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Five Elements for Organizational Decision-Making with an Environmental Management System

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Environmental management systems (EMSs) are growing in popularity as tools to manage corporate environmental issues. Despite widespread use, existing frameworks for EMSs may not provide organizations with the knowledge needed for decision-making. Through a synthesis of case studies and workshops, we suggest five elements for EMSs to be expanded for organizational decision-making. The five elements are process diagrams, long- and short-term goals linked to strategy, reliable information systems, risk assessment tools, and collaboration of environmental personnel across the organization. These five elements provide decision makers with relevant information linked to business strategy so that the organization can improve performance. The elements can be integrated with an existing EMS or used as a foundation for implementing one.

Introduction

Environmental management systems (EMSs) are tools intended to help organizations meet environmental goals. The specifics of any EMS vary from facility to facility, but most EMSs include common elements. Typically, an EMS includes a cycle of planning, implementation, review, and improvement in addition to documented procedures and reports, training, and communication which help to meet regulatory compliance as well as to support continuity of the system. The basic components of an EMS include a mission statement, a documented environmental policy, goals, timelines, data collection and organization, information systems, identification of environmental issues, regulatory requirements, personnel responsibilities and task list, training and awareness, management review, an organizational decision process, audits, annual reports, security measures, and emergency plans (*1*−*4*). Although these are common elements, individual EMSs vary considerably in content, coverage, and operation. A variety of guidance documents have been developed to aid in the implementation of EMSs. These include guides for EMS implementation for small- to medium-sized organizations (*4*), state environmental Web sites (examples include Pennsylvania (*5*) and North Carolina (*6*)), the Web site run by ISO (*7*), and the U.S. Environmental Protection Agency (EPA) (*8*).

EMSs are proliferating in organizations throughout the world. Within the U.S. government, Executive Order 13148 mandated that government agencies implement an EMS by 2005. Court settlements between companies and the U.S. EPA often require EMS implementation (*9*). Standardized programs such as the European Community's Eco-Management and Audit Scheme (EMAS), the British Standard BS 7750, the International Organization for Standardization ISO 14001 Environmental Management Standard, and the EPA's National Environmental Performance Track (NEPT) are becoming increasingly common (*10*−*12*). As of July 2003, approximately 54000 certifications to the ISO EMS standard (ISO 14001) have been registered worldwide (*13*). Approximately 300 facilities in the U.S. are members of the EPA NEPT program (*14*). In addition to these formalized programs, many corporations have implemented their own EMS. EMSs have been adopted by organizations of varying sizes and sectors including large corporations, small- and medium-sized enterprises, and government agencies (*15*).

Companies adopt an EMS for a variety of reasons. Metcalf (*16*) found several aims for an EMS, including maintaining compliance with regulatory requirements, lowering environmental costs, training employees, developing environmental impact indicators, and improving environmental performance. Other research has found that EMSs are developed to enable implementation of specific technological changes (*17*), manage risks (*18*), gain competitive advantage (*19*), receive regulatory relief (*15*), or achieve environmental improvement at lower social costs and with more flexibility than traditional regulations (*20*, *21*). Other motivating factors for implementation of an EMS include the leadership of an environmentally conscious individual (*22*) and viewing environmental issues as opportunities (*19*). As an internationally recognized standard, certification to the ISO 14001 Environmental Management Systems Standard is often sought. Companies choose to become ISO 14001 certified to enhance company image (*23*), to provide a competitive advantage (*24*), to lower insurance costs (*25*), to build on experience with quality management systems (*26*−*27*), to receive international approval (*11*), and to meet demands of customers (e.g., Ford Motor Co. and General Motors Corp. are requiring first tier suppliers to become certified to ISO 14001 (*28*, *29*)). Surprisingly, improved environmental performance is often not the primary reason for adopting an EMS.

Factors to be considered in EMS implementation include both internal and external influences. Internal factors include human resource issues (*30*), management support (*15*, *30*−*32*), adaptability (*12*), training, incentives, information systems (*33*), design for the environment tools (*34*, *31*), experience with quality management (*11*), and methods for identifying aspects and impacts (*35*). External factors include the relationship between government and business (*36*, *10*), involvement of external stakeholders (*37*, *38*), verification by outside auditors (*39*, *40*), and the industry sector of the company (*36*). These factors, and interactions among the factors, influence the final design and extent of the EMS.

The proliferation of EMSs across industry sectors and the world has led to research on the outcomes of these programs. In a study of the U.S. electronics industry, preliminary results showed that early adopters of ISO 14001 experienced environmental improvements with decreases in toxic emissions (using TRI data normalized for toxicity) while late adopters experienced increases (*41*). Matthews (*3*) found little difference in the toxic emissions (using TRI data normalized by production) of U.S. automobile assembly facilities with ISO 14001 certification and those without certification, and, in many cases, firms with a certified EMS fared worse. A survey of facility personnel shows mixed results of the perceived value of various voluntary environmental programs, including ISO 14001, for financial, marketing, or

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TABLE 1. Five Elements for Environmental Management Systems To Aid Organizational Decision-Making

1. Process diagrams identifying material and energy inputs and outputs
2. Quantifiable goals for both short- and long-term performance consistent with the organization's strategic plan
3. Reliable methods of collecting and disseminating environmental data
4. Risk assessment tools for current and emerging environmental issues for operations and products
5. Collaboration and education of environmental personnel both within and outside the organization

environmental performance improvements (*39*). The implementation of an EMS may lead to the adoption of pollution prevention technologies (*43*) and to increases in the level of integration of environment into other business areas (*44*). These results suggest that existing frameworks for EMS may not be sufficient for organizations to realize improvements in environmental performance. As larger corporations consider enhancing or expanding their EMS to fully manage environmental impacts, they must consider whether certification to ISO 14001 becomes a sufficient characteristic for assessing their own environmental performance as well as the environmental performance of their suppliers.

This performance variation raises the following question: What components of an EMS would improve environmental performance? More generally, what makes a successful EMS? If companies are going to spend money on implementing a widespread, comprehensive system, then the system should provide some benefit for the operation of the firm. An *environmental* management system, like any management system, should support decision makers in evaluating and choosing projects which benefit the firm through reduced environmental liability or risk.

In this paper, we describe five essential elements of an EMS to aid environmental decision-making (Table 1). The five elements provide decision makers with key information on how environmental issues influence day-to-day and long-term operations of the firm. The five elements developed from current activities in EMSs of companies participating in two research efforts. First, a series of case studies examined the decision-making capability of a facility EMS (*45*). Interviews with corporate, management, and facility-level environmental, health, and safety (EHS) personnel revealed the accessibility and usefulness of existing EMSs. The case studies identified activities and components of EMSs that clearly benefitted the decision-making process. Second, a workshop on environmental management for multinational corporations attended by corporate-level environmental, health, and safety executives further highlighted the role for an EMS in decision-making (*46*). The scope of issues confronted on a daily basis in multinational firms requires a broad EMS that captures more than just regulatory requirements.

Firms need to contemplate the purpose of their EMS and evaluate whether its design allows the purpose to be fulfilled. If the goal is improved environmental performance, then the EMS must support decision makers' efforts to change operations for this performance to be achieved. Companies possessing derivatives of these five elements are convinced that they are cost-effective means of improving their environmental performance.

These EMS elements are not universal, even among ISO 14001 certified EMSs. Other than establishing goals and targets (element 2), these elements are not required for ISO 14001 certification, although at various levels a certified system may have these attributes. The five elements do not focus on regulatory issues or compliance. Most organizations (with or without an ISO certified EMS) have existing systems to address regulatory requirements. Instead, the elements center on the goal of the EMS to provide timely, relevant information for decision-making on environmental issues that may occur across the organization.

While most large corporations may have sophisticated, mature EMSs, some adaptation of the elements is likely to be useful for even large corporations. All five elements were not present in every company that participated in the research. Our case studies identified areas where companies lacking one of the elements could benefit from its implementation. Small- and medium-sized firms with new EMSs, as well as industry sectors with low EMS adoption rates, can best incorporate the elements into their EMS as they are developed.

Five Attributes of an EMS To Support Decision-Making

1. Process Diagrams Identifying Material and Energy Inputs and Outputs. For every process that operates in a facility, a process diagram is needed to show major production steps and their materials and energy inputs and outputs. Process diagrams are essential for specifying materials and energy consumption points and for identifying wastes and linking them to their source. Process diagrams define the boundaries of the EMS by pinpointing environmental issues of a facility. The companies participating in the research and workshop which had developed process diagrams had a clearer understanding across departments of what items the EMS must monitor.

Process diagrams can be as simple as hand-drawn flow diagrams or as sophisticated as architecturally rendered three-dimensional images (Figure 1). It is not necessary to place quantitative figures with the process diagram as an initial step, although it is desirable. The task of creating a process diagram need not be complex, yet should involve input from various personnel to capture viewpoints from across the organization on the sequence, magnitude, and linkages between processes and products.

The exercise of producing process diagrams should be enlightening to an organization. It may be surprising to see how the same process and its inputs and outputs can be depicted by personnel with different plant responsibilities. For example, one case study participant brought together production managers and EHS personnel from one division to complete the design of a process diagram for the initial production process in the organization. The group easily agreed on the steps of the process as well as the inputs. The process was well defined and had not changed in technology for several years. The inputs were materials and energy clearly identified as costs to the production team, and a main goal had always been to use them efficiently. The list consisted of approximately seven items.

The discussion of the outputs was much more contentious. Desirable outputs were easily identified as the main product and a byproduct with sellable value. Then the production personnel began to name waste products, wastewater discharges, and air emissions that were well-known pollutant outputs. These output streams had costs of operation associated with them as pollution control equipment had been installed over the years. The list continued to grow as the environmental personnel began to add to the list of undesirable outputs. They often targeted general categories, such as wastewater effluent, by pinpointing specific contaminants that were imbedded in the effluent, such as heavy metals and potential bioaccumulative chemicals. These materials were not considered by the production staff as they considered the wastewater treatment system to deal with any pollutants in the wastewater stream. The environ-

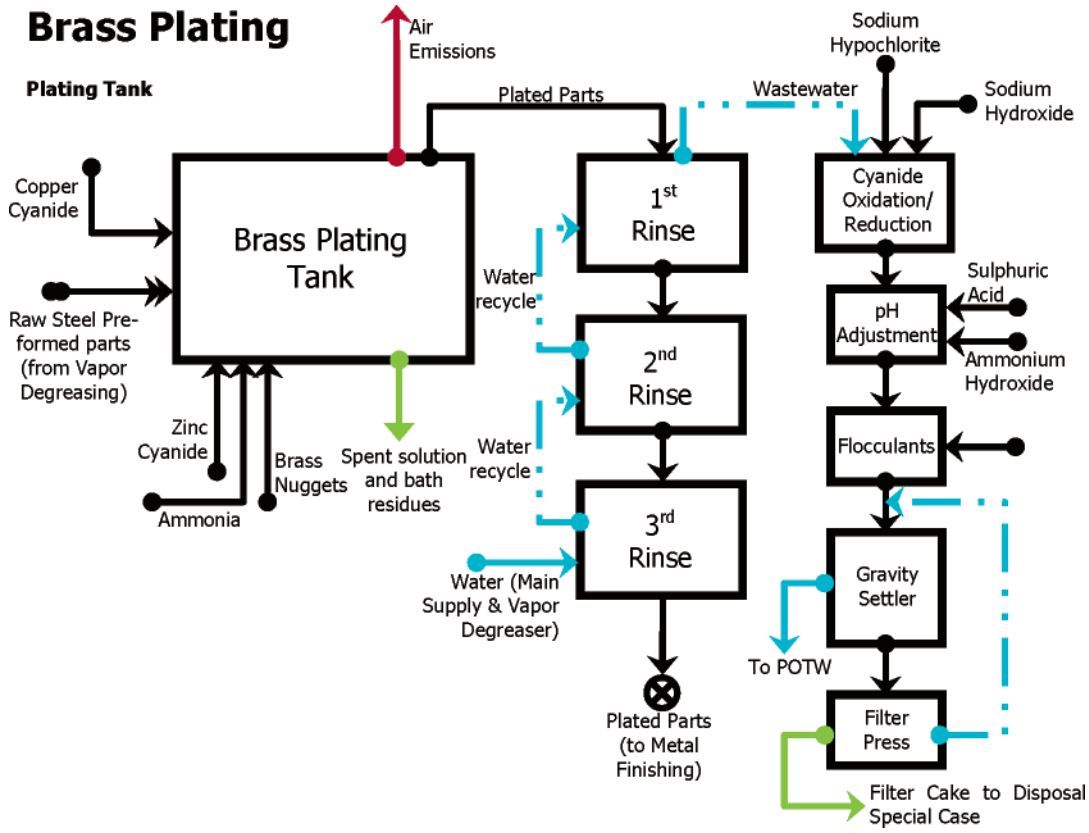

FIGURE 1. Example process diagram for a brass plating operation. Input and output mass flows could be added.

mental personnel further lengthened the list with items such as machine lubricating oils and cleaning wash waters, as well as treated waste streams that contained potentially reusable input materials. The final list included 4 times as many undesirable output flows as input flows. The list clearly identified the breadth of issues the environmental staff was required to monitor and began a further discussion of how to address these waste streams and their costs. The process diagram and list of inputs and outputs formed the basis of the EMS for this facility as well as other facilities in the organization with this same process. The results continue to be used as a tool for making decisions regarding capital expenditures, research areas, and assessment of future environmental concerns.

Process diagrams can be used in a variety of ways for decision-making within an EMS. Generally, process diagrams can be used to facilitate understanding of the complex processes and outcomes from a process within a facility. They can be used as a communication tool to ensure that EHS personnel understand the process while manufacturing personnel understand the environmental issues. Process diagrams, when combined with quantitative information about materials flows, allow mass balance calculations to verify the materials' disposition. Comparing process diagrams between facilities can generate discussion on solutions or similar difficulties. Process diagrams can also be useful for Design for the Environment evaluations and material selection for new or existing products. Finally, thorough process diagrams can identify potential future environmental problems beyond current regulatory requirements. As part of the environmental management system, process diagrams provide a foundation for identifying waste streams that should be addressed and points of energy consumption.

2. Quantifiable Goals for Both Short- and Long-Term Performance. Quantifiable goals of performance are the second essential component of an EMS. Goals target areas for improvement and link the environmental management systems in operation at production facilities to long-term corporate strategy. The process diagrams can be used to identify areas which should be targeted for improvement. Goals should establish long-term objectives with intermediate short-term milestones. Ambitious corporate goals and targets should be set to get the people closest to the problems working on solutions. Goals can focus the EMS to be used as a benchmarking tool (*42*). As the targets are defined, the goals provide a picture of the potential future limitations an organization may have on producing wastes and guide decisions to meet these levels. The companies investigated that had established long-term goals at the corporate level had EMSs within their facilities which were directly aimed at achieving these goals.

Goal setting may come from a strategy of cost setting. For example, one corporation in our case studies surveyed its production facilities around the world to identify what efforts would be needed to meet very low emission outputs for various pollutants. The responses included large expenditures on control equipment or major process changes, but also smaller capital expenses to fix recurring problems. The total cost was compared to the potential cost of fines for regulatory noncompliance over 20 years, and they were found to be similar. Thus, the ambitious goal to curtail emissions was established, with each facility setting milestones to reach the levels they had identified. The goals for long-term performance were then directly linked to activities within the EMS at each facility to meet the lofty targets. The consistency between EMS goals and corporate strategy to reduce emissions focuses efforts on improvement.

One problem often cited with establishing environmental goals is the broad spectrum of possible goals. With so many regulated pollutants and waste streams, and the potential impacts that vary on the basis of location (e.g., air pollution impacts are greater near urban areas where other factors contribute to poor air quality as well), coming to a consensus on which goals are the highest priority is difficult. In addition,

when risk of the impacts is not well understood, especially from low-volume but highly toxic materials, it may be difficult to agree to focus on a few particular risks.

One possibility is to set two to three goals which target understandable discharges where fluctuations indicate underlying problems in the production process. For example, high-level goals of minimizing total water effluent volumes (regardless of pollutant level) are easily quantifiable and understood. The benefit of reduced water discharge is understood: less effluent results in potentially lower costs for wastewater treatment, potentially lower costs of purchasing water if some can be reused, less chance of noncompliance pollutant levels, etc. At the same time, as progress toward the goal is achieved, other related operational burdens are addressed. For example, reducing wastewater discharges may preclude the need for expanded or upgraded water treatment facilities. Another suggested metric is the ratio of net product sold to total raw material purchased. The net product sold would exclude product that was left in stock, damaged, or otherwise unsold, to focus on the impact of management outside the manufacturing level. With goals firmly established as a priority, the environmental management system can monitor progress, identify processes which can be targeted for change, and share successful projects to meet the goal.

3. Reliable Methods for Collecting and Disseminating Environmental Data. A management system needs a reliable method of collecting and disseminating environmental data to be complete and effective. The companies in the research had a wide range of sophistication in their information management systems involving environmental data. However, the information which was reported regularly and consistently received the most action.

As a long-term goal, an EMS database would have several key characteristics. First, the database would be Web-based to facilitate use across multiple viewers and users of the information, as well as ease data collection. Second, data collection should be a task of personnel beyond the EHS staff. This may be achieved by linking the system to existing management systems (*47*). One example is staff in shipping and receiving who note incoming chemicals and hazardous waste shipments for accounting purposes when this information is also useful to the EMS. Third, the system should be consistent throughout the organization. This is essential for comparing data at an aggregated level or across facilities. Data elements must be defined clearly with units and measurement techniques specified. Multinational corporations must take care to ensure that information is consistent across national regulatory policy. For example, designations of hazardous waste vary between the U.S. and Europe. Fourth, the system should link to calendars and automated message delivery systems. With the trends of everyday office software applications, this is becoming easier and easier. Notifications can be sent to remind personnel of data entry requirements, regulatory report deadlines, or audits.

Many of the case study companies have existing information systems with environmental data. Christini (*45*) found that most common information systems include data for air emissions management, injury and illness incident statistics, nonconformance statistics, chemical inventory and management, EHS auditing, tracking notices of violation, and key performance indicators. Other than key performance indicators, the existing systems focus on regulatory needs. Due to time and resource constraints, especially available capital budget to purchase software applications with broad data capabilities, many information systems are individual files or spreadsheets that do not transfer data easily. EHS personnel at a facility may design a spreadsheet to suit their needs for data collection and retrieval. While effective for individual use, these spreadsheets do not provide long-term, consistent, available data through the EMS to be used for decision-making.

To expand the EMS for decision-making, these systems need to be expanded to include data to track the progress toward the EMS goals. Companies need to reassess the data available from the EMS and their information system to ensure that data are providing support and are available to decision makers when needed.

4. Risk Assessment of Current and Emerging Environmental Issues for Operations and Products. Incorporating risk assessment into environmental management systems allows an EMS to evolve and adapt to changing business strategy and regulatory requirements. Risk assessment is a key starting point for making decisions regarding production process changes or new product introduction. Assessing the risk in business terms (financial, marketing, etc.) should be accompanied by assessment of environmental risks as well. Very few of the companies participating in the research has risk assessment built into the EMS. Others struggled with how to determine and assess potential future risks. Both factors indicated the need for risk assessment within an EMS framework.

Risk assessment of existing environmental issues for operations and products can utilize the elements of the EMS. Having completed process diagrams and collecting data about operations, firms can assess the environmental risks of existing operations and products. The process diagrams indicate areas where materials purchases or environmental impacts pose potential problems. Data on quantities and concentrations identify potential risk levels. Results of risk assessment can be used to establish or reevaluate the goals of the EMS, generate internal commitment to improvement, and also communicate among personnel and communities.

Risk assessment of emerging environmental issues is more difficult, but nonetheless is an essential component of an environmental management system. Emerging environmental issues can shape the success (or failure) of new products or operations. Assessing these risks in the beginning stages of development, along with financial risks, market share expectation, and other standard business liabilities, allows the EMS to become a crucial part of organizational decision-making. Two examples of emerging environmental issues that companies should consider incorporating into an EMS's risk assessment component are evaluation of endocrine disruptors and carbon dioxide emissions. Neither issue has current regulatory requirements for U.S. firms, and thus may not be identified as an environmental issue in current EMSs. However, concerns in these areas are growing, especially on an international scale, and incorporating them into EMSs can greatly assist future decision makers.

An example of how to prioritize risks would be to develop a risk assessment tool. One company in the case study project developed a Web-based risk assessment tool to evaluate both current and emerging environmental issues. Each facility enters and assesses materials use, processes, and products within several categories. For each issue, EHS personnel determine the level of environmental impact, frequency of occurrence, permanence of environmental impact, legal mandates, business interruption potential, potential financial risks, potential reputation risks, and how much risk mitigation has already occurred. Personnel also estimate the abilitiy, cost, and time frame for implementing a means to mitigate the risk. Each of these categories is weighted, and then a total risk priority score is assigned. The tool plots the various issues on a chart of risk level versus feasibility of mitigating the risk (Figure 2).

Issues in the upper right corner (e.g., point A) have the highest risk, but are also the most difficult to remedy. This might represent the presence of a potential endocrine disruptor in a product for which no substitute is currently

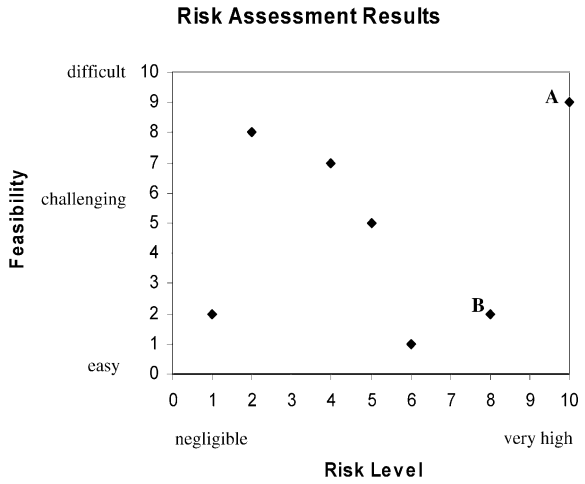

FIGURE 2. Example risk assessment plot.

available. Issues in the lower right corner (e.g., point B) have the highest risk, but are more feasible to change. This might represent a water effluent pollutant that could be removed by adding a new control technology to an existing wastewater treatment system at a large expense. The overall goal is to move issues toward the origin and reduce risk potential. In this example, the company did not necessarily remedy the "lower right" items first.

Decision makers use the risk assessment tool as a basis for developing business and environmental strategy. The risk assessment tool is used for completing audits, for setting goals, and for evaluating progress toward goals. For example, with frequent audits, personnel can assess whether a risk level has decreased even if the environmental impact has not been eliminated. One benefit of the tool is the ability for sensitivity analysis by varying the score given to a specific issue in different categories, or by adjusting the weighting factors for the categories. Decision makers can change either the characteristics of the environmental issue (i.e., greater frequency of occurrence or higher financial risk) or the weighting of the various characteristics toward the final risk score. The results of the sensitivity analysis highlight the change in position of the various issues and further assist decision makers in targeting specific issues of concern.

The tool can be specific to a facility or adapted to cover the entire firm. To encompass a wide range of risks, the firm must establish rubrics for measuring characteristics and weighting factors. These rubrics would provide consistency in how various issues are evaluated by personnel at different facilities, while still accounting for attributes specific to a facility (e.g., wastewater effluent to a public waterway would receive a higher risk than one to an on-site lagoon).

5. Collaboration and Education of Environmental Personnel Both within and outside the Organization. An EMS is often viewed as the responsibility of the environmental, health, and safety staff at a facility. At many facilities, this often means a small number of employees, perhaps only one. With the historical tensions between EHS and production and operations, EHS personnel can feel isolated. A key part of an EMS to be used for decision-making is overcoming this isolation and establishing collaboration. Each of the companies commented on the benefits gained from promoting interaction among EHS personnel.

A starting point is collaboration of environmental professionals within the organization. By bringing together staff from different facilities, common problems can be shared as well as proven solutions. This collaboration can begin with lines of distant communication, but should evolve into face-to-face contact. Several of the case study participants had programs to aid regular collaboration. For example, one firm performed internal audits with a team of auditors comprised of both EHS and non-EHS personnel from the audited facility as well as EHS and non-EHS personnel from other facilities. The process provided insight to not only the audit process and self-assessment, but also to the exchange of information about operations at the various facilities. A second firm holds an annual meeting of EHS staff across the organization to share experiences as well as learn about new initiatives and discuss potential future risks. The meeting includes EHS personnel with manufacturing oversight, facilities management responsibilities, and product design and development positions. The meeting helps to bridge the gaps found when each group normally operates in a vacuum. Interaction with external environmental professionals is also a means of collaboration. Industry groups that focus on environmental issues or environmental groups that focus on industry issues are available in some areas. Meetings and conferences again allow the exchange of experiences, problems, and solutions.

But how does this collaboration both inside and outside the company facilitate the environmental management system to be effective for decision-making? With the EHS staff, the key personnel involved with implementing and maintaining the EMS, keeping up-to-date on industry problems, potential future risks, and the work of their peers is essential. The collaborative atmosphere promotes a continual evaluation of the EMS itself. As the personnel learn about activities at other sites, the EMS at their own site benefits by becoming more comprehensive.

Integration with Existing EMSs

The five components—process diagrams, goals linked to strategy, information systems, risk assessment, and communication and collaboration—can form the basis of an EMS, or be integrated into existing EMS frameworks. These five elements complement the ISO 14001 environmental management system standard. Only one of the elements, establishing goals, is required under ISO 14001 (Section 4.2.3 Objectives and Targets). However, it is not specified for EMSs to have both short- and long-term goals, how aggressive these goals should be, or whether they are achieved. The other four elements are not necessarily part of ISO 14001, but can be integrated into existing systems. For example, developing process diagrams can be part of the environmental aspect and impacts evaluation. Risk assessment of future impacts can become a part of management review, or a procedure in and of itself. The various work practices and audits can become the source for data for the information management system. Collaboration among environmental professionals can be incorporated into the training or review processes. ISO 14001 certification is not the end-all solution for environmental issues, and an EMS should be broader than the ISO 14001 requirements.

For an organization without ISO 14001 certification, we feel these five elements are a basis for formalizing an EMS or a place for efforts to be specifically allocated. Organizations can begin by creating process diagrams to describe their inputs and outputs and focus efforts on the biggest problems. Next, short- and long-term goals can be established. Information systems to collect and analyze the data can be developed to capture the efforts toward meeting the goals. Regular assessment of risk concerns can become part of process changes or corporate strategy. Finally, firms can initiate opportunities for EHS personnel across the firm to meet and collaborate. As with ISO 14001, the elements are applicable to the range of industries and to the various sizes of organizations. The elements can be customized to focus on the most significant issues yet change as environmental concerns change.

The proper design of the EMS is essential for it to be useful. The design must encompass an organization's own

operation and culture to make it efficient and functional for decision makers. Still, in many organizations, EHS function must work to move from a tactical and operational function to become a strategic element in an organization. An EMS integrating these five elements can support this transition. Along with efforts to raise awareness of environmental issues and instill it in corporate culture, an EMS can contribute to EHS issues migrating to a stragetic factor in organizational decision-making.

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