Environmental Engineering Knowledge Library
Series editor: Dr. Domokos Endre

Volume XXVI

Environmental Management and Auditing
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Introduction

There is no single Environmental Management System (EMS) that could apply to all companies; however, this manual will identify techniques that may be adopted by any company. Requirements vary depending on the needs of the specific operations and on the business management system in place. The primary question company managements must consider is: What do we want our Environmental Management System to achieve?

- Reduced operation costs - greater efficiency.
- Ability to sell our products.
- Complying with governmental regulations.
- Response to community pressure.
- Avoiding environmental problems caused by new processes.
- Developing more broadly accepted new products.
- Preparing the company for investors’ offers or for joint-venture opportunities.
- Responding to customer demands.
- ISO 14000 certification.
- Cleaner environment for our children.

An Environmental Management System (EMS) will help to achieve each of these goals.

The individual parts of the EMS may be compared to “building blocks”. Each has a specific function and when they are used together they form a strong “structure” of a system. The size of the “structure” is determined by the number and size of the environmental problems that must be managed.

There are some common requirements for all Environmental Management Systems to be effective; however the scope of each of these requirements will vary depending on the actual needs. These basic requirements are described in the statements at the beginning of each chapter of this manual. The material under these general statements discusses some of the techniques that can be adapted to the specific needs of the company. If the company management adapts and implements the techniques appropriate for the company, the result will be an Environmental Management System that is adequate to meet company objectives.

There are five basic components in any Environmental Management System. These components have significant overlapping and a company may be working in several parts of the system at the same time. For constantly improved performance it is helpful to view these components as a continuous cycle of activities. The cycle is illustrated in Fig 1 and is further defined in Fig. 2.
Initially, the cycle starts by the MANAGEMENT REVIEW to assess the environmental status of the company. To make this review, Management must appoint an Environmental Leader to help in assembling the information. Based on this knowledge of the status of the company a vision can be developed and documented in a written POLICY, which is the commitment of Management to seek improvement. Management will adjust this vision as the company status is continually reviewed.

The next part of the cycle is PLANNING which includes the continual identification and prioritizing of Environmental Issues, inventorying of applicable Laws and
Regulations, establishing Environmental Goals and Targets, and development of Environmental Programs for improvement.

The fourth part of the cycle is IMPLEMENTATION AND OPERATION consisting of: Organization assignments, Training for improved awareness and competence, continual Communication with impacted internal and external groups, Documentation of pertinent information, Operational Control of all processes and Emergency Preparedness and appropriate Response for environmental incidents.

The fifth part of the cycle is CHECKING AND CORRECTIVE ACTION including Monitoring and Measuring of all environmentally significant process variables, establishing procedures for taking Corrective and Preventive Action, maintaining pertinent Records, and Auditing the effectiveness of the management system elements.

The cycle repeats itself by returning to MANAGEMENT REVIEW to routinely assess the Environmental Management System and to make necessary changes.

The application of the techniques in this manual will assist any company to develop the continuous cycle of activity consistent with its needs.
1. The Impact of Environmental Status on Business

With an understanding of the company’s Environmental Status, Management can define objectives for improvement.

The task of environmental management depends on the status of the company. If the company uses many hazardous materials, has a history of contamination, is located in a highly regulated community and/or has products considered hazardous by the public; the environmental management system will be broad and demanding. If the company is small with few hazardous materials, is located in a community with few environmental regulations, has minimal opportunity for contamination and/or has products considered non-hazardous by the public; the environmental system will be limited and easily integrated into the responsibilities of the production management. Some elements of an Environmental Management System must be adopted by all companies.

Establishing an Environmental Management System

The first step in establishing an Environmental Management System is to define the company's present status, its future and its total needs. Some questions to be answered at this stage:

Location:

- Where are all of the facilities of the company located? Which state and city laws impact the company?

Every government has laws regulating environmental issues within its jurisdiction. (The impact of the changes is illustrated in Fig. 3.). It is important to have a thorough understanding of the laws impacting the facilities and products of the company. It is also important to have an awareness of future regulations that will impact future business.

Figure 3: Components of change
**Processes:**

- What processes are adopted at each facility? What raw materials are used? Certain industries and/or processes are regulated by specific laws. The environmental impact will vary greatly depending on the processes. It is important to consider all processes in a thorough analysis. All materials used at a site must be considered. Many materials which perform secondary roles in the operations can impact environmental performance (see Fig. 4).

**Figure 4: Brewery processes**

**Wastes:**

- What are the waste streams originating from the facility? Are there controls on these streams? Has an analysis been made of the components of the streams? The majority of the environmental problems are the result of improperly controlled chemicals and wastes from factory processes. Increasingly in many countries the ultimate responsibility for contamination tends to be ascribed to the generating company with no regard to where or how the waste was disposed or treated. Consideration of waste disposal usually is a secondary concern; however, a company can be significantly impacted financially by improper disposal of waste or groundwater contamination. This problem has such great environmental potential that it is one of the most universally regulated areas of industrial activity. It is an area which has the greatest potential for cost savings Fig. 5.
Products:

- What are the products (or services) of the company? Who are the principal consumers? Where are the markets for these products? What are the hazards of the
handling, use and disposal of the product on the environment?

**Figure 6: Factors influencing the environmental decisions**

**Figure 7: Aspects influencing the environmental decisions**
For many years it was common business philosophy that the producer of a product was not responsible for the use or disposal of a product after it had been received by the purchaser. The world community no longer accepts this view. Producers of toxic materials have to share responsibility for controlling environmental exposure. Right-to-know regulations in many countries make the disclosure of the composition and safety information of chemical products mandatory. It is now common practice for suppliers to ensure that the purchaser is knowledgeable about the hazards of use; often the supplier will audit facilities to ensure that the user is equipped to handle toxic materials.

If products are to be sold in foreign markets, they must meet the specific state regulations, which may require the listing or registration of the ingredients of the product. Each country may have unique restrictions on specific chemicals. Although the producing company may not be responsible for acquiring such listing, sales can be affected if the user cannot use the material without such listing. (Some of the factors affecting environmental decisions are listed in Figs. 6, 7.)

Community:

- What is the nature of the communities in which the factories are located? Are there neighbors in the close proximity of the factories? Are there environmentally sensitive areas e.g. rivers, forests, hospitals, schools etc. near the factories? Is there community pressure on environmental issues?

The location of factories, particularly those having toxic emissions, can impact their acceptance by the community. Company management must be sensitive to the views of factory neighborhoods and is responsible for protecting them from any harm which may result from the operations. The success and possibly the survival of the factory may depend on the perception of the community about the environmental safety of the operations. Often, perception is reality.

Awareness:

- What is the present status of environmental awareness in the organization? Do all employees whose work potentially affects elements of environmental performance understand their responsibilities? Are they trained? Are there adequate written procedures for environmental control? Does everyone know how to respond in an emergency?

An understanding of environmental issues by Management is inadequate unless everyone in the organization knows the role he/she has in the controlling of these issues. Written procedures must be available for every operation and employees must be trained to follow them. They must have an understanding of the impact of both normal operations and misoperation on the environment and know how to respond. It is important to include the handling of wastes, emissions and discharges as part of operations.
Storage

- What is the status of storage facilities? Are all hazardous materials appropriately contained? How are materials transferred to the processes? Is there adequate protection from spills, leaks and overfills?

Soil and groundwater contamination most often occurs as a result of inadequate storage facilities of chemicals including support materials such as fuels, lubricants, agricultural chemicals etc. Incidents occur so readily that it is essential to have provisions to contain spills and leaks. All tanks need secondary containment to prevent the chemical from reaching the soil. Since leaks most often occur at the point of intersection of the tank and transfer line, it is important to have protection for these lines as well. If possible, all tanks must be installed above ground in such a manner ensuring physical observation of leaks.

Transportation

- Has consideration been given to potential incidents in transporting raw materials or chemical products? Are there procedures for responding to accidents? Has consideration been given to container safety?

Transportation safety is a major concern for all chemicals. Even non-toxic materials can contaminate the environment and cause community concern. Producers, users and transporters must all be involved in avoiding and responding to transportation accidents.

Compliance

- What is the record of compliance with laws and regulations? What is the factory management’s attitude towards compliance? What are the objectives of company and factory management? Are they consistent?

Sometimes compliance is a short-term business decision; for example, it may be less costly to pay a fine rather than to remedy a situation for compliance. This can be a local decision which may not be consistent with the intent of company management. Top management must communicate the company standards to all facility managers and to all employees.

Standards may be dictated by customers e.g. some companies insist that their suppliers must comply with industrial standards such as those published by the International Organization for Standardization (ISO).

The second step is to develop a vision for future operation

After characterizing the status of the company, Management must define the future environmental position for the company. This vision will provide direction for the environmental programs. The best way to communicate a vision of the company's future is through a written document that will provide guidance to all employees. Since such a document will demand strict adherence, it is important that much thought be given to its development.
The position taken by Management on environmental improvement and environmental programs is the basis for the vision. (Some basic environmental aspects are illustrated in Fig. 8.) Is their intent to do only what they are forced to do at the present time? This may be the position taken by a failing business or one with a limited future; but it is not appropriate for any progressive company.

**Figure 8: Environmental aspects of the sustainable development**

A progressive company wants to resolve its physical and socio-economic environmental issues (Fig. 9.) and will move to a position of environmental improvement consistent with its financial and technical ability. This position suggests that environmental laws...
and regulations will be followed and problems will be identified and programmed for resolution before they become regulatory or community issues.

Figure 9: Environmental issues and scale

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<th>NO GOALS</th>
<th>IMPROVEMENT GOALS</th>
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The ultimate position is a vision of operations without waste, employee health damage or injury. Such a position requires the company to consider all impacts on the environment and strive for total control.

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<th>NO GOALS</th>
<th>IMPROVEMENT GOALS</th>
<th>THE GOAL IS ZERO</th>
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The positioning of the company will define the degree of commitment of resources and capital. Justification for the position must be based on the value of the commitment in the business environment. There is no obvious recommendation since the position will be determined by the specific facts for each business. Questions that might help are:

What is the future of the company? Is it growing? Is it profitable? Is it looking for venture capital opportunities? How is the company perceived by the community, government, customers, competitors etc.? (Fig. 10)
What is the status of environmental issues? What are the potential future issues? How soon will they impact operations? What is the appropriate action for the good of the community or society?

Once Management has determined the appropriate vision for the company’s future, they must commit to achieving it. Management must communicate the vision to the employees so they can assist in making improvements through their actions.

**SUMMARY**

A manager or study group designated by top company management has to assess the environmental status of the company. Based on this assessment, management will
develop a vision of the future environmental state for the company. Management's commitment to achieving this vision is demonstrated by communication to all employees and support of environmental programs (Fig. 11.).

Figure 11: Steps of the Environmental Management System
2. Environmental Problems

After the environmental problems pertaining to operations have been identified, programs to correct problems can be implemented.

Since programs will be different for each company, a careful selection will be needed to correct the greatest threat to the business.

Problems to identify and resolve first

Regulatory non-compliance

Problems must be identified quickly to avoid major impact on business. Regulatory compliance can be a problem, particularly when it is an enforcement issue with the authorities. Such problems might include air emissions or water discharges that exceed permit limits or the unauthorized disposal of solid or hazardous waste. There could be non-compliance record-keeping issues (usually these are readily resolved).

If processes are not in compliance with established permits or with regulations, corrective measures must be taken. Necessary process modifications often require an extended time period for implementation. It may be advisable to negotiate with the regulators for a mutually agreeable schedule. Permits, operating procedures, area checklists and job cycle analysis are management techniques to reduce non-compliance problems.

Chemical leaks - contaminated groundwater or soil

There are other problems which may require immediate action to avoid major problems. Such a problem might be the discovery of a chemical leak, particularly of a toxic material. Unless controlled, such an occurrence could result in major soil or groundwater contamination issues. Experience indicates that such incidents can be extremely costly and require years of clean-up to remedy the situation.

The environmental survey and evaluations of potential problems must go beyond the assessment of toxic raw materials. Other chemicals, such as non-toxic chemicals, process intermediates, wash water including floor and equipment wash residuals, lubricating and fuel oils, gasoline, electrical equipment oils, contaminated steam condensate can result in significant environmental impact.

Toxic air emissions

Emission of toxic materials, particularly carcinogens, must be located and controlled quickly. Community exposure to such emissions can focus the public and government attention on deficiencies of the company, requiring excessive management attention through crisis management.
Visible contamination

Perception is reality to the public and the news media. Dark emissions, lagoons, trash and waste piles, discolored discharges and even odors can lead to a perception that the factory is badly managed. Such issues need to be identified and controlled as soon as possible.

Waste and emissions inventory plan

Initially, one of the major tasks of the environmental teams will be to survey and identify waste streams generated by the manufacturing and support processes. To ensure a systematic approach to the survey and a continuing effort to update the information, the environmental staff/team should prepare a waste and emission inventory. Programs based on the inventory include: waste minimization, control systems and research/engineering project development.

Waste minimization

It has been discovered in industry that an excellent way to avoid environmental problems is to avoid the creation of waste streams. This can be achieved by an aggressive waste minimization program that involves identifying and reducing all wastes generated in the factories. Changes in workers attitude can result in quick and small projects for significant cost savings. Process changes can be made. By-product waste may be used in other processes. It has been proven that through these steps not only are the environmental problems reduced but significant cost savings can be achieved, too. The ultimate goal is to recycle or develop a beneficial use for all materials.

Controlling emissions and discharges

Often it is necessary to use process controls on air emissions and water discharges to avoid atmospheric or water stream contamination. Such controls may or may not be mandated by regulation. Management may be able to justify such controls to avoid potential long term liability, loss of community respect and impact of future regulation. Some control can be achieved by modifying operational procedure, for example by stop using evaporating solvents as a means of controlling viscosity as is the practice in some factories. Controls may require the installation of expensive processes such as thermal oxidation of air emissions or biological waste water treatment. It may be cheaper to reduce the emissions or discharges by a process change than treating them. The environmental team must consider all approaches and their impact on business.

Remediation problems

If the survey conducted by the environmental team shows that soil or groundwater has been contaminated by chemicals traced to the company processes, it may be necessary to undertake a remediation project. The scope of the activity will depend on many variables, for example the characteristics and toxicity of the chemical, the quantity of contamination, the description of the aquifers and the use of the water and/or soil, the
geographic scope of contamination and the geological characteristics, in addition to governmental and community concerns.

There is no quick resolution to soil or groundwater contamination problems. Even minor problems may require years of remediation activity. In most instances an effort is made to control the extent of contamination by controlling the spread. The highest priority must be assigned to contamination which has affected a functional drinking water supply. If the contamination cannot be controlled by the use of separation techniques it may be necessary to provide an alternate source of drinking water. In general, these remediation projects are negotiated with the governmental authorities since the impact goes beyond the company property.

Avoiding future remediation

To avoid the cost in money, time and other resources of remediation projects, justifiable efforts may be made to improve or replace storage or process facilities. All new facilities must be designed so as to minimize the potential for contamination. Although an effort must be made to minimize leak potential, provisions must be made to prevent leaks from seeping into the soil.

Liquid chemical tanks should be located above the soil with provisions to physically view leaks if they do occur. In addition secondary containment must be provided for each tank in the event of any rupture. Careful evaluation of all facilities must be made to identify the facilities that might create a problem if they should fail. For example, although tanks contain the greatest quantity of chemicals, experience shows that most leaks occur in the feed or exit lines attached to the tanks. Appropriate techniques must be used to control or eliminate leaks from these sources.

Waste disposal sites

Another major source of potential contamination that may require remediation is the site of waste disposal. Such sites may be within the property of the company or may be under the control of a contractor or government. It is essential that management understands how the waste is handled and treated. In many countries it is the responsibility of the original producer (generator) of the waste to ensure that it is properly treated and if the waste is sent off-site for disposal, the same party assumes liability for contamination resulting from mishandling. For example, many cases of soil contamination have been traced to container (drum) recycling operations and the company that had sent the drums there had to share in the cost of clean-up.

Liability laws vary among countries; they are also subject to change. Quite often remediation becomes the liability of the companies that have the resources. If government assumes the liability, it may be forced to levy high taxes to provide funding for remediation.
Energy conservation

Energy reduction is a cost saving program that also results in better protection of the environment through the reduction of SO\textsubscript{x}, NO\textsubscript{x}, CO and particulates. This program can be led by the company environmental leader but should be carried out by a special team because of the safety and technical knowledge needed when working with electricity, natural gas and/or high pressure steam.

Setting priorities

An in-depth evaluation of the existing environmental problems within the company and those that the company may face in the future will lead to a subjective prioritization of their importance. Many will require money and personnel resources for their resolution. They must compete with operations and business needs for these resources, therefore it is important to understand the business justification for any environmental project. It takes a smart management to appreciate the long term implications of an environmental program.

A method for listing the problems and assessing their relative importance is shown in Fig. 9. A detailed inventory and impact assessment can be developed by the teams as the environmental programs progress; but for many companies a simple table such as this will provide enough information to start the program.

SUMMARY

Every company has unique environmental needs. An evaluation of these needs will identify specific projects that are justified to achieve environmental improvement. This assessment will lead to a selection of the projects that must compete with other business needs.
3. Standards and Guidelines

Standards must be sent for existing and new products, processes and facilities to ensure their environmental compatibility.

Standards and operating procedures

To maintain consistency in environmental performance it is essential that standards of operation be developed and documented. Such standards are intended to define limits of operation, product development and construction of facilities, and must be consistent with the company’s environmental vision. They also define the techniques that will be used to manage environmental issues. An extension of these standards is formed by operating procedures.

Examples:

- A company has adopted a standard that includes a statement that all chemical storage tanks will have secondary containment.
  It has developed operating procedures that includes a requirement for sampling and analysis of all liquids collected in the secondary containment of the storage tank before releasing them to the sewer.

Standards

Standards are:

- absolute; deviations from standards must be avoided
- recognized by employees and the public as indicative of how the company is to be operated
- documentation of how facilities are designed and maintained. They may be developed to apply to any part of operation
- clear statements that can be followed with minimum interpretation
- considered as the normal operating condition. (Some courts may consider them legally binding and may rule against a company if a problem results from not adhering to standards.)

It is not always necessary for a company to develop its own standards for routine operations (or products). It may be adequate to accept the standards developed by an industrial trade association and/or by an international or national standards organization. Responsible care promoted by the Chemical Manufacturers Association or ISO 14000 developed by the International Standards Organization are two examples of such standards.

Operating procedures

Operating procedures are an extension of standards and are necessary to ensure consistency of operations and of product quality. Also, they are required for controlling the environmental issues of operations. Maintenance procedures are operating
procedures written for mechanics. It is important that these procedures are well documented and available to the workers. They are an essential reference for training workers and for auditing performance (Fig. 12.).

Figure 12: Possible outcomes of operation
Guidance documents

There are other documents that do not require rigorous adherence, but provide useful options to resolve problems. (A guidance is illustrated in Fig. 13). These documents are called Guidelines and BestPractices.

![Figure 13: ICC Business Charter](image)

**Examples:**

- A guideline might be that a system can be installed on storage tanks to avoid overfilling and spills to the secondary containment. In the Best Practice various options are detailed for the construction of secondary containment facilities and for the proper mounting of tanks to allow rapid detection of leaks.

### Guidelines

Guidelines can be used to provide direction on measures supporting the intent of the standards. They indicate what must be done without specific details on how it is to be done. The design engineer can provide a system that meets the objectives of the guideline (Fig. 14, 15, 16).

![Figure 14: Elements of a successful organization](image)
Another guidance document that can be very useful is a documentation of ‘best practices’. The ‘best practices’ document provides several options to solve a specific environmental problem. The user can choose the solution that suits his/her needs best or has the option of developing a comparable solution. Usually the ‘best practices’ document is the result of a technical survey of available solutions to a problem and often includes methods or equipment that have been implemented or used successfully at other locations.

There are several advantages to be gained by using the documentation of best practices:

_Advantages_

- Information can be easily communicated to all people.
The listing of several acceptable options prevents spending time and resources to find new solutions or repeat the development process of solutions already in use at other locations.

The description of the options conveys the kind of solution necessary to resolve the problem.

The documentation can provide references for specific expertise and even suggest vendors and materials.

The information obtained through this technique can be an excellent training tool for engineers and managers.

If the ‘best practices’ are well developed and Management is convinced that they represent some of the best information available on the subject covered, then it might be desirable to insist that all solutions to specific problems must come from them. Not following the ‘best practices’ options must be justified before being implemented. This mandate forces the organization to use proven techniques and avoids the costly practice of researching new solutions for routine problems. Personnel with new ideas may be encouraged to suggest new options for inclusion in the ‘best practice’ document.

SUMMARY

Standards and guidance documents are needed to provide detailed direction in support of the environmental policy. Written standards and operating procedures define the operational and product philosophy of a company and are not to be violated. Written guidelines and documentation of ‘best practices’ provide guidance options for the implementation of company policy.
4. Monitoring

Monitoring and documentation of all significant environmental parameters help to track improvement.

Progress in environmental improvement is monitored by measuring and recording important parameters. These are dependent upon the nature of the business and the significant environmental issues that have been identified. Some of the common elements to be monitored are:

Water discharge

Industrial waste water

Most industrial factories generate a waste water stream that is sent to natural water bodies such as rivers, creeks, lakes, seas etc. Sometimes the waste water is sent to community or industrial waste water treatment systems (such as sewers or public treatment works). It is likely that such discharges are controlled by governmental regulation, and monitoring is a legal obligation. Many industries generating contaminated water have their own treatment systems to control the quality of the discharge from the factory. Such systems are generally regulated by permits.

If waste is discharged to a community sewer system with a central waste treatment process, the factory management must understand the capability of the treatment process. Such systems are usually limited to biological treatment and do not treat certain inorganic factory discharges. Quite often people assume that such community systems will treat all waste materials, which is not true. An understanding of the complete waste water disposal cycle is essential.

Monitoring

Regardless of the regulations or lack of regulation, it is important for Management to know the nature of the wastes being discharged from the factory and have appropriate treatment procedures for control. The procedures must cover the quantity and analysis of these wastes; therefore, routine measurements must be made (or estimated) of flow rates and concentrations of the contaminants. The sophistication of the measuring tools will depend on the significance of these streams. If the discharge is low and the contaminants relatively non-toxic, flow rates might be estimated and analyses performed occasionally. If the discharge is a major part of the receiving waters and/or the contaminants are very toxic it is advisable (and probably required by law) that the flow rates are continuously measured and analysis are performed to characterize all contaminant streams being discharged. Often the 24 hour proportional samplers are used to obtain representative samples for analysis. The procedures will describe the type and frequency of such monitoring requirements and designate the appropriate workers to perform the job.

Even if the waste steams are treated within the factory before discharge, Management must understand which processes are contributing to the waste. Therefore, internal
streams should be monitored on a routine basis depending on the significance of the individual streams. Such monitoring is required if progress is to be made in controlling and minimizing these discharges. Supervision of the contributing areas of the factory must always have accurate data on the quantity and quality of their waste streams. Tabulation and charting of these parameters are effective tools for gaining an appreciation of the discharges and for evaluating progress in controlling and reducing them; particularly if area supervision is held accountable for the waste minimization program.

**Communication**

Experience has shown that display of such charts, for the information of all employees in the area where the generation of waste occurs, can be very effective in gaining their assistance in reducing the discharges. Because of their thorough knowledge of the process they can make recommendations for improvement and, perhaps more importantly, if they have understanding of the significance of reducing the waste they can control their operations better. Workers who have an awareness of wastewater streams and their sources are valuable members of the factory team for waste minimization.

**Air emissions**

Emission of contamination into the atmosphere is another major environmental problem that is common to most industrial companies. Such emissions may be the result of process wastes or residual gas streams from combustion operations (i.e. boilers, furnaces, etc.) These emissions are often controlled by regulation requiring routine monitoring depending on the quantity and concentration of contaminants. In some cases small entrained particulates can make these emissions visible and require monitoring of the density of the ‘smoke’. As with all environmental discharges, the toxicity of the contaminants is an important variable that determines the extent type of monitoring required.

Continuous monitoring of emissions to obtain complete characterization is often difficult to achieve; therefore, periodic sampling and/or calculations are used for monitoring. Regardless of the monitoring tools, quality and contaminant concentration must be tabulated and charted for evaluation. If treatment devices are used to reduce concentration, monitoring of emissions must be done both before and after treatment. An evaluation of this information will lead to an understanding and control of treatment efficiency. Written procedures describing the sampling and monitoring requirements can help workers and supervision to ensure that the task is accomplished.

If treatment devices are used to control the contaminant emissions it is very important to understand all the variables affecting efficiency. For example, the effectiveness of filters and adsorbing materials is impacted by the quantity and concentration of the gases and contaminants to which they are exposed. Monitoring the exit gases is essential to maintain adequate treatment.
As discussed above, calculations are often used to determine the gaseous emissions from the factory. This is necessary because many emissions occurring from operation have inadequate gas capture capability. For example, much of the air contamination comes from open tank evaporation or from process equipment leakage. Such emissions can only be estimated by the use of calculation based on a material balance of raw materials, products and by-products.

A complete understanding of the gaseous emissions from a factory is essential if significant environmental improvement is to be achieved. All employees in the areas contributing to emissions must be aware of the sources, quantities and concentrations of emissions. This continual awareness of routine emissions is the first step in controlling the waste. Any unusual emissions must be located and reported.

Maintenance workers can contribute significantly to reporting and correcting emissions from pumps and process lines when they are part of a factory team and aware of the environmental program. Maintenance procedures and records should be modified to encourage waste minimization and reporting (Figs. 17, 18.).

**Figure 17: Possible impacts of air emissions**
Solid waste

Just like the above discussed waste water discharge and the gaseous emissions, solid waste, too, can be classified as non-hazardous or hazardous. Unlike waste water and gases, both hazardous and non-hazardous wastes constitute an environmental problem. It is obvious that hazardous waste must be segregated and treated to avoid health impacts on society. Non-hazardous waste is a disposal problem because of the huge quantity that is routinely generated. Natural processes such as biological degradation in landfills are being taxed to their limit, i.e. there is not enough space available. Other disposal processes such as incineration are expensive and lead to other contamination problems. Because of these concerns, solid waste generation is an issue that requires immediate programs for minimization and control. Recycling of non-hazardous waste using both internal and external processes should be a top priority for factory waste minimization teams.

The volume of all hazardous and non-hazardous waste must be tracked routinely. Since area supervision is accountable for the generation of all waste from their processes, the volume should be monitored for each area. This monitoring must also include all wastes treated within the factory or within the company. Also, wastes sent out for recovery or recycling must be monitored.
Common waste paper and packaging waste must be tracked to facilitate programs initiated for their control, even if they are disposed in a community or governmental facility. There have been examples of factories that had to suspend operations for lack of a place for disposal of non-hazardous waste.

Tabulation and charting are especially effective for solid waste since all areas, even office areas, create such waste. A chart indicating the impact of control which is publicized to all employees can be very useful in developing awareness.

**Monitoring tools**

Abnormal waste generation (including emissions and wastewater discharge) is often the result of an inadequate control of the manufacturing process.

Instruments and procedures for monitoring and controlling various process and waste streams must be understood and well maintained. If workers do not understand the need for the instruments or the monitoring procedures it is likely that the data obtained from them will not be accurate. Regardless of the sophistication or lack of sophistication in the monitoring and controlling tools, workers must know why measurements are being taken and how the data will be used.

One must never assume that an instrument is working properly without some means of checking. All instruments must be calibrated and cleaned routinely. Readings must be made on a predetermined schedule and they should be appropriately recorded. Instrument maintenance must also be performed routinely on an appropriate schedule.

**Toxicity**

The toxicity level of all materials in the company must be determined and recorded. Such a determination is required for the appropriate classification of the waste streams. Toxicity is a function of the chemical characteristics and concentrations.

**Units of measurement**

Although most tabulation is done in the common units of volume and concentration, there may be additional benefits to charting in other terms. It may be desirable to use the cost of disposal or the value of the waste lost in production. It is also effective to tabulate and chart unusual incidents of discharge or injuries resulting from incidents. If the wastes are regulated, incidents of non-compliance and the number of fines can be plotted. Another type of assessment, tabulating the amount of waste generated per unit of product made can be very enlightening, especially to Management. Many companies have analyzed their efficiency of operation by charting the pounds of waste generated for each pound of product made - this can be a very large number if the waste generated by the manufacture of the raw materials is also considered. Some synthetic materials create 9-10 kg of waste for every kg of product. Since this waste represents materials that have been purchased, it helps Management in recognizing the value of waste minimization programs.
SUMMARY

All waste water, air emissions and solid wastes generated in a company must be measured and monitored. Only through this kind of routine evaluation can programs for improvement be effective. Process controls and instrumentation must be properly maintained for maximum production efficiency. The support and assistance of all employees can be solicited by routinely sharing this information with them. Area supervision of the areas in which the waste is generated must assume accountability for the reduction of the volume and/or toxicity of the waste. Several different terms of measurement can be used to gain a complex apprehension of the problem.
5. Auditing

Auditing process ensures compliance with objectives and Management must routinely review the progress and the adequacy of the environmental management system.

With a strong commitment of Management and the support of the entire organization, an effective environmental program can be initiated. To maintain the direction toward achieving environmental improvement it is necessary to have specific, quantifiable goals and a procedure to audit performance relative to those goals. Auditing is done at all levels within the organization, and the methods vary according to the objectives of the specific audit. In general there are several benefits to be derived from a good audit procedure:

Benefits of auditing

- Potentially serious problems are uncovered before incidents occur.
- The effectiveness of a program can be evaluated.
- Information on a program can be collected.
- The manager can use results to make necessary changes in the program.
- Information and technology can be exchanged.
- Participants become more knowledgeable and inspired.
- Observations benefitting other programs are made.

Participation

For maximum benefit, efforts should be made to get everyone to participate in the audit process. Participation in an audit team encourages the individual employee to be part of the program that is being audited. Experience has shown that the individuals obtaining the greatest benefit from an audit are the people who participate in the audit.

Types of audits

Depending on the objectives of the audit, there is a wide range of techniques or combination of techniques that may be used.

Records audit

The audit of records is commonly done to determine compliance with administrative procedures. Much like financial auditing, this type of audit is done in an office reviewing all pertinent documents to ensure that legal and company requirements are being met.

Process audit

This audit requires a review of a specific process; including an overview for understanding and observation of the process in operation. The observation skills of the participants are utilized to evaluate performance versus accepted standards and
procedures. Deviations from the procedures are noted down for reporting to the process manager for corrective action and/or explanation.

Participation of workers in this audit team can greatly improve their environmental awareness and effectiveness.

**Product audit**

A team of people with different work assignments, knowledgeable in the manufacture and use of a product reviews the procedures for making and using the product. The objective is to determine if they are consistent with the accepted product stewardship standards. Observation of both manufacturing processes and product use are helpful in performing this evaluation.

**Systems audit**

Systems developed and implemented to manage specific programs must be routinely evaluated to ensure that they are being followed and that they satisfy the intended need. Even the audit procedure itself requires a routine system audit (Fig. 19, 20.).

![Figure 19: Main concepts environmental audit](image-url)
Facility audit

Factory property and service utilities must be audited for environmental compliance on a routine schedule. Such an audit must also be performed at some contractor sites e.g. waste disposal operation sites.

Often the audit is a combination of several of these techniques depending on the purpose. Although the audit can be used as a management tool for many reasons, a few specific examples are:

Management REVIEW

When management makes a commitment to achieve environmental improvement through the implementation of the Environmental Management System, it needs a periodic review to determine if the goals are being achieved and to adjust its commitment if justified. Such a review is usually performed in a regularly scheduled environmental management meeting in which various members of the organization can report on progress being made relative to established goals. This is the most general type of company audits with a broad overall focus on all environmental activities including management systems. Emphasis is placed on program results and specific technical detail is avoided. Enough information must be provided to assist management in their decisions of resource commitment versus environmental improvement. Participants in this high level review usually include the top manager of the company and their staff including the company environmental manager. Reports can be made by other managers, as requested by the participants.
Factory audits

Factory audits may be formal or informal.

A formal audit follows a protocol which includes a list of questions concerning compliance with procedures and regulations as well as adherence to a management system. These audits may be performed at several levels in the organization dependent upon the size and complexity of the factory. An audit for a large factory may be similar to the management review for evaluation of overall environmental performance. However, the majority of the factory audits are conducted with participants representing several organizational levels. The intent is to evaluate the routine operational performance of the factory against both established procedures and company objectives. It is usually most effective if the audit is divided into process areas so that the auditors can concentrate on the details of the operation. The typical team may include: an environmental specialist, an area supervisor, a process engineer, a product chemist and workers. The audit will likely include elements of a process, product, and records audit.

Informal audits can be made by factory or area supervision with the assistance of workers using a checklist of items they consider important. Since the protocol is very flexible and the reporting is usually minimal, these audits should be made frequently - perhaps even daily.

Environmental systems audit

To determine if all the elements of the Environmental Management System are effective for their intended use, it is necessary to periodically evaluate them by auditing. Company management will continually evaluate effectiveness in the management review; however, better assessment is made by others not directly involved. This can be accomplished in several ways.

To evaluate the Environmental Management Systems for a factory, participants of an audit team can be delegated from other company locations. This provides the opportunity to assess performance versus the standards external to the factory. Such an audit might use environmental specialists from the company headquarters or contractors. Frequently the team audits the compliance of the factory with standards and regulations at the same time as it evaluates the Environmental Management System.

Cross - auditing

The technique of using audit team members who do not work in the area or factory being audited is an effective method of obtaining an unbiased report of compliance. Not only will observations be made of conditions overlooked by people overly familiar with the area or factory; but they may also share general experiences and solutions to problems.
ISO 14001 certification

To determine if the company standards are consistent with some industry standards, it may be desirable to seek certification from an organization such as ISO. Auditors from ISO will perform an audit based on the 14001 standards for environmental management systems. If the company obtains certification, management will know that their system is consistent with the industry standard.

Job cycle audit

An important technique for evaluation of job performance is the job cycle audit. The intent is to determine if the operators are performing their specific individual duties as detailed in the operating procedure. As a part of the audit the operator performs their normal operations while being observed by their supervisor who checks the actions versus the written procedure. Such audits have discovered many changes in job performance that probably resulted from ‘shortcuts’. While some of these modifications may be desirable, they must be evaluated before they can be accepted. Many supervisors have discovered that they did not know how the job was actually being performed; many assume that written procedures are followed.

Auditing is a formal way of determining what is being done and evaluating its effectiveness. Anyone with good observation skills, an inquiring mind, and knowledge of the operation can be a good auditor. For this reason, many operators are excellent auditors of their work areas. They are usually the most knowledgeable about processes and operations.

Observation

The ability to ‘look and see’ is as important to auditing as job knowledge. People who observe and ask questions are valuable for both factory and auditing teams. The critical skills are observation and awareness. The observation skill can be taught. All employees must learn to look for environmental problems and report them. This will make them valuable team members and more alert workers, too.

SUMMARY

Auditing is an important element of any program. In environmental management it is essential to determine the effectiveness of programs and to assess compliance with regulations and company standards. Auditing must be done by all levels of the company organization using techniques applicable to the specific needs. For some purposes it is effective to use external auditors in order to obtain an objective evaluation of factory or company programs. Observation is an important skill for auditors and for factory team members. Workers who ‘look and see’ and then report become valuable members of the environmental program.
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