of these data are used to synthesize environmental costs which are stored on a manually generated spreadsheet. The spreadsheets are generated by the accounting department or by management on an as-needed basis. The level of detail depends on need, and is usually based on a particular commodity, chemical or contractor.

Specialty Refiners can modify their General Ledger in a fashion similar to International Refineries'. Any environmental area can be set up as a cost center at the business manager's discretion. One refinery is tracking costs using the system. This capability permits detailed information to be made available from high level categories, e.g., materials and supplies, labor, contract services, etc. This capability is rarely utilized and depends on a facility's desire to capture information. Although cost center codes are easy to set up, gaining approval for them may be politically difficult: cost codes require authorization of each division and each division's controller.

Capital project costs can be retrieved from invoices. There are tax benefits to capturing details on capital costs. These costs have been identified and broken out for several annual reports for the last 20 years. In determining which costs fall under the category "environmental", there is not much discretion since Specialty Refiners uses the percentages recommended by API.

Work order and material detail information can be obtained from the Maintenance Management System. Material detail is available only if a requisition is written or a warehouse has entered information. The discretionary use of credit cards for expenses under $5000, instituted three to four years ago, confounds the ability to accurately track all costs. These expenses translate into approximately $25,000 per supervisor per month, based upon EHS personnel estimates. Labor costs can only be obtained using the payroll system and are based on timecards.

Specialty Refiners maintains a capital projects database which monitors project information, including status, contract work orders (CWO), authorization requests and authorization for expenditures. This system generates and tracks CWO's, excluding vendors which are often charged on credit cards, for expense work. Contractor cost detail can be generated by the desired category.

Users of the system. The system's use depends on each facility's demand for environmental cost information. There is typically a monthly review of information by a

management team. The information is analyzed with both an environmental as well as non-environmental perspective. The information is used by waste management teams consisting of two or three individuals focused on a specific problem, and by project managers to justify environmental expenditures. Finally, the environmental department uses the various systems mentioned above to generate and report required regulatory data.

System maintenance. Accounting is charged with maintaining the General Ledger system. Maintenance is responsible for the Maintenance Management System. Interfaces are the responsibility of the Corporate Information Technology Group.

System strengths and weaknesses. The systems in place that are used to generate environmental cost data have many advantages. The General Ledger is a very reliable system and the accounting staff are well trained in its application. Cost data from the General Ledger are available on a monthly basis, so analyses can be fairly current. Capital projects are easier to monitor because they are well defined and have a paper trail associated with them, except for the smaller credit card charges. The Maintenance Management System can be used to respond to custom requests, e.g., VOC monitoring information was successfully generated using this system.

The systems used to provide environmental cost information are not very effective . They are primarily high level systems directed toward meeting government requirements, not business requirements. There is only limited user training, despite difficulties in manipulating the data, the complexity of the cost structure and the inflexibility in report generation. The system can allocate costs, but the process is manpower intensive.

The system allows environmental costs to be accumulated primarily at the cost center level, so detailed cost analysis is difficult. Specialty Refiners is converting a new accounting system (SAP AG), which should allow for more flexible cost monitoring, not only by cost center, but also by product line and product code. The allocation mechanism of the system will be improved and environment costs will be integrated into the facility cost structure. The allocation mechanism will be facilitated by the installation of better measurement equipment. For instance, Specialty Refiners is in the process of installing total organic carbon (TOC) analyzers on effluent streams to allocate back to “pieces” of the plant. Such information would also be useful for identifying alarm conditions or for source reduction.

Given the shortcomings associated with the high-level nature of the system, it is not surprising that Specialty Refiners identified “point of generation” environmental expense assignment to product lines as a future system need. A system that could determine the cost of spills, disposal costs, over/under treating for lube oils or permitting, etc., would enable field personnel to understand and take control of specific action or inaction costs to the company.

Table B - Environmental Cost Accounting : Cost Sheet for product A*

Cost Element	*Unit of Measure*	*Consumption per 100 lbs.*	*Unit Price*	*Cost per 100 lbs.*
Intermediate Material A	lb	75.3604	$6.0702	$457.45
Raw Material B	lb	125.2400	$1.5239	$190.85
Raw Material C	lb	92.8863	$1.7625	$163.71
Direct Labor	hr	1.3100	$26.3200	$34.48
Equipment X	hr	0.4400	$95.3818	$41.97
Equipment Y	hr	0.1364	$170.6994	$23.28
Equipment Z	hr	0.4000	$47.9629	$19.19
Repair/ Maintenance Equipment X	hr	0.4400.	$45.2140	$19.89
Repair/ Maintenance Equipment Y	hr	0.1364	$50.3554	$6.87
Repair/ Maintenance Equipment Z	hr	0.4000	$16.9008	$6.76
Electricity	KWhr	104.9500	$0.0467	$4.90
Steam	ml	4.8000	$4.2672	$20.48
Auditing and Quality Control	hr	0.1400	$53.3962	$7.48
Effluent - Flow	MG	6.0000	$0.3339	$2.00
Effluent -TOC	lb	35.2182	$0.4519	$15.92
Incineration - Solids	lb	23.8282	$0.4519	$10.77
Incineration - Organic Liquids	lb	85.2605	$0.4108	$35.03
Incineration - Aqueous	lb	65.4289	$0.7204	$47.13
Gen'l Facilities, Services & Overhead				$21.02
Unit Overhead				$42.33
Total				$ 1 171.50

* Adapted from (Ciba - Geigy, 1996)

Environmental Costs

As part of the initial questionnaire, the participating companies were asked to complete cost matrices, whose results are summarized in Table C. This was requested for three reasons.

First, the degree of effort required to complete the task reflects on the quality of the current environmental cost accounting system, if any. It is possible to evaluate the quality of the systems as they currently stand, by reviewing the information provided by each company.

Second, the costs are organized by the type of activity that generated the costs. By comparing the magnitude of the costs for each activity, the important activities could be identified. As it turned out, item 3, Environmental Aspects of Ongoing Operating, and item 4, Remediation Function, contained the most dollars for all participants. This was not surprising. Many costs associated with the on-going operations are tracked as separate expense elements in traditional cost accounting systems. As such, they are easily discernible as "environmental." Similarly, costs associated with remediation are easily identified as " environmental" and more easily quantified (if not accurately) since SEC regulations governing financial accounting requires they be reported.

Third, by comparing the costs for each activity across companies, it is possible to determine whether companies are having similar experiences in dealing with environmental issues, and whether their accounting systems are having similar success in capturing cost data.

The general results indicate that the participants varied greatly in their reported costs, although two variables - company size and type of business (refining or chemicals)-- can explain most of that variation. The level of detail in the breakdowns varied by company. Grupo Primex and Specialty Refiners provided detailed costs for subcategories in each relevant item, while Ciba-Geigy and International Refineries provided global totals. However, even Grupo Primex and Specialty Refiners acknowledged that it was very difficult to accurately complete the questionnaire, despite having environmental cost accounting systems in place. One problem may be that the environmental cost accounting systems tend to be aggregated at the plant level (especially Grupo Primex and Specialty Refiners), not at the corporate level.

There was general agreement that most costs will not increase drastically over the next few years. It was pointed out that some of the costs are discretionary, in that the timing of implementation is partially driven by what the company can afford in the given period.

There was surprisingly little reported investment in Centralized Environmental Activities (item 1) or Regulatory Affairs (item 2), given that all of the U.S. companies report a centralized function, including active interaction with federal and state agencies.

In fact, the presentation of the aggregate results to the participants was met with a surprisingly cool reception. It became clear that the participants do not feel that environmental costs by themselves are very interesting or important. However, the participants were able to identify and categorize a number of uses for environmental cost information. Although there appears to be some degree of overlap between them, three basic types of uses were identified:

1. **Decision Making:** Environmental cost information can illuminate issues such as determining the level of value added, use of risk-based versus necessity acquisitions, capital budgeting including lower Hurdle Rates for environmental projects, product costing and discretionary versus regulatory investments.

2. **Baseline Cost Information:** By developing baseline environmental cost information, managers can improve resource allocation decisions, support lobbying efforts, and improve cost control. Comparing baseline costs to current costs may help identify cost reduction opportunities, estimate future project costs, serve as a basis for budgeting, and capture cost avoidance.

3. **Management Incentives:** Participants agreed that management's incentives for environmental stewardship were sometimes complex, and that environmental cost information might be useful for improving the management performance evaluation process by incorporating environmental costs into financial performance measures. These costs could also be used for public relations purposes, by providing evidence of the efforts made by the company in environmental stewardship. For example,
several Partners discussed community relations problems that may lead to future costs if not resolved: for example, the legal release of irritating gases; and the "environmental justice" issue, in which the community which developed around the existing plant now claims environmental damage from the plant's proximity to the community. There was consensus that, even if company activities were above legal reproach, building better community relations can help avoid lawsuits, denied permits, and similar costs. Partners are often willing to invest in good community relations to avoid these future costs.

Finally, the participants agreed on the difference between production economics, politics, and the emotions of the press and of private citizens. These differences make "rational management techniques" somewhat risky, in that public opinion is often far removed from what is right or fair. In discussing the use of environmental costs for decision making, the participants differentiated between capital expenditures and routine operating and maintenance costs. All participants felt that environmental capital expenditures were special, because they are often mandated by government.

If technologies are mandated, the task is to implement them on a timely basis, even when mandated technologies represent an excessively expensive, suboptimal solution. Particularly, mandated technologies tend to represent "end of pipe" solutions, which may be less efficient than pollution prevention approaches, that depend on redesigning the waste generating processes. The companies would often rather be given a mandated outcome than a mandated method or technology for reaching that outcome, but the time horizon for meeting these targets is often too short to arrive at the best solution.

In addition to selected environmental cost information, all of the participating companies use non-financial input and output measures, which provide more detailed information more directly than anything which could be provided by the cost system. Non-financial indicators, such as number of incidents reported and TRI (Toxics Release Inventory) statistics, are often more useful for operating managers. Cost information is most useful as a way of determining the overall economic effects of current methods and of alternatives.

Table C - Comparative Environmental Costs

Sales (Worldwide) '94

A) International Refineries	$3.4B
B) Ciba-Geigy	($15.3B) $4.6B
C) Grupo Primex	$184M
D) Specialty Refiners	$1.51B
E) Celanese Mexicana	didn't provide any cost table information

1	2	3	4*	5	6
Environmental Function	Total Cost ($) (Most recent fiscal year)	Source of Information in Column 2	% of Total Cost Allocated to Product As Part of Cost of Goods Sold (COGS)	Source of Information in Column 4	Anticipated Annual Percentage Change Over Next 3 Years
1) Centralized Environmental Activities	B) $1000K		0%		5%
Permitting	A) 1,292K		0%		8%
Training	C) 173K		0%		15%
Environmental compliance auditing	D) 561K		0%		-33%
Environmental management systems audit					
Other					
2) Regulatory Affairs	B) 1,300K		0%		5%
Lobbying	A) ---		N/A		---
Political Action Committee	C) ---		0%		---
Regulatory agency involvement	D) ---		---		---
Involvement in legislative process					
Other					
3) Environmental Aspects of Ongoing Operations	B) 61,500K		100%		5%
Annual depreciation of environment assets	A) 23,076K		0%		5%
Stripping Column					
Incinerator	C) ~630K		17%		0%
Wastewater Treatment System					
Labor of operating the environmental assets	D) ~14,500K		100%		---
Maintenance of environmental assets					
Operations and maintenance					
Other					

4) Remediation Function	B) 60,000K		0%		significantly less
Labor					
Contractors/Studies	A) 25,800K		0%		10%
Disposal					
Annual depreciation of assets	C) 128K		0%		0%
Operation and maintenance					
Other Field work/implementation	D) Not broken out		---		---
5) Environmental Aspects of Community/External Affairs	B) (in #3)		NA		---
Public relations	A) Don't track		NA		N/A
Community affairs					
Philanthropy	C) 5K		0%		---
Industry groups					
Other	D) Not broken out		---		---
6) Environmental Aspects of Product & Process Development	B) 2,600K		30%		10%
R&D - Design for environment	A) Don't track		0%		N/A
Product engineering					
Process engineering	C) 30,172K		0%		0%
Pilot plant					
Marketing	D) Not broken out		---		---
Procurement					
Other					
7) Other (please specify)					
Marine Preservation Association	A) 2,464K		95%		
National Polystyrene Recycling Corp.			0%		

* Including cost of feedstock, labor and other refining/manufacturing costs.

What percentage of cost of goods sold (COGS) relates to feedstock? ____%
Provide capital expenditures for the last three years for environmental-related plant and equipment:

$_____1994,	$_____ 1993,	$_____1992.
A) 22M	A) 26M	A) 41M
B) 15M	B) 30M	B)49M
C) 2M	C) ---	C) 1M
D) 2.289M	D)26.263M	D)5.059M

Use of Environmental Cost Accounting in Managerial Decision Making

Decisions using cost data. A number of specific decisions were identified that could directly make use of environmental cost information. The list is not necessarily exhaustive. In many of these decision contexts, environmental cost information would be treated as just another cost of doing business, such as in product pricing or product mix. In other situations, the environmental cost accounting information may have a unique role in the decision process . This might be the case in waste management decisions, pollution prevention alternatives or market-based environmental options. In all cases, identifying and quantifying environmental costs, whether currently captured by the accounting system, or as part of future liabilities or intangible costs and benefits will enrich the quality of the following decisions.

1. Internal/External Benchmarking: How are we doing against competitors? How are individual plants doing, on a comparative basis?
2. Product Pricing: Better environmental cost accounting can lead to better understanding of what a particular product costs to produce. For products with price flexibility (differentiated products), this may be reflected in price adjustments.
3. Product Mix: Better environmental cost accounting can be beneficial even with commodity products, for which the price is market-driven. The company may choose to adjust their product mix to maximize overall profitability.
4. Waste Management Decisions: Better understanding of environmental cost structures will lead engineers and managers to make more cost-effective choices in treating and disposing waste.
5. Pollution Prevention Alternatives: A better understanding of current environmental costs, as well as that of prospective alternatives, will result in better capital expenditure decisions.
6. Materials/Supplier Selection: Companies committed to environmentally responsible manufacturing understand that a "cradle to grave" mentality is necessary. Through better sourcing of materials, companies can push environmental responsibility up the supply chain. They may partner with suppliers to make pollution prevention options more cost-effective. Also, can significant environmental costs be avoided through outsourcing?
7. Facility Location/Layout: Companies may find that their by-products can be used as inputs to other companies. Such companies often co-locate with these Partners.
8. Outbound Logistics: These issues pertain to finished product, by-products and waste. Packaging of finished product has significant environmental implications, if the packaging must be destroyed to use the product. Is additional cost of design and materials worth the investment, if the environmental liability might be reduced? For by-products and waste, off-site disposal raises the risk of future liabilities for activities which are currently legal, and off-site transport moves the material beyond the control of the company.
9. Market-Based Environmental Options: An active market in SO_2 and other pollution allowances is developing. Understanding the cost of reducing these emissions is key to establishing values for these allowances.

10. International Environmental Standards: ISO 14000 is expected to be finalized during 1997. This ISO 14000 requires that environmental standards be documented and followed, though environmental accounting is not explicitly mandated. Certification may be required to maintain the customer base, especially in Europe.
11. Public Relations / Lobbying: Understanding the cost of this activity, and of the costs of not participating in this activity, will help to rationalize the level of investment to be made here.
12. Training: The best level of training (from a cost-benefit point of view) is easier to determine if the benefits are quantifiable.

Decisions using nonfinancial data. As previously mentioned, one crucial issue is the degree to which financial indicators, such as environmental cost accounting information, are used, as compared with non-financial indicators, such as the number of incidents or TRI release information. The value of non-financial indicators is linked to the specificity and timeliness of those indicators. The value of financial information is that the net economic effect of the interplay of complex physical systems can be captured on a summary basis.

Participants seemed to agree that, at the plant level, non-financial indicators are essential, and cost accounting measures are secondary. Perhaps this is because the decisions that must be made at the operations level tend to be relatively straightforward, technical and immediate. Plant operations must be monitored and adjusted more quickly than cost information can be provided. The value of cost information seems to be limited to decisions requiring a common denominator.

The higher the management level, the more likely that financial information will be used, as costs can be seen as a shorthand for multiple factors. It is also likely that, the higher the management level, the more the manager's performance evaluation will be based on financial measurements. Thus, the high-level manager will be more interested in summary financial measurements of environmental activities than will plant operations. This is because the high-level manager is responsible for more diverse activities, and for activities with longer time spans. Of course, high-level management will be interested in aggregate nonfinancial data, as well.

Ciba-Geigy presented its use of life-cycle analysis as a method for evaluating relative environmental impacts of processes and products. This is found in case studies later in this document.

Company use of environmental cost information for decision making. Four companies made presentations on this topic: Ciba-Geigy, International Refineries, Grupo Primex, and Specialty Refiners. Two primary types of decisions were addressed, capital acquisitions and operating decisions.

Environmental Cost information was used primarily for capital acquisition decisions. The companies indicated that the processes used for capital acquisitions of environment items tended to be made using the same process as that for non-environmental items. However, as indicated below, in individual company coverage, the environmental items tended to be given priority, especially if the environmental investments were mandated by government regulation. Desirable environmental projects tended to be given informal priority, in that most companies did not use a lower Hurdle Rate for environmental investments. This was true of both U.S. and Mexican companies.

Identifiability of environmental portion of pollution prevention projects. The preference for environmental capital items is reflected in an issue also discussed in the "costs" section: that "end of pipe" sorts of acquisitions are clearly identifiable as environmental expenditures, but improved technology (which may also result in cleaner processes, thus addressing environmental issues at least as well, but less directly) are often considered operating improvements, not environmental. Because integrative solutions, such as improved technology, are clearly the superior approach to environmental stewardship (pollution prevention being superior to post-production clean up), the preference for clearly environmental capital expenditures over non-environmental may inhibit companies' ability to achieve greater environmental responsibility through pollution prevention.

Perhaps one solution is to identify differential economic benefits to investments that can be legitimately classified as environmental, whether they represent pollution prevention or end of pipe investments. The issue of determining what portion of the investment is environmental has already been tackled by the American Petroleum Institute(API). One company, Specialty Refiners, systematically allocates a portion of their investment in pollution prevention projects as being environmental, using API guidelines. It was pointed out that, in some jurisdictions, environmental projects are currently given special tax status, such as shorter depreciation periods (U.S.) or immediate write-off of cost (Mexico). These tax concessions may be justified by the environmental benefit to citizens within these jurisdictions.

The following describes how each of the participating companies uses environmental cost information:

Ciba-Geigy. *Capital Expenditure Decisions.* Ciba-Geigy tracks environmental costs separately as certain cost elements on product cost sheets. However, environmental capital expenditures are seen as part of normal business expenditures; they are part of viewed as a cost of doing business. The biggest difference between environmental and non-environmental expenditures relates to government mandates, whether the project is required, and whether the government regulation stipulates technologies or performance. Performance-based regulation is generally preferred, because companies can identify and implement the best alternative solution.

All potential capital projects are evaluated based on traditional capital budgeting criteria, and are all subject to the same approval levels, Hurdle Rates and other financial test, except in the case of mandated environmental projects. If the project is governmentally mandated, Hurdle Rates are meaningless; the project must be done.

Operating Decisions. Ciba-Geigy tracks environmental remediation costs separately. While significant differences exist, the internal approval process is similar to the capital expenditure approval process.

Grupo Primex. Grupo Primex tracks environmental costs relating to both capital expenditures and ongoing operations and maintenance. However, like the other Partner companies, decision-making with environmental costs focuses primarily on capital expenditures.

Capital Expenditure Decisions. The process for developing cost estimates is the same for any kind of capital project, whether environmental or not. The Environmental Manager decides whether a project is to be classified as environmental. However, environmental capital expenditures are tracked independently of other capital expenditures. Once needs or opportunity areas are identified, preliminary engineering studies identify critical parameters, leading to an estimate of the total capital expenditure required. If the project is required to meet regulations,

the project will be approved in virtually all cases, subject to final approval by the General Director. If the project is not required to meet regulations, the Payback period and Internal Rate of Return are determined. If the Payback period is less than three years and the Internal Rate of Return exceeds the Hurdle Rate, if sufficient cash is available, and other aspects of the project meet with the approval of senior management, then the project is undertaken. If the project does not meet the financial criteria, the project is put on hold until regulations change, unless there are significant intangible benefits associated with the project.

Operating Decisions. Grupo Primex captures the ongoing cost of environmental activities, but does not exhaustively differentiate between environmental and other operating and maintenance activities. The company views environmental activities as a part of doing business, and manages these activities accordingly.

International Refineries. The system has helped International Refineries better understand where they are spending money. Two areas with unexpectedly high costs proved to be waste hauling and operations analysis. With International Refineries' system, the cost per pound of waste can be estimated. They can breakdown waste hauling costs by vendor as well. Despite what might be expected, it is not uncommon for the same vendor to charge different prices for the same services that were negotiated separately. A side project developing around this system involves coordinating purchases and looking at volume discounts. A refinery manager could also use this type of information to improve selection or negotiations with catalyst suppliers, waste disposers, etc.

Improved understanding of environmental costs improves the budgeting process. The focus on expense codes is particularly useful, since budgets are constructed around expense codes. As a result of the Enhanced HSE accounting systems, there is a better understanding of remediation costs, as well as the costs of different types of remediation.

Accounting for environmental costs has also proved useful as a communication tool. International Refineries is now able to track environmental, health and safety (HSE) operating expenditures, HSE capital expenses as well as environmental accruals. Superfund expenses are tracked and are included depending on the information displayed. HSE expenditures are also tracked according to business sector, i.e., upstream, downstream and chemical.

Capital Expenditure Decisions. International Refineries evaluates environmental capital expenditures in the same way as non-environmental capital expenditures. However, the priority of the capital project is directly linked to whether the project is required to comply with government regulations.

HSE capital and operating budgets are developed by business units with input from on-site HSE personnel. Included are corporate HSE costs that are allocated to business units, based on a rough estimate of percentage of time spent by corporate HSE staff on each business unit.

International Refineries has developed a Capital Budgeting Guidelines hierarchy of projects, ranging from A to G. Category A consists of environmental projects, of which A1 projects are required for compliance with regulations in the current year, and A2 projects will be required in the future. B projects are health and safety projects, with B1 referring to legal mandates effective in the current year, and B2 projects referring to future legal mandates. C projects are expenditures required to avoid the loss of an asset, or to meet the terms of an existing contract. D projects are discretionary projects with a current year positive net cash flow, E projects with high returns where delay in investment will significantly reduce future returns, and

F projects are those with returns that exceed the Hurdle Rate for the year. G projects are projects with undefined economics. These G projects are virtually never funded.

Operating Decisions. International Refineries has a relatively well-developed environmental cost accounting system, but does not base ongoing operating and maintenance decisions on costs specifically identified as environmental. However, International Refineries uses this system to track all expenditures of HSE functions by category, media, location and line of business. It functions well in spotting irregularities.

Examples of uses of the International Refineries information include:

- Budgeting (by expense code)
- Identifying opportunities for Volume discounts / leverage with vendors.
- Making business units responsible for their own costs.

Specialty Refiners. Specialty Refiners uses environmental cost information extensively for both capital expenditure and operating decisions.

Capital Expenditure Decisions. Specialty Refiners' capital budgeting process is similar to that of the other companies, consisting of a multi-step process. The initial project is often conceived at the plant level, where the problem is most often identified, but it may originate at corporate or at the tech center, depending on the specific problem. An initial set of alternatives is evaluated, and the leading contender(s) are further refined. Process design specifications are generated, including a detailed Safety and Environmental checklist, which must be approved by corporate HSE before the project can proceed. A capital budget proposal is generated, consisting of both the technical and economic evaluations of the alternative. The approval process will be affected by the size of the project, the economics, and the degree of linkage to other projects in the current capital budget. As a part of the Authorization for Expenditure, the cost is apportioned between the environmental part and the non-environmental proportion, using API's guidelines and Specialty Refiners' experience. These environmental proportions are rough, usually 50% to 100%, but may be as small as 25%.

During the construction of the project, concurrent cost audits are regularly performed, providing a basis for evaluating both the budget and the actual performance. However, upon completion of the project, post-implementation audits are rarely, if ever, performed.

Operating Decisions. Specialty Refiners takes environmental costs into account when making operating decisions. For example, product mix decisions are affected by potentially high environmental costs of new products. Additional environmental responsibility brings the need for better environmental performance, which could translate into either more environmental staff, or larger non-environmental staff which takes responsibility for some environmental activities. Finally, environmental costs can affect product pricing for specialty products, for which there is pricing flexibility. One difficulty in using environmental costs for operating decisions is the accuracy and timeliness of cost assignments to specific products.

In addition, Specialty Refiners is aware of how current practices have a real, future cost but of uncertain magnitude and timing. For example, environmental liabilities and future disposal costs are real, but difficult to estimate. Environmental regulations are likely to change, and may bring about new retroactive liability. Consumer confidence and the support of the community are essential, but can be influenced either positively or negatively by public relations, quite apart from real environmental issues. These issues affect operating decisions, but are difficult to accurately quantify.

Appendix A
Partner Company Profiles

CELANESE MEXICANA

(Celanese Mexicana participated in only the first, two-day session. Thus, the volume of material reported in this section is limited, relative to the other Partner companies)

Celanese Mexicana has eight operating locations in Mexico. The company's total 1994 worldwide sales in U.S. dollars were over $800 million. The company employs over 7000 employees worldwide. Its major business segments are chemicals, fibers, and packaging materials.

In 1990, Celanese Mexicana established a company-wide environmental, health and safety organization. At about the same time, a company environmental policy was established and signed by the Board of Directors. Celanese Mexicana employees are expected to take responsibility for environmental issues as a condition of employment. Environmental performance of the company affects yearly bonuses, both positively and negatively.

Participation in voluntary programs is limited. Emission reductions of 85% were established as a goal for Celanese Mexicana in 1991, to be accomplished by 1997. So far, 70% reductions have been achieved. This program was started on the initiative of the company; there is no governmental agency requesting voluntary emission reductions.

One aspect of the culture at Celanese Mexicana that affects the company's ability to establish consistent standards across the company is the difference between fibers and chemicals personnel. Fibers personnel are more conservative, while chemicals personnel are much less conservative. One possible approach being considered to lessen this effect is interchanging personnel, so that each group can better understand the other.

Celanese Mexicana Case Study

Celanese Mexicana's case examined a technological process change which improved both their environmental and financial performance.

The main products of the this particular plant are acrylates, of which the plant produces 11,000 tons per year. Their old production method used acrylonitrile as its main input. The process generated 40,000 tons of waste stream every year, of which the main components were acrylamide, acrylic acid, alcohol and ammonium sulfate.

In 1990, the U.S. EPA released a list of regulated toxic pollutants. There are generally two to three years between the passage of an environmental regulation in the United States and the passage of a similar regulation in Mexico. Celanese Mexicana therefore decided to change its production process in anticipation of similar Mexican regulation.

The new technology uses propylene as an input instead of acrylonitrile, and eliminates the intermediate production of acrylamide. The waste stream produced consists of unsaturated acid, water, carbon dioxide and carbon monoxide, and unreacted propylene. In addition to reducing toxic output, the change has halved the process' production costs. While the investment in the new propylene based system was originally conceived as an environmental project, it was the expected fast payback that convinced management to approve the initial expenditure.

CIBA-GEIGY

At the time of this study, Ciba-Geigy was an international company with 13 operating units in the U.S., three in Canada and three in Mexico. The company's 1994 worldwide sales were over $1.5 billion. Ciba-Geigy had 87,000 employees worldwide, 15,000 in the United States. The company's major business segments were health care, agricultural products(including crop protection products), animal health care products and seeds, and industrial products(including additives, textile products, polymers, pigments, chemicals). A merger with Sandoz was announced by Ciba Geigy in March, 1997. It needs approval from U.S and Europe authorities in Federal Trade Commission. In this new Novartis business structure, MBT and speciality chemicals will be separately traded.

Ciba-Geigy Case Study

Ciba-Geigy presented a case study that addressed their use of Life-Cycle Assessment (LCA). LCA is a tool that is used to measure the relative environmental impact of processes or product uses. It considers all environmental impact occurring during the production and use of a product, including the raw material acquisition, manufacturing, application, utilization and disposal functions, within a predetermined boundary ("Battery Limit") for the study.

Ciba-Geigy uses an LCA method that was developed in Europe. It measures emissions in "pollution units" which are based on acceptable ambient concentrations as issued by government agencies, e.g., the EPA. The lower the acceptable ambient concentration of a substance, the greater are its number of pollution units per unit of mass.

The case study covered Ciba-Geigy's LCA of IRGAZIN DPP RED BO, a high performance pigment mainly used in automobile paint. The LCA considered all the environmental impacts, starting with the raw material aquisition, manufacturing, the chemical synthesis, packaging, transportation, as well as all the downstream customer uses (paint production and car painting) and the ultimate use and disposal of the cars. It shows that driving the cars has the highest environmental impact, followed by the painting process. Looking only at the chemical synthesis step (which is under Ciba-Geigy's direct control,) the LCA identifies the major environmental impact resulting not from the chemicals used, as might be expected, but from the energy requirements during manufacturing.

Using this information as a guide to prioritize the process improvement efforts, Ciba-Geigy has already managed to improve the yields by 10%, while reducing waste by 50% and the energy requirements by 14%. Further improvements are expected. Additional LCAs for major products are being developed.

GRUPO PRIMEX

Grupo Primex has one location in Mexico. The company's 1994 total worldwide sales were $181.1 million. Its worldwide employee base consists of 540 employees. The company's major business segments involve production of PVC resins, PVC compounds, phthalic anhydride and plasticizers.

Grupo Primex Case Study I

This case study examined a technological problem regarding the wastewater stream generated from the production of plasticizers. Plant capacity is 45,000 tons of plasticizer per year. This amount represents approximately 25% of the total physical output of the plant. In the plasticizer production sequence, the residual, which consists of water, alcohol and plasticizer,undergoes separation treatment for reclamation of the plasticizer in the material. The separation process is complicated by effects stemming from the high temperature of the residual.

To facilitate the recovery of plasticizer, Grupo Primex invested in a process modification consisting of two additional steps. The first step neutralized the electric charge of the plasticizer recovered from the previous batch. The second step involved the recovery of excess alcohol after the second heating step.

The primary advantage of the modification is that the residual wastewater is cleaner and can be re-used. The change has resulted in a cost saving of US $800,000. In addition, the unusable waste plasticizer stream was eliminated, resulting in additional production of 300 tons per year. Finally, downtime reserved for equipment cleaning (50 hours per month) was eliminated. Although environmental cost accounting did not a play a significant role in identifying the problem or determining a solution, the benefit of the project is reflected in improved financial performance.

Grupo Primex Case Study II

This brief case study identified options for treatment of Pthalic anhydride in gaseous emissions from a chemical plant. Pthalic anhydride is not regulated by the Mexican government, so there is no urgent need to control its release . However, it is an irritant and there are environmental benefits to be reaped from its removal. The company considers installing scrubbers or an incinerator to treat the Pthalic anhydride. Incinerators are the cheaper option, and Grupo Primex tentatively plans to install them next year.

INTERNATIONAL REFINERIES

International Refineries has 13 operating locations in the U.S. which include two refineries, four chemical plants, five product terminals and two oil and gas production units. The company's 1994 worldwide sales were over $1.5 billion; and worldwide it has over 2000 employees. The company's major business segments include exploration and production of crude oil, natural gas marketing and distribution, marketing and distribution of petroleum products, and manufacturing and marketing of chemicals and plastics.

International Refineries Case Study

International Refineries' case study discussed their system for estimating environmental liabilities. When an environmental liability is identified during the year, the responsible project managers and International Refineries' environmental advisor jointly determine the amount to be accrued. Accruals are based on an estimation of how much of the cost of any given incident can be attributed directly to International Refineries, and how much it will cost to remediate International Refineries' share. It is uncommon for International Refineries to be wholly responsible for a site.

Estimated costs include the cost of remediation according to current legal requirements, and sometimes the predicted cost of litigation as well. Accruals are indicated on the company's balance sheet as liabilities.

The accruals are reviewed quarterly by a team of International Refineries managers and outside auditors. The accrual process is fairly elaborate, but there are two caveats associated with it. First, the outside auditors may not agree with International Refineries' estimated costs. Second, the environmental liability accrual process is not linked to International Refineries' capital budgeting process. Thus, estimated liabilities are not directly linked with proposed capital expenditures for environment.

SPECIALTY REFINERS

Specialty Refiners has approximately 120 operating locations in the U.S. The company's 1994 worldwide sales were over $1.5 billion and it has over 2000 employees. The major business segments of the Company are domestic and international motor oil marketing and sales, refining, the industrial specialties business unit and the base oil marketing department.

Specialty Refiners Case Study I

Specialty Refiners' first case study described a technical problem that was analyzed and solved at one of their oil refineries. It is a relatively old plant, and its technology problems are not shared by other Specialty Refiners facilities. The analyzed process involved the removal of impurities from lube oil feed stock to make food grade white mineral oils. The process results in a highly acidic oil, which is neutralized with caustic, to protect equipment from acid corrosion. However, the caustic combines with the oil residue to create an emulsion layer referred to as "muck."

An excess of muck built up in the plant, and by 1991 the plant was spending a lot on storage and disposal of the emulsion. In addition, the emulsion chemically trapped by-products, such as petroleum sulfonate, which would otherwise be salable. The warning about excess emulsion first came from field operators rather than from the accounting department, but it took cost documentation from the accounting records to legitimize the concern.

Plant engineers as well as an outside consultant attempted to solve the problem to no avail. Finally, an operations employee suggested the use of sodium bisulfite to break down the emulsion. Sodium bisulfite was cheap N(.65/gal), easily available since it was a by product of current plant processes located near the system, and effective in breaking down the emulsion. So far, the new sodium bisulfite treatment has saved the company over $180,000.

Specialty Refiners Case Study II

The refinery examined in this case, which dates from the 1930's and refines an average of 50,000 bbl per day. This case deals with a change in their wastewater treatment costs.

The refinery's wastewater treatment system dates from the 1960's. It involves API and CPI separators, aerated lagoon and settling lagoon sections, stocked with commercially purchased microorganisms.

In 1993, the company's cost reports showed a yearly expenditure of $600,000 to replenish microorganisms in the lagoon system. A review board was formed to investigate the matter, composed of the Environment, Health and Safety manager, a wastewater engineer, operations management representatives, site managers, and the outside vendor. They examined the relevant data from 1994 and realized that alkanolamine and N-methylperoladine(NMP), a lube oil extracting agent in the wastewater were combining to form ammonia in the wastewater, which was toxic to the microorganisms. Orthophosphate soaps used to clean the system pipes were also harmful. Operators were unaware of the amine peaking and its effects downstream; they consider amine a waste product. The operators could only follow the lagged ammonia peaks.

In response to this information, the review board recommended that operations managers minimize their disposal of amines and NMP in the system. To accomplish this, operations instituted an inventory system. One conclusion was that chemical usage would be a valuable indirect measure of environmental cost. The operations' vigilance resulted in a reduction of 65% of the liquid biosupplements and 50% of regular biosupplements. They saved $200,000 per year on the cost of microorganisms. In 1995 the plant passed the state biomonitoring test for the first time, because its lagoon system was functioning so well. However, due to reassignment of personnel within the company, many of the experienced operations managers who enacted the change have been replaced in their positions by relatively inexperienced employees. This new group of personnel has not been able to maintain the improvements made by their predecessors, but Specialty Refiners believes that experience and training will improve their performance in the near future.

Appendix B

ENVIRONMENTAL COST ACCOUNTING *COOPERATIVE BENCHMARKING*$_{SM}$ STUDY

OVERVIEW

The questionnaire to be used in the Environmental Cost Accounting Cooperative Benchmarking study serves the following purposes:

Requires the Partner company filling out the questionnaire to understand the various Factors and Issues that are addressed by the questionnaire.

Provides a common level of understanding to the other Partner companies who are participating prior to the actual *Cooperative Benchmarking*$_{SM}$ meetings.

Facilitates discussion during the meetings based on how the questionnaire is answered by the Partner company.

The questionnaire is comprised of two parts. The first part is a strategic overview approach to environmental cost accounting within the organization. The nature of the questions is based on the list of Factors and Issues that were rank ordered by the Partner companies. In this manner, sufficient exposure is given to topics that are the highest priority to the Partners.

The second part of the questionnaire is the two case studies that are to be presented during the benchmarking sessions. The case studies may be projects that have been previously investigated by the Partner company or an area in which the company wants to conduct further study. The two case studies should be differentiated from one another. For example, the case studies might be on a mature product and a new product or on an old process and a new process. The distinguishing feature might be geographical, technical, commodity vs. specialized, etc.

The case studies may highlight a success in investigating environmental cost accounting or some critical information that was necessary for an important decision or the case study could highlight how a bad decision was made and how it might be improved in the future.

The case studies should be written up as part of the questionnaire with any appropriate flow diagrams, charts, tables, etc., to fully explain the case.

The agenda for the benchmarking meeting will allow one hour for the case study presentation, discussion and questions. Each participant will present one case study each day for approximately 30 - 45 minutes. There will then be a period of time for discussion and questions to fill out the rest of the hour.

INSTRUCTIONS

The requested information is provided in a Word Perfect 6.0/6.1 file (named "WORDPERF") and a MS Word for Windows 2.0(c) file (named "MSWORD") on the enclosed 3 ½ inch floppy and also with a hard copy. Please complete the questionnaire in one of the provided word processor files or by manually completing the hard copy and return one hard copy of the questionnaire. Use of the disk will allow you to expand the answer section if more room is needed. If you are completing the hard copy, attach additional pages if there is not enough room to adequately answer the question. Please do not return the disk. If you answer the questionnaire on disk, print out a hard copy and return to us.

PART I - QUESTIONNAIRE

1. Is the company participating in this study as a parent company, a subsidiary, a division, etc.? Please describe the relationship.

2. Indicate the number of operating locations for each of the geographical areas:

United States	Europe
Canada	Africa
Mexico	Asia
South America	Australia
TOTAL	

3. Indicate the company's 1994 worldwide sales in U.S. dollars:

$ (millions)_____

Indicate the company's worldwide employee base:

employees

4. Indicate the company's major business segments:

5. Attach a copy of the Environmental Organization Chart for the company.

6. List the three most significant difficulties the company faces in attempting to remain in compliance with environmental regulations:

1)

2)

3)

7. Does the company go beyond compliance? Going beyond compliance means that the company adopts standards which are more stringent

than those required by regulation. For example, a company may institute pollution control equipment prior to a regulatory deadline to take advantage of pollution credits. Another example might be that a company that adopts standards that exceed local standards.

Yes

No

If yes, under what conditions?

Does the company adopt "cleaner" technologies or methods that exceed requirements:

Yes
No

If yes, provide examples:

Does the company adopt "cleaner" technologies or methods before they are required?

Yes

No

If yes, provide examples:

Does the company participate in voluntary environmental programs?

Yes

No

If yes, provide examples:

8. Trade

In terms of environmental issues, how is the North American Free Agreement (NAFTA) expected to affect the company?

In terms of environmental issues, how is the General Agreement on Trade and Tariffs (GATT) expected to affect the company?

Will the company participate in ISO 14000?

Yes

No

If yes, please describe:

9. What incentives (financial or other) are provided for employees to participate in improving the environmental performance of the company?

Is environmental performance recognized in an employee's annual reviews? Employees include senior management, facility management, supervisory and operations personnel. Is participation in pollution prevention efforts encouraged? Provide examples:

10. If the company has faced reorganization/reengineering/downsizing in the last three years, how has this affected your environmental performance and cost monitoring abilities?

11. Does the company generate environmental cost information?

Yes

No

If yes, which of the following statements (a-e) best describes how you generate this information:

a) Generated as a part of your general ledger system.

b) Generated as a part of your management accounting system, separate from your general ledger system.

c) Generated by a free standing system, using data electronically transferred from your general ledger or management accounting system.

d) Generated by a free standing system, which does not directly access data in other systems, including non-automated, ad-hoc methods.

e) Generated by some other type of system. Please describe:

Who are the recipients of the information?

12. What internal barriers affect the ability of the company to collect environmental cost information?

What systems or organizational structures are in place that facilitate collecting environmental cost information?

Please provide examples of problems or successes encountered in collecting environmental cost information:

13. Does the company make estimates of the less tangible environmental costs or benefits such as liabilities from past operations, the indirect cost of regulation, the benefits of environmental proactivity, etc?

Yes

No

If yes, please elaborate:

14. If the company has attempted to identify these less tangible costs and benefits, was this attempt done as a pilot project, company-wide or on some other basis? Please elaborate:

15. Describe the environmental cost accounting system the company would like to have in place five to ten years from now. Describe what information would be gathered, to whom it would be distributed, and for what the information would be used:

16. List the five most important performance measures that the company uses to track/monitor environmental performance. Examples include both **Output Measures** such as: number of spills, number of permit exceedences, tons of hazardous waste minimized, dollar of environmental fines and penalties, and **Input Measures** such as training, compliance, audits, and drills for emergency preparedness:

1) Output: _____

Input: _____

2) Output: _____

Input: _____

3) Output: _____

Input: _____

4) Output: _____

Input: _____

5) Output: _____

Input: _____

17. Which, if any, of these performance measures have been translated into monetary units?

How is this information used within the company?

18. Are environmental operating expenditures tracked independently of other operating expenditures?

Yes

No

Why?

19. Are environmental capital expenditures tracked independently of other capital expenditures?

Yes

No

Why?

20. Who or what level decides whether a project should be classified as environmental? What criteria are used in the decision?

What criteria are used by the company to differentiate between capital and operating expenses?

21. Please describe the process of developing cost estimates for environmental projects utilized by the company:

22. Are estimates of current or future environmental costs utilized in new product design and development decisions?

Current Environmental Costs	Future Environmental Costs
Yes	Yes
No	No

In product mix decisions?

Current Environmental Costs	Future Environmental Costs
Yes	Yes
No	No

In what ways are they used?

23. Describe the process used by the company to determine whether a capital environmental expenditure should be undertaken:

24. At what organizational level in the company are capital environmental expenditures approved?

Is this the same level at which these projects are managed? If not, where are these projects managed?

Does this level differ for non-environmental capital expenditures?

25. When financial analysis of capital environmental expenditures is performed, are numeric estimates included for intangibles such as goodwill, improved community or employee relations, fines or penalties?

Yes

No

Describe:

26. What techniques (Return on Assets (ROA), Internal Rate of Return (IRR), Net Present Value (NPV), payback period, etc.) are used to evaluate the feasibility of the project?

Do these techniques differ from those used to evaluate non-environmental projects?

Yes

No

Are there different performance levels (i.e., Hurdle Rates) for environmental projects versus non-environmental projects?

Yes

No

Describe:

27. Is it easier to obtain approval for projects labeled as "environmental?"

Yes

No

Explain:

28. Describe the methods used to estimate future environmental liabilities that arose due to past activities or operations:

What outside support, if any, does the company rely on to estimate these liabilities?

What are the primary difficulties involved in estimating these liabilities?

29. How does the company estimate liabilities for future activities e.g., acquisition of sites with existing contamination, future spills, etc.?

What are the primary difficulties involved in estimating these liabilities?

30. Under what conditions would the company revise an estimate of a liability created from past operations or activities?

Would the company revise estimates of past liability as part of a periodic review process?

Yes

No

Describe:

Would the company revise estimates of past liability based on anticipated changes in regulations?

Yes

No

Describe

31. How does your company monitor future environmental regulations?

Who is involved in the environmental regulatory monitoring process?

What individuals or organizations outside your company are used to help forecast regulatory changes and their potential impacts to the company?

How does the company link environmental regulatory monitoring with the environmental budgeting process?

32. What activities does the company engage in to influence regulatory changes?

APPENDIX C :DEFINITION OF FACTORS

ENVIRONMENTAL COST ACCOUNTING COOPERATIVE BENCHMARKING$_{SM}$ STUDY

RANKING OF FACTORS AND ISSUES

Ranking Factors and Issues

* **Cross-Border - NAFTA/trade related -** Effect of NAFTA on environmental issues facing companies. Will NAFTA result in changes in laws and enforcement levels?

* **Environmental capital costs vs. environmental operating costs -** Differences between environmental capital and operating costs in terms of method of classification, size, timing, and visibility.
  - Effects of differences on process utilization or redesign
  - Effect on management behavior

* **Management control -** Environmental Cost Accounting (ECA) can provide management with tools for making good internal decisions which integrate economic and environmental concerns.

* **Other metrics/proxies for environmental cost information -** Is an ECA system set in the traditional mode of quantifying performance in terms of dollars the most effective, or is some other system which measures performance in terms of, say chemical pollution units, better?

* **Full cost accounting -** How to identify and quantify all the costs (direct, indirect and intangible) associated with products/processes or activities within the boundaries of the organization?

* **Environmental cost information for external-focused issues -** Using ECA information for dealing with issues external to the company like lobbying, regulations, providing information to the community, marketing, etc.

Ranking Factors and Issues

* **Environmental cost information for decision support -** ECA can be used for decision making, cost monitoring and control and motivation.

* **Environmental cost drivers/environmental cost inventory -** Identifying basic activities that cause environmental costs.

* **Remedial/cleanup costs -** Environmental remediation costs (e.g., Superfund) for current and past operations.

* **Environmental cost monitoring -** Is it important to quantify in absolute terms (dollar amounts) al environmental costs?

* **Public financial disclosure statements -** Is it important to have specific state/national rules regarding disclosure of financial liability?

* **Environmental compliance costs vs. Environmental voluntary costs -** Is it important to differentiate between the two categories and deal with them separately?

* **Future environmental liabilities -** Liabilities on the company for 1) Past activities/products 2) Current and future activities/products.

* **Budgeting processes - Political documents -** Are environmental projects treated differently than other (non-environmental) projects?

* **Reporting systems - Accounting system -** What kind of management information system is needed? How

does it capture environmental cost information?

* **Life cycle cost accounting -** Identifying all cost bearing activities that are associated with a product/process through its lifetime, from acquisition through disposal.

(Note: Full cost accounting only captures costs internal to the company whereas, life cycle cost accounting captures cost external to the company also. Full cost accounting is thus a sub-set of life cycle cost accounting)

Ranking Factors and Issues

* **Accounting information systems environmental accounting information systems -** Many companies are publishing separate environmental reports. But the reports are not always consistent in what and how much the say. I there a need to develop a uniform system for environmental reporting to outside constituents?

* **Environmental cost allocations -** Allocating costs correctly to environmental activities that cause them. Ideally everything should be charged to a product/process rather than to overhead.

* **Other**

* **Other**

* **Other**

COMPANY COMPLETING FORM:

INDIVIDUAL COMPLETING FORM: