BUSINESS PERFORMANCE MANAGEMENT

TITLE

Tools and Techniques of Environmental Accounting for Business Decisions

CREDITS

This statement was approved for issuance as a Statement on Management Accounting by the Management Accounting Committee (MAC) of the Institute of Management Accountants (IMA®). IMA appreciates the collaborative efforts of The Society of Management Accountants of Canada (SMAC) and the work of Dr. Marc J. Epstein, visiting professor at Stanford University, who drafted the manuscript.

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BUSINESS PERFORMANCE MANAGEMENT

Tools and Techniques of Environmental Accounting for Business Decisions

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I. RATIONALE

Successful business strategies depend on the quality and comprehensiveness of information available to decision-makers. The practice of generating management information such as cost of sales is well established, and the systems employed to produce conventional management reports generally ensure timely availability of high-quality data to management.

However, competitive advantage is gained by generating and capitalizing on business information *not* generally investigated by one's competitors. Comprehensive management information, including information on environmental costs and opportunities, can yield competitive advantage. Typically, environmental costs and associated opportunities are buried in various overhead accounts. By distorting costing and pricing across the business, this practice can result in poor investment and strategic decisions.

Methods are now available to measure, report and manage current and future environmental costs and opportunities. These management tools and techniques can help management isolate the sources and magnitude of previously hidden and misallocated environmental costs and facilitate better business decisions.

II. SCOPE

This guideline follows and relies on the material discussed in The Institute of Management Accountants' Statement on Management Accounting (SMA), *Implementing Corporate Environmental Strategies*. The statement provides a framework for companies to begin to implement a corporate environmental strategy.

This guideline assumes that users have read SMA *Implementing Corporate Environmental Strategies,* and have a basic understanding of the need for and benefits of a proactive corporate environmental strategy and overall guidelines for implementation.

This guideline builds on *Implementing Corporate Environmental Strategies* in providing various tools and techniques used by companies in order to integrate environmental impacts into management decisions. It focuses on three such management decision-making processes: *costing analysis*, *investment analysis* and *performance evaluation*.

This guideline will be useful to all organizations regardless of size, location or the relative sophistication of their existing environmental health and safety (EH&S) systems.

This guideline will help management accountants and others to:

- understand the relationship between organizational goals, strategies and objectives, and the tools and techniques of environmental accounting;
- comprehend their role and responsibilities in environmental accounting;
- understand various guiding principles for costing analysis, investment analysis and performance evaluation from an environmental accounting perspective; and
- appreciate the organizational and management accounting challenges in applying various tools and techniques of environmental accounting for business decisions.

III. THREE STAGES OF IMPLEMENTING A CORPORATE ENVIRONMENTAL STRATEGY

Environmental concerns play a significant role in the formulation of corporate strategy. *Implementing Corporate Environmental Strategies* describes three stages of corporate involvement

in the development and implementation of a corporate environmental strategy. These stages are: Stage 1, *managing regulatory compliance*; Stage 2, *achieving competitive advantage*; and Stage 3, *completing environmental integration.*

In *Stage 1*, organizations develop environmental management programs in response to increases in both external pressure and internal awareness. Stage 1 organizations are motivated by concerns about the potential liability exposure they may face. They realize the possible risks, such as litigation and cleanup costs, associated with current practices; and they develop systems for identifying and monitoring physical risks and hazards relative to regulatory requirements.

Beyond a commitment to compliance with legal requirements, *Stage 2* organizations realize that using resources more efficiently can gain them a competitive advantage. Minimizing environmental risk and liability exposure is the hallmark of Stage 1 organizations; Stage 2 companies focus on cost management.

In *Stage 3*, organizations have fully integrated environmental considerations into corporate life. They recognize that environmental performance is not just a legal requirement, moral imperative or cost of doing business but a part of surviving in a competitive world economy. Environmental issues, large and small, are part of everyone's day-to-day decision-making. Stage 3 companies recognize that long-term economic growth must be environmentally sustainable.

The tools and techniques of environmental accounting for business decisions that are described in this guideline can be used by companies in each of the three stages. Just as companies can straddle the boundaries of these stages, they often use these tools and techniques in more than one stage.

IV. DEFINING ENVIRONMENTAL ACCOUNTING

The term "environmental accounting" is open to interpretation. In this guideline, environmental accounting is the identification, measurement and allocation of environmental costs, the integration of these environmental costs into business decisions, and the subsequent communication of the information to a company's stakeholders.

Identification includes a broad examination of the impact of corporate products, services and activities on all corporate stakeholders.

After companies identify the impacts on stakeholders[1] as far as they can, they measure those impacts (costs and benefits) as precisely as possible in order to permit informed management decision-making. Measurements might be quantified in physical units or monetized equivalents.

After their environmental impacts are identified and measured, companies develop reporting systems to inform internal and external decision-makers. The amount and type of information needed for management decisions will differ substantially from that required for external financial disclosures and for annual environmental reports.

Organizations use environmental accounting for several reasons, including the following:

- to help managers make decisions that will reduce or eliminate their environmental costs;

1 Stakeholders are those with an interest in the environmental effects, activities, products and services of an organization. Examples of stakeholders include bondholders, shareholders, managers, Board of Directors, customers, suppliers, regulators, policy makers, employees, consumers, and community and environmental groups.

- to better track environmental costs that may have been previously obscured in overhead accounts or otherwise overlooked;
- to better understand the environmental costs and performance of processes and products for more accurate costing and pricing of products;
- to broaden and improve the investment analysis and appraisal process to include potential environmental impacts; and
- to support the development and operation of an overall environmental management system.

V. DEFINING ENVIRONMENTAL COSTS

To successfully implement a corporate environmental strategy, decision-makers require precise information about the environmental costs of the company's products, processes and activities.

How organizations define environmental costs typically depends on how they intend to use the information and the scale and scope of the exercise. Whether or not a cost is environmental may not always be apparent. However, determining whether a cost is environmental is not critical; the goal is to ensure that relevant costs receive appropriate attention.

Union Carbide Corp. (UCC), for instance, has specific guidelines regarding environmental costs, which are distinguished from capital expenditures. Environmental expenses "cover all non-capitalized environmental costs charged to operations for the year." UCC includes a measure of the benefits in determining the "net total cost" for the environmental expense.

The U.S. Environmental Protection Agency (EPA) *Pollution Prevention Benefits Manual* and the Global Environmental Management Initiative (GEMI) *Environmental Cost Primer* provide frameworks for identifying environmental costs. Exhibit 1 illustrates examples of these costs, labeled as *conventional company, potentially hidden, contingent* and *image/relationship*.

According to the U.S. EPA, *conventional company costs* include costs typically recognized in investment analysis and appraisal such as capital equipment and raw materials. *Potentially hidden costs* result from activities undertaken to 1) comply with environmental law (i.e., regulatory costs); or 2) go beyond compliance (i.e., voluntary costs). *Contingent costs* are costs that may or may not be incurred in the future, such as the cost of remedying and compensating for future accidental pollution. Because pollution prevention projects aim to reduce or eliminate pollution, the savings from lower contingent costs could produce significant benefits that might otherwise be ignored. *Image and relationship costs* are costs incurred to affect the subjective (albeit measurable) perception of stakeholders, such as the costs of annual environmental reports and community relations activities.[2] (Definitions for other cost categories shown in Exhibit 1 are provided in the glossary.)

Involuntary failure costs, such as environmental fines, are paid for directly by corporations and *internalized*. Other costs, such as environmental damage, may not be always completely identified. These *external costs* are costs to society and the environment. External environment costs include such potential liabilities as the risk of cleanup and damage to natural resources or damage to people and property.

Exhibit 2 provides a graphical representation of the important difference between *internal*

2 These definitions are provided in the U.S. EPA primer, *An Introduction to Environmental Accounting as a Business Management Tool: Key Concepts and Terms*.

EXHIBIT 1. ENVIRONMENTAL COSTS INCURRED BY FIRMS

Potentially Hidden Costs		
Regulatory	**Upfront**	**Voluntary**
- Notification - Reporting - Monitoring/testing - Studies/modeling - Remediation - Recordkeeping - Plans - Training - Inspections - Manifesting - Labelling - Preparedness - Protective equipment - Medical surveillance - Environmental insurance - Financial assurance - Pollution control - Spill response - Stormwater management - Waste management - Taxes/fees	- Site studies - Site preparation - Permitting - R&D - Engineering and procurement - Installation **Conventional Company Costs** - Capital equipment - Materials - Labor - Supplies - Utilities - Structures - Salvage value **Back-End** - Closure/decommissioning - Disposal of inventory - Post-closure care - Site survey	- Community relations/ outreach - Monitoring/testing - Training - Audits - Qualifying suppliers - Reports (e.g., annual environmental reports) - Insurance - Planning - Feasibility studies - Remediation - Recycling - Environmental studies - R&D - Habitat and wetland protection - Landscaping - Other environmental projects - Financial support to environmental groups and/or researchers
Contingent Costs		
- Future compliance costs - Penalties/fines - Response to future releases	- Remediation - Property damage - Personal injury damage	- Legal expenses - Natural resource damages - Economic loss damages
Image and Relationship Costs		
- Corporate image - Relationship with customers - Relationship with investors - Relationship with insurers	- Relationship with professional staff - Relationship with workers - Relationship with suppliers	- Relationship with lenders - Relationship with host communities - Relationship with regulators

Source: EPA. *An Introduction to Environmental Accounting as a Business Management Tool: Key Concepts and Terms*. 1995.

and *external* environmental costs. For many companies, current environmental accounting practices typically encompass only Box A *conventional company costs*, including such items as:

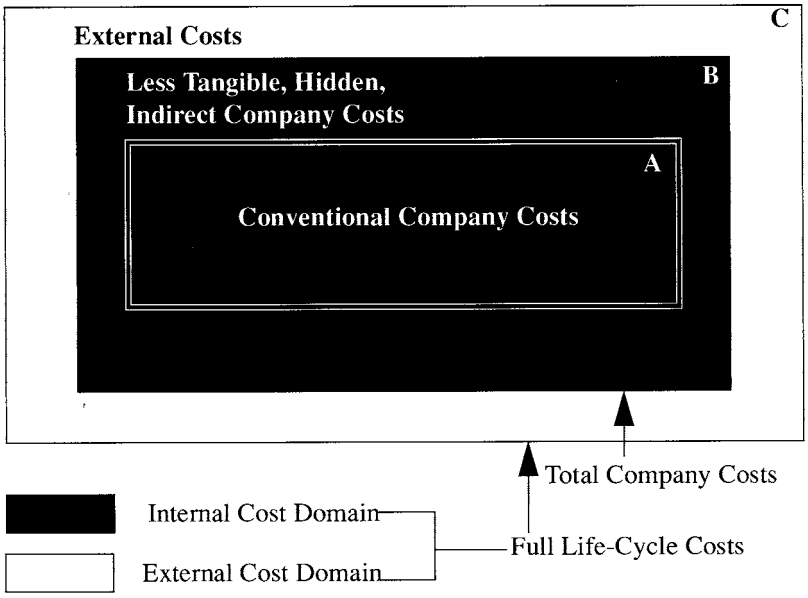
- off-site waste disposal;
- purchase and maintenance of air emissions control systems;
- utilities costs; and
- perhaps costs associated with permitted air or wastewater discharges.

Beyond this conventional cost domain is Box B, which encompasses a wide range of *less tangible*, *indirect company costs* (and savings and revenue streams) including:

- liability;
- future regulatory compliance;
- enhanced position in "green" product markets; and
- the economic consequences of changes in corporate image linked to environmental performance.

Boxes A and B collectively make up the *internal cost domain*, which contains costs that affect the firm's bottom line under current and foreseeable regulatory and market conditions.

EXHIBIT 2. INTERNAL AND EXTERNAL ENVIRONMENTAL COSTS



Source: White et al. 1995.

Box C comprises *external costs*, or externalities. These are costs for which firms are not accountable or that have no material economic consequences to firms under current and foreseeable regulatory and market conditions. For example, Box C may include:

- environmental damage due to acid rain deposits from combustion of fossil fuels;
- adverse health effects due to noise pollution from airports or highways; and
- ozone depletion caused by aerosol cans containing CFCs.

As regulation and penalties proliferate, many of these external costs eventually become internal costs. When it evaluates the long-term profitability of a product line, a firm must consider that its total costs will likely include expenditures for short-term, external costs. To do otherwise can lead to undercosted products, poor management decisions and reduced corporate profitability.

VI. THE ROLE OF THE MANAGEMENT ACCOUNTANT

Given ever-changing environmental laws and the complexities of environmental management, proactive businesses recognize the need to integrate environmental considerations into decisions made *throughout* the organization.

Incorporating environmental considerations into decision-making throughout the organization requires the combined skills of multiple disciplines, including environmental managers, economists, engineers, operations managers,

planners, scientists, lawyers and management accountants.

The management accountant has an important role to play on the corporate environmental team. The management accountant may help develop and implement better environmental analysis tools and techniques in several ways, such as:

- helping assess the need for new or modified management information and financial systems;
- developing or seeking capital investment and appraisal tools that more effectively incorporate environmental costs and benefits;
- isolating and computing individual environmental costs;
- helping resolve conflicts between environmental management and traditional financial management systems, such as those that occur in capital investment appraisal;
- considering the financial costs and risks associated with an investment or product/process design choice that will likely cause or increase pollution;
- helping improve methods for reallocating internal environmental costs to specific products and activities;
- training line personnel in environmental accounting reports and concepts, and in performing new procedures (e.g., coding) to implement environmental accounting processes and systems;
- working with other professionals in the organization to assess the potential costs of failing to undertake environmental initiatives; and
- offering expertise in the financial evaluation of environmental litigation and settlement options.

VII. TOOLS AND TECHNIQUES OF ENVIRONMENTAL ACCOUNTING

Companies use a variety of tools and techniques in order to integrate environmental impacts into management decisions. This guideline focuses on three such management decision-making processes: costing analysis, investment analysis and performance evaluation.

Costing Analysis

Effective corporate environmental management is impossible without an adequate system to identify and measure environmental costs. Some of the tools and techniques that can help companies define the activities, processes and products that cause environmental costs are:

- allocation of environmental costs;
- life-cycle assessment;
- hierarchical cost analysis;
- activity-based costing; and
- quantification and monetization of externalities and full environmental cost accounting.

Allocation of Environmental Costs

It is generally agreed that, decades ago, the lack of understanding of the eventual environmental impacts of products and services and their related legal liabilities[3] caused companies to ignore those impacts in their calculation of product costs. Remediation costs related to Superfund[4]

3 As used in this guideline, environmental liabilities mean legally established obligations related to 1) the management use, handling or release of potentially harmful substances or 2) the ownership or operation of activities or properties where such substances are located. These obligations are liabilities because their discharge involves costs or payment to others.

4 In 1989 the U.S. Congress passed the Comprehensive Environmental Response Act, referred to as "the Superfund Act," empowering the EPA to enforce cleanup efforts. The reimbursement provisions of Superfund create huge potential civil liabilities for businesses because they allow the EPA (and others) to recover response costs (costs incurred in cleaning up a site) and payment for natural resource damages (costs incurred in remedying damage to flora, fauna and wildlife at the site).

were caused decades ago, but are being incurred today. Thus, the products that caused those costs were undercosted and probably underpriced. Companies must ensure that current costs include an estimate of total product costs, so that future generations of managers and products are not encumbered by those costs when they occur.

Many companies are investigating and implementing systems that better accumulate and measure their past, present and future environmental costs related to product costing. Companies generally distinguish among three categories of environmental costs. These are costs incurred to respond to:

- past pollution not related to ongoing operations;
- current pollution related to ongoing operations; and
- future environmental costs related to ongoing operations.

Past Pollution Not Related to Ongoing Operations

Some companies are paying a significant portion of their total environmental cost to clean up pollution caused decades ago. For example, remediation costs related to Superfund are only being incurred today but pertain to pollution of decades ago. Because these corporate environmental expenditures are often substantial, including them in product costs often dramatically affects the profitability of products, facilities and divisions. But many companies include current operating costs pertaining to past environmental liabilities in their current product costs.

Some companies justify this inclusion as follows: earlier (maybe decades ago), other expenses that created future benefits were charged to product costs or corporate overhead, including product development, research and development, and advertising expenses. Thus, current products benefit from those prior expenditures. The product must now bear the costs related to prior production, just as it reaps the benefits.

Current products are often improvements over their predecessors. Even when the company no longer makes those predecessor products, often a particular facility still bears the costs. Many managers believe that loading these costs onto product costs fails to accurately measure the profitability of the product, facility or division. More important, this practice damages performance evaluation and compensation.

For many companies, it is more appropriate to include these costs in corporate overhead or general and administrative expense accounts rather than in product costs. Other companies place them in overhead accounts and then spread them to products through an allocation system that less directly affects a particular product. But even after allocating past costs, the performance evaluation of managers includes costs incurred possibly decades earlier. Companies with negotiated U.S. Government contracts should discuss with their government representatives the potential impact of the allocation basis on the allowability of the costs allocated to negotiated government contracts.

According to traditional concepts of responsibility accounting, managers should not be held accountable for costs beyond their control. In order to effectively measure the performance of products, facilities, divisions and division managers, many companies believe that placing current costs for past environmental liabilities into current product costs is inappropriate.

Many organizations argue that, as the company must bear past costs, these costs should be assigned to facilities and products on some basis. If not, the business units might show a profit even as the corporation itself shows a loss. This case also highlights the extensive costs incurred through a lack of effective planning for future impacts and a failure to consider full life-cycle costs.

Current Pollution Related to Ongoing Operations

No such controversy is raised by including current operating costs that relate to current production in product costs. These costs vary widely. But as they pertain to the current environmental impacts of producing current corporate products and services, most organizations agree that they should be included in current product costs.

Many companies, however, do not adequately separate or track their environmental costs so they are unable to determine their product costs accurately. Most companies arbitrarily assign environmental costs, continuing the practice of undercosting some products and overcosting others. Analysis and cost reduction are difficult because these companies do not know which products cause the environmental costs.

Future Environmental Costs Related to Ongoing Operations

For many companies, estimated costs that might be incurred in the future from today's processes and products are typically excluded from current product costs and prices. Past experience with environmental law shows that today's processes and products might be subject retroactively to regulations not yet written. It is difficult enough to estimate and book costs accurately when the business context is well understood, let alone when the focus shifts between today and tomorrow. But such estimation is important for managerial decision-making.

Although identifying and measuring future impacts depends on many factors that are unclear today, the process of broadly identifying impacts by examining all relevant stakeholders is certainly beneficial—and will increasingly be expected by shareholders, other investors and purchasers of corporate assets. Investors and others will gravitate toward investments when they are confident that the potential environmental risks and liabilities of current operations have been adequately assessed and incorporated into business strategy.

Life-Cycle Assessment

The momentum toward responsible management of global energy and environmental resources is unmistakable and irreversible. Customers are demanding products that are functional, energy-efficient and environmentally responsible. For example, new German washing machines contain computer microchips that sense the weight of a load and dispense soap and water accordingly. Both Germany and Japan are on the cutting edge in developing zero-polluting electric and hydrogen vehicles in response to increasingly stringent environmental legislation.

By integrating environmental considerations into their products and processes now, companies are strategically positioning themselves for the next century, when aggressive environmental management will be an imperative for business survival. These organizations focus not only on complying with government regulations but on reducing their corporate environmental impacts.

Sophisticated companies are applying various methods and techniques that encourage a comprehensive evaluation of all "upstream" and

"downstream" effects of their activities or products.

For example, some companies use *Life-Cycle Assessment* (LCA) to help them evaluate the cradle-to-grave environmental burdens and opportunities associated with their products, processes or activities. They use LCA to help bridge the gap between improved accounting for existing *internal* environmental costs and recognition of *external* environmental impacts.

By looking beyond the corporation's facility and outside the boundaries of traditional environmental strategies, the LCA process helps companies to identify and assess environmental impacts that they may not presently capture. This process evaluates the environmental effect of a product or activity holistically, by analyzing its entire life cycle. This includes identifying and quantifying energy and materials used and wastes released to the environment, assessing the environmental impact, and evaluating opportunities for improvement. LCA addresses environmental impacts in ecological health, human health and resource depletion. It does not address social effects. (SETAC)[5]

To illustrate how LCA differs from traditional approaches, consider product disposal costs. Previously, few manufacturers were concerned with the ultimate disposal of their products or post-consumer waste. It was up to the consumer to figure out how to safely dispose of the product. Today's *take-back*[6] principle shifts this burden for disposal of products and raw material components back to the manufacturer. The company must determine, allocate and formally account for costs in order to ensure that products can be properly disposed of after their useful life.

For most organizations, the primary objectives of carrying out a LCA are:

- to provide as complete a picture as possible of the interactions of activities with the environment;
- to contribute to understanding the overall and interdependent nature of the environmental consequences of human activities; and
- to provide decision-makers with information that defines the environmental effects of these activities and identifies opportunities for environmental improvements.

LCA consists of four inter-related activities: *goal-setting, inventory analysis, impact assessment* and *improvement assessment*. Depending upon the purpose of the assessment, one or more stages might be included.[7]

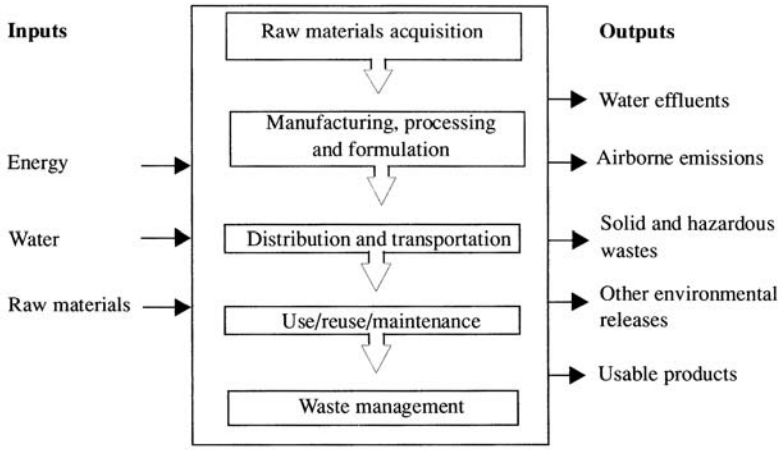
- *Goal-Setting (Scoping)*—The first stage of LCA identifies which issues are pertinent to the particular study product in each of its life-cycle stages, and identifies specific environmental vulnerabilities. Goal-setting identifies the "big picture" issues without the detailed research necessary for a full-blown inventory analysis.
- *Inventory Analysis (Data Collection)*—The second stage of LCA quantifies energy and raw

5 The Society of Environmental Toxicology and Chemistry (SETAC) is a professional society established to promote the use of a multi-disciplinary approach to solving problems of the impact of chemicals and technology in the environment. It published in 1993, guidelines for LCA in a document entitled, "Guidelines for Life-Cycle Assessment: A Code of Practice."

6 Take-back legislation requires that a company take back specified components of a product or the entire product itself after the consumer finishes with it. The most notable example is the German requirement that companies selling products in Germany collect and recycle their packaging. New laws across Europe will soon compel manufacturers of everything from autos to telephones to take back used products after consumer use.

7 The EPA has issued two documents that explain the concepts and analytical methods: Life-Cycle Design Guidance Manual and Life-Cycle Assessment, Inventory Guidelines and Principles. In Canada, the Canadian Standards Association (CSA) has issued two documents on LCA, Z760 and Plus 1107. The "Canadian" LCA process recognizes four phases: Initiation, Inventory, Impact and Improvement.

EXHIBIT 3. LCA INVENTORY ANALYSIS



Source: SETAC. 1991.

material *inputs*, and air, water and waste *outputs* associated with each phase in the product life-cycle from raw materials acquisition to disposal, as illustrated in Exhibit 3.

Inventory analysis is a fairly complex, in-depth process. It is usually completed by consultants or by several internal teams with knowledge and experience in each stage of the life cycle.

If the necessary information is already available in various formats, it can be compiled to complete the inventory analysis. For example, a company might already have gathered information about air emissions, water pollutants and even habitat destruction in order to apply for government permits and comply with regulations.

- *Impact Assessment (Environment Evaluation)*—This stage of LCA characterizes the effects (e.g., ecological, health, economic, esthetic) and significance of the pollutants identified in an inventory analysis. It is usually accomplished by completing an assessment matrix in which relevant impacts are qualified. A hypothetical matrix of the relationship between specific impact categories and the various areas of protection is illustrated in Exhibit 4.

An organization can usually improve its impact assessment by including a cost comparison of either competing products or competing materials and manufacturing processes (including such costs as raw materials, manufacturing, R&D and process redesign). Both internal and external environmental costs should be included in LCA.

- *Improvement Assessment (Company Response)*—The final stage of LCA strategically evaluates the options for reducing the environmental impact of the product or process, considering the product's environmental vulnerabilities and strengths.

  Opportunities for impact reduction include: minimizing energy and raw material consumption; introducing closed-loop systems for chemicals; minimizing activities that destroy habitat; and minimizing releases.

EXHIBIT 4. LCA IMPACT ASSESSMENT MATRIX

SPECIFIC IMPACT CATEGORIES (Examples)	GENERAL AREAS FOR PROTECTION		
	Resources	Human	Health
Ecol. health			
Resource depletion			
- Depletion of abiotic resources	+		
- Depletion of biotic resources	+		
Pollution			
- Global warming		(+)	+
- Ozone depletion		(+)	(+)
- Human toxicity		+	
- Ecotoxicity		(+)	+
- Photochemical oxidant formation		+	+
- Acidification		(+)	+
- Eutrophication			+
Degradation of ecosystems and landscape			
- Land use			+

+ A direct potential impact
(+) An indirect potential impact.

Source: SETAC, 1993.

The four stages of LCA are interdependent. Knowing the impact of the production process, for example, should determine what factors are included in the inventory analysis. Because LCA is a time-consuming activity, the most environmentally malign products should be tackled first.

LCA is not a static exercise but an iterative, dynamic one that develops along with understanding of the impacts of activities. Improvements will likely be incremental, with each LCA building on the next (Gray et al., 1993).

Ciba-Geigy, Dow Chemical, and Church & Dwight have already adopted elements of LCA. Ciba-Geigy, a Switzerland-based company with interests in health care, pharmaceuticals, agricultural products and chemicals, uses LCA in project selection and product design. It uses LCA to choose product packaging and to compare energy requirements for producing various materials. Dow Chemical has completed pilot LCA projects in its chemical and plastics business, and Church & Dwight conducted a LCA study on its Arm and Hammer® baking soda.

The lack of standardized LCA tools and lack of standardized data sets can make widespread, consistent, and cost-effective use of LCA difficult sometimes. However, LCA is a relatively new and evolving technology that is rapidly being developed in order to overcome these barriers.

For example, Canadian businesses will soon be able to obtain environmental information on raw materials for their products and packaging systems through a Canadian Raw Material Database. The Database will address the need for more standardized LCA tools and data sets, and is being developed by Environment Canada, in partnership with the Canadian Standards

Association (CSA) and a number of Canadian raw material producers.[8]

Hierarchical Cost Analysis

In Stage 1 of implementing a corporate environmental strategy, companies are seeking the least costly option for complying with environmental standards. As Stage 1 companies typically believe pollution concerns have minimal importance or value to their success, their investments for environmental projects usually focus on pollution control. These pollution control projects focus on "end of pipe" techniques and aim to control and reduce the release of pollutants.

In contrast, Stage 2 companies generally focus on more comprehensive *pollution prevention* methods that target the root cause of pollution.[9] Stage 2 corporate environmental strategies typically include designing products/processes that take environmental impacts into account.

When cost inventory and cost allocation practices fail to provide a level playing field for all investments, organizations may lack the information they need to make optimal use of limited resources, especially for environmental projects with strong pollution prevention content.

To remedy this situation, the U.S. EPA has supported several studies to demonstrate how economic assessments and accounting systems can be modified to improve the analysis of prevention-oriented investments for pollution prevention initiatives.

In one such study, the EPA developed a hierarchical costing method to identify, track and monitor environmental costs for companies. [10] This technique for pollution prevention contains a four-tier hierarchy of costs including:

- *Tier 0, Usual Costs*—are directly linked with a project, products or process. They typically include the following:
  - ✔ capital expenditures/depreciation
    buildings;
    equipment;
    utility connections;
    equipment installation; and
    project engineering;
  - ✔ operating and maintenance expenses
    materials;
    labor;
    waste management; and
    utilities.
- *Tier 1, Hidden Costs*—refer to regulatory compliance or other costs that are "hidden" or lumped into a general account. These are hidden costs because they are obscured in overhead accounts, making it impossible for managers to manage them effectively. Examples of hidden costs are:
  - ✔ compliance reporting;
  - ✔ legal support;
  - ✔ waste management;
  - ✔ sampling and testing; and
  - ✔ monitoring.

These costs could be significant, and an effective pollution prevention project could possibly reduce them.

8 The International Organization for Standardization (ISO) Technical committee 207 is developing environmental management standards known as the ISO 14000 Series. Five LCA standards and guidelines are being developed as part of the ISO 14000 Series. These LCA standards will provide an international consensus on LCA and its applications.

9 Pollution prevention methods use processes, practices, materials, products or energy that avoid or minimize the creation of pollutants and waste and reduce the overall risk to human health or the environment. Pollution prevention practices include the efficient use and conservation of natural resources, materials and feedstock substitution and increasing operating efficiencies.

10 This material can be found in the EPA's Pollution Prevention Benefits Manual cited in the bibliography.

- *Tier 2, Liability Costs*—are costs associated with contingent liabilities that may result from waste and materials management. Just as the regulatory costs of *Tier 1* are hidden, so too are many of the contingent liability costs.

- *Tier 3, Less Tangible Costs*—are benefits that derive from improved corporate image, customer acceptance and community goodwill. A company may realize savings in less tangible costs as a result of reducing or eliminating pollution. These cost savings are increased revenues or decreased expenses due to improved customer acceptance, employee relations and corporate image. Although it is difficult to predict with certainty the extent of these benefits, it is reasonable to assume that they may be significant.

The EPA hierarchy of costs reduces the effort needed to reveal the economic benefit of a pollution prevention investment. Companies can begin by analyzing *Tier 1* costs; if this analysis does not reveal an economic benefit, then they may want to analyze *Tier 2* costs; and so forth. By analyzing pollution prevention investments in this way, a company will not have to analyze costs in all the tiers in order to prove the economic viability of every pollution prevention investment. In the process, the company saves time and money.

The analysis suggested in each of the tiers is as follows:

- *Tier 0, Usual Costs*
  - ✔ Identify pollution prevention alternatives.
  - ✔ Estimate usual costs of current and alternative practices.
- *Tier 1, Hidden Costs*
  - ✔ Establish facility's regulatory status.
  - ✔ Estimate hidden capital expenditures.
  - ✔ Estimate hidden expenses.
- *Tier 2, Liability Costs*
  - ✔ Identify regulatory programs under which penalties and/or fines could be incurred.
  - ✔ Estimate expected annual penalties and fines associated with each program and requirement.
  - ✔ Identify waste-management issues with which liabilities can be associated.
  - ✔ Estimate total expected liabilities.
  - ✔ Estimate expected years of liability incurrence.
  - ✔ Estimate the firm's share of total future liabilities.
- *Tier 3, Less Tangible Costs*
  - ✔ Identify qualitatively less tangible costs and benefits of pollution prevention.
  - ✔ Quantify less tangible costs and benefits of pollution prevention.

After completing all steps within all tiers, organizations conduct a financial analysis of all current and proposed alternative practices. They compile and analyze the calculated costs to yield estimates of three financial indicators that underpin a ranking of practices. The three recommended financial indicators are total annualized savings (TAS), NPV and IRR.

Hierarchical cost analysis helps firms consider the full range of environmental costs and thereby encourages improved quantitative analysis. As some of the equations involve long algorithms, organizations might have difficulty using these equations without any software. Many software tools exist that can help users identify and/or quantify some of their environmental costs.[11]

11 For example, P2/Finance, an EPA-funded software tool, or Eco Accounting, a tool utilized by Arthur Andersen consultants. These tools and many more are profiled in "Incorporating Environmental Costs and Considerations into Decision Making: Review of Available Tools and Software," completed by the Research Triangle Institute for the U.S. EPA.

EXHIBIT 5. ENVIRONMENTAL COMPLIANCE COSTS CLASSIFIED BY COST DRIVERS

Cost Driver	Compliance Requirement	Expected Relationship of Compliance Cost to Cost Driver(s)
• Hazardous substances (HS) used	• Permit preparation and fees	• per HS per plant
	• Inspection and monitoring	• per HS per plant
	• Worker right-to-know training	• per HS per plant • per new worker per process
	• Filing and recordkeeping	• per HS per plant • per new worker per process
	• Regular (periodic) training	• per number of workers per plant
	• Process safety equipment Process emission controls	• per process • per process
	• Emergency response planning	• per HS-generating process per plant
• Hazardous wastes (HW) produced	• Permit preparation and fees	• volume-related step function per HW
	• Inspection and monitoring	• per HW per plant
	• RCRA reporting costs	• volume-related step function per HW
	• Filing and recordkeeping	• volume-related step function per HW
	• Worker training requirements	• per worker
	• Pre-disposal storage costs	• volume-related step function per HW
	• Hazardous waste transportation and disposal fees	• per volume of HW
	• Minimization planning	• per HW-generating process
	• Emergency response planning	• per HW-generating process

Source: Adapted from Hamner, et al. 1995.

Activity-Based Costing

When organizations incur environmental costs, not all processes and products are equally responsible for cost generation. Even in modest-sized manufacturing firms with two or three production lines, environmental costs are not driven equally by each production line. Various lines may contain more hazardous materials, generate more emissions per unit of output, require more frequent intensive inspection and monitoring, and generate greater quantities of waste requiring off-site disposal.

Similarly, particular processes or products may cause a disproportionate share of costs associated with training and reporting to government agencies, or lead to risks that may increase insurance costs.

Given the current costs associated with environmental concerns and the expected increases in these costs, companies should know the principal factors that determine the environmental costs incurred. Companies should also assign environmental costs to products properly.

Traditional accounting systems usually fail to provide accurate environmental cost information, for two main reasons: they often allocate environmental costs to overhead costs; and they often

combine environmental costs into cost pools with nonenvironmental costs.

For example, many companies assign environmental compliance costs (costs directly imposed by regulations, including pollution-control equipment costs, disposal fees, etc.) and oversight costs (costs that arise indirectly from satisfying various compliance requirements) to general overhead rather than trace them to particular products or manufacturing processes.

Although some firms subsequently allocate these environmental costs to products or processes, the basis for these allocations is often ill-conceived. When costs are improperly allocated, managers receive distorted signals regarding the true costs and benefits of retaining or changing processes or products. Moreover, misallocation of environmental costs prevents effective performance monitoring, product pricing, incentive and reward systems, and other activities essential to maintaining a competitive enterprise.

In order to get more accurate and useful information about their costs, and given the shortcomings of traditional cost accounting systems, some firms implement activity-based costing (ABC) for specific processes or systems that contain a large portion of the environmental risks and liabilities. ABC is especially relevant to environmental costs because of the diffuse, long-term and less tangible nature of so many environmental costs. These attributes make allocations particularly challenging from an accounting perspective.

While traditional cost accounting assumes that costs arise out of making products and providing services, ABC attributes costs to the associated *activities* involved in making products and providing services.

ABC provides two approaches for tracking the costs of activities. One approach is to establish sub-accounts in the general ledger, which allocates costs to various activities in the appropriate proportions. This approach resembles traditional accounting systems but permits the organization to emphasize environmental costs.

The other approach is to mirror more closely the actual flow of costs through the organization. This method emphasizes the relationships among activities and different *cost drivers*. Following this approach, costs move from incurrence to cost objects in a series of steps, all based on a cause-and-effect relationship.

Exhibit 5 illustrates how environmental compliance costs can be classified according to cost drivers. This hypothetical example shows that the cost of "hazardous waste transportation and disposal fees" varies with the volume of hazardous waste (HW) produced.

Cost driver analysis also reveals opportunities for improvement. For example, incorporating sensitivity to environmental costs into its ABC approach has enabled AT&T to better identify its true product costs. Cost driver analysis prompted AT&T to conduct process improvements and re-engineering, unlike its traditional cost accounting system, which had failed to highlight environmental costs. [12]

Using ABC to identify cost-bearing activities effectively and to allocate costs to individual products can help rationalize managerial decisions. Armed with information on how environmental costs affect current product costs,

12 U.S. EPA "Case Studies in Environmental Accounting: Green Accounting at AT&T." July 1995.

organizations can make better strategic decisions about continuing or abandoning products. Knowing the full costs of current production and processes also allows managers to focus on opportunities to minimize compliance costs, reduce operating costs, and fully mesh the organization's environmental and financial goals.

However, implementing ABC to rationalize environmental managerial decisions carries its own cost. Organizations must always weigh the value of disaggregating cost information against the attendant costs of setting up and maintaining the accounting infrastructure to collect, analyze and digest its outputs.[13]

Quantification and Monetization of Externalities and Full Environmental Cost Accounting

Despite much progress, corporate costing systems fail to produce a true picture of environmental costs. For instance, no company has fully implemented a system to integrate *all* present and future *external* and *internal* environmental costs into its product costing system. For external costs, it is difficult to measure the cost to society of such factors as the degradation of quality of life caused by air pollution.

In Stage 3, organizations expand their systems to include a broader inventory of environmental costs. One such system is full environmental cost accounting. Although definitions vary, the vision is consistent. Full environmental cost accounting includes the current and likely future costs, including externalities related to the environmental impacts of a company's products, services and activities.[14] It takes into consideration the future costs imposed by a product and allocates them to the product itself.

Ontario Hydro has made a corporate commitment to using full environmental cost accounting in its decision-making. For the utility, full environmental cost accounting is a tool that can help integrate environmental considerations into business decisions.[15]

Ontario Hydro's approach to full environmental cost accounting incorporates environmental and other internal costs with data on the external impacts and costs/benefits of the utility's activities on the environment and on human health. When the company cannot monetize these external impacts, it uses qualitative evaluations.

An approach used by Ontario Hydro that considers internal and external costs, including present and future costs, is the *damage function approach*. The damage function approach attempts, where possible, to place a dollar value on "actual" environmental impacts. It does so by considering site-specific environmental and health data, using environmental modeling techniques to translate activities (e.g., air emissions, water emissions, land use, etc.) into damages on the ground, and applying economic valuation techniques to translate physical impacts into monetary terms.

Four specific methods suggested by Ontario Hydro to monetize these environmental impacts are:

13 The reader should refer to The Institute of Management Accountants' "Implementing Activity-Based Costing," for additional information regarding ABC.

14 For some organizations, full environmental cost accounting refers only to *internal* environmental costs. Other organizations use the term to refer to *both* internal and external environmental costs. This guideline uses the term in the context of the latter view because of 1) the importance of understanding a company's total impact on the environment and 2) the possibility that these external costs will ultimately be internalized through societal pressure, or competition and regulation.

15 Ontario Hydro 1995. *Corporate Guidelines for Full Cost Accounting*.

- *Market-price method*: using information on market prices of, for example, crops that have been damaged or lost due to toxic emissions;
- *Hedonic-pricing method*: using differences in real-estate values or wage rates, assuming that such differences are attributable to relative environmental quality (also known as the property-value approach);
- *Travel-cost method*: using the economic value of "time" as the central indicator of willingness to pay for improvements in environmental quality. This approach evolved to measure the value of public recreation locations and activities and is most often used to monetize recreational activities such as sport fishing, etc.
- *Contingent-valuation method*: contingent valuation (CV) is a survey technique used to estimate individuals' willingness to pay (WTP) for improvements to environmental quality, or willingness to accept (WTA) a loss in environmental quality. For example, the CV method was used to assist in estimating the economic value of environmental damages caused by the Exxon Valdez disaster.

Full environmental cost accounting is not a precise science. It can be constrained by data limitations. Such limitations primarily affect the quantification of hidden regulatory costs, contingent liability costs and less tangible costs. Monetary estimates of externalities are also generally uncertain. Organizations must determine whether the benefits of collecting environmental data outweigh the costs of doing so.

Allied Signal Aerospace Corp. in Kansas City uses *legacy costing* as an alternative approach to full environmental cost accounting.

The broad definition of legacy costing includes an analysis of all corporate environmental impacts:

> "Legacy costs include costs incurred to minimize environmental impact (prevention costs), to assess environmental impact (assessment costs), and to remediate damage caused by the failure to avoid environmental insult (failure costs). Failure costs may be further classified as either voluntary failure costs or involuntary failure costs." (Lawrence and Butler 1995)

Voluntary failure costs include costs that the company might avoid by redesigning products (including the use of less toxic materials) or processes. They also include legal and environmental, health and safety (EH&S) costs. Involuntary failure costs include fines levied for environmental damage caused by accidental spills.

Legacy costing attempts to help companies avoid regulatory surprises and to encourage engineers and others to cooperate in solving problems detected through the legacy costing process and process waste assessments.

Like LCA and full environmental cost accounting, legacy costing attempts to identify and better measure environmental costs and benefits of corporate activities. By identifying and measuring impacts, organizations can better identify and evaluate alternatives and make decisions that yield the greatest environmental improvement for the resources invested.

Investment Analysis and Appraisal

In many organizations, traditional investment analysis and appraisal approaches overlook pollution prevention projects. Pollution prevention projects usually fare poorly because a systemic bias in traditional investment analysis places them at a competitive disadvantage. For exam-

ple, managers accustomed to using traditional accounting methods are unable to pinpoint other quantified (internal) environmental costs.

Another bias is the mere fact that many environmental costs are uncertain: managers do not know what they are, their ultimate magnitude, and when they will occur. This uncertainty reflects the inherent complexity of use, movement and exposure to hazardous substances. Rapidly changing regulations and judicial decisions also cause uncertainty.

Another bias is the tendency of traditional investment appraisal techniques—typically discounted cash flow (DCF) and payback—to narrow the range of issues considered and to favor short-term, less risky options. For example, DCF tends to discourage large projects that are expected to last more than about 10 years. Most important in an environmental context, DCF inevitably places less emphasis on events later in the project's life.

For instance, a conventional DCF calculation typically fails to account for a plant's reduced efficiency toward the end of its life (and the attendant potential increases in emissions and spills) and thus discounts abandonment and decommissioning costs or any other environmental problems (e.g., land contamination) that might then arise.

Because of these systemic biases, companies may not recognize financially attractive investments in pollution prevention and cleanup technology.

Organizations in stages 2 or 3, that are concerned with achieving a competitive advantage and/or completing environmental integration use several frameworks and measurement techniques to effectively incorporate environmental risks and uncertainties into their capital decision processes. Although not without their limitations, these approaches offer significant improvements for environmental management. They include:

- total cost assessment;
- multi-criteria assessment; and
- risk and uncertainty analysis.

Total Cost Assessment (TCA)[16]

Company investment projects must usually pass a so-called "hurdle rate," or an acceptable profitability threshold. Environmental projects must compete with other investment alternatives, environmental or otherwise. A critical dimension of this capital allocation process is to examine how a firm defines and estimates project costs and benefits.

When examining proposed environmentally related projects, organizations usually account for all *direct costs*. However, project estimators usually omit *indirect costs*, as they do not directly affect a project's financial profile.

As disposal costs rise, some environmental projects become more competitive. In order for these projects to reach corporate hurdle rates, organizations need to include indirect or less tangible, hidden regulatory and liability costs associated with their current production processes. Likewise, they need to use a longer time frame and account for any indirect benefits of alternative production processes.

Total cost assessment (TCA) improves the decision-making process for investment analysis and appraisal by ensuring that the data gathered include environmental costs—both direct and

16 TCA was developed by the New Jersey Department of Environmental Protection (NJDEP).

indirect—and environmental risks. TCA helps organizations analyze the long-term costs and savings of pollution prevention projects. It considers a broader range of costs than does traditional investment analysis, including certain probabilistic costs and savings. TCA utilizes full environmental cost accounting techniques to properly assign environmental costs and savings to all competing projects, products or processes.

In research studies for the EPA's Office of Pollution Prevention, the Tellus Institute[17] proposed four key elements for TCA: *cost inventory, cost allocation, time horizon* and *financial indicators.*

- *Cost inventory*—includes all benefits and costs of a proposed capital investment, including direct and indirect costs, future liability costs, less tangible benefits and non-environmental costs.
- *Cost allocation*—requires an understanding of the manufacturing process so that organizations can apply all costs to a specific product or process. These allocations can become difficult, for example, when the waste costs from various products and processes are accumulated for disposal.
- *Time horizon*—is important in examining how long it will take for a project to become profitable. For pollution prevention projects, companies should consider avoidance of future liability from personal injury, property damage or environmental regulation fines. Future, harder-to-quantify, benefits that organizations should consider might include higher revenues from better product quality, improved corporate and/or product image, and lower health maintenance costs. These benefits are better captured in financial indicators that allow for a longer time horizon.
- *Financial indicators*—typically, discounted cash flow methods such as NPV, IRR, and Profitability Index (PI)[18] are used for this analysis.

Without these considerations, it will be impossible to level the playing field to enable environmental projects to compete. This does not mean that, with TCA, all or most environmentally oriented projects will be able to compete on purely economic terms. It does mean, however, that firms will discover a wider variety of benefits over a longer time frame than they normally would utilizing traditional investment analysis. It also means that the cost of existing environmental practices will not be excluded from the calculation. [19]

Multi-Criteria Assessment

Another technique that offers improvements to traditional investment analysis and appraisal is multi-criteria assessment (MCA).[20] MCA is designed to help companies systematically evaluate options according to multiple criteria that are sometimes measured on different and/or non-commensurable scales. This evaluation tool enables organizations to consider and trade off all relevant criteria in decision-making.

The main objectives of MCA are to:

- display trade-offs among different objectives (i.e., cost, social, environmental, reliability, risk, etc.) and;

17 A non-profit research group based in Boston.

18 Profitability index is a measure of an investment's profitability, used for ranking proposals with different initial investments. The index is calculated by dividing the present value of inflows by the present value of cash outflows.

19 To implement TCA, the Tellus Institute has developed computer software, P2/Finance, that can perform the TCA analysis for pollution prevention projects. The software offers three different time frames as options for users. Organizations interested in finding out more about this software tool can contact the Tellus Institute directly, or contact the EPA's Pollution Prevention Information Clearinghouse (202) 260-1023, which will be distributing an upgraded version of this software free of charge to industry and anyone interested in using it.

20 Also commonly referred to as Multiple-Objective Decision Making or Multi-Criteria Decision Method.

- help participants in the decision-making process decide what trade-offs they are willing to accept, determine which alternatives they prefer, and document the results.

MCA can be used to compare and evaluate "unlike" environmental and social impact information when the company lacks a full range of monetized impact data. For instance, Ontario Hydro has used MCA to make trade-offs among environmental measures to identify key indicators of environmental impact/damage for inclusion and evaluation within its corporate planning process.[21]

Companies can also use MCA to compare and make trade-offs of environmental and other attributes (e.g., private costs, internal environmental costs, reliability, flexibility, etc.) that must be considered in the investment decision-making processes.

The methodology of MCA can be divided into three steps: 1) structuring the decision problem, 2) formulating a preference model, and 3) evaluating and comparing alternatives. Structuring the decision problem includes the specification of objectives and attributes, the generation of alternatives, and the assessment of consequences of each alternative in terms of multiple criteria. A formal preference model is developed to represent the decision-maker's values and to elicit relevant information about the decision-maker's preferences. Finally, evaluating and comparing alternatives provides the ordering of decision alternatives required in a problem.

Ontario Hydro has also recently used MCA to assess the relative performance of planning horizon portfolios, according to criteria reflecting objectives of option costs (private costs), environmental performance (including external impacts and costs) and resource use efficiency, social and economic benefits, and financial and operational viability. [22]

Environmental Risk Assessment and Uncertainty Analysis

Although the terms *uncertainty* and *risk* are often used interchangeably, they are distinctly different. Uncertainty relates to a situation in which the probability distribution of an event is unknown; risk relates to a situation in which such a distribution is known. To assess risk in environmental situations, it is often suggested that the company make adjustments to the cost and benefit profiles rather than to the discount rate. A better approach to this problem is to test the sensitivity of the outcome of project evaluations to variations in the key parameters (Kula, 1992).

Environmental decisions are considered complex and risky, and can cause enormous financial impact. Remediation costs for environmental spills and other accidents, fines, penalties, legal costs, damages and bad decisions have increased dramatically in recent decades. Traditional financial analysis of uncertain future events as best- and worst-case scenarios is inadequate as it ignores risk components. New techniques for risk assessment have recently been developed, and existing techniques have been applied more frequently to environmental issues.

Numerous frameworks and measurement techniques are available to effectively incorporate environmental risks and uncertainties into the investment analysis and appraisal process. For example, many companies actively use such techniques as:

21 Ontario Hydro. 1995. *Corporate Guidelines for Full Accounting*. September.

22 Boone, C., H. Howes, and B. Reuber. 1995.

- option assessment, option screening, and scenario forecasting;
- Monte Carlo Simulation and decision trees.

Option Assessment, Option Screening and Scenario Forecasting

Option assessments and option screenings are designed to provide all of the available alternative options to decision-makers. They help decision-makers assess, and act on, the relative attractiveness of options to reduce the environmental impact of substance chains. (Winsemius and Hahn, 1992)

Organizations can use a three-phase methodology to help them select among alternative options. The first phase is to generate options. It is based on cost-effectiveness, relevance for decision-makers and environmental impact. This selection phase includes four steps:

- drawing a flow diagram;
- identifying the major environmental issues;
- defining the options; and
- selecting the most likely options for future evaluation.

The second phase prioritizes the options by determining an economic and environmental profile of the effects. These effects are quantified in monetary terms, and typically include the net changes in operating and capital costs. The options are then positioned on an "option map" based on the relative weight and importance of the costs and the benefits of each option.

The last phase requires the establishment of targets, resources and responsibilities.

Niagara Mohawk Power uses option screening to compare potential environmental scenarios and associated costs of environmental considerations. It implemented a system to identify and measure the options related to both the demand and supply side of electric power usage. The company uses option screening to determine the optimum mix of demand and supply strategies that provides electrical energy services at the lowest cost, within a set of various constraints. It used focus groups to determine the appropriate options and assign probabilities to the most likely scenarios.

Some companies use scenario forecasting techniques to help them examine the likely impacts on their total environmental costs of changing regulations, changing technologies and changing technology costs. For companies facing high levels of uncertainty, imminent change, and a diversity of opinions, scenario forecasting can help clearly identify various choices for decision-makers. Some companies suggest that scenario forecasting aids in assessing and managing risk, broadens corporate thinking, and makes managers focus on the long-term impact of their decisions.

Option assessment, option screening and scenario forecasting helps business unit managers to be proactive rather than wait for regulatory or technology changes to affect their businesses. These techniques also provide information, albeit imprecise, that is useful in improving business and environmental planning.

Monte Carlo Simulation and Decision Trees

Monte Carlo is a simulation technique that permits the calculation of probability distributions of outcomes for complex decision trees. The technique employs a computer to repeatedly and rapidly simulate the outcome of a series of probable events.

A decision tree visually portrays the structure of a decision problem, thus displaying the alterna-

tive courses of action, all possible outcomes and the probability values of each decision.

Companies have applied Monte Carlo simulation to the problem of comparing the possible costs of alternative environmental remediation option's. Using Monte Carlo random sampling from an option's cost probability distribution, the probability that one option will cost more than another can be estimated and the most likely costs of each operation can be compared. Probabilities (i.e., confidence levels) can be assigned to a range of possible costs, leading to more credible and defensible comparisons.

Monte Carlo simulation assigns a probability distribution to environmental risk. That risk can increase or decrease depending on changes to environmental legislation. Once probability distributions are established for all inputs required for an NPV analysis, the Monte Carlo simulation begins. A computer program implementing the algebraic formula for NPV is written. When the simulation calls for the dollar value of future liabilities or interest rates, these amounts are replaced by random numbers drawn from the appropriate probability distributions.

The computer works through the decision tree, drawing a sample from the relevant probability distributions at each point where an event occurs and then applying simple logic to determine how to proceed through the tree. When alternative technologies are available, the computer model will determine the probability distributions of the possible costs of the technologies and then choose the least costly option. If different possible events exist in the decision tree, the computer will model each event and the possible outcomes. This process is repeated until meaningful probability distributions can be established.

Performance Evaluation

In Stage 3, companies are committed to fully integrating environmental considerations into corporate life and recognize the importance of integrating environmental measurements into their performance evaluation systems. This ensures that statements of environmental responsibility articulated by the CEO and in corporate mission statements are properly implemented.

If environmental performance is truly important, evaluations and rewards should highlight that component. If a company sincerely wants to establish and maintain environmental leadership, then the environmental performance of individuals, facilities and divisions must become an integral part of the performance evaluation.

In the long run, environmental performance and financial performance are inter-related. Companies cannot continue to strive for environmental excellence while evaluating and rewarding performance based strictly on short-term financial indicators.

Environmental performance evaluation techniques include:

- corporate, strategic business units and facilities evaluations;
- individual incentives;
- environmental multipliers;
- internal waste and environmental taxes; and
- balanced scorecard measures.

Corporate, Strategic Business Units and Facilities Evaluations

Numerous organizations have developed environmental performance indices to help them gauge the performance of strategic business units and company facilities. This development is sometimes prompted by external evaluators and

sometimes as part of a comprehensive performance evaluation system that is used partly to encourage better environmental performance.

Niagara Mohawk Power began developing a comprehensive self-assessment program as part of its 1989 settlement with the New York State Public Service Commission. This assessment concluded, in part, that sustaining long-term improvement necessitated a change in corporate culture. In order to implement this change, the Measured Equity Return Incentive Term (MERIT) was developed. The organization identified three performance areas that affect value creation for various stakeholders and developed measures in all three areas:

- responsiveness to customer needs;
- efficiency through cost management, improved operations, employee empowerment and safety; and
- aggressive, responsible leadership in addressing environmental issues.

Success in these three goals determines how large a financial award is available for distribution to company employees.

The organization developed an Environmental Performance Index (EPI) and established targets to focus on consistent, measurable improvements from a base-line of environmental performance. Establishing solid benchmarks against which to measure environmental performance encourages management and staff to improve compliance with environmental regulation and can reduce costly non-compliance issues and corrective actions.

Three categories of performance were measured: emissions/waste, compliance and environmental enhancements. For two of the categories, weights were assigned and benchmarks established for continuous improvement. For example, weights were assigned in the *compliance category* based on their relative importance, including the number of notices of violation and the number of environmental audits performed.

In the *emissions/waste category*, the weights were "subjectively assigned to reflect the relative environmental externalities costs based on currently available information." For example, weights and benchmarks for sulfur dioxide and nitrogen oxides have been established for use in the scoring system. (Miakisz, 1992)

The *environmental enhancement category* is scored based on the number of dollars invested in the enhancement. For every $200,000 invested, an additional point is scored. The scores for these three categories are totalled in order to determine a composite index score used for yearly comparisons. If the organization fails to achieve at least half of the category point total, no MERIT award is earned for that category.

Driving this system down to individual performance indicators and individual compensation might be desirable. However, explicitly identifying corporate goals and setting explicit targets likely improves corporate environmental performance and focuses attention on areas of concern and priority. Niagara Mohawk managers believe that applying MERIT and the EPI has improved the company's environmental performance.

Although this system affects the amount of money that the company sets aside for bonuses, an explicit system that directly affects individual pay often provides stronger individual incentives and has a more powerful impact on corporate culture.

Individual Incentives

The traditional accounting system in most organizations acts as a negative incentive (disincentive) to report potential hazards or violations of environmental laws, corporate goals and corporate practices. Employees are sometimes reluctant to notify a manager about a potential hazard, as they believe that eliminating the hazard might cause the business unit to suffer a short-term financial loss. This expenditure typically is viewed as an expense rather than an asset and often reduces a manager's overall rewards.

To confront this concern, many companies encourage excellence in environmental performance by establishing individual environmental goals and tracking progress toward those goals. Often, specific environmental attributes are listed on a performance evaluation form. Comparing performance with goals in this way ensures that both the employee and the evaluator consider environmental impacts in the performance evaluation process.

Although poor environmental performance should affect pay, there is no evidence of such an influence in most companies. Only a fully integrated explicit system can do that. Some companies have intentionally opted for an implicit system that gives managers discretion to make trade-offs between environmental performance and financial performance. If a company views environmental performance as a core value and wants to change its corporate culture, an explicit performance evaluation system will probably produce more powerful results.

One way to improve environmental performance is to involve employees throughout the organization in seeking out violations and quickly reporting them, or, in some cases, to empower them to repair the problem. Some companies develop extensive training programs that sensitize employees to the environmental and financial impacts of various projects and products. These programs demonstrate to employees what they can do to help themselves, the corporation and the environment.

Going a step further, some companies move much of the internal environmental audit work from the central internal environmental audit staff to local employees at the manufacturing facilities. These employees conduct self-audits and report or repair the problems. This also drives home to employees the importance of environmental compliance to the corporation, their individual welfare and their jobs.

If developed properly, the system can affect the pay of the factory workers, their supervisors and senior managers through divisional performance evaluations that include an environmental component besides the standard profit component. The system also can:

- substantially reduce fines for violations of environmental laws;
- increase efficiency through better monitoring of process performance; and
- reduce the amount of work that the central environmental audit staff must perform.

When the system is pushed down to local staff levels, suggested process improvements are more noticeable, waste is often reduced and profits often increase. Employees can even receive small monetary rewards for discovering and reporting potential or existing hazards.

Environmental Multipliers

Among the most advanced and explicit integrations of environmental performance into performance evaluation systems is that of Browning-Ferris Industries (BFI). With 30,000 employees,

EXHIBIT 6. BFI MULTIPLIER SCALE

Points Earned	District Environmental Multiplier
95-100	1.00
90-94	0.90
85-89	0.80
80-84	0.75
75-79	0.50
70-74	0.25
below 70	0.00

Source: Epstein, 1995.

BFI is one of the largest solid waste handlers in North America. In the late 1980s, BFI decided that it needed to change its corporate direction. Hired as CEO, former EPA administrator William Ruckelshaus recognized that the company needed to view changing societal requirements for corporate environmental responsibility as new opportunities rather than regulations to be opposed. Altering the view of its societal role and attempting to reposition itself for future growth, the company decided in 1990 that it needed to make a fundamental change in its corporate culture.

Among its first steps, the company developed Awareness Compliance Tools (ACT) to guide the training needed to meet its new corporate environmental objectives. The objectives used to measure environmental performance are very specific. They include both core corporate objectives and district objectives that apply both to specific business needs and community needs. The company developed a different set of ACT tools for each of its three major lines of business: landfill operations, solid waste and medical waste. A detailed training manual more than 200 pages long describes the objectives, explains the problems and the roles of all employees in achieving corporate environmental compliance and responsibility, and provides training videos and extensive detailed tools to help all employees meet the performance objectives.

Senior corporate officers recognized that in order to effectively implement this change in strategy, the company needed to change its incentives and tie environmental performance directly to employee pay. Under the new system implemented in fiscal 1991, one-third of total compensation became at-risk pay, and the company integrated an environmental compliance component into its bonus calculations.

Exhibit 6 illustrates the multiplier scale used in the performance evaluation system. The scale converts the total points earned on the environmental compliance goals to the environmental multiplier.

Thus, an employee who scores 70 points receives only 25 percent of the incentive pay related to financial and revenue objectives, as described below. A score of less than 70 produces a multiplier of 0. This system is obviously a powerful performance motivator for a company that considers environmental performance as critical to corporate financial success and that wishes to become more environmentally sensitive.

The advantage of a compound incentive plan like this is clear. Under an additive system with multiple performance measures, employees could focus on one or two goals at the expense of others without incurring a severe penalty. Under a compound plan, the multiplicative effect encourages employees to consider all company objectives and goals, rather than ignore some performance measures and still receive a bonus. The company might use weights on each performance measure if it wishes to focus attention on one or two goals.

BFI believes this emphasis on environmental compliance boosts the company's public image and, ultimately, its financial performance. This system works partly because all employees understand that environmental compliance is non-negotiable and is a critical success variable for both their own and the company's performance. This incentive pay system does not apply to employees below the level of district manager. But district managers themselves use incentives to encourage their subordinates to be environmentally responsible in order to achieve bonuses.

Internal Waste Taxes

Another way that companies can motivate behavior is by using a waste tax. In Dow Chemical's Michigan division, for example, one waste landfill was built to last until 2007. Recently, the company has charged each plant a fee based on the amount of waste that it brings to the landfill. It became more economical for plants to introduce process improvements to reduce their waste quantities. This internal waste tax has reduced the amount of solid waste by half, and the Michigan landfill is now expected to last until 2034. Integrating environmental impacts into product costs and then driving those costs into the performance evaluation system can be a powerful motivator of individual behavior.

An Ontario Hydro study recommended establishing a "liability fund," which would consist of monies collected from customers for asset removal, decommissioning, irradiated fuel disposal and radioactive waste disposal. In addition, a provision for the amounts collected in prior years, including interest, would be fully funded.

Some companies believe a waste tax might work better in highly centralized organizations than in less centralized counterparts. In decentralized organizations, a single tax imposed on business units would conflict with corporate culture and would generate resistance. Managers make their own trade-offs of business and environmental improvements rather than obtain penalties or extra funds through internal taxes and redistribute those funds. But such waste taxes have given business units information on the costs of environmental pollution and they often motivate managers to reduce waste.

Balanced Scorecard Measures

Companies seldom connect various financial performance measures with non-financial measures of corporate performance in such areas as productivity and environmental management.

The corporate scorecard developed by Kaplan and Norton is based on a recognition that managers need *both* financial and operational measures to effectively manage an enterprise and that a choice between the two is unnecessary. They write that "the balanced scorecard is like the dials in an airplane cockpit: it gives managers complex information at a glance." It also forces managers to recognize how implementing one corporate policy affects the performance of several variables simultaneously and to consider whether "improvement in one area may have

been achieved at the expense of another." (Kaplan and Norton 1992)

This is exactly what is required of today's managers. They need to institutionalize environmental considerations into all levels of managerial decisions. They need to link environmental information systems with the management accounting, management control and financial reporting systems already in place in organizations. They need to integrate them with existing cost management and capital investment decision systems.

The balanced scorecard forces managers to turn their goals and organizational strategy into action by specifying the measurements to be used in evaluating the implementation of the strategy. Incorporating environmental management into the balanced scorecard format thus forces the managers to develop specific measures that can be used to measure success. Thus, a company needs to do far more than just establish a goal of being environmentally sensitive. It must specify the measurable goals. It must develop goals and performance measures for the corporation, its business units and facilities, and its teams, managers and staff.

Kaplan and Norton include four perspectives in their balanced scorecard: 1) financial, 2) customer, 3) internal, and 4) learning and improvement. These all relate to the core values of the company. A company that develops a corporate environmental strategy within its overall corporate strategy must develop measures of success.

As increased environmental sensitivity becomes a core corporate value, it should become an overlay onto the balanced scorecard and should be an additional goal within each of the four scorecard perspectives. Environmental sensitivity must be seen as relating to 1) increased financial profitability, 2) increased customer satisfaction, 3) increased operating effectiveness, and 4) increased innovation and learning. Alternatively, environmental responsibility and performance could be viewed as a fifth perspective rather than as a core corporate value. In either case, goals and performance measures must be developed and specified.

The balanced scorecard model suits the three stages of implementing a corporate environmental strategy framework used in this guideline. It examines the importance of the performance measures in the implementation of strategy. By integrating environment as a core corporate value, the balanced scorecard can become an important component of the overall implementation of a corporate environmental strategy.

VIII. ORGANIZATIONAL AND MANAGEMENT ACCOUNTING CHALLENGES

Managers need information to make decisions on product costing, product pricing, capital investments and performance evaluations for the corporation, its business units and its employees. In order to make better decisions and minimize environmental impacts and their related costs, managers need to coordinate employees from accounting, finance, legal, engineering, operations and EH&S departments in gathering information and providing inputs. The management accountant can play a critical role by applying the appropriate tools and techniques, yielding better information for better decisions.

In helping organizations implement more effective tools and techniques of environmental accounting, management accountants will face challenges in the following areas:

- Long-term planning and forecasting systems

are needed that incorporate environmental improvement targets and their financial implications. Management accountants must assess the need for new and/or modified information and financial systems.

- New costing and capital appraisal systems may need to be developed. Whether these systems are based on standard or unconventional accounting information systems, they must give decision-makers adequate information about environmental costs and risks.
- Implementing new cost accounting systems is an organization-wide effort and requires the support of senior management as well as a formal implementation plan. An implementation plan should anticipate requirements such as employee training, assignment of responsibility for providing input into the system, and the likely effects of the new information on current operations.
- Conversion of any cost accounting system must be shown to be cost-effective, as with any other investment.
- Environmental costs are often lumped into overhead accounts. These costs must be removed and applied to appropriate accounts in order to help the company better understand its environmental costs and their causes.
- Management accountants need to find ways to account for quantifiable and tangible environmental factors in investment decisions. Otherwise, some proposals that are economically and environmentally sound in the long term may be rejected; alternatively, omission of significant environmental costs might cause the company to accept environmentally unsound proposals.
- Companies must adopt long-term accounting goals for producing environmental accounts that reflect the full cost of production—even when monetary values cannot be assigned.

IX. CONCLUSION

Few would dispute the argument that the emerging "green" debate in boardrooms represents a pressing issue for the 1990s. The stakes are already high, and are rising daily, not only in the legal context but in terms of becoming a good corporate citizen, running a leaner, more energy-efficient and cost-effective operation, and identifying short- and long-term business advantages.

The tools and techniques suggested in this guideline are meant to improve corporate environmental management practices to minimize corporate environmental negative impacts and also to improve corporate financial performance. The development and implementation of a corporate environmental strategy that integrates environmental impacts into all relevant management decisions is essential for all progressive companies.

GLOSSARY[23]

BACK-END COSTS—include environmental costs that arise after the useful life of processes, products, systems or facilities.

FAILURE COSTS—refer to costs incurred to remediate damage caused by the failure to avoid environmental insult.

HIDDEN COSTS—refer to the results of assigning environmental costs to overhead pools or overlooking future and contingent costs. In addition, hidden costs include costs that are identified and recorded in the accounting system but are not typically used in capital budgeting.

INVOLUNTARY FAILURE COSTS—relate to costs associated with environmental damage from unintended spills including fines and other costs.

23 Several of these terms and definitions have been adapted from the U.S. EPA's primer, An Introduction to Environmental Accounting as a Business Management Tool: Key Concepts and Terms.

LESS TANGIBLE COSTS—refer to expenses incurred for corporate image purposes or for maintaining or enhancing relationships with regulators, customers, suppliers, host communities, investors/lenders and the public (also termed "relationship costs" or "image costs"). Previously, less tangible costs were difficult if not impossible to quantify. Recent experience—and growing awareness of the benefits of pollution prevention—may provide essential insight into estimating these costs and savings.

LIFE-CYCLE ANALYSIS—a system-oriented approach that estimates the environmental inventories (i.e., waste generation, emissions and discharges) and energy and resource usage associated with a product, process or operation throughout all stages of the life-cycle.

LIFE-CYCLE COST ANALYSIS—a cost is assigned to each impact quantified in the life-cycle analysis, and these costs are totalled to estimate the net environmental cost of a product, process or project.

REGULATORY COSTS—costs incurred to comply with environmental laws (also termed "compliance costs").

UP-FRONT COSTS—include pre-acquisition or pre-production costs incurred for processes, products, systems or facilities (e.g., R&D costs).

VOLUNTARY COSTS—costs incurred by a company that are neither required nor necessary for compliance with environmental laws but that go beyond compliance.

VOLUNTARY FAILURE COSTS—include costs that could be avoided through product or process redesigns (including the use of less toxic materials). These include legal, and environmental, health and safety (EH&S) costs.

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