Monitoring and Measurement

Background and Exhibits

An EMS without effective monitoring and measurement processes is like driving at night without the headlights on—you know that you are moving but you can't tell where you are going. Monitoring and measurement helps you to:

- Measure environmental performance;
- Analyze root causes of problems; and
- Assess compliance with legal requirements.

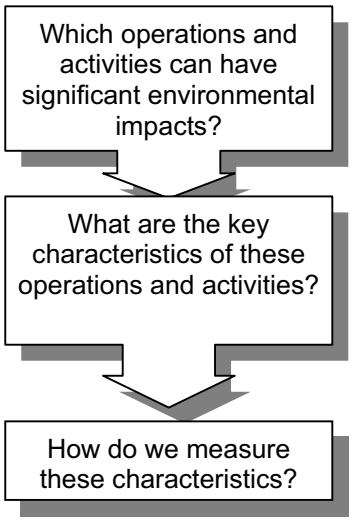
In short, monitoring and measurement helps you manage your organization better. The results of pollution prevention and other efforts are easier to demonstrate when current and reliable data are available. These data can help you demonstrate the value of the EMS to top management.

Your facility should develop means to:

- Monitor key characteristics of operations and activities that can have significant environmental impacts and/or compliance consequences;
- Track performance (including your progress in achieving objectives and targets);
- Calibrate and maintain monitoring equipment; and
- Periodically evaluate your compliance with applicable laws and regulations through internal audits.

Monitoring **Key Characteristics**

Consider adopting as a management tool the concept of the "vital few"—that is, choosing a limited number of factors can have a substantial impact on the outcome of a process. The key is to figure out what those factors are and how to measure them. Process mapping can help you determine those factors (see *Module 5* for examples).



There are several key performance indicators that can be examined to provide information about the facility's performance related to environmental management and operations.

Management performance indicators should provide information on the facility's capabilities and efforts in managing:

- Training;
- Resource allocation;
- Purchasing; and
- Funding.

Operational performance indicators should provide information on the environmental performance of the activity operations, such as:

- Inputs (quantity of materials processed vs. recycled, or energy or water used);
- Operation and maintenance;

- Emergency events and non-routing operations;
- Outputs (waste, emissions, noise, heat, light, etc.); and
- Service provided by activity.

To examine these indicators, you should track costs associated with environmental issues and environmental performance. Key indicators that show how management and operations are performing include:

- Safety (frequency of injuries, seriousness of injuries);
- Customer delivery (complaints, targets met);
- Production cost (tons, cost, yield, stock price);
- Sales and price;
- Environment (BOD index, TSS, NOVs);
- Human resources (Training days/employee, turnover rates); and
- Financial performance (EBIT, working capital).

Most effective environmental monitoring and measurement systems use a combination of process and outcome measures. **Outcome measures** look at results of a process or activity, such as the amount of waste generated or the number of spills that took place. **Process measures** look at "upstream" factors, such as the amount of paint used per unit of product or the number of employees trained on a topic. Select a combination of process and outcome measures that are right for your facility.

Tracking Performance

To have a successful EMS, it is important to determine program measurement criteria. Determining measurement criteria, also called performance indicators, will help you evaluate the success of your overall EMS program. Performance indicators measure overall success, while key characteristic indicators measure progress against EMS objectives for specific significant environmental aspects (SEAs). The following are examples of EMS results performance indicators for your EMS or various program components that can be tracked over time:

- Number of SEAs included in environmental projects plan;
- Number of environmental objectives and targets met;
- Pounds of hazardous waste generated per unit of production;
- Employee sick leave absences related to work environment;
- Percentage of employees completing environmental training;
- Average time for resolving corrective action;
- Energy or water use per unit of production;
- Percentage of solid waste recycled/reused;
- Number of complaints from community and/or number of responses to complaints;
- Number of pollution prevention ideas generated by employees;
- Resources used per unit of product or service;
- Pollution (by type) generated per unit of product or service;
- Percentage of products for which life cycle assessment has been conducted;
- Number of products that have a recycling program; and
- Number of instances of non-compliance.

It is the results shown by these environmental performance indicators that will become the basis for your plans for next year and for documenting continuous improvement.

The purpose of these indicators is different from the specific measurement criteria you developed for evaluating progress toward individual objectives. These performance indicators focus on how well the overall system for improving environmental management is functioning. Select performance indicators that will help you and your employees decide whether success has been achieved or whether improvement in procedures needs to be made. It is easier for management and staff to understand how things are going if they have benchmarks as guidelines.

You will need performance indicators that describe how well your environmental policy is being implemented. In addition, you will need performance indicators for all of the various components of your EMS. The measurement criteria selected for each component of your EMS will probably be different. For example, how will you measure the success of communication, documentation, stakeholder outreach, or training programs?

One approach is to measure the actions, for example, number of meetings held with stakeholders, number of documents created, number of employees trained, or number of hours of training. Action, however, does not always mean results. Consider the objective of each EMS component and define a way to measure results so that you will feel satisfied that the objectives are being achieved.

To measure results effectively, you methods should be:

- Simple;
- Flexible;
- Consistent;
- Ongoing;
- Produce reliable data; and
- Communicate results.

Measuring Improvement in **Pollution Prevention**

Measuring pollution prevention achievements is part of tracking performance, but may be different from, and often more difficult than, measuring environmental achievements in general. Simply measuring the reduction in a waste stream might mean only that the waste has been transferred to another medium, not reduced. It is therefore important to measure the reduction at the source of waste generation. It may also be important to measure the activities that your company directs towards pollution prevention. The following sources of information may help you track pollution prevention:

- Permit applications;
- TRI reports;
- Purchasing records;
- Utility bills;
- Hazardous waste manifests; and
- Material Safety Data Sheets.

In addition, administrative procedures can be established to support pollution prevention activities. Your facility should consider:

- Establishing procedures in each facility area for identifying pollution prevention opportunities;
- Having a chemical or raw material inventory system in place; and
- Assessing how many objectives have been met through pollution prevention.

Calibrating Equipment

A component of monitoring and measurement is equipment calibration. Your facility should identify process equipment and activities that affect your environmental performance. As a starting point, look at those key process characteristics you identified earlier. For monitoring and measurement you can measure the equipment itself (for example, measuring the paint flow rate through a flow gun to see if it is within the optimal range for transfer efficiency) or you can add measurement equipment to a process to help measure the key characteristic (for example, a thermometer on a plating bath to make sure that the temperature is within the optimal range for plating quality to reduce the need for replating, which causes significant waste through product rework).

Some facilities place critical monitoring equipment under a special calibration and preventive maintenance program. This can help to ensure accurate monitoring and make employees aware of which instruments are most critical for environmental monitoring purposes. Some facilities find it is more cost effective to subcontract calibration and maintenance of monitoring equipment than to perform these functions internally.

Getting **Started**

Monitoring and measuring can be a resource-intensive effort. One of the most important steps you can take is to clearly define your needs. While collecting meaningful information is clearly important, resist the urge to collect data "for data's sake."

Review the kinds of monitoring you do now for regulatory compliance and other purposes (such as quality or health and safety management). How well might this serve your EMS purposes? What additional monitoring or measuring might be needed?

Start with a relatively simple monitoring and measurement process, then build on it as you gain experience with your EMS. It's better to measure fewer items consistently than to measure many items inconsistently.

Here are some things to think about to expedite the determination of your facility's monitoring and measurement process:

- Put a procedure in place to systematically identify, correct, and prevent violations. You can customize ***Exhibit 17-3: Procedure for EMS and Regulatory Compliance Audits***, for this purpose. Determining your compliance status on a regular basis is very important. Effectiveness of the compliance assessment process should be considered during EMS management review. The EPA encourages "systematic discovery" of regulatory violations, which means detecting potential violations through environmental audits or compliance management systems that show due diligence in preventing, detecting, and correcting violations. EPA has prepared guidance documents and protocols for conducting environmental compliance audits under a number of its regulatory programs. For more information, visit the EPA Web site at **www.epa.gov/compliance/**.
- Consider what information you will need to determine whether the facility is implementing operational controls as intended.
- Measure progress on achieving objectives and targets on a regular basis and communicate the results of such measurement to top management. To measure progress in meeting objectives, select appropriate measurements of the key characteristics that apply to that objective.
- Select performance indicators to help you understand how well your EMS is working overall and that will provide top management with the information they need to make decisions about the EMS (see *Module 18*). Start by identifying a few performance indicators that are:
  - · Simple and understandable;
  - · Objective;
  - · Measurable; and
  - · Relevant to what your organization is trying to achieve (i.e., its objectives and targets).
- Make sure you can commit the necessary resources to track performance information over time. It is OK to start small and build over time as you gain experience in evaluating your performance. Keep in mind that no single measurement will tell your organization how it is doing in the environmental area.
- Put environmental information in a form that is relevant to employees' functions to increase the likelihood that they will act on the information. People respond best to information that is meaningful to "their world." Be sure to link your measurement program with your communications program and other elements of the EMS (such as management reviews).

Use your answers to the questions provided in ***Exhibit 14-1: Element Review Questions*** to begin the process of determining your facility's monitoring and management process. ***Exhibit 14-2: EMS Program Measurement Criteria Worksheet*** is a worksheet to help guide your facility to create a thorough and effective monitoring and measurement element for your EMS.

You can customize ***Exhibit 14-3: Procedure for Monitoring and Measurement (EP-009)*** to develop a procedure for your facility to monitor and measure significant environmental aspects associated with your operations and activities; to calibrate and maintain monitoring equipment; and to evaluate compliance with relevant environmental legal requirements. ***Exhibit 14-4: Compliance Tracking Log***, ***Exhibit 14-5: Pollution Prevention Tracking Log***, ***Exhibit 14-6: Calibration Log***, and ***Exhibit 14-7: Environmental Measurement Indicators Log*** are provided as examples of helpful tools that could be incorporated into the procedure. Also note that *Module 17* addresses regulatory compliance audits.

Exhibit 14-1: **Element Review Questions**

Questions	Your Answers
Have we **identified operations and activities** associated with significant environmental aspects, legal requirements, and environmental objectives? If, not how will this be accomplished?	
What type(s) of monitoring and measurement do we need to ensure that **operational controls** are being implemented correctly?	
What type(s) of monitoring and measurement do we need to ensure that we are **complying** with **applicable legal requirements**?	
What type(s) of monitoring and measurement do we need to ensure that we are **achieving** our **environmental objectives and targets**?	
How do we identify the **equipment** used for any of the monitoring or measurement listed above?	
How will we ensure that monitoring and measurement equipment is properly **calibrated and maintained**?	
What process do we have to periodically **evaluate compliance with legal requirements**? How effective is this process?	
Our next step on monitoring and measurement is to…	

Exhibit 14-2: **EMS Program Measurement Criteria Worksheet**

Facility Name:

Measurement Elements / EMS Component(s)	Objectives of Component	Activity Measures	Results Indicators	Review Period
Communication Plan				
Stakeholder Input				
Environmental or EMS Training				
Review of Aspects				
Operational Controls				
Environmental Review of New Processes and Activities				
Setting Objectives and Targets				
Environmental Management Program 1				
Environmental Management Program 2				
Documentation				
Regulatory Compliance				
Pollution Prevention				
Other				

Contact person for form: Date Completed:

Exhibit 14-3: **Procedure** for **Monitoring** and **Measurement** (EP-009)

1.0 Purpose/Scope

This procedure defines the mechanism for the monitoring and measurement of significant environmental aspects associated with **[Facility's Name]** operations and activities, the calibration and maintenance of monitoring equipment, and the evaluation of compliance with relevant environmental legal and policy requirements.

2.0 Activities Affected

All areas and departments

3.0 Forms Used

None

4.0 References

4.1 Procedure for Identification of Legal and Other Requirements (EP-001)

4.2 Procedure for Environmental Aspects, Objectives and Targets, and Programs (EP-003)

4.3 Procedure for Communication with Stakeholders (EP-004)

4.4 Procedure for Environmental Management System Management Review (EP-006)

4.5 Procedure for Emergency Preparedness and Response (EP-007)

4.6 Procedure for Environmental Training and Awareness (EP-008)

4.7 Procedure for Environmental Review for New Purchases, Processes, and Products (EP-010)

4.8 Procedure for Contractors and Sub-contractors (EP-016)

4.9 Procedure for Corrective and Preventive Action (EP-015)

4.10 Procedure for Environmental Management System and Regulatory Compliance Audits (EP-017)

4.11 ISO 14001:1996, Element 4.5.1

5.0 Definitions

None

6.0 Exclusions

None

7.0 Procedure

7.1 Monitoring and Measurement of Significant Aspects, Objectives and Targets, and Operational Controls

7.1.1 The monitoring and measurement of key characteristics and environmental performance associated with significant aspects will be specified in environmental management programs.

7.1.2 The monitoring and measurement of conformance to specified environmental objectives and targets will be accomplished through the internal system audit process and through the creation of Corrective Action Requests.

7.1.3 Operational controls will be monitored and measured as indicated in applicable environmental management programs, procedures, work practices, or visual aids. The methods, frequencies and responsible parties for completing the monitoring and measuring activities will be specified in these documents.

Exhibit 14-3: Procedure for Monitoring and Measurement (EP-009) (continued)

7.2 Calibration and Maintenance of Environmental Monitoring Equipment

7.2.1 Relevant areas and departments shall ensure that environmental monitoring equipment is calibrated and maintained at a frequency consistent with manufacturers' recommendations, or at least every year if those recommendations are unknown. Relevant areas and departments shall maintain calibration and maintenance records as necessary to prove conformance with this procedure.

7.2.2 Calibration and maintenance of environmental monitoring equipment shall be addressed in area and department preventative maintenance programs, where applicable, or in local work practices, if desired.

7.2.3 Each applicable area and department will maintain a list of EMS equipment requiring calibration and the corresponding calibration frequency.

7.3 Evaluation of Compliance

7.3.1 The evaluation of compliance with relevant environmental legal requirements shall be accomplished through the implementation of Procedures for Environmental Management System and Regulatory Compliance Audits (EP-017).

8.0 Frequency

Ongoing

9.0 Records

Records shall be retained consistent with the Procedure for Environmental Records (EP-005).

Record of Revisions

Revision Date	Description	Sections Affected

Exhibit 14-4: **Compliance Tracking Log**

Person Responsible	Regulation	Root Cause	Compliance Check Date	Results	Corrective Action/Date (see: TCA-01)	Compliance Verified/Date

Contact Person:

Date Completed:

Exhibit 14-5: **Pollution Prevention Tracking Log**

Area of Company	Pollution Prevention Activity	Date Started	Results	Measurement Method	Person Responsible

Contact Person:

Date Completed:

Exhibit 14-6: **Calibration Log**

Indicator	Measurement Method	Equipment Used	Equipment Calibrated: Date/Method

Contact Person:

Date Completed:

Exhibit 14-7: **Environmental Measurement Indicators Log**

Aspect	Objective	Indicator	Date Checked	Who Checked	Result	Corrective Action

Contact Person:

Date Completed:

Examples

An illustration of how monitoring and measurement is tied to the significant environmental aspects, objectives and targets, and operational controls of a shipbuilding facility's EMS is presented in ***Example 14-1: Example of Links Between Aspects, Objectives and Targets, Operational Controls, and Monitoring and Measurement***.

Example 14-2: Linking Operational Controls and Monitoring provides an illustration of how calibration needs are tied to SEAs, operational controls, key characteristics of the operation, and monitoring and measurement methods.

Example 14-1: **Example** of **Links Between Aspects, Objectives** and **Targets, Operational Controls,** and **Monitoring** and **Measurement**

Significant Aspect	Objective	Target	Operational Control	Monitoring and Measurement
Anti-corrosive paint X	C-Maintain compliance	Ongoing	• Coating and thinning NESHAP Environmental work instruction (EWI) • Paint application EWI • Bulk storage EWI and containment EWI	• Compliance audit • Regulatory reporting • EMS audits
Non-abated emission of VOCs	I-Reduce VOC emissions	10% by January 2002	• VOC - reduction EMP	• VOC volume reduction tracking metric • EMS audits
Solid waste from unmasking process	S-Investigate potential for reduction	Complete study by January 2002	• Solid waste reduction EMP	• Waste reduction tracking metric • EMS audits

Example 14-2: **Linking Operational Controls** and **Monitoring**

Operation with Significant Environmental Aspect	Operational Controls	Key Characteristics of Operation or Activity	Monitoring or Measurement Methods	Equipment Calibration Needs
Surface Coating Operation (SEA is VOC emissions)	• Approved list of coatings	• Type of coating	• Compare to approved list	• None
	• Coating EWI	• Rate of application	• Measure quantity applied	• Flow meter
		• Frequency of application	• Use coating log book	• None
	• Permit report EWI	• Emissions of VOCs	• Calculate based on use	• Flow meter
Liquid Waste Storage (SEA is potential for spills)	• Generator EWI	• Use of proper containers	• Inspections of storage area	• None
		• Segregation of incompatibles	• Inspections of storage area	• None
	• Storage area EWI	• Availability of spill equipment	• Inspections of storage area	• None