International Federation of Accountants

Exposure Draft
November 2004
Comments are requested by February 28, 2005

Exposure Draft

International Guidelines on Environmental Management Accounting (EMA)

International Federation of Accountants

INTERNATIONAL GUIDELINES ON ENVIRONMENTAL MANAGEMENT ACCOUNTING (EMA)

CONTENTS

Request for Comments

Environmental issues – along with the related costs, revenues and benefits – are of increasing concern to many countries around the world. But there is a growing consensus that conventional accounting practices simply do not provide adequate information for environmental management purposes. To fill in the gap, the emerging field of Environmental Management Accounting (EMA) has been receiving increasing attention. In the early 1990s, The US Environmental Protection Agency was the first national agency to set up a formal program to promote the adoption of EMA. Since that time, organizations in 30+ countries have begun promoting and implementing EMA for many different types of environment-related management initiatives.[1]

The International Federation of Accountants (IFAC) decided to contribute to developments in this emerging area by commissioning this guidance document to bring together some of the best existing information on EMA and, at the same time, to update it and add to it as necessary. This document is neither a standard with defined requirements, nor a descriptive practitioner or research report. It is **not** intended to be standard that IFAC Member Bodies are expected to follow or adopt as part of their responsibilities under IFAC's Statement of Membership Obligations (SMOs). Rather, it is intended to be a guidance document that falls into the middle ground between regulatory requirements, standards and pure information. As such, its goal is to reduce some of the international confusion on this important topic by providing a general framework and set of definitions for EMA that is fairly comprehensive and as consistent as possible with other existing, widely used environmental accounting frameworks with which EMA must coexist.

The mission of IFAC is to serve the public interest, strengthen the accountancy profession worldwide and contribute to the development of strong international economies by establishing and promoting adherence to high-quality professional standards, furthering the international convergence of such standards and speaking out on public interest issues where the profession's expertise is most relevant.

IFAC is indebted to the two authors who have labored intensively over this draft. Our thanks go to:

Deborah E. Savage, Ph.D.
Environmental Management Accounting Research & Information Center (EMARIC), Massachusetts, USA
dsavage@emaric.org tel: 617-848-8305 www.EMAwebsite.org

Christine Jasch, Ph.D.
Austrian Institute for Environmental Management & Economics (IÖW), Vienna, Austria
jasch.christine@ioew.at tel: 431-587-2189 www.ioew.at

[1] United Nations Division for Sustainable Development, *Environmental Management Accounting: Policies and Linkages* (New York and Geneva: United Nations Publications, 2002), http://www.un.org/esa/sustdev/sdissues/technology/estema1.htm.

Response Due Date

To be considered, comments on this exposure draft should be submitted so as to be received by **February 28, 2005**, preferably by e-mail or on a computer disk, or in writing. All comments will be considered a matter of public record. Comments should be addressed to:

International Federation of Accountants
545 Fifth Avenue, 14th Floor
New York, New York 10017 USA
Email responses should be sent to: EMAcomments@ifac.org

Acknowledgements

We would like to gratefully acknowledge the efforts of Mr. Tarcisio Alvarez-Rivero of the Division for Sustainable Development of the United Nations Department of Economic and Social Affairs (DSD/UNDESA), who first communicated our idea for a guidebook to IFAC and has helped us develop the proposal and coordinate international funding for the project.

The US Environmental Protection Agency (Ms. Kristin Pierre) and the UK Environment Agency (Mr. Howard Pearce) contributed to the preliminary phases of document development by providing funding for development of the project proposal and for a preliminary EMA literature review, respectively. Funders of the effort to write and review the guidance document itself include DSD/UNDESA, the UK Environment Agency (Mr. Howard Pearce), the Japanese Ministry of Environment (Mr. Kenji Sawami) and the German Federal Ministry for Education and Research (Mr. Alex Grablowitz).

This guidance document already has undergone one substantial review process by selected EMA experts around the world, as well as by IFAC representatives. We would like to thank the following individuals for their time and effort in reviewing the first draft of this document:

Roger Adams, Association of Chartered Certified Accountants
Tarcisio Alvarez-Rivero, Division for Sustainable Development, UN Department of Economic & Social Affairs (DSD/UNDESA)
Martin Bennett, University of Gloucestershire Business School, UK
Roger Burritt, Australian National University, Australia
Dr. Geoff Frost, University of Sydney, Australia
Christian Herzig, Lueneburg University, Germany
Tomoko Kurasaka, Japanese Institute of Certified Public Accountants
Thomas Loew, Institute for Ecological Economy Research (IOEW), Germany
Robin Mathieson, International Federation of Accountants (IFAC)
Takeshi Mizuguchi, Japanese Institute of Certified Public Accountants
Maryna Mohr-Swart, Technikon Pretoria, South Africa
Dick Osborn, Green Measures, Australia
Carsten Redmann, Institute for Management and the Environment (IMU – Augsburg), Germany
Sarah Reed, UK Environment Agency
Maria Fatima Reyes, Philippine Institute of Certified Public Accountants
Kenji Sawami, Japanese Ministry of Environment, Japan
Graciela Scavone, Buenos Aires University, Argentina
Stefan Schaltegger, Lueneburg University, Germany
Hans Schnitzer, Technical University of Graz, Austria
James M. Sylph, International Federation of Accountants (IFAC)
Bernd Wagner, University of Augsburg, Germany
Gwen White, Ball State University, USA
Alan Willis, Canadian Institute of Chartered Accountants

Thanks also go to Ms. Elizabeth Levy for assistance in preparing the EMA literature review and the guidance document itself.

D. Savage and C. Jasch
November 2004

Foward

Accountants constitute the main audience for this guidance document. The document is aimed at both accountants within organizations, who may be most interested in the potential economic and other internal management benefits of EMA, as well as public accountants and auditors, who more and more are tracking or verifying not only financial data but also environment-related information in financial and other reports. Accountants have a special role in EMA, or should have, since they typically have access to the important data and information systems needed for EMA activities. In recognition of this fact, several accounting associations have taken a leadership position in clarifying the value of EMA to their members and promoting the adoption of EMA more widely. These associations include, among others, the Association of Chartered Certified Accountants (ACCA), CMA Canada, CPA Australia, the Philippine Institute of Certified Public Accountants (PICPA) and the Japanese Institute of CPAs (JICPA).

Many organizations have already published guidance documents on EMA.[2] Guidance is also available on the related subject of environmental costing for financial accounting and reporting[3] and on statistical accounting and reporting.[4] As well, several books on environmental accounting have been published (see the bibliography in Appendix A). All of these have contributed greatly to the understanding and practice of EMA.

The existing guidance documents on EMA typically have focused on:

- guidance for different national audiences, supplemented by national case studies and pilot projects (e.g., Argentina, Australia, Austria, Canada, the Czech Republic, Germany, Japan, the Philippines, Spain, the UK, the USA);
- specific environmental management initiatives supported by EMA (e.g., solid waste management vs. supply chain management vs. environmental management systems vs. external reporting);
- differing levels of emphasis on particular EMA methodologies/approaches.

---

[2] *An Introduction to Environmental Accounting as a Business Management Tool: Key Concepts and Terms* (Washington: United States Environmental Protection Agency, 1995); *Introductory Guide to Environmental Accounting: Environment and Decision-making: An Appropriate Accounting* (Ottawa, Ontario: Environment Canada, 1997); US Department of Defense, National Defense Center for Environmental Excellence, *Environmental Cost Analysis Methodology ECAM Handbook* (Fairfax, Virginia: Concurrent Technologies Corporation, 1999); United Nations Division for Sustainable Development, *Environmental Management Accounting, Procedures and Principles* (New York and Geneva: United Nations Publications, 2001), *http://www.un.org/esa/sustdev/sdissues/technology/estema1.htm*); *VDI 3800 Determination of Costs for Industrial Environmental Protection Measures* (Berlin: Association of German Engineers, 2001); T. Loew, K. Fichter, U. Müller, W. Schulz and M. Strobel, *Guide to Corporate Environmental Cost Management*. Translated from *Leitfaden Betriebliches Umweltkostenmanagement* (Berlin: Bundesumweltministerium Umweltbundesamt (German Environment Ministry), 2003); *Environmental Accounting Guidelines* (Tokyo: Ministry of the Environment, 2002), http://www.env.go.jp/en/ssee/eag02.pdf); and *Increase your profits with environmental management accounting* (Oxfordshire, UK: Envirowise, 2003).

[3] United Nations Conference on Trade and Development. *A Manual for the Preparers and Users of Eco-Efficiency Indicators* (New York and Geneva: United Nations Publications, 2004); and *Commission Recommendation on the Recognition, Measurement and Disclosure of Environmental Issues in the Annual Accounts and Annual Reports of Companies* (Brussels: European Commission, 2001).

[4] *Definitions and Guidelines for Measurement and Reporting of Company Environmental Protection Expense* (Luxembourg: Eurostat, 2001); and United Nations (Statistical Division), European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development and World Bank. *Handbook of National Accounting: Integrated Environmental and Economic Accounting* (2003).

It makes sense that different countries and organizations would adapt general EMA concepts, language and practices to better suit their own national and organizational goals. A certain amount of experimentation and variation is also to be expected because EMA is still a relatively young and emerging field in comparison to conventional management accounting. The very number of existing guidance documents, however, has contributed to confusion on the exact definition, benefits and applications of EMA as well as available EMA approaches and tools. This has been exacerbated by the fact that EMA information is broadly useful for so many different types of management decisions and activities, as well as for external reporting.

With all this in mind, the Board of the International Federation of Accountants (IFAC) decided to commission this guidance document on EMA to bring together some of the best existing information on EMA and to update it and add to it as necessary. The goal is to help reduce some of the international confusion on this important topic and to give some practical introductory guidance to individuals and organizations that wish to explore EMA further.

Executive Summary

Chapter 1 of this document provides an introduction to several topics. First, because the world's accountants operate with different accounting practices and languages, there is a brief review of general accounting concepts and language as used in this document. The main point is to distinguish between management accounting (MA), the focus of which is internal decision making, and financial accounting (FA), which aims to provide information to external stakeholders.

There is also an introduction to the broad field of environmental accounting (EA). The types of EA that take place within an organization are distinguished from the higher level of EA performed at geographic (e.g., a watershed) or geopolitical levels (e.g., a nation). The environmental parallels to MA and FA are briefly outlined – Environmental Management Accounting (EMA) vs. Environmental Financial Accounting (EFA) – along with the types of external reporting typically associated with them.

Chapter 1 also provides a more detailed introduction to the main subject of this document, **Environmental Management Accounting**. Although EMA has no single, universally accepted definition, this international guidance document uses the definition adopted by the United Nations Expert Working Group on EMA:[5]

EMA is broadly defined to be the identification, collection, analysis, and use of two types of information for internal decision-making:

- physical information on the use, flows, and fates of energy, water, and materials (including wastes) *and*
- monetary information on environment-related costs, earnings, and savings.

> To assess costs correctly, an organization must collect not only monetary data but also non-monetary data on materials use, personnel hours and other cost drivers. EMA places a particular emphasis on materials-related costs because: (1) materials purchase costs are a major cost driver in many organizations and (2) use of energy, water and materials, as well as the generation of waste and emissions, are directly related to many of the impacts organizations have on their environments. This chapter briefly describes the types of environmental impacts related to materials use and goes on to provide a brief history of the types of costs that typically have been considered as environment-related as EMA has evolved. The final section of Chapter 1 describes the evolution of the practice and goals of MA in general, and how EMA fits in.

Chapter 2 answers the important question: Why EMA? First of all, various stakeholders, such as business customers, investors, local communities and government are applying pressure on organizations to continually improve on and report environmental performance. Second, as a result of this stakeholder pressure, environment-related costs, earnings and benefits are on the rise and are becoming a more important part of organizational decision making. And, finally, there is increasing recognition that conventional MA practices often do not provide sufficient, and sufficiently accurate, information for environmental management and environment-related

[5] United Nations Division for Sustainable Development, *Environmental Management Accounting, Procedures and Principles* (New York and Geneva: United Nations Publications, 2001), *http://www.un.org/esa/sustdev/sdissues/technology/estema1.htm.*

cost management. As a result, many organizations significantly underestimate both the costs and benefits of sound environmental management. The potential uses and benefits of EMA are wide ranging and significant, and fall into three broad areas: Compliance Efficiency, Eco-Efficiency and Strategic Position. It is particularly important to note that EMA not only helps an organization assess and plan for unavoidable pollution control costs, but also helps it reduce control costs as well as the costs of poor materials use efficiency via preventive environmental management.

Chapter 3 discusses the physical accounting side of EMA in more detail, including very brief discussions of the related concepts of materials balances, materials flow accounting and physical environmental performance indicators. The types of physical materials tracked under EMA include: Material Inputs (materials, water, energy); Product Outputs (products, by-products, packaging); and Non-Product Outputs (solid waste, hazardous waste, wastewater, air emissions).

Chapter 4 discusses the monetary accounting side of EMA in more detail. Organizations tend to define environment-related costs differently, depending on the intended uses of the cost information, an organization's view of what is "environmental," an organization's economic and environmental goals and other reasons. One of the most important goals of this guidance document is to clarify the environment-related cost information that managers need to manage both their organization's environmental performance and its associated economic performance. Since this is an international guidance document, it was also important to review the varying cost guidelines in different countries, and to make the cost scheme outlined here consistent with international practice as much as possible, considering the wide range of language and practice. Finally, the goal was to outline cost categories that represent not just widely accepted current practice, but also emerging best practice. The cost categories are shown below.

1. Material Costs of Product Outputs
2. Material Costs of Non-Product Outputs
3. Waste and Emission Control Costs
4. Prevention and other Environmental Management Costs
5. Research and Development Costs
6. Less Tangible Costs

Chapter 4 also briefly discusses environmental performance indicators that have a monetary component, including eco-efficiency indicators.

Chapter 5 presents a number of brief, real-world examples of EMA applications and links, meant to illustrate the wide range of potential uses and benefits of EMA. The examples come from Argentina, Australia, Austria, Denmark, Germany, Japan, the Netherlands, the UK and the USA

First, the chapter offers several examples of EMA applications for internal decision making, at three different broad levels: (1) EMA for a site or organization as a whole; (2) EMA for a

particular material or class of materials used or produced in an organization; (3) and EMA for a particular project within an organization. These examples cover a range of issues, such as the use of EMA approaches for chemicals management, logistics management, investment appraisal, development of environmental performance indicators, and tracking annual environment-related costs by environmental domain. They illustrate the efficiency benefits of EMA for both business and government. They also illustrate the links between physical and monetary information in "Materials Flow Cost Accounting."

Second, several examples are given of the links between EMA and other types of accounting and reporting: financial accounting and reporting, statistical accounting and reporting and environmental performance reporting. These examples discuss the similarities and differences between the types of information collected under these accounting and reporting schemes compared to EMA, and illustrate the potential for EMA to inform these schemes, and vice-versa.

Appendix A of this document gives a list of references used and Appendix B ("Where to Go for More Information") lists the most prominent organizations and websites where more information may be found.

Chapter 1 – Introduction

This chapter provides introductions to the following:

- Accounting Concepts and Language
- Environmental Accounting Concepts and Language
- What is EMA?
- Is EMA the Next Step in the Evolution of Management Accounting?

Accounting Concepts and Language

The types, goals and levels of sophistication of accounting systems found around the world can vary quite widely, depending on the size of organization involved, the type (e.g., private companies vs. government agencies), the host country and many other factors. The language used to describe accounting systems and activities also varies. Therefore, this section provides a very brief introduction to some common accounting concepts and language, both for accountants in countries that may have different accounting languages and practices, as well as for any non-accountant readers who may not be familiar with accounting terminology at all.

The two broad categories of accounting that typically take place within an organization are management accounting (MA) and financial accounting (FA). In general, FA tends to refer to accounting activities (e.g., bookkeeping) and reports directed to external stakeholders, while MA focuses on providing information to organization management for internal decision making.

Management accounting is the application of the principles of accounting and financial management to create, protect, preserve and increase value and then to deliver that value to the stakeholders of profit and not-for-profit enterprises, both public and private.
Management accounting is an integral part of management. It requires the identification, generation, presentation and use of information relevant to:

- *formulating business strategy;*
- *planning and controlling activities;*
- *decision making;*
- *efficient resource usage;*
- performing improvement and value enhancement;
- safeguarding tangible and intangible assets;
- corporate governance and internal control.

Management accountants help organizations establish viable strategies and convert them into value. To achieve this, they work as an integral part of multi-skilled management teams in carrying out:

- formulating policy and setting corporate objectives;
- strategic planning;
- operational planning and budgeting;
- treasury management;

- designing systems, recording events and transactions and managing information systems;
- cost accounting;
- business analysis and decision support;
- financial and management control;
- performance management and review.

Many of these activities are forward-looking.

Although there are accepted good practices in the realm of MA, these practices are not regulated by law. Each organization can determine which MA practices and information are best suited to its organizational goals and culture.

In contrast, **Financial Accounting** is mainly designed to satisfy the information needs of external stakeholders, such as tax authorities, creditors and investors, all of whom have a strong interest in receiving accurate, standardized information about a organization's financial performance. FA focuses on activities such as bookkeeping, account balancing, auditing of the financial statements and external reporting. Financial reporting is regulated by national laws and international standards, which specify how different financial items should be treated, for example, whether or not different types of investments should be capitalized or expensed and how different kinds of liabilities should be reported.

FA focuses on several types of financial information. An organization's financial statements provide information on annual revenues and expenditures in an Income Statement (which also may be known as an Income & Expenditure Account or a Profit & Loss Account). The Balance Sheet reports assets, liabilities and equity at a specified date. In addition, the financial statements include a Cash Flow Statement.

There are, of course, typically many links between an organization's FA and MA practices. For example, total costs and earnings calculated for MA purposes are related to the organization-wide revenues and expenditures collected for financial reporting purposes. An organization uses data from its MA system for FA purposes, for example, to determine the amount and value of finished goods that must be reported in the FA Balance Sheet. Many companies, particularly small and medium-sized ones, do not have an independent MA system; they simply use data from their FA bookkeeping for internal decision making as well as for external reporting, perhaps with a few minor adjustments.

Environmental Accounting Concepts and Language

Environmental accounting is a broad term used in a number of different contexts. At the *organization level*, EA takes place in the context of both management accounting (e.g., assessment of an organization's expenditures on pollution control equipment; revenues from recycled materials; annual monetary savings from new energy-efficient equipment) and financial accounting (e.g., evaluation and reporting of the organization's current environment-related liabilities).

At the *geographic and geopolitical levels*, EA information is collected to assess the health of a particular ecosystem (e.g., a watershed), a particular political entity (e.g., a nation) or even the entire world. This type of EA can include not only aggregated information from individual

organizations (e.g., total annual expenditures on environmental remediation by industry and government within a country), but also estimates of the costs/benefits of environmental externalities, which typically are not estimated or reported by individual organizations (e.g., total societal healthcare expenditures on pollution-related illness; the total economic benefit of new jobs related to environmental protection). Another type of valuable EA information is provided by **natural resource accounting (NRA)**, which accounts for the stocks and flows, actual and potential uses and potential value of natural resources such as forestland, clean water, mineral deposits, etc. For example, forestland might be valued for purposes such as helping provide a source of clean water to nearby communities and/or identifying the potential value of the timber on the market.

There is certainly overlap between the broad types of EA described above. For example, organization-level information (including EA information) is often aggregated by national governments for national-level statistical accounting. Conversely, the information collected by individual organizations primarily for statistical reporting purposes is potentially quite valuable for internal management decision making at the organization level. Unfortunately, the communities that practice organization-level accounting and higher levels of accounting do not seem to be well coordinated or even aware of the potential value of the information that the other community collects, or could collect.

The language used for all the different types of environmental accounting is not standardized. The very broad term “environmental accounting” itself often is used to refer to the different types of accounting described above. Even within a particular subset of EA, such as EMA, terminology differs in different organizations and countries. For example, EMA has been variously called EA, EMA, environmental cost accounting (ECA), full cost accounting (FCA), total cost assessment (TCA), etc. Thus, in discussing any type of environment-related accounting within an organization or elsewhere, it is important to clarify the definitions and language being used.

Table 1 below provides a more detailed comparison of the two major subdivisions of organization-level EA.

TABLE 1 - ORGANIZATION-LEVEL ACCOUNTING AND REPORTING

Traditional Accounting	Environmental Accounting Parallel	Associated MANDATORY External Reporting	OTHER External Reporting Links
Financial Accounting (FA): An organization's development of standardized financial information for reporting to external parties (e.g., investors, regulators, financial authorities).	***Environmental* Financial Accounting (EFA):** Financial accounting with a particular focus on earnings and expenses of environment-related investments, environmental liability and other significant expenses related to the organization's environmental performance.	Financial reporting to external parties is regulated by national laws and international standards, which specify how different financial items should be treated. The financial reports issued by organizations increasingly include information related to their environmental and social performance. Some countries require such content in financial reports, while some organizations include such information voluntarily.	In addition, organizations use some of the environment-related information gathered for financial reporting purposes for environmental regulatory reporting, statistical reporting or voluntary corporate environmental and sustainability reporting.
Management Accounting (MA): Management accounting is the application of the principles of accounting and financial management to create, protect, preserve and increase value and to deliver that value to the stakeholders of profit and not-for-profit enterprises, both public and private.	***Environmental* Management Accounting (EMA):** Management accounting with a particular focus on physical information on the flow of energy, water and materials, including wastes, as well as monetary information on related costs, earnings and savings.	There are no external reporting requirements specifically associated with MA or EMA.	However, organizations use some of the information gathered under EMA for environmental regulatory reporting, statistical reporting or voluntary corporate environmental and sustainability reporting.

Just as there are typically many links between an organization's FA and MA practices and activities, there are potentially many links between EFA and EMA. For example, as requirements for environmental content in financial reports increase, organizations can draw on EMA information originally collected for internal decision-making purposes to help fulfill their external reporting requirements. Although this link between EFA and EMA is discussed in more detail in Chapter 5, the major part of this guidance document will focus on the primary goal of EMA, which is to provide information for internal decision making.

What is EMA?

Environmental Management Accounting has no single, universally accepted definition. According to IFAC's Statement, *Management Accounting Concepts*, published in 1998, paragraph 1, EMA is "the management of environmental and economic performance through the development and implementation of appropriate environment-related accounting systems and practices. While this may include reporting and auditing in some companies, environmental management accounting typically involves life-cycle costing, full-cost accounting, benefits assessment, and strategic planning for environmental management."

This international guidance document uses the definition adopted by the United Nations Expert Working Group on EMA, as it more distinctively highlights both the physical and monetary sides of EMA. This definition was developed by international consensus of the group members, representing 30+ nations. According to the UN group:[6]

EMA is broadly defined to be the identification, collection, analysis, and use of two types of information for internal decision-making:

- **physical information on the use, flows, and fates of energy, water, and materials (including wastes) *and***
- **monetary information on environment-related costs, earnings, and savings.**

Physical Information under EMA

To assess costs correctly, an organization must collect not only monetary data but also non-monetary data on materials use, personnel hours and other cost drivers. EMA places a particular emphasis on materials-related costs because: (1) materials purchase costs are a major cost driver in many organizations[7] and (2) use of energy, water and materials, as well as the generation of waste and emissions, are directly related to many of the impacts organizations have on their environments.

Most organizations purchase energy, water and other materials to support their activities. In a manufacturing setting, some of the purchased material is converted into a final product that is delivered to customers. Most manufacturing operations also produce waste – materials that were intended to go into final product but became waste instead because of product design issues, operating inefficiencies, quality issues, etc. Manufacturing operations also use energy, water and materials that are never intended to go into the final product but are necessary to manufacture the

---

[6] United Nations Division for Sustainable Development, *Environmental Management Accounting, Procedures and Principles* (New York and Geneva: United Nations Publications, 2001, *http://www.un.org/esa/sustdev/sdissues/technology/estema1.htm.*

[7] M. Strobel, *Flow Cost Accounting* (Augsburg, Germany: Institute for Management and Environment, 2001).

product (e.g., water to rinse out chemical tanks between product batches). Most of these materials eventually become waste streams that must be managed. Non-manufacturing operations (e.g., agriculture and livestock, resource extraction sector, service sector) can also use a significant amount of energy, water and other materials to help run their operations, which, depending on how those materials are managed, can lead to a significant generation of waste and emissions.

Thus, the most obvious example of materials-related environmental impacts is the generation of waste and emissions, which can affect the health of both humans and natural ecosystems, including plants and animals. Air, water or land can end up polluted or even cross-contaminated.

The second broad area of materials-related environmental impact is the potential impact of the physical products (including by-products and packaging) produced by a manufacturer. These final products have environmental impacts when they leave the company, for example, when a product ends up in a landfill at the end of its useful life. Some of the potential environmental impacts of products can be reduced by changes in product design, such as reducing the volume of paper used in packaging or replacing a physical product with an equivalent service, etc. In many manufacturing plants, most of the materials used become part of a final product rather than part of waste or emissions; thus, the potential environmental impacts of products is high, and the potential environmental benefits of product improvements is correspondingly high.

Tracking and reducing the amount of energy, water and materials used can also have indirect environmental benefits upstream, because the extraction of almost all raw materials has environmental impacts. For example, activities such as forestry and the extraction of materials such as coal, oil, natural gas, oil, as well as gold and other minerals, can have extreme impacts on the local environment surrounding the site of extraction. These impacts include not only the pollution and waste generated during extraction operations, but also the erosion or outright removal of topsoil and vegetation, sedimentation of nearby water bodies and the disruption of wildlife feeding, reproduction and migration habitat. And let’s not forget impacts on local human populations that depend on the affected ecosystem for food and clean water.

Thus, to effectively manage and reduce the potential environmental impacts of its products, as well as of its waste and emissions, an organization must have accurate data on the amounts and fates of all energy, water and materials used to support its activities. It needs to know which and how much energy, water and materials are brought in, which become product and which become waste and emissions. This physical accounting information does *not* provide all of the data needed for effective management of all potential environmental impacts, but is essential information that can be provided by the accounting function. The physical accounting side of EMA is discussed in more detail in Chapter 3.

Some organizations that own large amounts of property (e.g., timber companies, oil companies, mining operations, agricultural operations) may have to do physical accounting that is a type of natural resource accounting, for example, a timber company keeping track of its timber stock. This type of physical accounting information is not discussed further in this document.

Monetary Information under EMA

Organizations define environment-related costs differently, depending on the intended uses of the cost information, an organization’s view of what is “environmental,” its economic and

environmental goals and other reasons. Two of the mostly widely used schemes for defining and categorizing organization-level environment-related costs for EMA purposes are those of the US Environmental Protection Agency[8] and the Japanese Ministry of Environment,[9] but there are many other examples.[10]

Cost taxonomies developed for the purposes of financial reporting[11] and statistical reporting[12] are also prominent, and have influenced the kind of environment-related cost information collected and reported to external stakeholders. These cost schemes for financial and statistical reporting are briefly described in Chapter 5 as examples of the growing volume of initiatives and requirements that promote external reporting of environment-related cost information, information that can be used both for external reporting and internal management.

It is beyond the scope of this guidance document to discuss the individual cost schemes used around the world in any more detail, but some historical and evolving trends can be noted. First, most of the schemes developed internationally include the types of costs that are clearly driven by efforts to control or prevent waste and emissions that can damage environmental or human health. Examples include: costs incurred to prevent the generation of waste/emissions; costs to control or treat waste once it has been generated; and costs for remediation of polluted sites. These types of costs are often referred to as environmental protection expenditures, or EPEs.[13]

Environment-related costs under EMA include not only EPEs, but also other important monetary information needed to cost-effectively manage environmental performance. One important example is the cost of purchasing materials that eventually become waste or emissions. Another recent development in the area of EMA is a push to view the purchase costs of *all* natural resources (energy, water, materials) as environment related. In a manufacturing setting, where most of the purchased materials are converted into physical products, this would allow more cost-effective management of the materials-related environmental impacts of those products. Of course, organizations do consider materials purchase costs in their internal management decision making in some fashion, but do not necessarily view them as environment related. However, these costs can be viewed as environment related as well, because an organization must have this cost information to fully assess financial aspects of the environmental management related to both physical waste and physical products. The physical accounting side of EMA provides the needed information on the amounts and flows of energy, water, materials and wastes to assess these purchase costs.

---

8 *An Introduction to Environmental Accounting as a Business Management Tool: Key Concepts and Terms* (Washington: United States Environmental Protection Agency, 1995).

9 *Environmental Accounting Guidelines* (Tokyo: Ministry of the Environment, 2002), http://www.env.go.jp/en/ssee/eag02.pdf).

10 L. D. Parker, "Environmental Costing: A Path to Implementation," *Australian Accounting* (November 2000).

11 *Commission Recommendation on the Recognition, Measurement and Disclosure of Environmental Issues in the Annual Accounts and Annual Reports of Companies* (Brussels: European Commission, 2001).

12 *Definitions and Guidelines for Measurement and Reporting of Company Environmental Protection Expense* (Luxembourg: Eurostat, 2001); and United Nations (Statistical Division), European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development and World Bank, *Handbook of National Accounting: Integrated Environmental and Economic Accounting* (2003).

13 *VDI 3800 Determination of Costs for Industrial Environmental Protection Measures* (Berlin: Association of German Engineers, 200).

Some organizations may prefer to focus their EMA activities on the narrower range of costs encompassed under environmental protection expenditures (EPEs). Others will take a broader and more strategic view of both environmental management and environment-related costs and, thus, may be comfortable with defining a broader range of costs as environment related, even if some of those costs are viewed as quality related or efficiency related at the same time. In this guidance document, the broader range of environment-related costs is used, because that is what is needed to cost-effectively manage potentially significant aspects of environmental performance. More detailed descriptions and rationales of specific environment-related cost categories are given in Chapter 4.

It should be noted that EMA typically does not include "external" costs, the environment-related costs to individuals, business partners, society or the planet for which an organization is not legally held responsible. This would include, for example, healthcare costs incurred by a local community due to industrial air pollution. Organizations can choose to include these external costs in their management decision making and external reporting, but most do not attempt to do so, partly because such costs can be very difficult to estimate. Such costs are also difficult to assign to individual organizations, since many, if not most, external environmental impacts and costs result from the actions of multiple organizations and individuals.

Many stakeholders argue that organizations should consider external costs if they are to manage their potential environmental impacts effectively. In light of the growing emphasis on corporate social responsibility, the consideration of external costs for internal decision making is likely to become more common, especially in the case of external costs expected to become internal in the foreseeable future, due to increasing regulation. At present, however, most organizations tend not to consider external costs, and the calculation methods for external costs are typically quite different from those utilized in MA. Thus, external costs are not discussed further in this document.

Is EMA the Next Step in the Evolution of MA?

The IFAC 1998 Statement, *Management Accounting Concepts*, outlines how the field of MA has evolved over time, in four recognizable stages with a different focus in each stage:

1. Stage 1 (prior to 1950) – a focus on cost determination and financial control;
2. Stage 2 (by 1965) – a focus on the provision of information for management planning and control;
3. Stage 3 (by 1985) – a focus on the reduction of waste in resources used in business processes;
4. Stage 4 (by 1995) – a focus on generation or creation of value through the effective use of resources.

Thus, according to the IFAC analysis, the leading-edge practice of MA has shifted beyond information provision to focus on the reduction of waste (i.e., the reduction of resource loss) and the generation of value (i.e., the effective use of resources). In other words, leading-edge MA centers around the use of resources, which are defined as "monetary and physical" resources as well as information itself, along with other resources created and used by an organization, e.g., "work processes and systems, trained personnel, innovative capacities, morale, flexible cultures, and even committed customers."

Although EMA is a comparatively new tool, it has been used for all of the MA goals listed in the four stages shown above. And there is a clear parallel between the Stage 3 and 4 focus on resource productivity and EMA's focus on accounting for the flows of natural resources, such as energy, water and other materials. There is a similar parallel in the Stage 3 and 4 focus and that of EMA in accounting for the costs associated with the inefficient use of materials in production or products themselves, through the generation of pollution and other forms of material waste. It should be noted, however, that for many organizations, EMA still has a strong focus on the Stage 1 and 2 goals of cost determination, financial control and information provision. Nevertheless, EMA information and practices are continuing to evolve in the same direction as conventional MA – towards the resource productivity and value creation activities for which EMA data are so well suited.

In principle, EMA should be an integral part of MA and not a parallel system. In the real world, EMA ranges from simple adjustments to existing accounting systems to more integrated EMA practices that link conventional physical and monetary information systems. But, regardless of structure and format, it is clear that both MA and EMA share many common goals. And it is to be hoped that EMA approaches eventually will support the IFAC proposals in *Management Accounting Concepts* that, in leading-edge MA, "inattention to environmental or social concerns are likely to be judged ineffective," and that "resource use is judged effective if it optimizes value generation over the long run, with due regards to the externalities associated with an organization's activities."

Chapter 2 – Why EMA?

There are several core reasons for the current level of international interest in EMA:

- increasing pressure from stakeholders interested in environmental issues;[14]
- increasing importance of environment-related costs;[15]
- increasing recognition of problematic accounting practices.

Each of these EMA drivers is discussed in more detail below.

Increasing Pressure from Stakeholders Interested in Environmental Issues

Many internal and external stakeholders are showing a great and increasing interest in the environmental performance of individual organizations (particularly private sector companies). Examples of internal stakeholders include employees that might be affected by pollution within the work environment. External stakeholders include communities affected by local pollution, environmental activist groups, government agencies, shareholders, investors, customers, suppliers and others with an interest in environmental issues.

The types and intensities of pressures on organizations can vary quite widely from country to country and among different business sectors, depending on an organization's involvement in global markets, etc. It is safe to say, however, that environmental stakeholder pressure is forcing many organizations to look for new, creative and cost-efficient ways to manage and minimize environmental impacts.

---

[14] S. Schaltegger and R. Burritt. *Contemporary Environmental Accounting: Issues, Concepts and Practices* (Sheffield, UK: Greenleaf Publishing, 2000).

[15] *Ibid.*

Prominent examples of stakeholder pressure relevant at the international level include:

- the RoHS Directive, a regulation in the European Union (EU) that restricts the use of certain hazardous substances in electrical and electronic equipment sold in the EU;[16]
- requirements by large companies that their suppliers comply with the Environmental Management System (EMS) standard of the International Standardization Organization;[17]
- pressure from various stakeholders to publicly report their environmental performance, for example, via the guidelines of the Global Reporting Initiative.[18]

Increasing Importance of Environment-related Costs

In the past, internal costs associated with an organization's poor environmental performance were relatively low. There were few environmental regulations or other stakeholder pressure to force the organization to manage and minimize its environmental impacts. But growing stakeholder pressures in many countries are leading to increased environment-related costs.

For example, in countries with strong environmental regulatory regimes, the introduction of environmental regulations has led to a wide variety of additional environment-related costs. Organizations have seen costs of environmental compliance rise, including costs for required pollution and control equipment, pollution monitoring and emission fees and regulatory paperwork and reporting. Pollution clean-up regulations have resulted in increasing liability costs for site remediation and liability-related insurance costs. Pressure from stakeholders, such as local communities, environmental activist groups and business partners (customers, investors and finance providers) has also added to environment-related costs as organizations need to initiate voluntary programs to communicate with and respond to the interests of these groups.

The recognition of the growing importance of environment-related costs is illustrated by the following examples:

- the development of the many EMA guidance documents around the world (see references given in the Foreword);
- the development of a System of Integrated Environmental and Economic Accounts by the United Nations;[19]
- the European Commission Recommendation on the recognition, measurement and disclosure of environmental issues in the annual accounts and annual reports of companies.[20]

Many organizations are developing a clear understanding of the potential links between environmental performance and the efficiency of natural resource use. They have discovered

---

[16] D. Lea, *Briefing Paper on the RoHS Directive* (Herndon, Virginia: Celestica, Inc., 2004), http://www.nemi.org/projects/fis/RoHS.pdf).

[17] *Environmental Management – Environmental Management Systems – Specification* (Geneva: International Standardisation Organization, 1996).

[18] *Sustainability Reporting Guidelines on Economic, Environmental and Social Performance* (Amsterdam: Global Reporting Initiative, 2002), http://*www.globalreporting.org*).

[19] United Nations (Statistical Division), European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development and World Bank. *Handbook of National Accounting: Integrated Environmental and Economic Accounting* (2003).

[20] *Commission Recommendation on the Recognition, Measurement and Disclosure of Environmental Issues in the Annual Accounts and Annual Reports of Companies* (Brussels: European Commission, 2001).

that enhancing the efficiency with which they use energy, water and other materials not only brings environmental improvements (e.g., reduced resource use and reduced waste and emissions), but also potentially significant monetary savings as costs of materials purchase and waste treatment decrease accordingly.

Increasing recognition of Problematic Accounting Practices

A number of limitations of conventional management accounting systems and practices have been identified that can make it difficult to collect and evaluate environment-related data effectively. These limitations can lead to missing, inaccurate or misinterpreted information being used for management decisions. As a result, managers may well misunderstand the negative financial consequences of poor environmental performance and the potential costs and benefits of improved environmental performance. Some of the culprits are general management accounting limitations, such as the typical focus on past performance rather than future performance. Other limitations are more specific to environment-related information.

Communication/links between accounting and other departments often not well developed

An organization's environmental personnel often have a great deal of knowledge about environmental issues. Similarly, technical staff may have considerable experience with the flow of energy, water and other materials throughout an organization. Environmental and technical personnel, however, often have little knowledge of how those issues are reflected in the accounting records. In contrast, the accountant or controller has much of the accounting information at hand, but often has little knowledge of the environmental issues the organization faces, nor of the flow of physical resources. Thus, accounting personnel are often not providing the types of accounting information that environmental and technical personnel might find most useful.

Different departments may also have different goals and perspectives with respect to EMA-type activities. For example, they may not have the same perspectives on the issue of who is responsible for managing different types of environment-related costs. Production centers, which may produce waste but do not have data on the costs of waste disposal? The design department, which selects the materials, equipment and processes used? The environmental manager, who does not produce waste but must dispose of it? The accounting department, which may inadvertently "hide" environment-related costs by placing them in general overhead accounts?

In addition, accounting, environmental and technical personnel often use different information systems that are not checked for consistency. In many cases, a consistency check would be quite difficult, if not impossible, because the various information systems use different boundaries for materials tracking. These differences in knowledge and information access and structure can be made worse by language differences in the cultures of accounting, environmental and technical personnel.

Environment-related cost information is often "hidden" in overhead accounts

Numerous examples exist of potentially important environment-related costs being inadvertently hidden in the accounting records where a manager who would benefit from that information cannot find it easily. One particularly common way to inadvertently hide environment-related

costs is to assign them to overhead accounts rather than directly to the processes or products that created the costs.[21] While overhead accounts are a convenient way to collect costs that may be difficult to assign directly to processes or products, this practice can create problems later if a manager does not know where to look for the needed cost information. It might not be immediately obvious to a production manager that an overhead account called "Divisional Overhead" contains information on environmental permit fees, training costs and legal expenses.

The use of overhead accounts for environment-related costs can also be problematic when overhead costs are later allocated back to cost centers (e.g., processes or products) for product pricing, etc. Overhead costs typically are allocated back to cost centers using a variety of allocation bases, such as production volume, machine hours, personnel hours, etc. This might, however, be an inaccurate way to allocate some typical environment-related costs. An example would be hazardous waste disposal costs, which might be quite high for a product line that uses hazardous materials and quite low for another that does not. In this case, allocation of hazardous waste disposal costs on the basis of production volume would be inaccurate, as would be product pricing and other decisions based on that information.

Organizations have taken different approaches to resolving the issue of hidden environment-related costs. One common solution is to set up separate cost categories or cost centers for the more obvious and discrete environmental management activities. The less obvious environment-related costs that will still appear in other accounts and cost centers can be more clearly labeled as environment related so that they can be traced more easily. An assessment of the relative importance of environment-related costs and cost drivers of different process and product lines can help an organization determine whether or not the cost allocation bases being used are appropriate for those costs.

Materials use, flow and cost information often not tracked adequately

Although larger manufacturing companies annually generate millions of data records concerning material movements from Enterprise Resource Planning (ERP) and other software systems, the available information often is still not sufficiently accurate or detailed for environmental, efficiency and other decision-making purposes.

For example, sometimes the posting of materials purchase information does not allow clear identification of the amount and value of different categories of purchased materials. In some accounting systems, all materials purchase information is posted into one account, while the detailed material numbers and amounts are recorded only in the stock management records. So, there is no easy way to aggregate the data from stock management by materials group or trace the actual annual consumption of the different categories of materials. A time-consuming and expensive manual process of data reorganization and comparison would be required. Thus, no one knows the amount and value of materials consumed by materials groups. Even if a production manager had an estimate of materials loss percentages during the production process, the total value of lost materials could not be calculated because of missing data on the value of materials purchased by materials groups.

[21] A. L. White and D. E. Savage, "Budgeting for Environmental Projects: A Survey," *Management Accounting* (October 1995); and C. Deegan, *Environmental Management Accounting: An introduction and case studies for Australia* (Sydney: Institute of Chartered Accountants in Australia, 2003).

Another example is the practice of aggregating materials purchase costs and materials processing costs (e.g., labor) into a single cost item. For example, in a company that uses several manufacturing steps to make its final product, the value of the semi-finished product that enters the final manufacturing step is accurately viewed as the sum of all costs of materials purchase and processing incorporated into that semi-finished product. If, however, this cost information is recorded in the accounting records as a single lump sum figure, with no detail on the split between materials purchase costs and other processing costs, then disaggregation of these costs for later decision making can be difficult and time consuming.

In addition, conventional cost accounting systems often do not record data on material inputs to and from each cost center in production, but rely on general calculations provided by the production planning system, which may or may not reflect an organization's real-world use and flow of materials. For example, many production planning systems calculate materials loss by using average loss percentages that are inaccurate. They may have little to do with the actual losses that occur during production. The employees on-site often have more precise estimates than the accounting system.

Many types of environment-related cost information not found in the accounting records

Accounting records typically do not contain any information on *future* environment-related costs that may be quite significant, because accounting systems typically look towards the past rather than the future. Many less tangible environment-related costs are also not found in the accounting records. Examples include the costs incurred when poor environmental performance translates into lost sales to customers who care about environmental issues, lost access to markets with environment-related product restrictions and lost access to financing and insurance when business partners decline to take on the potential environmental risk associated with the business partnership. These types of costs may be difficult to estimate, but they can be both real and significant to an organization's financial health. It should be noted that some cost accounting tools add an average risk premium to production costs to reflect less tangible issues.

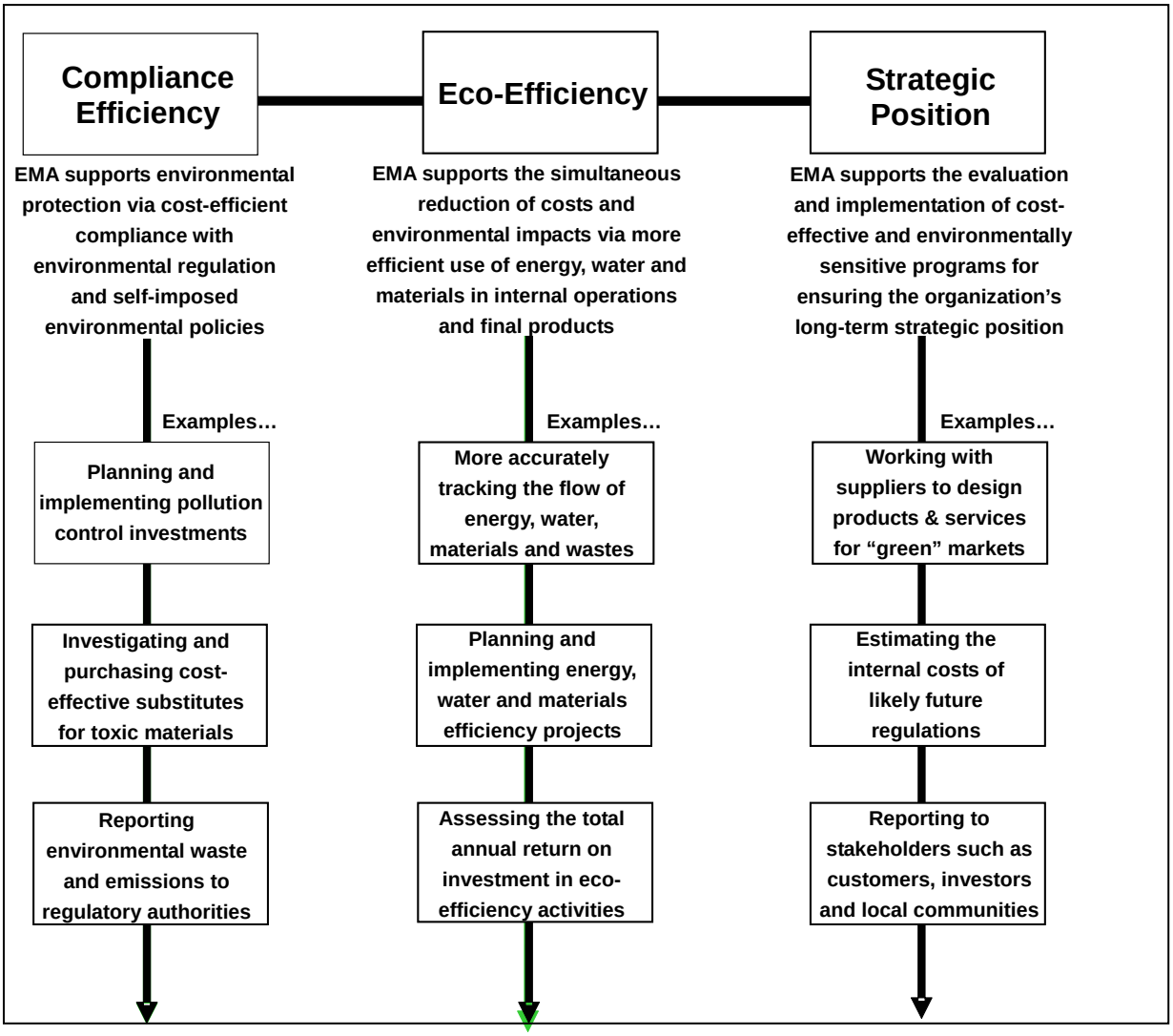
Uses and Benefits of EMA

EMA is particularly valuable for internal management initiatives with a specific environmental focus, such as cleaner production, supply chain environmental management, "green" product design, environmentally preferable purchasing and environmental management systems. In addition, EMA-type information is increasingly being used for external reporting purposes as well. Thus, EMA is not merely one environmental management tool among many. Rather, EMA is a broad set of principles and approaches that provides the data essential to the success of many other environmental management activities. And, since the range of decisions affected by environmental issues of one type or another is increasing, EMA is becoming more important not only for environmental management decisions, but for all types of management activities. The specific uses and benefits of EMA are numerous, but can be organized into three broad categories, as illustrated below.

It should be noted that, often, there is no strict dividing line between those three categories. For example, a manufacturing firm that reduces water use and, thus, wastewater generation via eco-efficiency projects might also reduce the load to, and costs of, an in-house wastewater treatment plant installed primarily for compliance purposes.

Some real-world examples of how organizations have used and benefited from EMA are given in Chapter 5.

FIGURE 1 – USES AND BENEFITS OF EMA



Adapted from *Guide to Corporate Environmental Cost Management* (Berlin: German Environment Ministry, 2003).

Chapter 3 – Physical Information: Flow of Energy, Water, Materials and Wastes

This chapter outlines the type of physical information relevant under EMA in more detail and briefly discusses the related concepts of materials balances, materials flow accounting and environmental performance indicators.

Physical Information and Environmental Performance Indicators

As mentioned in Chapter 1, the tracking of physical information on the flow of energy, water, materials and wastes is important under EMA because such information allows an organization to assess (and report) the important materials-related aspects of its environmental performance. In addition, materials purchase costs are key cost drivers in many organizations.

Unfortunately, as noted in Chapter 2, much of the required physical accounting information is not easily available to accounting personnel, as it is not systematically recorded or is not recorded in a way that reflects the real-world flow of materials within the organization. Personnel in other areas, such as production, environmental or other operations, often have more detailed estimates and measurements of physical flows of materials, but often this information is not cross-checked with that of the accounting department. Thus, accountants need to work more closely with personnel from other departments to accurately do the physical accounting side of EMA.

Under the physical accounting side of EMA, an organization should try to track all physical inputs and outputs and ensure that no significant amounts of energy, water or other materials are unaccounted for. The accounting for all energy, water, materials and wastes flowing into and out of an organization is called a "materials balance," sometimes also referred to as "input-output balance," a "mass balance" or an "eco-balance." (Many organizations perform energy balances and water balances separately from other materials balances.) As this terminology implies, the underlying assumption is that all physical inputs must eventually become outputs – either products or waste and emissions – thus, the inputs and outputs must balance. The level of precision of a materials balance can vary, depending on the specific purposes of the information collection and the availability and quality of the data.

Materials balances can take place at many different levels. An overall materials balance would list the inputs and outputs flows, treating the organization and its processes as a black box. Materials balances can also be done within an organization, for particular sites, cost centers, processes, materials, product lines or waste streams.

For a complete picture of materials use, the details of materials flows must be traced through all the different materials management steps within an organization, such as materials procurement, delivery, inventory, internal distribution, use and product shipping, as well as waste collection, recycling, treatment and disposal, all with all the materials balance numbers attached. This type of accounting can be referred to as "materials flow accounting."

Once the physical accounting data have been collected, they can be used both to support the cost accounting side of EMA and to create environmental performance indicators (EPIs) that help an

organization assess and report the materials-related aspects of its environmental performance.[22] Even organizations that may not have the expertise or resources to perform comprehensive materials balances or materials flow accounting, such as some smaller and medium-sized enterprises, can benefit greatly from the estimation of key EPIs.[23]

From an environmental impact point of view, the absolute data collected are the most important, as these *absolute indicators* illustrate the consumption of natural resources and the generation of waste and emissions, such as:

- the total amount of fresh water consumed each year;
- the total amount of wastewater generated each year.

Relative indicators represent an organization's environmental performance in terms of its size, production output or number of employees. These are important indicators since company size, production output, etc., can vary from year to year. Thus, these indicators allow an organization to distinguish between changes in environmental performance due to changes in these factors and changes in performance due to environmental management efforts. Examples of relative indicators include:

- amount of fresh water consumed per unit product manufactured;
- amount of wastewater generated per unit of product manufactured.

Relative indicators may also tie physical and monetary terms together. Such cross-cutting indicators will be discussed in Chapter 4.

EPIs can be calculated at many different levels – for the organization as a whole, for specific products or product lines, for specific material groups, etc., depending on the intended use of the information. For example, a local community might be most interested in wastewater generation rates for a facility as a whole, while internal managers would also be interested in wastewater generation rates for specific process lines in order to make process improvements.

Detailed Description of Types of Physical Information

The following table lists the basic types of energy, water, materials and waste information that should be included under EMA. Material Inputs are any energy, water or other materials that enter an organization. As used here, the term "Material Inputs" does *not* include capital items such as equipment, buildings, land, etc. These items also become waste eventually, but are normally not monitored via material balances or materials flow accounting.

Outputs are any products, wastes or other materials that leave an organization. Any Output that is not a Product Output is by definition a Non-Product Output (NPO). In organizations that use energy and materials but do not manufacture tangible products, such as service sector companies, all energy, water and other materials used will leave as Non-Product Output, by definition. The

---

22 *Environmental Management – Environmental Performance Evaluation – Guidelines* (Geneva: International Standardisation Organization, 2000).

23 T. Loew, K. Fichter, U. Müller, S. Werner and M. Strobel, "Ansätze der Umweltkostenrechnung im Vergleich." In *Vergleichende Beurteilung von Ansätzen der Umweltkostenrechnung auf ihre Eignung für die betriebliche Praxis und ihren Beitrag für eine ökologische Unternehmensführung*, (Berlin: UBA-Texte 78-03, 2003).

remainder of this document will use the term NPO synonymously with the term "Waste and Emissions." Table 2 describes each type of Input and Output.

TABLE 2 - INPUT AND OUTPUT TYPES

Material Inputs	**Product Outputs**
Raw and Auxiliary Materials	Products (including Packaging)
Packaging Materials	By-products (including Packaging)
Merchandise	**Non-Product Outputs (Waste and Emissions)**
Operating Materials	Solid Waste
Water	Hazardous Waste
Energy	Wastewater
	Air Emissions (including radiation, noise, etc.)

Material Inputs

Material Inputs are any energy, water or other materials that enter an organization. As used here, the term "Material Inputs" does not include capital items such as equipment, buildings, land, etc. Definitions of the various Material Input categories are given below.

Raw and Auxiliary Materials

Raw and Auxiliary Materials are input materials that become part of an organization's final product or by-product. Raw Materials are the major product components (e.g., the wood used in furniture manufacturing); Auxiliary Materials are the more minor product components (e.g., the glue used in furniture manufacturing). Any water that becomes part of an organization's final product is covered separately in the "Water" category.

Packaging Materials

Packaging materials are input materials intended for use in shipping the organization's final products. These materials can be purchased in ready-to-use form, or may need to be processed on-site before being used.

Merchandise

Some businesses purchase items that are then directly sold again as products, with little or no additional processing. These input materials are categorized as merchandise. Example of environmental impacts/costs associated with merchandise include the impacts and costs of energy for storing and handling the merchandise or impacts and costs of disposal of merchandise (e.g., food) that that has outlived its useful shelf life. In such cases, merchandise materials and related costs should be tracked. Generally, however, since merchandise does not run through any kind of production line, there tend to be fewer environmental impacts and environment-related costs associated with an organization's handling of merchandise than with other input materials. Thus, merchandise is not discussed in further detail in this guidance document.

Operating Materials

Operating Materials are Input Materials that an organization purchases and uses but do not become part of any tangible product delivered to a customer. Examples include office supplies, building cleaning supplies, lighting fixtures, etc. For non-manufacturing organizations, most Input Materials will be these types of Operating Materials. Manufacturing operations will use these types of Operating Materials as well as other types such as chemical catalysts, equipment cleaning solvents, etc. Because Operating Materials by definition do not become part of any product, they automatically become a form of Non-Product Output (i.e., Waste and Emissions) when they leave the organization.

Water

The Water category includes all the water an organization uses, from all sources, such as rainwater, groundwater, surface water from rivers and lakes, regardless of how the water is obtained (e.g., private wells, the public water supply system, etc). In some manufacturing sectors, such as food processing, Water may go into the final product (much like Raw and Auxiliary Materials). In many other types of organizations, however, Water is more like an Operating Material, because it is never intended to go into a final product but is used for other purposes, such as cooling or cleaning. Thus, some Water may leave the organization in the form of product, but the remainder will leave as Waste and Emissions. Water is in a separate category from other input materials because it is particularly important from an environmental perspective and because water flow information is often managed differently from other materials flow information in accounting systems.

Energy

The Energy category includes all the energy, of all types, that an organization uses: electricity, gas, coal, fuel oil, district heating and cooling, biomass, solar, wind, water, etc. In some manufacturing operations, Energy may be viewed as something that is incorporated into a final product (e.g., via a chemical reaction) but, more often, Energy acts more like an Operating Material in that the Energy is never intended to become part of the product, but is instead used for running equipment, etc. Energy is in a separate category from other input materials because it is particularly important from an environmental perspective and because energy flow information is often managed differently from other materials flow information in accounting systems.

Product Outputs

Output*s* are any products, wastes or other materials that leave an organization. Product Outputs are those products, by-products and associated packaging that are delivered to external customers. Definitions of the various Product Output categories are given below.

Products (including packaging)

Product*s* include any tangible products created by an organization, such as the computer chips produced by an electronics-manufacturing firm, including packaging.

By-products (including packaging)

By-products are minor products incidentally produced during the manufacture of the primary product. All by-products that result in earnings are considered, as well as associated by-product packaging. It is

important to note that the boundaries between products, by-products and waste are not well defined in some companies, and depend partially on how well an organization separates by-products and waste.

Non-Product Outputs (Waste and Emissions)

Any Output that is not a Product Output is by definition a Non-Product Output (NPO). Examples include solid waste, hazardous waste, wastewater and air emissions – all defined further below. These Wastes and Emissions are generated in two ways. First, they are generated when Material Inputs that were intended to leave the facility in the form of Product Output become Waste and Emissions instead because of poor equipment efficiency and maintenance, inefficient operating practices, production losses, product spoilage, poor product design or other reasons. Material Inputs that contribute to NPO in this way include Raw and Auxiliary Materials, Packaging Materials, Merchandise and sometimes Water. For all these, loss (scrap) percentages should be measured, calculated or estimated.

Waste and Emissions are also generated when Material Inputs that were never intended to become part of Product Output leave an organization. Inputs that contribute to Waste and Emissions in this way are Operating Materials and Water and Energy.

Waste and Emissions can result from continuous losses (e.g., continuous heat loss from an uninsulated oven or continuous water leaks from an old storage tank), episodic losses (e.g., scrap from a poor quality batch of product), or one-time losses (e.g., an accidental spill of some kind), and can come from any part of an organization – inventory, manufacturing, building services, shipping, etc.

Solid Waste

Solid Waste is defined to be relatively non-hazardous waste in solid form, such as waste paper, plastic containers, food waste, non-hazardous solid scrap product, etc.

Hazardous Waste

Hazardous Waste is defined to be more hazardous waste materials in solid form (e.g., discarded batteries), liquid form (e.g., waste paint and solvents) or mixed form (e.g., wastewater treatment sludge). Hazardous could be defined as infectious, flammable, toxic, carcinogenic, etc. – depending on the context.

Wastewater

Wastewater is defined to be waste streams whose primary component is water but which also contain contaminants of some kind, such as high biological oxygen demand (BOD), total suspended solids (TSS), nutrients (e.g., phosphates), excess heat and toxic materials such as solvents, pesticides or heavy metals.

Air Emissions

Air Emissions are air streams contaminated with problematic levels of pollutants. Examples of pollutants include energy combustion by-products, such as nitrogen oxides, sulfur dioxide, carbon monoxide, particulate matter consumed and volatile organic compounds, as well as other pollutants such as metal particulates, etc.

Chapter 4 – Monetary Information: Environment-RELATED Costs and Earnings

This chapter outlines the type of monetary information relevant under EMA, with a discussion and outline of specific cost categories as well as a brief description of environmental performance indicators that incorporate monetary information, e.g., eco-efficiency indicators. In addition, environment-related earnings and savings are discussed, as is the distribution of environment-related costs by environmental domain.

Cost Categories

One of the most important goals of this guidance document is to clarify the environment-related cost information that managers need to manage both their organization's environmental performance and its associated economic performance. Since this is an international guidance document, it was also important to review the varying cost guidelines in different countries, and to make the cost scheme outlined in this document consistent with international practice to the extent possible. A final goal was to outline cost categories that represent not just widely accepted current practice, but also emerging best practice. With all this in mind, Table 3 sets out the defined environment-related costs categories. More specific descriptions of the categories and types of costs are given later in this chapter.

TABLE 3 – ENVIRONMENT-RELATED COST CATEGORIES

1. Material Costs of Product Outputs Includes the *purchase costs* of natural resources such as energy, water and other materials that are converted into products, by-products and packaging.
2. Material Costs of Non-Product Outputs Includes the *purchase (and sometimes processing) costs* of energy, water and other materials that become Non-Product Output (i.e., Waste and Emissions).
3. Waste and Emission Control Costs Includes costs for: *handling, treatment and disposal* of waste and emissions; *remediation and compensation* costs related to environmental damage; and any control-related *regulatory compliance* costs.
4. Prevention and Other Environmental Management Costs Includes the costs of *preventive environmental management activities* such as cleaner production projects. Also includes costs for *other environmental management activities* such as environmental planning and systems, environmental measurement, environmental communication and any other relevant activities.
5. Research and Development Costs Includes the costs for *Research and Development* projects related to environmental issues.
6. Less Tangible Costs Includes costs related to less tangible issues such as *productivity*, *potential future liability*, *future regulation* and *company image and stakeholder relations*.

Note: Although this chapter and table use the term "costs," these categories may also cover information on any environment-related earning (e.g., revenues from recycled materials) or savings (e.g., monetary savings from eco-efficiency projects).

Category 1 – Material Costs of Product Outputs

In many manufacturing companies, most Input Materials are eventually incorporated into tangible products (including by-products and packaging). These have potential environmental impacts when they leave the manufacturer, for example, when a product leaches toxic materials after it has been disposed of in a landfill at the end of its useful life. In addition, the extraction of all natural resources has environmental impacts, such as ecosystem disturbance at the extraction site. Thus, from the point of view of sheer material quantities, the materials-related environmental impacts of a manufacturer's products may often outweigh the environmental impacts of the smaller amount of materials that leave as Waste and Emissions.[24]

[24] Personal communication with Bernd Wagner of the University of Augsburg, Germany, and Carsten Redmann of the Institute of Management and Environment (IMU), Augsburg, Germany, 2004.

Therefore, this cost category includes the purchase costs of Input Materials that are converted into products, by-products and packaging. These cost data help an organization to cost-effectively manage the materials-related environmental impacts of its products. For example, it might consider replacing a toxic product ingredient with a less-toxic, cost-effective alternative. The physical accounting side of EMA provides the information on the amounts and flows of materials and products needed to assess such costs.[25]

Category 2 – Material Costs of Non-Product Outputs

Despite the fact that the largest quantity of physical outputs from manufacturing operations are usually the Product Outputs, the amount of NPO (i.e., Waste and Emissions generated in manufacturing) can still be quite large, costly and environmentally significant. In non-manufacturing operations, where there is no tangible product, all Input Materials leave the organization as NPOs, by definition.

Therefore, this cost category includes the purchase costs of Input Materials that are converted into NPOs. Although many organizations may consider these costs to be related to efficiency or quality, these cost data are also environment related because they help an organization to cost-effectively manage the environmental impacts of its Waste and Emissions. It might consider, for example, acquiring more efficient process equipment that generates less waste per unit product output. In fact, these environment-related costs are often higher than the more familiar environmental protection costs covered in Categories 3 to 5.[26] The physical accounting side of EMA provides the information on the amounts and flows of materials and wastes needed to assess these costs.[27]

Not all types of waste and emissions can be reduced – some are probably inevitable – but it is clearly in the financial best interest of organizations to use as little material, energy and water as possible in achieving their goals. Luckily, preventive and proactive environmental management that reduces the amount of waste generated, rather than just treating the waste once it is generated, can often reduce not only the purchase costs of materials lost as wastes, but also subsequent waste control and treatment costs. Thus, assessment of these costs also allows managers to better assess the potential monetary value of preventive environmental management.

For manufacturing operations, this cost category also includes the processing costs of Raw and Auxiliary Materials up to the point that that they are converted into Waste and Emissions. These processing costs are the proportion of equipment depreciation and labor costs that have been used to help generate Waste and Emissions rather than a final product.

---

[25] M. Strobel, *Flow Cost Accounting* (Augsburg, Germany: Institute for Management and Environment, 2001).

[26] K. Fichter, T. Loew and E. Seidel, *Betriebliche Umweltkostenrechung* (Berlin: Springer Verlag, 1997); K. Fichter, T. Loew, C. Redmann and M. Strobel, *Flusskostenmanagement, Kostensenkung und Öko-Effizienz durch eine Materialflußorientierung in der Kostenrechnung.* (Wiesbaden, Germany: Hessisches Ministerium für Wirtschaft, Verkehr, und Landesentwicklung, 1999); United Nations Division for Sustainable Development, *Environmental Management Accounting, Procedures and Principles* (New York and Geneva: United Nations Publications, 2001), *http://www.un.org/esa/sustdev/sdissues/technology/estema1.htm;* C. Jasch and H. Schnitzer, *Umweltrechnungswesen – Wir, zeigen, wie sich Umweltschutz rechnet, Beispielsammlung zur Umweltkostenrechnung und Investitionsrechnung* (Vienna: Bundesministerium für Verkehr, Innovation und Technik and Bundesministerium für Land- und Forstwirtschaft, Umwelt, und Wasser, 2002); S. Schaltegger, K. Müller and H. Hinrichsen, *Corporate Environmental Accounting* (Chichester, UK: John Wiley & Sons, 1996).

[27] M. Strobel, *Flow Cost Accounting* (Augsburg, Germany: Institute for Management and Environment, 2001).

Category 3 – Waste and Emission Control Costs

This category covers: the costs of handling, treating and disposing of the Waste and Emissions; remediation and compensation costs related to environmental damage; and any regulatory compliance costs related to Waste and Emission control.

Category 4 – Prevention and Other Environmental Management Costs

This category covers: the costs of preventive environmental management activities such as green purchasing, supply chain environmental management, cleaner production, extended producer responsibility, etc. It also includes costs for other environmental management activities such as environmental planning and systems (e.g., environmental management systems), environmental measurement (e.g., monitoring, performance auditing), environmental communication (e.g., community group meetings, government lobbying) and any other relevant costs (e.g., financial support of environmental projects in the community).

Category 5 – Research and Development Costs

This category includes the costs of Research and Development activities on environment-related issues and initiatives. Examples are the costs of: research on the potential toxicity of raw materials, development of energy-efficient products and testing of new equipment designs with higher materials use efficiency.

Category 6 – Less Tangible Costs

This category includes less tangible (i.e., difficult-to-quantify) costs that typically are not found in the information systems, but can be potentially significant. Less Tangible Costs related to environment fall into four broad categories: productivity (e.g., worker absenteeism due to pollution-related illness); potential liability (e.g., legal judgments related to natural resource damage); future regulation (e.g., likely future costs of stricter regulation of greenhouse gas emissions); and image and stakeholder relations (e.g., barriers to financing for projects with negative environmental components).

Monetary Environmental Performance Indicators

Assessment of environment-related costs can take place at many different levels. For example, the total environment-related costs for an organization can be estimated, or more detailed data can be collected for specific sites, cost centers, processes, materials, product lines or waste streams of interest. The cost data can help translate environmental performance into the “cost and savings” language that business managers understand.

Thus, some individuals may prefer to see environmental performance indicators expressed in monetary rather than in physical terms. For example, managers who might not appreciate or react to information on the total volume of wastewater generated each year (a physical EPI) might be very interested in an estimate of the total treatment costs of wastewater each year (a monetary EPI). If an estimate of the purchase value of raw materials lost in wastewater is added, the cost information may be compelling enough to trigger action to reduce those costs, which often will also reduce environmental impact.

Cost data can also be combined with physical accounting data to create cross-cutting EPIs called eco-efficiency indicators.[28] The concept of eco-efficiency (first developed by Schaltegger and Sturm in 1990)[29] links monetary and physical EMA for decision making in a systematic manner. The World Business Council for Sustainable Development (WBCSD) defines an eco-efficiency indicator as an indicator that relates "product or service value" in terms of turnover or profit to "environmental influence" in terms of energy, material and water consumption, as well as waste and emission in terms of volumes.[30] In using these indicators, care should be taken to consider other factors that influence the monetary part of an indicator. For example, changes in world market prices for raw materials may affect eco-efficiency indicators in a way that has nothing to do with environmental issues.

Detailed Description of Cost Categories

There are a few environment-related costs that may fit into more than one of the cost categories listed below. For example, the purchase costs of operating materials used to run waste treatment equipment might fit in several different places, as will be described in more detail. The cost category chosen for inclusion of such costs will depend on the level of detail at which the data are available, the intended use of the information and company preference. However, in cases where an organization's goal is to estimate and sum up its total environment-related costs, care should be taken not to double-count any costs by accidentally including them in more than one category.

Material Costs of Product Outputs

This cost category covers the purchase costs of materials that eventually are converted into Product Output (i.e., products, by-products and packaging). The physical accounting side of EMA provides the information on the amounts and flows of materials needed to assess these costs.

MATERIAL PURCHASE COSTS

Organizations need to consider the purchase costs of the following Material Inputs that become part of the final Product Outputs:

- *Raw and Auxiliary Materials;*
- *Packaging Materials;*
- *Water; and*
- *Energy.*

The purchase cost of Operating Materials is not included in this category because these materials are, by definition, never intended to become part of a final tangible product. Water purchased by an organization may either end up in the final product or be used as an Operating Material; the portion of Water that is incorporated into any final products should be included here. The same holds true for any Energy that the organization views as being incorporated into final products.

---

[28] United Nations Conference on Trade and Development, Committee on International Standards of Accounting and Reporting, *Accounting and Financial Reporting for Environmental Costs and Liabilities* (New York and Geneva: United Nations Publications, 2004).

[29] S. Schaltegger and A. Sturm, "Ökologische Rationaltiät," *WWZ- News*, Nr. 7 (1990), pp. 14-18.

[30] *Measuring Eco-Efficiency: A Guide to Reporting Company Performance* (Genf: World Business Council for Sustainable Development, 2000).

Material Costs of Non-Product Outputs

This cost category covers the purchase costs of materials that eventually are converted into Non-Product Output (i.e., Waste and Emissions). These are the costs an organization incurs as Waste and Emissions are generated within its operations, even before the costs of treating or disposing of those Waste and Emissions have been considered. The physical accounting side of EMA provides the information on the amounts and flows of materials needed to assess these costs.

Material Purchase Costs of NPO

Managers should consider the purchase costs of the following Material Inputs that become part of the NPOs:

- *Raw and Auxiliary Materials;*
- *Packaging Materials;*
- *Operating Materials;*
- *Water; and*
- *Energy.*

The purchase costs of merchandise can also be tracked if significant amounts of merchandise become waste before it is sold, e.g., the waste generated during a one-time clean out of merchandise inventory.

For all the different types of Material Inputs, if actual measures of losses are not available, estimates of loss and scrap percentages can be used to help calculate the Material Purchase Costs of NPOs.

Material Processing Costs of NPO

This subcategory – relevant for manufacturing operations only – includes the processing costs of Raw and Auxiliary Materials up to the point that that they are converted into Waste and Emissions. These processing costs are the proportion of equipment depreciation and labor costs that have been used to help generate Waste and Emissions rather than a final product.

These Material Processing Costs of NPO can often be estimated as a percentage of the standard production costs of equipment depreciation and internal personnel. When estimating Material Processing Costs of NPO, care must be taken to avoid double counting. In most organizations, data on standard production costs would include not only equipment depreciation costs and internal personnel costs, but also costs already covered by other categories. One example is the purchase cost of Raw and Auxiliary materials, which would be covered under Material Purchase Costs of NPO.

Waste and Emission Control Costs

This cost category deals with the costs of controlling and treating all forms of Waste and Emissions once they have been generated – solid waste, hazardous waste, wastewater and air emissions. Waste and Emission control activities include: equipment maintenance; internal waste handling; waste and emission treatment; waste disposal; remediation of contaminated sites and other pollution clean-up; and any environmental regulatory compliance costs related to generated waste or emissions. It is in the best interest of an organization to try and minimize these unproductive costs while still maintaining a high level of environmental performance.

This category does not include environmental management activities intended to prevent the generation of Waste and Emissions in the first place. Such activities are covered under the next cost category.

This category includes costs for:

- Equipment Depreciation;
- Operating Materials;
- Water and Energy;
- Internal Personnel;
- External Services;
- Fees and Taxes;
- Fines;
- Insurance; and
- Remediation and Compensation.

EQUIPMENT DEPRECIATION

Equipment Depreciation costs are the investment in a piece of equipment spread over its expected lifetime, recorded on an annual basis. Any other relevant asset acquirement costs could also be included in this category. Examples might be annual equipment rental or leasing costs, the annualized cost for constructing buildings to house waste and emission control equipment or the annualized costs for the purchase of land for a private landfill.

Examples of waste and emission control equipment include:

- waste handling equipment (e.g., solid waste dumpsters, waste transportation equipment);
- waste and emissions treatment equipment (e.g., wastewater treatment systems, air scrubbers);
- waste disposal equipment (e.g., earth moving equipment for an on-site landfill).

Waste and Emission Control systems include both standalone, “end-of-pipe” control equipment, the sole purpose of which is to control waste and emissions, as well as integrated control equipment, which may be closely integrated into actual production equipment. Organizations with large, standalone waste and emission control equipment, such as wastewater treatment plants, often record cost information related to the operation of this equipment in separate cost centers within their accounting systems. In such cases, many of the associated Waste and Emission Control Costs can be taken directly from these cost center reports. For waste and emission control equipment that does not have separate cost centers, an organization will need to spend some time tracing the relevant costs. Where waste and emission control equipment is integrated into production equipment or processes, an organization may wish to estimate how much of the integrated system and costs are actually dedicated to Waste and Emission Control and how much to other purposes.

Operating Materials

As stated previously, Operating Materials are Input Materials never intended to leave the organization in the form of product, but are still necessary to run the organization. An example of an Operating Material used specifically for the purposes of Waste and Emission Control would be the chemicals used in an on-site wastewater treatment plant. Depending on an organization's accounting practices, these costs may end up simply being included among the total purchase costs of Operating Materials under the cost category Material Costs of NPO. Or these purchase costs may be available from cost center reports pertaining to an organization's waste and emission control equipment, in which case they can be included under the Waste and Emission Control Costs category. Examples of Operating Materials related to Waste and Emission Control include:

- maintenance of waste and emission control equipment (e.g., equipment cleaning materials);
- waste handling (e.g., containers);
- waste and emission treatment (e.g., wastewater treatment chemicals);
- waste disposal (e.g., lining materials for an on-site landfill);
- related regulatory compliance (e.g., personal protective equipment, training materials).

Water and Energy

As with Operating Materials, an organization's total purchase costs for Water and Energy that become Waste and Emissions rather than a final product can be accounted for under Material Costs of NPO. Water and Energy used specifically for Waste and Emission Control purposes can instead be assessed under the Waste and Emission Control Costs category – if the data are available from cost center reports or can be estimated manually. Examples include Water and Energy purchase costs related to:

- waste handling (e.g., energy for transport equipment);
- waste and emission treatment (e.g., clean scrubber water for an incinerator);
- waste disposal (e.g., energy for earth-moving equipment at an on-site landfill).

Internal Personnel

Internal Personnel costs include the costs of both full-time and part-time personnel for Waste and Emission Control activities and should include the costs of both salaries and benefits. Examples include internal personnel for:

- maintenance (e.g., wastewater treatment plant maintenance);
- waste handling (e.g., waste segregation, collection, testing, internal transport);
- waste and emissions treatment (e.g., operation of wastewater treatment plants and incinerators);
- waste disposal (e.g., management of an on-site landfill);
- regulatory compliance (e.g., labeling, record keeping, inspections, notification, training, etc.).

EXTERNAL SERVICES

The costs of all External Services provided by consultants, contractors, law firms, etc., related to Waste and Emission Control should be included here.

FEES AND TAXES

This category includes any Fees and Taxes related to Waste and Emission Control, such as solid waste disposal fees, wastewater discharge fees, carbon dioxide emission fees, eco-taxes related to packaging, etc.

FINES

This category includes any Fines or penalties assessed by a government for lapses in regulatory compliance related to Waste and Emission Control.

INSURANCE

This category includes any costs of Insurance held by an organization to cover potential liability related to Waste and Emission Control, such as insurance related to the accidental release of hazardous materials.

REMEDIATION AND COMPENSATION

This category includes any Remediation and Compensation costs related to cleaning up sites contaminated with pollution, recovery of sites where ecosystem or other damage has been done, compensation to third parties, etc.

Prevention and other Environmental Management Costs

This category deals with the costs associated with efforts to prevent the generation of Waste and Emissions and implement other general environmental management activities not directly related to Waste and Emissions Control. First of all, it includes the costs of preventive environmental management activities, such as proactive eco-system management, on-site recycling, cleaner production, green purchasing, supply chain environmental management and extended producer responsibility. It also includes costs for more general environmental management activities such as: environmental planning and systems (e.g., environmental management systems, environmental financial accounting, environmental management accounting); environmental measurement (e.g., monitoring, performance auditing, performance evaluation); environmental communication (e.g., performance reporting, community group meetings, government lobbying) and any other relevant activities (e.g., financial support of environmental projects in the community, etc.).

This category includes costs for:

- Equipment Depreciation;
- Operating Materials, Water and Energy;
- Internal Personnel;
- External Services; and
- Other Costs.

This category should not double-count any costs already included in the previous categories. For example, if environmental monitoring costs are incurred because of regulations related to Waste and Emission Control, these costs should be included under Waste and Emission Control Costs.

It is important to note that preventive activities such as on-site recycling, cleaner production and the others listed above play a special role in environmental management. Costs incurred for preventive environmental management activities often not only improve environmental performance, but also bring a financial payback as materials use efficiency rises and waste declines. Accordingly, some projects with preventive environmental benefits are implemented not only to meet environmental goals, but also with efficiency, product quality or other goals in mind.

Equipment Depreciation

Equipment used for Prevention and Other Environmental Management can be either standalone equipment (e.g., a new computer system for environmental data collection) or equipment closely integrated into production equipment (e.g., a solvent distillation and re-use system that is an integral and automated part of a chemical manufacturing process). In the case of integrated equipment, an organization may wish to estimate how much of the integrated system is actually dedicated to Preventive and Environmental Management and how much to other purposes.

In addition, some equipment (e.g., a high-efficiency spray paint system or a high-efficiency boiler) contributes to Preventive Environmental Management because it uses energy or raw materials more efficiently and produces less waste than alternative equipment. The equipment may have been chosen for other reasons, however, such as materials efficiency, rather than for its environmental benefits. In these cases, the organization may wish to simply consider the equipment as both efficiency and environment related simultaneously, or prefer to estimate a percentage split between the different efficiency and environmental characteristics and costs of the equipment.

Operating Materials, Water and Energy

As stated previously, Operating Materials are Input Materials never intended to leave the organization in the form of a product, but are still necessary to run the organization. An example of an Operating Material used specifically for Prevention and Other Environmental Management would be supplies for voluntary environmental monitoring and sampling. Water and Energy are also used for Prevention and Other Environmental Management, for example, Water and Energy used for in-house recycling equipment. These purchase costs typically are included under an organization's total purchase costs of Operating Materials, under the cost category Materials Costs of NPO, because the available data are not disaggregated enough to account for them separately. Where these costs are considered potentially significant for a particular purpose, such as appraisal of a potential investment in a materials efficiency project, however, they can be estimated manually under this category.

Internal Personnel

Internal Personnel costs related to Prevention and Other Environmental Management include the costs of both full-time and part-time personnel and should include the costs of both salaries and benefits. Examples are personnel costs for:

- preventive environmental management (e.g., operation of recycling equipment, internal personnel to set up a green purchasing program);
- environmental planning and systems (e.g., implementation and maintenance of the environmental management system);
- environmental measurement (e.g., internal environmental auditing);
- environmental communication (e.g., compilation and publication of an environmental performance report);
- other (e.g., selection and management of financial donations related to environment).

External Services

The costs of all External Services provided by consultants, contractors, certification bodies, law firms, etc. related to Prevention and Other Environmental Management should be included here.

Other Costs

Any other relevant Prevention and Other Environmental Management Costs should be included here. Examples might be ecosystem management costs or donations to nature reserves.

Research and Development Costs

This category includes the costs of Research and Development activities involving environment-related issues and initiatives. Examples are the costs of: research on the potential toxicity of raw materials; development of energy-efficient products; and testing of new equipment designs with higher materials use efficiency. Research and Development costs related to the environment might include costs of all kinds, such as those for equipment depreciation, operating materials, water and energy, internal personnel and external services.

These costs have a special category of their own because they are sometimes substantial in comparison to other environment-related costs and can distort environment-related cost comparisons from year to year or between multiple sites owned by the same organization. In addition, some statistical reporting schemes, such as those of UN SEEA,[31] require reporting of Research and Development costs as a separate category. In many organizations, Research and Development is a separate department with its own cost center, where environment-related costs can be found, but the organization will need to determine which Research and Development costs are actually environment related and which are not.

Less Tangible Costs

All costs in the previous categories are theoretically available somewhere in an organizations' accounting and information management systems, with some collaboration between the accounting and other staff, and some manual work to check data accuracy, consistency, completeness, etc. There are some types of costs (and benefits), however, that typically cannot be found anywhere in an organization's collective information systems. Although these Less Tangible Costs can be difficult to quantify or even predict, they can have a significant impact on an organization's environmental performance and business value.

[31] *Definitions and Guidelines for Measurement and Reporting of Company Environmental Protection Expense* (Luxembourg: Eurostat, 2001); and United Nations (Statistical Division), European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development and World Bank, *Handbook of National Accounting: Integrated Environmental and Economic Accounting* (2003).

The potential business impact of less tangible issues becomes more concrete and obvious when an organization is purchased for a price that exceeds its value shown on the books. When this occurs, accounting rules refer to such additional value as intangible assets, and allow a listing of such values in the balance sheet. Thus, less tangible issues related to environment should not be viewed solely as a source of potential costs, but also as a source of significant potential value.

Less Tangible Costs related to the environment fall into four broad categories: productivity, potential liability, future regulation and image and stakeholder relations. Each is described briefly below.

PRODUCTIVITY

The productivity of an organization can be linked to its environmental performance in many ways. For example, inefficient equipment can negatively impact both productivity (via reduced production volume) and environmental performance (via increased waste and emissions generation). Similarly, an operation with product quality problems is also likely to generate waste. Some of the productivity costs associated with these waste issues are already included in the cost category Material Costs of NPO. Costs not covered there are the potential profit/losses on materials that become waste rather than product.

Poor environmental performance is not only linked to productivity – it can be an actual driver of poor productivity. Personnel who are busy managing waste do not have the time for more productive activities. And a polluted working environment can lead to low worker morale and high worker absenteeism – both of which affect productivity. In some situations, these types of productivity costs may be significant and should be considered under EMA.

POTENTIAL LIABILITY

Two general forms of Potential Liability Costs related to environmental issues can be distinguished:

- liability for violation of environmental regulations (for example, non-compliance fines, required site clean-up costs, legal costs, and business shutdown costs);
- liability assigned by the judicial system for personal injury, property damage, or natural resource damage (for example, legal costs, restoration costs, compensation costs and punitive costs).

In financial accounting, a significant, legally imposed clean-up obligation may be required as a provision in the balance sheet. Some of these risks may be covered by insurance. But estimation of potential future liability due to current environmental performance (or avoided potential liability due to improved environmental performance) is clearly relevant and potentially significant under both traditional MA and EMA.

FUTURE REGULATION

In many countries, environment-related regulatory costs are rising. Regional and international regulations also affect the environmental performance requirements of many organizations, some by direct mandate and some via increasingly global markets. Thus, under EMA, it can be important to consider not only current regulatory costs but also likely future regulatory costs. These Future Regulation Costs might include those related to stricter enforcement of current regulation modification of current regulations and new regulations. Regulation at all levels could be significant – local, national, regional and international.

IMAGE AND STAKEHOLDER RELATIONS

Image can be critical to economic survival, as it affects relationships with key stakeholders that help an organization not only survive but also prosper. For example, in the context of environmental performance, the image of an organization can affect its access to "green markets," such as consumers who care about the environmental performance of companies and products. Relationships with business partners can also be affected. Finance and insurance providers may be reluctant to enter into a business relationship that may transfer environmental liability to them in the future. Relationships with non-market stakeholders who care about the environmental impacts of the organization or its products may also be affected. Examples include local community residents, government and environmental organizations.

Environment-related Earnings and Savings

Environment-related Earnings are derived from sales of scrap or waste (for reuse by another organization), subsidies, sales of excess capacity of waste treatment facilities, earnings from insurance reimbursements from environment-related claims, sales of green products, higher profit margins due to environmentally benign products, etc.

In contrast, Environment-related Savings are realized only when a current, defined system changes in some way. For example, if efficiency improvements reduce materials use and waste generation, the monetary savings due to the improvement can be calculated by comparing the reduced costs to the previous, higher costs. These types of savings tend to occur when preventive environmental management activities are implemented, such as on-site recycling, cleaner production, green research and design, green purchasing, supply chain environmental management, extended producer responsibility, etc. Savings can also result from improvements in areas such as environmental planning and systems (e.g., via the implementation of EMA).

Distribution of Costs by Environmental Domain

Environmental protection agencies in some countries (e.g., Germany) require that environment-related costs be reported by environmental domain, that is, by type of environmental issue. Also, national statistical collection agencies often require the reporting of environment-related costs by environmental domain. In addition, the distribution of environment-related costs by environmental domain can show results and trends that are interesting and useful for internal management purposes.

The total amount of environment-related costs borne by an organization does not necessarily reflect the level of its actual environmental performance. Similarly, the amount of environment-related costs attributed to any particular environmental domain does not necessarily reflect an organization's level of environmental performance or impact in that domain.

The columns of the following table show the assignment of environment-related costs to environmental domains used by the System of Integrated Environmental and Economic Accounting (SEEA) of the United Nations:[32]

- Protection of Ambient Air and Climate
- Wastewater Management

[32] United Nations (Statistical Division), European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development and World Bank, *Handbook of National Accounting: Integrated Environmental and Economic Accounting* (2003).

- Waste Management
- Protection and Remediation of Soil, Groundwater and Surface Water
- Noise and Vibration Abatement
- Protection of Biodiversity and Landscape
- Protection against Radiation
- Other Environmental Protection and Management Activities.

Most organizations rarely have any cost data for the columns on soil, noise, biodiversity or radiation. If appropriate, organizations may also wish to add a column for occupational health and safety issues, particularly if environmental issues are handled by an integrated environment, health and safety department.

TABLE 4 – SUMMARY OF ENVIRONMENT-RELATED COSTS BY ENVIRONMENTAL DOMAIN

ENVIRONMENTAL DOMAIN **ENVIRONMENT-RELATED COST CATEGORIES**	**Air and Climate**	**Waste Water**	**Waste**	**Soil, Surface and**	**Noise and Vibration**	**Biodiversity and Landscape**	**Radiation**	**Other**	**Total**
MATERIAL COSTS OF PRODUCTS									
• Raw and Auxiliary Materials									
• Packaging Materials									
• Operating Materials									
• Water									
MATERIAL COSTS OF NON-PRODUCT OUTPUTS									
• Raw and Auxiliary Materials									
• Packaging Materials									
• Operating Materials									
• Water									
• Energy									
• Processing Costs									
WASTE and EMISSION CONTROL COSTS									
• Equipment Depreciation									
• Operating Materials									
• Water and Energy									
• Internal Personnel									
• External Services									
• Fees and Taxes									
• Fines									
• Insurance									
• Remediation and Compensation									

ENVIRONMENTAL DOMAIN **ENVIRONMENT-RELATED COST CATEGORIES**	**Air and Climate**	**Waste Water**	**Waste**	**Soil, Surface and**	**Noise and Vibration**	**Biodiversity and Landscape**	**Radiation**	**Other**	**Total**
PREVENTIVE and OTHER ENVIRONMENTAL MANAGEMENT COSTS									
• Equipment Depreciation									
• Operating Materials, Water, Energy									
• Internal Personnel									
• External Services									
• Other									
RESEARCH and DEVELOPMENT COSTS									
LESS TANGIBLE COSTS									

Note: Although this table uses the term “costs,” these categories may also cover information on any environment-related earning (e.g., revenues from recycled materials) or savings (e.g., monetary savings from eco-efficiency projects).

Chapter 5 – Selected Examples of EMA Applications and Links

This chapter presents a number of brief, real-world examples of the uses and benefits of EMA approaches for both internal decision making and other related accounting and reporting efforts. These examples do not cover all of the many potential uses and benefits of EMA – they are illustrative only. Appendix B ("Where to Go for More Information") lists information sources where other case studies may be found.

EMA Data for Internal Management

EMA data can be collected, analyzed and used at a number of different levels within an organization, for example, at the level of:

- a particular raw, operational or waste material;
- a particular process or equipment line;
- a particular product or product line;
- a single site or facility;
- a particular division;
- the entire organization.

From an accountant's point of view, the most likely starting point for EMA is the list of accounts, which is the most common source of cost information available in both big and small organizations. Working with the list of accounts allows an assessment of site-wide or organization-wide annual costs related to environmental issues. This assessment alone will probably lead to improvements in the accounting, information and control systems, as problems such as inconsistencies in the posting to accounts or in assumed scrap percentages and missing information will become obvious.

From an environmental manager's point of view, the desired starting point may be an EMA analysis of a particular waste stream of environmental interest. A production manager might be the most interested in an EMA analysis of a particular product line or set of production equipment. These more detailed analyses will require going deeper into the accounting systems – looking at cost center reports, calculations of production costs and product prices, statistics on scrap and returned poor quality product, recipes from the production planning system, inventory reports, waste reports, as well as energy, water and material balances – to the extent that this information is available.

The following sections illustrate the use and benefits of EMA for internal decision making at three different general levels: the level of an entire site or organization; the level of different materials; and the level of specific projects. Some of the case studies could illustrate EMA at more than one level. For example, EMA done at the organization-wide level almost inevitably leads to more in-depth EMA in support of specific improvement projects.

EMA at the Site and Organization Level

EMA for Estimation and Distribution of Total Environment-related Costs – Austria

SCA Graphic Laakirchen AG, a forest products operation site of SCA, has been tracking its physical and monetary information under EMA since 1999 and now has a well-established, consistent system for capturing and assessing materials flows and environment-related costs. The information collected is used for decisions related to both environmental management and general production. SCA Laakirchen annually calculates the distribution of the environment-related cost information it collects in its Environmental Statement, as illustrated in Table 5.

The data in Table 5 illustrate the fact that, in many companies, the Material Purchase and Processing Costs of NPOs are often significantly higher than more familiar environment-related costs of Waste and Emissions Control – approximately four times as high in the case of SCA Laakirchen. Table 5 also illustrates the fact that Prevention and other Environmental Management Costs at SCA Laakirchen are quite low, despite the fact that the company has implemented a number of preventive projects in past years that have achieved significant savings in Materials Costs of NPO as well Waste and Emission Control.

The data in Table 5 allow SCA Laakirchen to compare its environment-related costs from year to year. For example, although manufacturing output rose almost 23% between 2002 and 2003, due to a new paper machine, the total environment-related costs increased by only 14.7% over the same period. This illustrates the overall positive financial impact of the company's environmental management initiatives. A more detailed look at the cost changes between 2002 and 2003 also revealed some interesting points. For example, the overall costs of operating the wastewater treatment plant did not change, even though it was enlarged to handle increased wastewater resulting from the expanded production. This was because the operational efficiency and maintenance of the wastewater treatment plant were improved in several ways as it was expanded.

Costs in other categories did increase. For example, the purchase costs of auxiliary materials increased not only because of expanded production, but also because of international price changes. SCA Laakirchen was also able to observe that the distribution of total costs and earnings across the different environmental domains remained more or less constant over the years – 22% air/climate; 54% wastewater; 23% waste; 1% other.

The physical results of SCA Laakirchen's environmental management efforts are also given in the annual Environmental Statement. For example, despite the production increase of about 23%, the procurement of water increased by only 11%, the volume of wastewater generated by only 13%. These are increases in absolute terms, but are improvements per unit of production. Use of physical inputs such as filler, recovered paper and energy also increased in absolute terms but reflected eco-efficiency improvements.

www.sca.at – SCA Laakirchen Environmental Statement 2003.

TABLE 5 – ENVIRONMENT-RELATED COSTS AT SCA LAAKIRCHEN* DISTRIBUTED BY PERCENTAGE TO ENVIRONMENTAL DOMAINS (2003)**

Environmental Domain **Environment-related Cost Categories**	**Air + Climate**	**Waste-water**	**Waste**	**Soil + Ground water**	**Others**	**Sum**
I – Material Purchase Costs of Products	This cost category not considered by SCA Laakirchen					
IIa. Material Purchase Costs of NPOs						
Raw materials			15.2%			15.2%
Packaging			0.1%			0.1%
Auxiliary materials			2.7%			2.7%
Operating materials	0.1%	42.2%	0.5%			42.8%
Energy	19.8%					19.8%
Water		0.0%				0.0%
IIb. Material Processing Costs of NPOs		0.2%	1.0%			1.2%
Subtotal	**19.9%**	**42.4%**	**19.5%**			**81.8%**
III. Waste & Emission Control Costs						
Equipment Depreciation	0.1%	2.8%	0.4%			3.3%
Operating Materials and Services	0.2%	5.5%		0.1%		5.8%
Internal Personnel	0.7%	1.0%	0.1%			1.8%
Fees, Taxes and Fines	0.9%	2.7%	6.0%			9.6%
Subtotal	**1.9%**	**12.0%**	**6.5%**	**0.1%**		**20.5%**
IV. Prevention and Other Environmental Management Costs						
External Services for env. Management					0.4%	0.4%
Internal Personnel for env. Protection	0.1%				0.3%	0.4%
Subtotal	**0.1%**				**0.7%**	**0.8%**
V. Research and Development Costs	This cost category not considered by SCA Laakirchen					
VI. Less Tangible Costs	This cost category not considered by SCA Laakirchen					
I - VI Environment-related Cost Total	**21.9%**	**54.4%**	**26.0%**	**0.1%**	**0.7%**	**103.1%**
Environment-related Earnings Total			**-3.1%**			**-3.1%**
Total Environment-related Costs & Earnings	**21.9%**	**54.4%**	**22.9%**	**0.1%**	**0.7%**	**100.0%**

*The language of the company's Environmental Statement has been modified to better match the cost categories in Chapter 4 of this guidance document, and data subtotals were created, but none of the raw data have been changed.

**Data are presented as a percentage of the Total Environment-Related Costs and Earnings for the company

Extracting EMA Data from Enterprise Resource Planning – Austria

The Verbund group is Austria's largest electric utility, generating about 50% of the electricity consumed in the country. The group consists of the corporate parent and a number of subsidiaries (energy generating companies, a grid operating company, etc.). In 1994, Verbund started to report on its performance on environmental issues, including some environment-related costs for measures taken to avoid or minimize environmental impacts.

In 2001, Verbund decided to take part in a pilot project that would assist the company to better assess environmental performance and environment-related costs via more rigorous EMA. Three different sites, each representing one of Verbund's business groups, were chosen to take part in the pilot project: a small hydro power station, a fossil fuel power plant and a substation of the transmission grid. At each site, an assessment of annual costs was performed, and intensive discussions were held as to which costs would be defined as environment-related. Agreement was reached that costs driven by environmental regulation or community concerns about environmental issues would be defined as environment related.

It was also necessary to clearly specify which data would be needed from the company's Enterprise Resource Planning accounting system (from SAP). Within the SAP system, environment-related costs can be found in two different places: (1) data records associated with a specific company project or (2) cost center data records. For data from both types of records, the company had to determine which costs were environment related, per the company's definition. For costs with dual characteristics, for example, a cost considered to be both environment related and efficiency related, an appropriate percentage of the cost was taken to be environment related for the purposes of the pilot project.

During the course of the pilot study, it was realized that it was not possible to have the SAP software automatically extract and report the needed environment-related cost data. So, a formal data collection procedure was written for environmental managers from the about 150 sites of the three largest subsidiary companies. This procedure helps the mangers to extract SAP data that must be reported to the corporate parent company each year. The extracted data are reported by cost category and by environmental domain. Environment-related earnings are also reported. Each subsidiary reports not only costs for the previous year, but also budgeted costs for the upcoming year.

In 2003, this EMA process developed during the pilot project has been adopted by all of Verbund's power generation companies and its grid operating company. The data will be used for internal management decision making and external reporting at both the corporate and site level, and will allow performance comparisons between different sites.

1. www.verbund.at.

2. C. Jasch and H. Schnitzer, *Umweltrechnungswesen – Wir, zeigen, wie sich Umweltschutz rechnet, Beispielsammlung zur Umweltkostenrechnung und Investitionsrechnung.*(Vienna: Bundesministerium für Verkehr, Innovation und Technik and Bundesministerium für Land- und Forstwirtschaft, Umwelt, und Wasser, 2002).

EMA for Government Efficiency – UK

EMA concepts are being promoted within the UK Environment Agency as part of a broader efficiency program. The EMA part of the program is a five-year effort to move to "green" accounting systems that was initiated in 1997. Under this accounting initiative, the agency is developing and integrating a system that:

- informs core organizational processes such as planning and accounting;
- links financial data to other quantitative information such as materials flow data;
- tracks approximately UK £55 million (approximately US $ 78 million) in agency expenses on key environmental issues (i.e., energy, water, transport, etc.);
- tracks efficiency gains, e.g., a reduction of £2.4 million in costs related to travel, business (office) materials, utilities and engineering materials (from 2000-2003, a period during which the agency grew by 17%);
- tracks environmental benefits, e.g., a 53% reduction in carbon dioxide emissions over the same time period.

http://www.www.environment-agency.gov.uk/environmentalaccounting.

EMA at the Materials Level

EMA provides many organizations with a comprehensive set of materials flow information and associated cost information for the first time. The following examples illustrate the use of EMA approaches for analysis at the materials level.

Materials Flow Cost Accounting – Germany

In 2001, Ciba Specialty Chemicals in Germany undertook a case study to evaluate potential improvements to its internal information systems. The methodology used was materials flow cost accounting (MFCA), which focuses on accurate tracing of the materials flows throughout a facility as well as on identification of all significant quantities and costs associated with those materials flows.

Under MFCA, Ciba first mapped both the physical flow of materials (including wastes) inside a pilot facility, as well as the flow of materials-related information (e.g., posting structures) in the facility's Enterprise Resource Planning (ERP) system. The two maps were then compared to reveal any mismatches between the physical reality and the informational data structures in the ERP-system. Then, quantitative data on materials amounts and costs were extracted from the ERP and other information systems (e.g., process computers, warehouse systems) and were assigned to the real-world flows of Input Materials, Product Outputs and Non-product Outputs.

The MFCA project at Ciba revealed materials discrepancies valued at about US $2 million. These discrepancies were caused not only by actual materials losses, but also by inaccurate data records in the ERP system. In response, the company has introduced numerous technical and organizational improvement measures. For example, the modification of the formulation and processing of a standard product component led to estimated annual cost savings of about US $100,000. In addition, the production capacity for the product could be increased by 30%.

1. *Case Study – Ciba Spezialitaetenchemie Pfersee GmbH)* (Augsburg: Institute for Management and Environment, 2002).

2. http://www.imu-augsburg.de/engl/index.php.

EMA for Chemicals Management – USA

Raytheon, an electronics and aerospace company located in the United States, has used EMA to support a supply chain initiative with both financial and environmental benefits. First, a cross-functional team of staff from purchasing, environmental, inventory, quality, finance and engineering mapped the flow of a set of priority materials (chemicals and gases) and wastes through one of its facilities, covering all materials management steps, i.e., procurement, inventory, delivery, use and waste collection, disposal and treatment. A cost analysis then revealed materials management costs of US$1 for every dollar of materials purchased. The EMA analysis was repeated at 10 other Raytheon facilities with high chemicals use.

In 1995, the information was used to negotiate the goals and costs of a Chemical Management Services (CMS) contract with a supplier, Radian International, now part of Haas TCM. Haas TCM is now responsible for all materials management activities at more than 70 facilities at 30 Raytheon sites, as well as for all environment-related data management and reporting. The contract gives Haas TCM financial incentives to help Raytheon achieve reductions in materials use and purchase prices and to improve process efficiency. These incentives include sharing of any monetary savings that result from projects initiated by TCM Haas, and a monetary bonus for actual chemical use reductions. These incentives reverse the usual supplier incentive to sell the customer more chemicals and, instead, encourage the supplier to help the customer use fewer chemicals for the same activities.

Examples of the benefits of this program at the pilot facility include:

- scrap costs reduced from US $750,000/year to $62,000/year;
- ♦ inventory turnover time reduced from 3-4 months to 1 week;
- ♦ purchase order cycle time reduced from 3-7 days to 2 days.

1. http://www.chemicalstrategies.org/case_studies.htm.
2. T. Votta, R. Broe, J. Kauffman and A. White, “Using Environmental Accounting to Green Supplier Contracts,” *Pollution Prevention Review* (Spring 1998).

EMA for Logistics Management – UK and the Netherlands

In the 1990s, Xerox Corporation’s photocopier business involved manufacturing in two factories in the UK and the Netherlands, shipment to a European Logistics Center in the Netherlands and then distribution to 68 delivery points across Europe, from which the copiers were finally delivered to customers. Xerox did not have firm data on the costs of this expensive logistics operation, but estimated the total cost to range between US $100 million and $600 million per year.

Therefore, a study was done to calculate the total cost of logistics operations in Europe. Because of the complexity of data collection across a large, decentralized company, including many subcontractors, this exercise took two years to complete. Much of the data had to be collected via written questionnaires and direct inquiry. This study revealed that the true total logistics costs were at the high end of the range of previous estimates.

The attention that this information generated prompted several relatively easy improvement projects that produced substantial monetary savings. It was realized that to go further, however, it

would be necessary to consider a major redesign of the entire logistics process. This prompted further data collection to analyze the costs related to each type of resource consumed at each stage of the logistics process.

One major result of the more detailed study was a significant change in Xerox's product packaging system. At the time, Xerox manufactured 23 different product lines of photocopiers – large, valuable and delicate products – each of which required its own specifically designed packaging. This packaging was typically disposed of by customers after delivery, as it would have been impractical and uneconomic for anyone to try and return such a wide variety of packaging materials to Xerox for reuse. Under the new system, a single standard packaging container was designed that would work for all of Xerox's photocopier products. These containers could be returned and reused after each delivery. The end result was substantially reduced waste, a financial payback period of four years and a number of less tangible benefits related to product handling and installation as well as administrative issues and customer service.

The project stimulated permanent improvement to Xerox's accounting and other information systems, which were adapted to include significant operational data that had not previously been captured and to improve awareness of how costs are incurred in different stages of the logistics chain.

Personal communication with Martin Bennett of the University of Gloucestershire Business School, 2004.

EMA and Environmental Performance Indicators – Austria

A brewery in Austria, Murauer Bier, installed an Environmental Management System (EMS) in 1995, based on voluntary guidelines outlined in the European Union's 2001 Regulation on Environmental Management and Audit Systems. Murauer's EMS is supplemented by an extensive system of environmental performance indicators. The company uses physical and monetary accounting data to calculate these EPIs and to calculate the annual monetary savings achieved since the implementation of the EMS.

Absolute EPIs calculated by Murauer include the total amounts of all significant Materials Inputs (e.g., hectoliters of fresh water, kilograms of heating oil). Relative EPIs are also created by calculating the ratio of each Material Input to hectoliters of Product Output, that is, beer. Similar absolute and relative EPIs are calculated for the brewery's Non-Product Outputs (e.g., glass, paper, wastewater, carbon dioxide and other air emissions).

Murauer also compares EPIs from year to year to track its environmental performance trends and overall progress. The following EPIs illustrate the success of some of Murauer's waste minimization efforts during that five-year time period:

- reduction in fresh water use per unit product (1995-2000) – 19%;
- reduction in fuel oil use per unit product (1995-2000) – 30%;
- reduction in wastewater generation rate per unit product (1995-2000) – 32%.

Monetary savings are calculated for each Material Input by applying current year purchase prices to the physical reductions since 1995. These efforts saved the medium-sized firm approximately US $186,000 in the year 2000.

1. www.murauerbier.at.

2. Jasch and Schnitzer, op.cit.

EMA at the Project-level

EMA approaches can also be used to do a more comprehensive and environmentally sensitive assessment of specific projects and initiatives within an organization. Some of the earliest EMA work was done in the area of investment project appraisal. Several examples are given below.

EMA for Investment in Process Efficiency – USA

A fine paper mill in the USA commissioned a study of its rather complex water recycling and reuse system to identify changes that would reduce peak wastewater flows, reduce contaminant levels in wastewater and reduce total freshwater intake for the mill as a whole. The final study recommended that the mill consider installation of new equipment for capturing more wastewater in process, separating out lost raw materials from the water and recycling both materials and water for reuse in the facility.

The feasibility study included an estimate for the up-front capital costs necessary to purchase and install the new equipment. Annual operating costs were also estimated for:

- purchase costs of raw materials lost in the wastewater;
- purchase costs of energy for operating the new equipment;
- purchase cost of operating materials for the new equipment;
- personnel costs to operate the new equipment; and
- wastewater treatment fees to the local utility.

Unfortunately, this initial investment appraisal estimated the internal rate of return (IRR) on the project to be only 1% over a five-year time horizon. A second and more thorough look at the project produced very different results, however. The original financial analysis did not include a number of costs that were relevant and significant:

- purchase costs of freshwater treatment chemicals;
- purchase costs of fuel for generating process steam to heat freshwater; and
- purchase costs of electricity for pumping both freshwater and wastewater.

When these costs were included in the analysis, the five-year IRR jumped from 1% to 37%, because the annual monetary savings from the project were actually three times higher than originally expected. The environmental benefits of the project included significant reductions in materials use, freshwater use, energy use and wastewater generation.

A. White, L., M. Becker and D. E. Savage, "Environmentally Smart Accounting: Using total Cost Assessment to Advance Pollution Prevention," *Pollution Prevention Review* (Summer 1993).

EMA and Less Tangible Costs – USA

A major manufacturing firm in the US was concerned about the potential cleanup and liability costs associated with potential fires or chemical spills involving its hundreds of transformers currently using polychlorobiphenyls (PCBs) as a transformer fluid. PCBs released to the environment are highly persistent (i.e., resistant to degradation), able to accumulate in the food chain and are connected with a variety of animal and human health problems. According to US regulation at the time, the company could continue to use its PCB transformers until the end of their useful life (which could be as much as 40 years), but then it would have to replace them with transformers using other fluids.

The company decided to investigate the technical and cost implications of phasing out the PCB transformers ahead of schedule. Various costs associated with such a phaseout were estimated: the cost for removal and safe disposal of the PCB-contaminated transformers; the purchase costs of new transformer equipment; and purchase costs of new alternative fluids vs. the current PCB fluids. Some of these data were available from the company's accounting and information systems, while other data were collected from equipment vendors and chemical suppliers.

The company also wished to further assess the less tangible costs of greatest concern, including potential cleanup and liability costs. To that end, the possible ramifications of an acute event such as PCB transformer fire or spill were mapped, and it was determined that the most significant potential costs associated with such events would be those related to PCB cleanup, litigation insurance and business shutdown. Approximate cost estimates and event probabilities were developed using publicly available historical data and internal company estimates. These costs and probabilities were combined to generate a total cost per transformer per year of lifetime. This unit cost was applied to the company's many transformers over their various remaining useful lifetimes to generate a series of annual total cost estimates for the period of years that the company would have PCB transformers under business as usual.

The less tangible costs turned out to be quite significant in the opinion of the company's managers. The accelerated phaseout project was initially rejected when only the costs from the accounting records and vendors were presented. When the less tangible cost estimates were presented, however, even considering all the uncertainties in these estimates, upper management decided to approve the project, and the company proceeded to phase out its PCB transformers in favor of less hazardous options.

A. L. White, A Dierks and D. E. Savage, *Environmental Accounting Principles for the Sustainable Enterprise,* Proceedings of the 1995 International Environmental Conference of the Technical Association of the Pulp and Paper Industry (Atlanta, 1995).

EMA for New Product Development – Argentina

A typical sawmill operation in Misiones Province, Argentina has a materials use efficiency rate of 40-44%. That means that, of the wood entering a sawmill, approximately 40-44% leaves the mill as sellable product, while the remaining 56-60% is viewed as waste. About 10-16% is used to fuel boilers at the mill, and the remainder is simply burned in the open air. It is estimated that, each year, approximately 500,000 tons of waste sawdust and serrated wood are burned in this way.

Alternative ways of using the waste stream (e.g., in some type of by-product) have been investigated to reduce the volumes of burned waste and the associated environmental impacts. For example, waste from pinewood that enters the mill can be used to produce wooden chips suitable as raw material for the paper manufacturing industry. The best available equipment for this purpose, plus accessories and related building improvements, are valued at US $122,966.

EMA techniques were used to estimate the annual cash flows for such a waste reduction project, including: initial investment costs for equipment, accessories and building improvements; annual savings from waste reduction volumes and their processing and handling costs; and the expected earnings from the new by-product. The assessment revealed an investment payback period of about 3.8 years, which is typical for this industry sector, and a predicted annual profit of US $28,380, which represents approximately 24% of the current annual income of a sawmill.

Personal communication with Graciela Scavone of Buenos Aires University, Argentina, 2004.

Links Between EMA and Other Types of Accounting and Reporting

Governments in a number of countries have imposed obligations or incentives to disclose information on environmental performance, risks and associated financial impacts. International rating agencies and award systems for environmental and sustainability reports are also beginning to place more emphasis on incorporating monetary data for environmental and social activities.

Subsets of EMA information are disclosed via several other different types of reporting:

- financial accounting and reporting;
- statistical accounting and reporting;
- reporting on corporate environmental performance to environmental protection agencies and the public.

The EMA-type information collected for external reporting purposes can also be quite useful for internal decision making. The range of EMA-type information that must be reported under financial or statistical accounting schemes, however, is typically narrower than the set of information needed for internal management decision making under EMA. Thus, in most cases, an organization should not base its internal decision making only on the data collected for purposes of external reporting. EMA-type information collected for external reporting can, however, be an excellent and easy EMA starting point for organizations that have never before attempted to do EMA explicitly for internal decision making purposes.

Some brief examples of reporting schemes that can benefit from EMA information are given below.

EMA Links to Financial Accounting and Reporting

There is a growing trend to include increasing amounts of environment-related financial information (as well as non-financial information) in corporate financial reports to external stakeholders.[33] Accountants within organizations play a key role in providing the information, and external auditors play a key role in verifying the accuracy of the information reported, as well as verifying the information systems and practices from which the reported information is derived.

The EC Recommendation on Environmental Issues in Company Annual Reporting

In May 2001, the European Commission adopted a Recommendation on the recognition, measurement and disclosure of environmental issues in the annual accounts and annual reports of companies. The Recommendation is intended to encourage higher levels of reporting of environmental issues in the annual accounts and reports of companies, to provide stakeholders such as investors and government regulators with more reliable information, to reinforce EC goals in environmental protection and to contribute to policy harmonization efforts with the EC market.

The Recommendation states that environmental issues should be disclosed to the extent that they are material to the financial performance of an organization. The relevant environmental issues should be described, as well as the organization's response to them. For example, when appropriate and relevant to the nature of the business, physical information on environmental performance should be reported. On the monetary side, the Recommendation covers items such as environmental expenditures, environmental liabilities and risks and related assets. Annual environmental expenditures would appear in the Profit & Loss Statement. Monetary information on environment-related assets (e.g., waste and emission control equipment) as well as environmental provisions and long-term liabilities would appear in the Balance Sheet.

The Recommendation suggests that reporting organizations refer to the 2001 guidelines developed by the Statistical Office of the European Union for a set of detailed definitions of expenditures by environmental domain. These definitions cover expenditures for activities whose primary purpose is environmental protection – similar to the information covered under Cost Categories 3-5 of EMA: Waste and Emission Treatment, Prevention and Other Environmental Management, and Research and Development. Under Eurostat's Classification of Environmental Protection Activities and Expenditures (CEPA), cost data are first reported by environmental domain (e.g., wastewater management, waste management, etc.) and then broken down to distinguish between treatment, prevention and other activities.

CEPA does not cover information contained in EMA Cost Categories 1, 2 and 6: Material Costs of Product, Material Costs of NPO and Less Tangible Costs. Therefore, the information collected under CEPA currently does not include all the information needed for internal management decision making under EMA.

[33] United Nations Conference on Trade and Development, Committee on International Standards of Accounting and Reporting, *Accounting and Financial Reporting for Environmental Costs and Liabilities* (New York and Geneva: United Nations Publications, 2004).

Although the implementation of the EC Recommendation by European companies is voluntary, Spain has already decided to require compliance by its publicly listed companies.

1. *Regulation on Environmental Management and Audit System* (Brussels: European Commission, 2001).

2. *Definitions and Guidelines for Measurement and Reporting of Company Environmental Protection Expense* (Luxembourg: Eurostat, 2001).

EMA Links to Statistical Accounting and Reporting

A large number of organizations worldwide report environment-related data to government under statistical reporting requirements. For example, in 1996, approximately 20,000 organizations in Australia reported data on their environmental protection expenditures (EPEs) to the Australian Bureau of Statistics.[34] About 1,000 of these organizations were government departments and agencies, but the great majority was in the private sector: 13,000 producing goods and 7,000 in the service sector. This is many orders of magnitude greater than the numbers of organizations that have specific EMA initiatives or take part in other activities that require EMA-type data, such as voluntary environmental performance reporting under GRI or compliance with the ISO 14001 Environmental Management System standard.

Similarly to financial reporting, the EMA-type information collected for statistical reporting purposes is typically narrower than the complete set of information needed for internal decision making under EMA. The data collected could serve as an excellent and easy EMA starting point for the many organizations that do collect it. The following two examples illustrate the similarities between statistical data and the EMA information discussed in this guidance document, and how statistical data have been used for internal decision making.

The UN System of Integrated Environmental and Economic Accounts

The United Nations Statistic Division first issued guidelines on Integrated Environmental and Economic Accounting (SEEA) in 1993. The most recent version of the UN SEEA guidelines outlines the types of physical and monetary information useful for environmental accounting at the national level. The main goal of UN SEEA is to allow assessment of interactions between the natural world and the economy, and to provide information to support the design of integrated social, economic and environmental government policies.

Although the language used is different, some of the physical information collected under the UN guidelines and EMA is quite similar: Materials Input (e.g., natural resources such as water, wood, fish, livestock, grains, natural gas, petroleum, metal ores); Product Outputs (e.g., food and beverage products, tobacco, textiles, leather, furniture, pulp and paper, chemicals); and Waste and Emissions (e.g., solid waste, air emissions, water emissions, dissipative emissions from products, etc.).

On the monetary side, UN SEEA has adopted the Classification of Environmental Protection Expenditures (CEPA) developed by Eurostat (see previous case study). The classification includes expenditures whose primary purpose is environmental protection (EMA Categories 3-5) but not environment-related materials costs (EMA Categories 1-2) or less tangible costs (EMA Category 6).

34 D. Osborn, " Showcasing Environmental Management Accounting in Local Government: contexts, methods, and summary results" (Hawker, Australia: Green Measures, 2001), http://www.greenmeasures.com.au/publicationsmiddle .html.

United Nations (Statistical Division), European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development and World Bank, *Handbook of National Accounting: Integrated Environmental and Economic Accounting* (2003).

Mining Statistical Data for Internal Management Purposes – Australia

The information collected by the Australia Bureau of Statistics from both government and private sector organizations is a subset of the CEPA categories adopted by UN SEEA. Six local government councils in Australia participated in a project to review environment-related information originally collected for statistical reporting purposes and to assess its usefulness for internal decision making as well. The range of environmental issues these councils faced ranged from management of air and water pollution to management of natural resources in their jurisdictions.

One project finding was that collecting the CEPA-defined cost data from the existing financial information systems of the local councils took from about 8 to70 hours, the average being 34 hours. The amount of time then devoted to reorganizing and reporting the collected data for non-statistical purposes such as internal decision making varied quite widely, depending on the experience and goals of the particular council. Accordingly, the benefits derived varied widely. When asked to guesstimate the benefit:cost ratio of the added value of the information for purposes beyond statistical reporting, the estimates ranged as follows: benefit:cost ratio of 100:1 (two councils); ratio of 10:1 (two councils); ratio of 1:1 (one council); ratio of 0:1 (one council). Examples of benefits gained by individual councils follow:

- One council learned that its annual expenditures on environmental protection were approximately eight times higher than it had estimated prior to mining the statistical data. This gave the council an increased appreciation of its role in environmental protection, and enhanced the council's decision making regarding its climate protection activities and future budget allocations. The findings also influenced restructuring of the financial management computer system to facilitate data mining.
- Another council with significantly more CEPA experience used the mined data to help establish targets for maintenance spending on environmental protection assets (e.g., sewer systems) and on asset values, and track performance with respect to those targets. Net expenditures on environmental protection services were also estimated. The council reported these data in an environmental supplement to its annual financial statement, which allowed external stakeholders to better understand the council's environmental protection efforts and the associated financial impacts.

D. Osborn, " Showcasing Environmental Management Accounting in Local Government: contexts, methods, and summary results," http://www.greenmeasures.com.au/publicationsmiddle.html; "Showcasing Environmental Management Accounting in Local Government, Working Draft of 31/05/01" and "How Environmental Management Accounting Supports the 'Good Government, Better Living' Vision of the Eurobodella Shire Council, New South Wales," http://www.greenmeasures.com.au/pdf.surf.pdf (Hawker, Australia: Green Measures, 2001).

EMA Links to Corporate Environmental Performance Reporting

Although EMA focuses primarily on internal management decision making, physical accounting information also is often reported to external stakeholders. The process of gathering physical data to be reported is often not called EMA at all, or even called accounting, as the experts on much of this physical flow information tend to be the personnel in purchasing, production, environmental, etc., rather than those in accounting.

On the regulatory side, an example of one initiative is Denmark's Green Accounting Act, which requires reporting of the physical accounting information by certain companies.

Green Accounting and Reporting – Denmark

In Denmark, EMA materials accounting by Danish companies is promoted via the requirements of the Green Accounts Act, which requires that a priority set of companies report the following:

- data on consumption of water, energy, and raw materials;
- significant types and volumes of pollutants emitted to air, water and soil;
- significant types and volumes of pollutants in production processes, waste or products.

A 1999 evaluation of the 1995 Act revealed that 41% of regulated enterprises have achieved environmental improvement through "green accounting," while 52% have gained an economic profit. In addition, Danish companies who report under green accounting have a competitive advantage when the information is requested by external stakeholders such as industry customers in Germany. The dialogue between reporting companies and local government has improved, and the national government is using the collected data to help satisfy its own reporting responsibilities under international agreements and conventions.

United Nations Division for Sustainable Development, *Environmental Management Accounting, Procedures and Principles* (New York and Geneva: United Nations Publications, 2001), http://www.un.org/esa/sustdev/sdissues/technology/estema1.htm.

On the voluntary side, many corporate environmental performance reports, such as those following the voluntary guidelines of the European Union Regulation on Environmental Management and Audit Systems, EMAS or the 2002 Global Reporting Initiative, include the physical accounting information necessary for EMA. Many companies in Japan include both physical and monetary EMA information in their environmental and sustainability reports. An example is given below.

Valuing and Reporting Environmental Activities – Japan

In Japan, many companies voluntarily report on their environmental and sustainability performance. Out of all companies listed on the Tokyo Stock Exchange, companies representing approximately 58% of the total value of listed stocks report this information. Physical and monetary information are both reported widely in annual performance reports, per guidelines developed by the Japan Ministry of Environment. The guidelines published by the MOE propose a format for external reporting that includes not only monetary information on "environmental conservation costs," but also information on the physical and monetary benefits of conservation efforts. As a follow-up effort to the MOE guidelines, a number of industry associations have published similar guidelines for their industry sectors, e.g., machinery, construction, gas, rubber, oil, food, chemical and railways.

Ricoh is a Japanese company that manufactures and provides services related to equipment such as office copy machines, other office information equipment and optical equipment. Ricoh uses the materials and energy tracking side of EMA for its corporate operations in an approach called an "Eco Balance." The financial side of EMA at Ricoh is called "environmental accounting," which is the term most commonly used in Japan. Ricoh uses the EMA information it gathers to plan activities in areas such as resource conservation and recycling, energy conservation and

pollution prevention. In addition, Ricoh is able to estimate the total costs and benefits of the company's environmental activities. In 2000, Ricoh estimates that it spent about US $66 million on environmental management activities, with resulting benefits to the company of US $79 million. Ricoh makes much of its EMA information publicly available by publishing the information in the company's annual environmental report, per the guidelines of the Japan Ministry of Environment.

1. *Environmental Accounting Guidelines* (Tokyo: Ministry of the Environment, 2002), http://www.env.go.jp/en/ssee/eag02.pdf.

2. http://www.ricoh.co.jp/ecology/e-/report/index.html.

APPENDIX A

Bibliography

Association of German Engineers. *VDI 3800 Determination of Costs for Industrial Environmental Protection Measures*. Berlin, 2001.

Bennett, M., and P. James, eds. *The Green Bottom Line, Environmental Accounting for Management.* Sheffield, UK: Greenleaf Publishing, 1999.

Bennett M., J. J. Bouma and T. Wolters, eds. *Environmental Management Accounting: Informational and Institutional Developments*. Selected papers from EMAN-Europe conferences, 1999 and 2000. Dordrecht, Netherlands: Kluwer Academic Publishers, 2002.

Bennett M., P. Rikhardsson and S. Schaltegger, eds. *Environmental Management Accounting: Purpose and Progress.* Selected papers from EMAN-Europe conference, 2002. Dordrecht, Netherlands: Kluwer Academic Publishers, 2003.

Bennett, M. Personal communication with Martin Bennett of the University of Gloucestershire Business School, 2004.

Burritt, R., and S. Schaltegger. "On the Interrelationship between Eco-Efficiency and Operational Budgeting." *Environmental Management and Health*, No. 2 (2001), pp. 158-174.

Burritt, R., T. Hahn and S. Schaltegger. "Towards a Comprehensive Framework for Environmental Management Accounting – Links Between Business Actors and Environmental Management Accounting Tools." *Australian Accounting Review* (July 2002).

Burritt, R., S. Schaltegger, K. Kokubu and M. Wagner. "Cultural Traits and Environmental Management Accounting for Staff Appraisal. Evidence from Australia, Germany and Japan." In *Environmental Management Accounting: Cultural Aspects.* Edited by M. Bennett, P. Rikhardsson and S. Schaltegger. Dordrecht Netherlands: Kluwer Academic Publishers, 2003, pp. 151-188.

Deegan, C. *Environmental Management Accounting: An introduction and case studies for Australia.* Sydney: Institute of Chartered Accountants in Australia, 2003.

Envirowise. *Increase your profits with environmental management accounting*. Oxfordshire, UK, 2003.

Environment Canada. *Introductory Guide to Environmental Accounting: Environment and Decision-making: An Appropriate Accounting.* Ottawa, Ontario: Environment Canada, 1997.

European Commission

- *Commission Recommendation on the Recognition, Measurement and Disclosure of Environmental Issues in the Annual Accounts and Annual Reports of Companies.* Brussels, 2001.
- *Regulation on Environmental Management and Audit System*. Brussels, 2001.

Eurostat. *Definitions and Guidelines for Measurement and Reporting of Company Environmental Protection Expense.* Luxembourg, 2001.

Fichter, K. *Die EG-Oko-Audit-Verordnung: Mit Oko-Controlling zum zertifizierten Umwelt-management system.* Munich: Hanser, 1995.

Fichter, K., T. Loew and E. Seidel. *Betriebliche Umweltkostenrechung*. Berlin: Springer Verlag, 1997.

Fichter K., T. Loew, C. Redmann and M. Strobel. *Flusskostenmanagement, Kostensenkung und Öko-Effizienz durch eine Materialflußorientierung in der Kostenrechnung*. Wiesbaden, Germany: Hessisches Ministerium für Wirtschaft, Verkehr, und Landesentwicklung, 1999.

Global Reporting Initiative (GRI). *Sustainability Reporting Guidelines on Economic, Environmental and Social Performance*. Amsterdam, 2002; http://*www.globalreporting.org*.

Gray, R., J. Bebbington and D. Walters. *Accounting for the Environment*, 2nd ed. London: Sage Publications, 2001.

Institute for Management and Environment (IMU). *Case Study – Ciba Spezialitaetenchemie Pfersee GmbH)*. Augsburg, 2002.

International Federation of Accountants. *Management Accounting Concepts*. New York, 1998.

International Standardisation Organization (ISO)

- *Environmental Management – Environmental Management Systems – Specification*. Geneva, 1996.
- *Environmental Management – Environmental Performance Evaluation – Guidelines*. Geneva, 2000.

Japanese Ministry of the Environment. *Environmental Accounting Guidelines*. Tokyo, 2002; http://www.env.go.jp/en/ssee/eag02.pdf.

Jasch, C., and H. Schnitzer. *Umweltrechnungswesen – Wir, zeigen, wie sich Umweltschutz rechnet, Beispielsammlung zur Umweltkostenrechnung und Investitionsrechnung*. Vienna: Bundesministerium für Verkehr, Innovation und Technik and Bundesministerium für Land- und Forstwirtschaft, Umwelt, und Wasser, 2002.

Lea, D. *Briefing Paper on the RoHS Directive*. Herndon, Virginia: Celestica, Inc., 2004; http://www.nemi.org/projects/fis/RoHS.pdf.

Loew, T., K. Fichter, U. Müller, W. Schulz and M. Strobel. *Guide to Corporate Environmental Cost Management*. Translated from *Leitfaden Betriebliches Umweltkostenmanagement*. Berlin: Bundesumweltministerium Umweltbundesamt (German Environment Ministry), 2003.

Loew, T., K. Fichter, U. Müller, S. Werner and M. Strobel, M. "Ansätze der Umweltkostenrechnung im Vergleich." In *Vergleichende Beurteilung von Ansätzen der Umweltkostenrechnung auf ihre Eignung für die betriebliche Praxis und ihren Beitrag für eine ökologische Unternehmensführung*. Berlin: UBA-Texte 78-03, 2003.

Osborn, D.

- "Showcasing Environmental Management Accounting in Local Government: contexts, methods, and summary results." Hawker, Australia: Green Measures, 2001; http://www.greenmeasures.com.au/publicationsmiddle .html.
- "Showcasing Environmental Management Accounting in Local Government, Working Draft of 31/05/01." Hawker, Australia: Green Measures, 2001.

- "How Environmental Management Accounting Supports the "Good Government, Better Living" Vision of the Eurobodella Shire Council, New South Wales." Hawker, Australia: Green Measures, 2001; http://www.greenmeasures.com.au/pdf.surf.pdf.

Parker, L. D. "Environmental Costing: A Path to Implementation." *Australian Accounting* (November 2000).

Scavone, G. Personal communication with Graciela Scavone of Buenos Aires University, Argentina, 2004.

Schaltegger, S., and A. Sturm. **"**Ökologische Rationaltiät. **"** *WWZ- News*, Nr. 7 (1990), pp. 14-18.

Schaltegger, S., K. Müller and H. Hinrichsen. *Corporate Environmental Accounting*. Chichester, UK: John Wiley & Sons, 1996.

Schaltegger, S., and R. Burritt. "Environmental Management Accounting and the Opportunity Cost of Neglecting Environmental Protection." In *Environmental Management Accounting: Informational and Institutional Developments*. Edited by M. Bennett, J. Bouma and T. Wolters. Dordrecht, Netherlands: Kluwer, 2001. pp. 265-277.

Schaltegger, S., and R. Burritt. *Contemporary Environmental Accounting: Issues, Concepts and Practices.* Sheffield, UK: Greenleaf Publishing, 2000.

Society of Management Accountants of Canada. *Tools and Techniques of Environmental Accounting for Business Decisions.* Hamilton, Ontario, 1996.

Strobel, M. *Flow Cost Accounting*. Augsburg, Germany: Institute for Management and Environment, 2001.

United Nations Conference on Trade and Development, Committee on International Standards of Accounting and Reporting

- *Accounting and Financial Reporting for Environmental Costs and Liabilities*. New York and Geneva: United Nations Publications, 2004.
- *A Manual for the Preparers and Users of Eco-Efficiency Indicators* (UNCTAD/ITE/IPC/2003/7). New York and Geneva: United Nations Publications, 2004.

United Nations Division for Sustainable Development

- *Environmental Management Accounting, Procedures and Principles.* New York and Geneva: United Nations Publications, 2001; *http://www.un.org/esa/sustdev/sdissues/technology/estema1.htm.*
- *Environmental Management Accounting: Policies and Linkages.* New York: United Nations Publications, 2002*; http://www.un.org/esa/sustdev/sdissues/technology/estema1.htm.*

United Nations (Statistical Division), European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development and World Bank. *Handbook of National Accounting: Integrated Environmental and Economic Accounting,* 2003.

US Department of Defense, National Defense Center for Environmental Excellence. *Environmental Cost Analysis Methodology ECAM Handbook.* Fairfax, Virginia: Concurrent Technologies Corporation, 1999.

United States Environmental Protection Agency. *An Introduction to Environmental Accounting as a Business Management Tool: Key Concepts and Terms.* Washington, 1995.

Votta, T., R. Broe, J. Kauffman and A. White. "Using Environmental Accounting to Green Supplier Contracts." *Pollution Prevention Review* (Spring 1998).

Wagner, B., and C. Redmann. Personal communication with Bernd Wagner of the University of Augsburg, Germany and Carsten Redmann of the Institute of Management and Environment (IMU), Augsburg, Germany, 2004.

World Business Council for Sustainable Development. *Measuring Eco-Efficiency: A Guide to Reporting Company Performance*. Genf, 2000.

White, A. L., M. Becker and D. E. Savage. "Environmentally Smart Accounting: Using total Cost Assessment to Advance Pollution Prevention." *Pollution Prevention Review* (Summer 1993).

White, A. L., A Dierks and D. E. Savage. *Environmental Accounting Principles for the Sustainable Enterprise.* Proceedings of the 1995 International Environmental Conference of the Technical Association of the Pulp and Paper Industry. Atlanta, 1995.

White, A. L., and D. E. Savage. "Budgeting for Environmental Projects: A Survey." *Management Accounting* (October 1995).

APPENDIX B

WHERE TO GO FOR MORE INFORMATION

The International Website on EMA

This website includes a section on EMA news and events, a searchable electronic library of EMA documents, and descriptive links to the organizations and websites listed below.

http://www.EMAwebsite.org

Asia-Pacific Centre for Environmental Accountability

http://www.accg.mq.edu.au/apcea/

Association of Chartered Certified Accountants (ACCA): Social & Environmental Accounting

http://www.accaglobal.com/publications/environment/

Canadian Institute of Chartered Accountants (CICA): Environmental Accounting Resources

http://www.cica.ca/index.cfm

The Centre for Social and Environmental Accounting Research (CSEAR)

http://www.gla.ac.uk/departments/accounting/csear

EMA Network (EMAN) Asia Pacific

http://www.eman-ap.net/

EMA Network (EMAN) Europe

http://www.eman-eu.net/

Environmental Management Accounting for South-East Asia

http://www.environmental-accounting.org

Environment Agency (England and Wales): Environmental Accounting

http://www.environment-agency.gov.uk/environmentalaccounting

Environmental Management Accounting Research and Information Center (EMARIC)

http://www.emawebsite.org/about_emaric.htm

The European Federation of Accountants (FEE): Sustainability Working Party

http://www.fee.be/issues/other.htm#Sustainability

German Technical Cooperation Association (GTZ): Environment-oriented Cost Management (EoCM)

http://www.gtz.de/p3u/english/EoCM.htm

Institute for Environmental Economics and Management (IOEW) Vienna

http://www.ioew.at/ioew/index-en.html [click on "projects" then "environmental accounting"]

Institute for Management & the Environment (IMU): Eco-Effizienz Project - Materials Flow Accounting

http://www.imu-augsburg.de/engl/index.php?seite=material_intelligence/mi_problemstellung.html **or** http://www.eco-effizienz.de/index_noflash.htm

Japan Ministry of the Environment (MOE): Environmental Accounting Guidelines

http://www.env.go.jp/en/ssee/eag02.pdf

Northeast Waste Management Official's Organization (NEWMOA): Environmental Management Accounting Topic Hub

http://www.newmoa.org/prevention/topichub/toc.cfm?hub=105&subsec=7&nav=7

United Nations Division of Sustainable Development (DSD/UNDESA): EMA Initiative

http://www.un.org/esa/sustdev/estema1.htm

United States Environmental Protection Agency (USEPA): Full-Cost Accounting (FCA)

http://www.epa.gov/epaoswer/non-hw/muncpl/fullcost/index.htm

University of Lueneburg, Germany: Centre for Sustainability Management, Contemporary Environmental Accounting

http://www.uni-lueneburg.de/csm