Environmental Compliance and Enforcement Capacity Building Resource Document

International Comparison of Source Self-Monitoring, Reporting, and Recordkeeping Requirements

April 1996

Submitted to:

U.S. Environmental Protection Agency
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EPA Contract 68-W2-0026
Work Assignments 39-II and 39-III
SAIC Project 01-0834-07-5144-100

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ACKNOWLEDGEMENTS

This document, *International Comparison of Source Self-Monitoring, Reporting, and Recordkeeping Requirements*, is one of six draft Environmental Compliance and Enforcement Capacity Building Technical Resource Documents that are being developed to support the Fourth International Conference on Environmental Compliance and Enforcement to be held in Chiang Mai, Thailand, April 22-26, 1996. These documents are being developed as resource documents to be used by government officials and others who have responsibility for developing and/or enhancing environmental compli-

ance and enforcement programs. The six Technical Resource Documents include:

- Organization of Environmental Enforcement Programs,

- Financing Environmental Enforcement Programs,

- International Comparison of Source Self-Monitoring, Reporting, and Recordkeeping Requirements,

- Multimedia Inspection Protocols

- Communications Strategies for Enforcement Programs, and

- Enforcement Issues Related to Transboundary Shipments of Hazardous Waste, CFCs, and Pesticides

Consistent with the goals of the Fourth Conference, its international sponsors, and the Executive Planning Committee to build capacity internationally for environmental compliance and enforcement, this document addresses source self-monitoring, reporting and recordkeeping as a cornerstone to compliance monitoring. Source self-monitoring constitutes those activities that are required to be undertaken by regulated entities to monitor and report on their environmental compliance. This document presents comparative information on how different countries use source self-monitoring requirements as a form of compliance monitoring within their environmental enforcement programs. The information presented can be used by government officials to help design or enhance their own environmental enforcement programs with the objective of achieving a higher level of compliance.

This document was developed with the support of Science Applications International Corporation under U.S. Environmental Protection Agency Contract 68-W2-0026, Work Assignment 39-II. Technical direction was provided by Ms. Cheryl Wasserman of U.S. EPA's Office of Enforcement and Compliance Assurance, in cooperation with the conference sponsors and Executive Planning Committee members, each of whom, along with their governments or organizations, must be recognized for their support in reviewing and commenting on the draft outline and early drafts of the document.

Finally, the document could not have been developed without the generous assistance of the following individuals who provided the detailed information on their country programs:

- Christopher Currie, Environment Canada,
- Dr. Manfred Putz, Germany,
- Robert Reiniger, Hungary National Authority for the Environment,
- Dr. B. Sengupta, India Central Pollution Control Board,
- Jo Gerardu and Robert Glaser, The Netherlands State Pollution Control Authority,
- Jens Erik Pettersen, Norway State Pollution Control Authority,
- Alun James, United Kingdom, Her Majesty's Inspectorate of Pollution, and
- Cheryl Wasserman, United States Environmental Protection Agency.

These individuals expended significant effort to gather information, complete tables, respond to questions, provide relevant reference materials, and review draft documents. Because the information they provided has been essential to the completion of this report, these individuals deserve special thanks for the time, effort and patience they committed to this project.

We seek your comments as to whether these documents serve their intended purpose and how they might be improved. We will finalize the documents following a four month international review process. Please send comments in writing:

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1 INTRODUCTION

1.1 SCOPE AND PURPOSE

Compliance monitoring is a fundamental component of an effective environmental compliance and enforcement program. Compliance monitoring allows the regulated community and the government to detect and correct violations, obtain evidence to support enforcement actions, and evaluate program progress.[1]

Beyond identifying compliance monitoring as fundamental to enforcement programs, participants at the Second International Conference on Environmental Enforcement (Budapest, Hungary, 1992) reached a consensus regarding the importance of source self-monitoring as a means of supplementing traditional compliance monitoring methods (for example, conducting inspections, relying on citizen complaints, or conducting monitoring of environmental conditions near regulated facilities). Source self-monitoring was recognized as an important form of compliance monitoring because it offers certain desirable attributes: increasing awareness within the regulated community, deterring noncompliance, facilitating data collection, promoting public access to compliance-related information, leveraging other compliance monitoring resources, and facilitating enforcement.

This document summarizes and contrasts how several different countries use source self-monitoring requirements to conduct compliance monitoring within their respective environmental enforcement programs. The purpose of this analysis is to share alternative approaches to source self-monitoring activities so conference participants and the growing network of governmental and non-governmental officials can use such information as they see fit to design or enhance their own environmental enforcement programs.

1.2 INFORMATION DEVELOPMENT

The information presented in this document was developed by requesting data regarding source self-monitoring, recordkeeping, and reporting requirements from the following countries:

- Canada,
- Germany,
- Hungary,
- India,
- Mexico,
- The Netherlands,
- Norway,
- United Kingdom, and
- United States.

These countries were selected based on several factors, including prior contact and access to preliminary information indicating that these countries have source self-monitoring requirements in place, as well as on each country's willingness to provide such information. Although a cross-section of developing, transitional, industrial, and rapidly industrializing countries was sought, the countries included are not deemed to be representative of all programs.

In some tables throughout the text, information has been included for other countries (for example, Japan, Israel) based on available references or unsolicited submissions of information from:

- Thailand (to be added).

Each country was requested to complete an information collection guide that asked for data regarding seven distinct aspects of their programs. These included: 1) self-monitoring requirements; 2) reporting requirements; 3) recordkeeping requirements; 4) data quality assurance; 5) data management; 6) data use; and 7) types of enforcement actions.
Exhibit 1-1 illustrates on a country-by-country basis those programs for which data were provided.

1.3 DOCUMENT ORGANIZATION

The information on the various countries is presented in Chapters 2 - 7. These Chapters are organized based on the key design issues that present themselves when designing or enhancing an enforcement program. These key design issues, and the corresponding Chapters of the document, are:

Chapter 2 *An overview of source self-monitoring*. What is source self-monitoring? What program objectives can it be used to achieve/How are data used? Through what legal mechanisms is self-monitoring imposed? At what level of government is self-monitoring implemented?

Chapter 3 *Who must conduct source self-monitoring?* What industries should be subject to source self-monitoring requirements? Should this include all of an industry or some subset?

Chapter 4 *What source self-monitoring activities are required?* What parameters must be monitored, at what frequency, using which method?

Chapter 5 *What information must be reported and what records must be maintained?* What information must be reported, in what format, at what frequency, and to whom? What information must be maintained and for how long?

Chapter 6 *What quality assurance and data validation procedures are implemented, and how are data managed?* What procedures are conducted to ensure the accuracy of the self-monitoring data (by both the regulated community and the regulatory agency)? How are data managed by the regulatory agency?

Chapter 7 *How is self-monitoring enforced?*

Within each Chapter, the factors and/or criteria typically used by countries in answering these design questions are discussed. Country-specific examples are then provided that illustrate how these factors have been utilized in the development of various countries' programs. Detailed country-specific information (for example, copies of reporting forms, listing of approved analytical methods) is included in the Appendices as reference materials.

2 OVERVIEW OF SOURCE SELF-MONITORING, REPORTING, AND RECORDKEEPING

2.1 INTRODUCTION

Source self-monitoring, reporting, and recordkeeping constitute one of four basic approaches to conducting compliance monitoring as part of an environmental enforcement program.[2] This section examines different program objectives that can be served by these activities, and the implications for designing or enhancing a program posed by these different objectives. It also provides background on the how source self-monitoring is implemented. For purposes of this document:

> Self-monitoring is any activity undertaken by a facility or entity to measure an emission, discharge, release, or performance parameter, or to observe operations, processes or activities with the purpose of identifying potential emissions, discharges, or releases.
> Recordkeeping is documentation or records required to be maintained by the regulated facility regarding its regulated activities or processes. Such documentation must generally be maintained for a defined period of time and must be available to the regulatory authority for review (for example, during inspections).
> Reporting is the submission of information or self-monitoring data periodically and/or upon the request of the enforcement authority.

2.2 PROGRAM OBJECTIVES OF SOURCE SELF-MONITORING, REPORTING, AND RECORDKEEPING

As a specific form of compliance monitoring, source self-monitoring may serve several distinct objectives within an environmental program. These objectives include:

> ***Enforcement*** - Source self-monitoring data can identify violations of environmental standards and provide the regulatory authority with data or other documentation of such violations. Thus, such monitoring data can serve as the basis for an enforcement action. Such monitoring may also provide information that serves as the basis for follow-up monitoring (that is, an inspection), which also may result in an enforcement action. In addition, information obtained through source self-monitoring can support the development of an enforcement strategy. This occurs when such information is used to help target enforcement resources at high priority problems.
>
> ***Increasing Awareness Within the Regulated Community*** - Source self-monitoring promotes environmental awareness within the regulated community. Such monitoring, reporting and

recordkeeping requirements compel the regulated community to become involved in the monitoring process. There are several natural consequences of such involvement. First, the regulated community becomes more knowledgeable about its environmental performance. Second, management personnel at regulated facilities increase their role in assuring environmental compliance. Finally, the increased awareness promotes the early detection of noncompliance, which allows a facility to quickly identify and remedy environmental problems.

Deterrence - Source self-monitoring activities deter violations of environmental standards because they ensure that violations are discovered and reported. Self-monitoring and reporting requirements combine to fulfill the first tenet of deterrence -- ensuring that a violation will be detected. In addition, because regulated facilities are involved in the monitoring process and are therefore more aware of their compliance status than they would otherwise be, they may be viewed as having greater responsibility for curing minor problems before they become significant. This also helps deter violations.

Data Collection - Source self-monitoring may be used to collect various types of environmental data. Such data may be very basic (for example, identification of the regulated community), in the realm of general information (for example, indicating general environmental performance/management activity), or compliance-specific (for example, indicating compliance or noncompliance with specific environmental standards). These different types of data may be compiled in data bases and have many potential uses, including targeting areas for regulation or enforcement, targeting specific chemicals or activities for regulation, characterizing the practices and processes used by the regulated community, and assessing general environmental. conditions.

Public Access - Source self-monitoring information also may be made publicly available either directly or through a regulatory agency. Such access promotes increased public scrutiny of environmental performance, which may come in the form of citizen enforcement suits (where authorized) or informal pressure on a facility to improve performance. Both promote improved environmental compliance.

Leveraging Compliance Monitoring Resources - Finally, source self-monitoring allows regulatory agencies to place a portion of the compliance monitoring burden on the regulated community. This subjects all regulated entities to compliance monitoring, which dramatically increases the impact of the compliance monitoring program compared to a program that relies solely on inspections.

In designing or enhancing an environmental compliance monitoring program, source self-monitoring may be used to promote one, some, or all of these objectives. As an example of how these objectives are pursued by the countries reviewed, **Exhibit 2-1** presents data on which programs use source self-monitoring to achieve specific objectives. Because the objectives of increasing awareness, deterrence, and leveraging resources are more general objectives that are achieved to some extent through all forms of source self-monitoring, these are not addressed in the Exhibit.

In addition to these objectives, countries may have to consider international standards when designing or enhancing a self-monitoring, reporting, and recordkeeping program. For example, several countries are now requiring facilities to be certified in ISO 14001 or other similar environmental management standards. Norway requires its facilities to have in place an internal control system to ensure that regulatory requirements are being complied with. These Internal Control Regulations, with guidelines, are contained in Appendix I. Likewise, several countries are developing similar standards with which facilities must comply. Usually, such standards or specifications have a component that addresses compliance tracking through require self-monitoring and reporting.

2.3DESIGN IMPLICATIONS OF PROGRAM OBJECTIVES

Different compliance monitoring program objectives require different capabilities in a source self-monitoring system. As a result, the structure of a source self-monitoring program is affected by the objectives sought to be achieved by the program. For example, a source self-monitoring program that is used to identify cases warranting enforcement action must identify violations of applicable standards in sufficient detail and be based upon sufficiently reliable data to support initiation of an enforcement action. In contrast, a program that uses source self-monitoring primarily to increase the awareness of the regulated community with regard to their environmental compliance status (and, perhaps, secondarily to deter environmental violations) may be broad in scope but requires less active data management by the regulatory agency. **Exhibit 2-2** summarizes the basic design implications presented by different source self-monitoring program objectives.

As indicated above, key aspects of a country's self-monitoring program, including its scope, the level of specific information required, the amount of documentation needed, the extent

Exhibit 2-2. Design Implications Presented by Different Self-Monitoring Program Objectives

Objectives	Desired Program Characteristic	Design Implications
Enforcement	Must identify violations	
Must document violations		
Data must be reliable	Should identify all violations, but need not provide data unrelated to violations	
Provide high degree of specificity in data		
Use specified methods for gathering and analyzing data		
Increase Awareness	Broad scope	
Require management involvement		Require monitoring of all significant program compo- nents
Require management certification of data/ reports		
Data need not be actively managed by regulatory agency		
Deterrence	Broad scope	
Must include basic elements for detecting violation		Require monitoring of all significant program compo- nents
Require reporting and/or recordkeeping as necessary to achieve to deterrence		
Data need not be actively managed by regulatory authority		
Data Collection	Data are useful, complete, and accurate	
Data easily usable	Base data needs on assessment of use	
Impose standard format to extent feasible		
Public Access	Data are useful, complete, and accurate	
Data easily usable	Base data needs on assessment of use	
Impose standard format to extent feasible		
Leverage Resources	Requirements address key areas	

System is self-implementing

Base program on priority concerns

Require self-monitoring and reporting of key data elements

and nature of reporting requirements, and the degree of active management of data necessary by the regulatory agency, are affected by the objective(s) of the source self-monitoring program. The key point is that program objectives drive the design of the source self-monitoring programs and, thus, such objectives must be clear when designing or enhancing a program.

2.4LEGAL MECHANISMS AND LEVEL OF IMPLEMENTATION OF SOURCE SELF-MONITORING REQUIREMENTS

2.4.1Legal Mechanisms for Implementing Source Self-Monitoring Requirements

Self-monitoring requirements may be imposed by various legal authorities or regulatory mechanisms, including national or local statutes, regulations, permits (or licenses, authorizations), or policies.

2.4.1.1Statutes

Generally, authority for self-monitoring is initially provided through statutory authority, either in an expressed self-monitoring requirement, or in a general expression of authority for information collection and/or reporting. Where self-monitoring is imposed through statute, the key design question involves determining whether and to what extent the statute should specify the nature of the self-monitoring requirements versus providing discretion for determining the nature of these requirements to the government agencies responsible for implementation.

Countries Using Statutes to Impose Self-monitoring Requirements

- Germany (air, water, drinking water, solid nonhazardous waste)
- Hungary (all programs except air and pesticides)
- The Netherlands (drinking water, chemical and toxic substances)

Providing general statutory authority takes advantage of the agency's expertise in knowing when self-monitoring will work and integrating self-monitoring with other, complementary program elements (for example, compilation, organization and use of self-monitoring data; follow-up compliance monitoring and enforcement actions).

Examples of a statutory requirement imposing self-monitoring and a general authorization for information collection are provided below:

…Such [hazardous waste generator] standards shall establish requirements respecting -- (6) submission of reports to the Administrator (or the State agency in any case in which such agency carries out a permit program pursuant to this subchapter) at least once every two years, setting out -- (A) the quantities and nature of hazardous waste … generated during the year; (B) the disposition of all hazardous waste…: (C) the efforts undertaken … to reduce the volume and toxicity of waste generated; and (D) the changes in volume and toxicity of waste actually achieved… (U.S.,

Resource Conservation and Recovery Act, 42 U.S.C. §6922(a)(6)).

(2) A State Board may give directions requiring any person who in its opinion is …discharging effluent or trade effluent into any such stream or well, to give such information as to the …discharge at such times and in such form as may be specified in the directions. (India, The Water (Prevention and Control of Pollution) Act, 1974, §20.(2)).

Directly mandating self-monitoring or reporting restricts the discretion that may be exercised by the implementing agency or department. Such a direct approach may make sense where a country wants to impose self-monitoring requirements but does not anticipate developing regulations to implement its environmental laws.

2.4.1.2Regulations

Countries Using Regulations to Impose Some Self-monitoring Requirements

- Germany (air, water, drinking water, solid nonhazardous waste)
- Hungary (pesticides)
- India (all programs except drinking water)
- Norway (hazardous waste, chemical or toxic substances)
- United States (all program areas)

Self-monitoring is often imposed through regulations, pursuant to a general grant of statutory authority. Regulations tailor the authority provided by statutes through the use of the expertise of the administrative agency or department (including its understanding of how all of the specific components of its environmental programs fit together) to achieve the desired policy objectives. One design issue presented by imposing self-monitoring through regulations is the how much flexibility to provide to implementing authorities. A second issue is determining when the burden (including the collective burden from all self-monitoring requirements) imposed on the regulated community is too great. Most of the environmental laws reviewed are not so prescriptive as to require self-monitoring. Rather, the administrative or regulatory level of government in each country has imposed self-monitoring requirements. Note that imposition of self-monitoring requirements through regulations may also involve applying such provisions through permits as well. Examples of regulatory language that impose self-monitoring are provided below:

6. (1) The operator shall submit to the Minister for each calendar quarter, not later than 30 days after the end of the quarter, a report in the form set out in (a) Schedule I, in respect of any release of vinyl chloride form a process vent; (b) Schedule II, in respect of any release of vinyl chloride from a polymerization reactor that is opened; (c) Schedule III, in respect of any release of vinyl chloride from all sources downstream of the slurry stripper or resin stripper; and (d) Schedule IV, in respect of any release of vinyl chloride from ... any source referred to in paragraphs (a) to (c). (Canada, Vinyl Chloride Release Regulations, 1992).

9. (1) The occupier generating hazardous waste and operator of a facility for collection, reception, treatment, transport, storage, and disposal of hazardous waste shall maintain records of such operations in Form 3. (2) The occupier and operator of a facility shall send annual returns to the State Pollution Control Board in Form 4. (India Hazardous Waste Rules, S.). 594(E), Ministry of Environment and Forests, 1989).

2.4.1.3Permits

Countries Using Permits to Impose Self-monitoring Requirements

- Germany (air, water, solid nonhazardous waste)
- Hungary (air)
- India (all programs except drinking water and pesticides)
- Mexico (air)
- The Netherlands (all program except drinking water and chemical or toxic substances)
- Norway (all programs except drinking water, pesticides, and chemical or toxic substances)
- United Kingdom (all programs except drinking water and chemical or toxic substances)
- United States (hazardous waste, water)

Permits, licenses, and authorizations consist of documents that specify the conditions under which regulated facilities operate. Because they are facility-specific, permits allow for self-monitoring requirements (that is, monitoring parameters, monitoring frequency, reporting frequency) to be tailored to the particular needs of the facility. Some advantages of imposing self-monitoring requirements through permits include the fact that there is no question of whether the requirements are applicable to a particular facility (that is, facilities have a difficult time arguing they were unaware of their own permit conditions), the specific requirements are clear and known to the facility, and the permit serves as an enforceable document. However, design issues include determining how specific such requirements should be and how much discretion should be delegated to permit writers. The more discretion provided to permit writers, the less consistent source self-monitoring requirements will be program-wide.

2.4.1.4Policies

Although self-monitoring requirements may be imposed through policy, this is rare. Rather it is much more common for policy to be used to specify or clarify how self-monitoring (for example, sampling, reporting) should be conducted. For example, India reports that it uses policy to implement self-monitoring requirements in its air and solid waste programs. Similarly, The Netherlands identifies policy as a mechanism for implementing some requirements in its air program. The United States also uses policy to impose self-monitoring, but such use is exclusively to clarify requirements imposed through permits or regulations.

2.4.2Level of Implementation of Source Self-Monitoring Requirements

Most countries distribute responsibility for the implementation and enforcement of source self-monitoring requirements among three levels of government -- National, regional/provincial/state, and local -- depending on the country's institutional and industrial structure as well as the environmental medium.

The level of government used to implement source self-monitoring requirements affects three design issues. First, whether a country imposes source self-monitoring requirements at a national, regional, or local level impacts the degree of uniformity of the data produced by such monitoring. Depending on the intended use of the data, this may affect its utility (for example, data addressing national hazardous waste management trends must use common terminology/definitions and units of measurement).

The second issue associated with the level at which source self-monitoring requirements are implemented pertains to the type of data collected. Regional and local implementation allow for more tailoring of source self-monitoring requirements. Such tailored requirements can support regional and local levels of government, but may not support national program needs.

The final issue involves resources available to implement a source self-monitoring program. The scope and significance of a source self-monitoring program must be matched with the availability of governmental resources to implement the program. **Exhibit 2-3** indicates the level of government at which source self-monitoring is implemented for countries and programs addressed.

3 SCOPE OF SOURCE SELF-MONITORING REQUIREMENTS

3.1 INTRODUCTION

The first issue presented in developing or enhancing an environmental compliance and enforcement program through the use of source self-monitoring is determining who should be required to conduct self-monitoring. This question involves determining:

- Which activities/entities should be subject to source self-monitoring requirements?
- Should all or some subset of certain categories of activities or an industry be subject to such requirements?

3.2 APPROACHES FOR SELECTING ACTIVITIES SUBJECT TO SOURCE SELF-MONITORING REQUIREMENTS

There are basically three approaches to determining which activities/entities should be subject to source self-monitoring requirements. These approaches include imposing source self-monitoring requirements on:

- All activities/entities within a new program area,
- Defined categories of activities/entities, and

- Activities/entities that generate specified pollutants.

The most basic approach to selecting those activities/entities subject to source self-monitoring requirements is to impose such requirements on all activities/entities within a new program area. Under this approach, all activities/entities subject to the program area of concern (for example, hazardous waste generators) would be subject to source self-monitoring requirements. This approach is simple, uses source self-monitoring to full advantage, and is fair. It also may be more protective of health, safety, and the environment since it does not exempt sub-categories of activities/entities from self-monitoring requirements. However, subjecting all entities within an environmental program to self-monitoring requirements may impose a significant burden on both the regulated community and the regulatory agency. Thus, it is important that this burden is commensurate with the purpose of such monitoring.

A second approach for defining the scope of source self-monitoring requirements is to impose such requirements on defined categories of activities/entities. Under this approach, only specified categories of facilities are subject to source self-monitoring requirements. Categories may be based on their propensity to pose high risks to health, safety, or the environment, or the fact that certain activities/entities, which might individually pose relatively low risks to society, are prevalent in a country or region. This approach offers the advantage of targeting source self-monitoring requirements based on risk. However, this approach requires the regulatory agency to develop a methodology to determine which categories should be subject to source self-monitoring.

The third approach to selecting those activities/entities subject to source self-monitoring requirements is to impose such requirements on those activities/entities that generate specified pollutants. Under this approach, any activity/entity generating, for example, sulfur dioxide, would be required to comply with specified source self-monitoring requirements. This approach directly addresses pollutants of concern and avoids some of the burden of having to target specific categories of activities/entities. However, targeting pollutants may capture some unintended activities and impose an unjustified monitoring/reporting burden upon such activities.

Each of the approaches identified above may be subject to specific exceptions that, in effect, modify the scope of the self-monitoring requirements. Two common exceptions include 1) activities conducted by small busses and 2) activities conducted by entities that do not meet specified process/production size criteria. Under some programs, small businesses[3] are excepted from having to comply with source self-monitoring requirements. Generally, this is done to reduce the regulatory burden on small businesses, which are often viewed as posing less risk to health, safety, and the environment, and generally have fewer resources available to meet regulatory responsibilities. In addition, because small businesses often represent a large number of entities within any given regulatory scheme, this exception reduces the administrative burden on the regulatory agency.

Some programs also exempt from self-monitoring requirements those entities that do not meet specified process/production size criteria. This exception is premised on the idea that smaller operations pose less risk to health, safety, and the environment than larger operations. This exception also reduces the administrative burden imposed on both the regulated community and responsible regulatory agency.

3.3EXAMPLES OF HOW COUNTRIES SELECT ACTIVITIES SUBJECT TO SOURCE SELF-MONITORING REQUIREMENTS

3.3.1 Imposing Source Self-Monitoring On All Activities/Entities

One program area where countries tend to impose source self-monitoring requirements on all entities subject to the program area is drinking water. In the drinking water program area, most countries impose self-monitoring, reporting, and recordkeeping requirements on community water systems. Generally, community water systems are the entities responsible for providing the public with safe drinking water. Because of the importance of this service, all such systems must monitor the levels of contaminants to prevent adverse effects on human health.

Another example of where source self-monitoring requirements are applied to all entities subject to program regulations is the under part of the U.S.'s hazardous waste program. Under this program, all hazardous waste generators that ship hazardous waste off-site for treatment must submit a biennial report to the U.S. EPA identifying where the waste was shipped, the transporter used, waste identification and quantity information, and other relevant information. This information enables U.S. EPA to create a data base capable of tracking significant hazardous waste transactions and trends in waste generation and management.

3.3.2 Imposing Source Self-Monitoring On Specified Categories

There are many examples of programs that impose source self-monitoring requirements on specified categories of activities/entities. This approach is common in programs that regulate air and water pollution because, often, the standards imposed under these programs are developed on an industry-by-industry basis. For example, under its air pollution program, The Netherlands establishes basic requirements that are generally applicable and also establishes additional specific requirements that are applicable to the categories of activities/entities listed in **Exhibit 3-1.**

Exhibit 3-1. Categories of Activities/Entities
Subject to Additional Source Self-Monitoring Regulation in The Netherlands

Specific standards are included for the following:

Manure processing plants
Sugar factories
Production of starch and starch derivatives
Wood processing
Coking plants
Asphalt mixing plants
Chlorine production
PVC production
Production of acrylonitrile
Production of plastics containing acrylonitrile
Claus plants (for sulphur production and use in gas cleaning)
Production of nitrogen-based fertilizer

Ammonia plants
Plants for production, formulation, or packaging of pesticides

Silicon carbide production
Coarse ceramics industry
Mineral fibre production
Pig iron production; iron ore sintering
Pig iron production; iron ore pelletizing
Pig iron production; blast furnaces
Oxygen steel production
Primary aluminum production
Thermal reclamation of metals from cables and similar plants
Iron and steel foundries and smelting plants
Surface treatment of metals with nitric acid
Production of carbon anodes
Pyrolysis plants
Plants for the thermal cleaning of contaminated soil

These categories are those that either have been identified as posing significant risk to health, safety, or the environment, and/or exist in significant numbers to warrant regulatory control. An example of where industries have been selected for monitoring based on their propensity to contribute to the country's pollution problem is Hungary. In Hungary, industrial emissions contribute approximately 40-45 percent of the country's air pollution. As a result, Hungary has targeted incinerators of commercial and communal waste under its category of stationary sources.[4] Both the United States air and water programs impose source self-monitoring requirements through regulations that address specific categories of industries (See, 40 CFR Part 60, and 40 CFR Part 401, et seq.) (See Appendices A-1, A-2).

Not all of the countries reviewed specify the categories of entities subject to source self-monitoring requirements on a program-by-program basis. The United Kingdom has recently revised their environmental programs to address a common set of activities/entities. The United Kingdom has chosen to control "pollution of the environment"[5] through Integrated Pollution Control of prescribed processes and substances.[6] The prescribed substances are divided into lists according to whether a substance is released into the air, water, or land. The prescribed processes have been identified as the most potentially polluting or technologically complex industrial processes throughout England and Wales. These prescribed processes are listed in **Exhibit 3-2.**

Exhibit 3-2. Prescribed Processes Under United Kingdom Integrated Pollution Control

Fuel and Power Industry
Combustion (> 50 MW) Boilers and Furnaces
Gasification
Carbonization
Combustion (remainder)
Petroleum

Waste Disposal Industry
Incineration
Chemical Recovery

Waste Derived Fuel

Mineral Industry
Cement
Asbestos
Fibre
Glass
Ceramic

Chemical Industry
Petrochemical
Organic
Chemical Pesticide
Pharmaceutical
Acid Manufacturing
Halogen
Chemical Fertilizer
Bulk Chemical Storage
Inorganic Chemical

Metal Industry
Iron and Steel
Smelting
Non-ferrous

Other Industry
Paper Manufacturing
Di-isocyanate
Tar and Bitumen
Uranium
Coating
Coating Manufacturing
Timber
Animal and Plant Treatment

3.3.3 Imposing Source Self-Monitoring Based on Specific Pollutants

Pollutants may also define which entities must conduct self-monitoring and keep up-to-date with reporting and recordkeeping requirements. For example, The Netherlands has set ambient-based standards for sulphur dioxide and particulates, nitrogen oxide, and carbon monoxide and smoke. Based on sources which emit these pollutants, approximately 350 plants fall under the requirements of The Netherlands' Air Pollution Act.[7] As discussed above, the United Kingdom's Integrated Pollution Control also uses pollutants, in concert with industrial process, as a second criterion for imposing environmental regulation, including self-monitoring requirements.

An example of this approach as implemented in the U.S. is the Toxic Release Inventory, required under the Emergency Planning and Community Right-to-Know Act (42 U.S.C. §11001-11050). Under this program, specified industrial facilities are required to report environmental releases of specified toxic chemicals.[8] These data are compiled in a national data base, known as the Toxic Release Inventory (TRI).

Finally, the chemical and toxic substance program area may be viewed as imposing source self-monitoring based on pollutants, since the monitoring and reporting requirements imposed under these programs are linked to specific chemical substances.

4 SELF-MONITORING REQUIREMENTS

4.1 GENERAL DESIGN FACTORS

General factors to consider when designing or enhancing a source self-monitoring program under any environmental program include:

> ***Parameters*** - After regulated processes, activities, or entities have been identified, typical parameters generated and the characteristics of those parameters are determined. Characteristics (that is, toxicity to human health and the environment) of the parameters in air emissions, wastewater discharges, or releases to land and whether there are national, regional, or local standards for the parameters must be considered when designing a self-monitoring program.
>
> ***Mass of Parameters Released*** - The potential impact of any release is related to the quantity as well as the toxicity of the parameter. Thus, in designing a self-monitoring program, the potential size of the release from the specific process or entity is often considered. This is why countries often have increased self-monitoring requirements for processes with a higher production or design capacity and consequently higher parameter releases.
>
> ***Monitoring Techniques*** - Available techniques for quantifying parameters in releases to the environment must be considered. The selection of monitoring techniques in a self-monitoring program may be affected by detection limits and suitability for particular sample matrices.

The application of these general factors in specific self-monitoring programs for air emissions, wastewater discharges, drinking water supplies, and releases to land are discussed in the following sections.

4.2 SELF-MONITORING REQUIREMENTS FOR AIR PROGRAMS

This section discusses parameters, monitoring techniques, and self-monitoring frequencies applicable in the design of self-monitoring requirements for air programs. This section also includes examples that illustrate how countries have used design factors presented in Section 4.1 in developing their specific air emissions self-monitoring programs.

4.2.1 Parameters

Parameters are generally regulated and included in self-monitoring programs because of their adverse effects on human health and the environment. Characteristics of typical air parameters and the rationale for their inclusion in air self-monitoring programs are described in **Exhibit 4-1.**

Exhibit 4-1. Air Parameter Characteristics and Rationale for Requiring Self-Monitoring

Sulfur Dioxide (SO_2) is a pungent, colorless gas that is formed primarily by the combustion of sulfur-containing fossil fuels. Compared to air, the gas is quite heavy. Sulfur dioxide is a major air pollutant that is unhealthy for plants, animals and humans, and is corrosive to structural materials. It is one of the two constituents in air that is responsible for the acid rain problem that exists in parts of the world (the other constituent being NO_x).

Carbon Monoxide (CO) is a colorless, odorless, very toxic gas produced by any process that involves the incomplete combustion of carbon-containing substances. Carbon monoxide is found in exhaust gases from both mobile and stationery sources that burn fossil fuels.

Nitrogen Oxides (NO_x) are gases formed primarily from atmospheric nitrogen and oxygen when combustion takes place at a high temperature and with an excess of oxygen [compared to the theoretical (stoichiometric) requirement for complete combustion of the fuel]. The nitrogen oxides composing NO_x are nitric oxide (NO) and nitrogen dioxide (NO_2). Nitric oxide is generally the predominant nitrogen oxide in combustion exhaust gas, but after discharge to the atmosphere, it is oxidized further to the more toxic and acidic nitrogen dioxide. Nitrogen dioxide contributes to acid rain and is responsible for the reddish brown color of polluted air. Upon photochemical reaction with certain volatile organic fumes, nitrogen dioxide forms oxidants that lead to dangerous levels of highly toxic ozone in the lower troposphere (where most flora and fauna exist).

Volatile Organic Compounds (VOCs) are those organic compounds that participate in atmospheric photochemical reactions that form ozone. If a monitoring technique for total organic compounds also measures nonreactive organic compounds, these nonreactive compounds may be excluded when determining compliance with a standard.

Metals: There are a considerable number of toxic metals that may occur as solid compounds, and thus as a portion of the particulate matter that may be emitted to the atmosphere. Only mercury is stable enough and has a sufficient vapor pressure to occur in elemental form as an air emission. Other metals occur primarily as oxides, carbonates, sulfates, or in combination with silicon or aluminum as silicates or alluminates.

Particulate Matter (PM) is any material, except water in uncombined form, that is airborne and exists as a liquid or solid at standard conditions of temperature and pressure. In some regulatory jurisdictions PM_{10}, which is that portion of PM loading in an air emission that is equal or less than ten microns in equivalent diameter, is the regulated parameter. PM having an equivalent diameter of more than ten microns (PM_{10}) is apt to fall to earth quickly and less likely to be drawn into the human respiratory system. PM_{10} is more likely to enter the respiratory system where any toxic components can enter the blood system relatively easily.

Opacity can be defined as the degree to which emissions reduce the transmission of light and obscure the view of an object in the background. Zero opacity represents 100 percent transmission of light, whereas 100 percent opacity represents zero transmission of light. In many jurisdictions, emissions of 20% opacity are the maximum permissible, but the allowable value may, in some circumstances be as low as 0-5%. Although somewhat related, the PM and opacity parameters are not identical. Intuitively one would suspect that the greater the PM value in a given air emission, the greater the opacity and this is qualitatively correct. However, the relationship is not necessarily linear or quantitative.

Hydrogen Chloride (HCl) in air emissions normally exists as an aqueous compound dissolved in water vapor. HCl may have acute health effects and can cause damage to structural materials.

Exhibit 4-2 presents the parameters monitored in selected countries' air self-monitoring programs.

4.2.2 Monitoring Techniques

Techniques for monitoring air emissions include: continuous emissions monitoring (CEM); periodic monitoring (that is, stack sampling, followed by chemical and/or physical analysis); surrogate monitoring; visual or olfactory monitoring and process material balances. Descriptions of these air monitoring techniques including advantages and disadvantages are presented in **Exhibit 4-3**. The specific monitoring technique used in a self-monitoring program will vary depending on certain factors such as parameters monitored, available technology, and the type of data needed (for example, accurate precise data to determine compliance or data to be used as early indication of a problem).

Exhibit 4-4 contains a summary of monitoring techniques commonly used for parameters typically monitored in air emissions. Additional information on each of the analytical methods is briefly discussed in the glossary. Although not discussed in this document, it is important to note that there are problems such as interference associated with some of the analytical techniques. Self-monitoring requirements established in regulations generally state that analyses must be performed using specified techniques (discussed in Section 6.1).

4.2.3 Monitoring Frequencies

In general, required self-monitoring frequencies are based on several factors including type and size of facility, type and concentration of emission parameters, and mass flow. Required self-monitoring frequencies are also affected by limitations of monitoring techniques. For

Exhibit 4-3. Monitoring Techniques for Air Emissions

Continuous emissions monitoring	Based on several different technologies, all incorporating three basic systems: sampling, monitoring or analyzing, and data acquisition and reporting/handling. Extractive (use of a sampling probe to remove and transport a gas sample to a remote analyzer) or in-situ (no remote analyzer, directly monitor and sample the gas within the stack or duct). Requires the largest up-front capital expenditures, possibly exceeding an outlay of several hundred thousand U.S. dollars. Eliminates hazards associated with manual stack sampling, provides accurate emissions data in real time, and if incorporated into the process central system, can improve and stabilize process control efficiency. Is only available for certain pollutants. Several countries explicitly name CEM as the monitoring technology of choice.
Periodic sampling (including stack sampling)	Most labor intensive, requires skilled technicians or engineers (sometimes working under onerous weather conditions on outside stack platforms). Sampling protocols are precisely described and must be adhered to; sampling equipment is also generally complex and must be precisely designed and operated. The proper capture and transport of samples to a laboratory is also strictly dictated by protocol. Problems that may be encountered include sample degeneration, adsorption onto the sample container, and sample contamination by the container. If properly carried out, probably the most accurate means for determination of PM and metals, and possibly also for VOCs in some processes during periods of operational stability.
Surrogate	Used to indicate relative performance and/or process variation, data not used to demonstrate compliance with a specific numeric emissions limit. For process, measurements of parameters such as feed rate or production rate, flow rate, pressure, temperature at thermal dryer outlet. For control devices, measurements of parameters such as afterburner combustion temperature, carbon adsorber stream flow and bed temperature, emission capture system flow rate and exhaust ventilation rate.
Visual or olfactory	Most basic form of monitoring and very inexpensive. Limited usefulness because of subjectivity. Good for early indication of problems of "nuisance" parameters of smoke and smell.
Process material balance	Relatively inexpensive means of assessing air emissions. Particularly useful for VOCs in certain printing or coating operations where VOCs may not be completely evaporated from the inks or coatings applied at the production unit. These VOCs may evaporate slowly and over extended periods of time during storage and shipping.

example, technology is available to conduct continuous monitoring of CO, SO_2, NO_x, and opacity but is not generally available to conduct continuous monitoring of all types of VOCs.

Exhibit 4-5 contains information on frequencies of self-monitoring in selected countries' air programs. Selected country examples illustrating how these design factors are used are provided.

The Netherlands. The Netherlands has a fairly sophisticated method for determining the type of self-monitoring required for air emissions. The Netherlands program is primarily based on two design factors: the type of parameter and the mass of parameter released. The Netherlands Emissions Regulations set out the following required forms of "inspection"[9]:

- No fixed inspection obligation,
- Regular inspection of the functioning of control devices,
- Separate monitoring of emission-relevant parameters at an appropriate frequency,
- Monitoring of emission-relevant parameters, and

•Continuous emissions monitoring.

The required inspection regime applied to each regulated source is determined by the ratio of mass flow (usually treated) permitted under the license to the "mass flow check level" for specific parameters set out in the regulations. As an example, a facility has been licensed for a total mass flow of 500 gram/hour of particulates and the mass-flow check level for particulates is 1000 grams/hour (Ratio = 500/1000 =.5). Using the guidance in **Exhibit 4-6**, this entity would be required to regularly inspect equipment functioning. Monitoring of emission-relevant parameters is required where equipment sensitive to malfunctions is involved. A summary of the mass-flow check levels in the Netherlands Emissions Regulations for various parameters is included in Appendix B-1.

Exhibit 4-6. The Netherlands Guidance for Type and Frequency of Air Monitoring

Inspection regime options	Ratio of permitted mass flow to mass flow check level	Range of inspection
0	..< 0.1	No fixed inspection obligation, or where equipment sensitive to malfunction is involved, regular inspection of equipment functioning.
1	0.1 < .. < 1	Regular inspection of equipment functioning, or where equipment sensitive to malfunction is involved, monitoring of emission relevant process parameters emission-relevant parameters.
2	1 < .. < 2	Monitoring of emission-relevant parameters, or separate monitoring with a frequency of at least once in three years, or in exceptional cases, regular inspection of equipment functioning may suffice.
3	2 < .. < 5	Monitoring of emission-relevant parameters, or separate monitoring with a frequency of at least once a year, or in the case of heavy fluctuations in emissions, where necessary, continuous measurement.
4	5 < ..	Monitoring of emission-relevant parameters, or continuous monitoring, or in exceptional cases, separate monitoring with a frequency of at least twice a year.

Germany. Germany's requirements for air emissions monitoring are found in the Administrative Regulation on Air Conservation and are shown in **Exhibit 4-7**. Germany's program is also based on the type of parameter and amount of parameter released. Continuous monitoring is required when levels for certain parameters (for example, SO_2, NO_x, CO) are exceeded. Regular (for example, daily monitoring) is required for carcinogenic and toxic substances (for example, benzene and cadmium) when particular levels are exceeded. In all other cases, monitoring is required when the plant starts operations and every three years. In addition, there are supplementary monitoring regulations for 13 heavy metals and nonmetallic elements and for random monitoring of dioxins and furans (not shown in **Exhibit 4-7**).

Exhibit 4-7. Germany's Administrative Regulation on Air Conservation

Emission standards for:

35 inorganic compounds; 150 organic compounds; and 23 carcinogenic compounds **Continuous monitoring if emission fluxes are exceeded for:**

- Dust
- SO_2, CO, HC, NOx, HF, C, Cl_2, H_2S

(for example, SO_2 flux > 50 kg/h) **Regular monitoring (for example, daily) for carcinogenic and highly toxic compounds, if fixed emission fluxes are exceeded** (for example, benzene >250 g/h) **Otherwise (every three years, 4-6 half hour averages)**

4.3 SELF-MONITORING REQUIREMENTS FOR DRINKING WATER PROGRAMS

This section discusses general design factors associated with designing or enhancing a self-monitoring program for drinking water. It then provides examples that illustrate how selected countries use these design factors in their current program.

4.3.1 Parameters

Generally, parameters are included in drinking water self-monitoring programs because of their potential for adverse effects on human health. Characteristics of typical drinking water parameters and the rationale for their inclusion in self-monitoring programs, are described in **Exhibit 4-8**.

Exhibit 4-9 presents the parameters monitored in selected countries' drinking water programs.

Exhibit 4-8. Drinking Water Monitoring Parameters and Associated Rationale for Monitoring

Microbiological. Water contains many microbes including bacteria, viruses, and protozoa. Some of these organisms are harmless but others can cause disease if present in drinking water supplies. Common diseases include gastroenteritis, typhoid, dysentery, hepatitis, and giardiasis. Disease causing microorganisms are difficult to detect in drinking water. Therefore, monitoring for an indicator organism (a microorganism whose presence is evidence that the water is contaminated with human or animal feces) is often conducted instead. Coliform bacteria and fecal streptococci are two common indicator organisms. Both are excreted in large numbers by humans and other warm-blooded animals. The presence of these indicator organisms in drinking water supplies indicate fecal contamination and the possible presence of disease causing microorganisms.

Inorganic Chemicals. Inorganic chemicals include metals, nitrate/nitrite, chlorides, sulfate, fluoride, and hardness.

Metals. Toxic metals are capable of causing a variety of human health problems. For instance, health effects related to the consumption of too much lead include impaired blood formation, anemia, brain damage, increased blood pressure, premature birth, low birth weight, and nervous system disorders. Young children are especially at risk from high levels of lead in drinking water.

Nitrate/Nitrite. Although adults can consume large quantities of nitrates with no adverse effects, ingestion of excessive nitrate may cause methemoglobinemia in infants, particularly in those under three months old. The nitrate is reduced to nitrate in the infant's intestine. Nitrite absorbed into the blood can interfere with oxygen transfer.

Chlorides. Chlorides may cause taste and add to Total Dissolved Solids (TDS) and scale in drinking water distribution systems. The presence of chlorides may also indicate contamination.

Sulfate. Higher levels of sulfate can have a laxative effect.

Fluoride. The correct concentration of fluoride in drinking water can help prevent tooth decay. However, excessive amounts of fluoride cause mottling (stained spots) on teeth.

Hardness. The major constituents of hardness are calcium and magnesium. Hardness causes scale.

Synthetic Organic Chemicals. Drinking water may contain trace amounts of toxic organic chemicals. Toxic organic chemicals including pesticides, solvents, PCBs, and dioxins are cancer-causing substances and can also cause other chronic health effects.

Trihalomethanes. Trihalomethanes can result from the chlorine used in disinfection interacting with organic substances present in water supplies. Chloroform, bromodichloromethane, dibromochloromethane, bromoform, and dichloroiodomethane have been detected in drinking water supplies, particularly treated surface waters. Some trihalomethanes such as chloroform have been demonstrated to be carcinogenic to laboratory animals.

Volatile Organic Compounds. Some volatile organic compounds are carcinogens (for example, vinyl chloride) or mutagens. Phenols impart objectionable taste and odor at low concentrations. The toxicity of phenols varies, depending on chlorination of the phenolic molecule.

Exhibit 4-8. Drinking Water Monitoring Parameters and Associated Rationale for Monitoring (continued)

Radionuclides Radioactivity in drinking water can be from natural or artificial radionuclides. Radionuclides are radioactive isotopes that emit radiation as they decay. Radium, uranium, and radon are significant in drinking water. All of these occur in nature. Ingestion of uranium and radium in drinking water may cause cancer of the bone or kidney. Radium and uranium enter the body through ingestion while radon (a gas) is usually inhaled after being released into the air during showers and baths. Radionuclides in drinking water occur primarily in ground water systems. Naturally occurring radionuclides are seldom found in surface waters.

Corrosivity. Corrosion products are unappealing, cause deterioration of water systems, and may have health effects. In addition, corrosive water can have an unappealing taste and odor.

Other. Other parameters typically monitored in drinking water include the following:

Turbidity is the interference of light passing through water and is caused by insoluble particles. Turbidity in drinking water supplies can cause interference with disinfection, interfere with coliform testing, and act as a food source for microorganisms.

Color may indicate the presence of dissolved organics, which may lead to trihalomethane formation. Color also causes aesthetic problems.

Presence of an odor makes water unappealing to drink and may indicate contamination.

Water with a pH of less than 6.5 is corrosive, water with a pH of greater than 8.5 will form scale and cause water to taste bitter.

Alkalinity is a measure of a water's capability to neutralize. Bicarbonate, carbonate, and hydroxide ions are the primary contributors to alkalinity. Alkalinity is a measure of water's capacity to absorb hydrogen ions without significant pH change.

4.3.2 Monitoring Techniques

Techniques for sampling drinking water include grab and composite sampling. Description of these monitoring techniques including advantages and disadvantages are presented in **Exhibit 4-10**.

Exhibit 4-10. Sampling Techniques for Water Samples

Composite samples — Samples collected over time (either by continuous sampling or by combining individual grab samples)

Reflect average characteristics of water supply or wastestream during the sample period

Useful in determining average characteristics of water supply or wastestream, particularly if parameter concentrations or flows are variable

Flow Proportional: Volume of samples collected is proportional to water flow at time of sampling. Flow proportional samples can be obtained by collecting various sample volumes at equal time intervals or by collecting a constant sample volume per unit flow

Time proportional: Consist of constant volume sample aliquots collected in one container at equal time intervals.

Grab samples — Individual samples generally collected over a period of time not exceeding 15 minutes.

Represent the water or wastestream only at the time the sample is collected and may be appropriate for batch discharges, constant conditions, screening for specific parameters, or when extreme conditions such as high pH are characteristic of the water supply or wastestream.

May be appropriate for parameters (for example, pH, cyanide, total phenols, volatile organic compounds) that tend to change or decompose during a period of compositing.

May be appropriate for oil and grease samples since oil and grease tend to adhere to sampling equipment

Both grab and composite samples can either be collected manually or with automatic samplers. Manual sampling requires less equipment but is labor intensive. Automatic samplers require less time but are costly and require maintenance. For certain parameters (for example, pH and flow), continuous monitoring may be conducted.

4.3.2.1Analyses

Many parameters are unstable and may alter in composition prior to analysis. To ensure that samples remain representative, they should be analyzed as soon as possible after collection. Certain parameters such as pH are often performed in the field. If immediate analysis is not possible, samples should be preserved to minimize the changes in parameter concentrations between collection and analysis. Preservation methods include cooling, pH adjustment, and chemical fixation. Even properly preserved samples should be analyzed within certain holding times. Holding times depend on the pollutant being analyzed.

The complexity of analytical methods available range from simple test kits to complex instruments for performing analyses such as gas chromatography/mass spectrometry (GC/MS). Field test kits have been developed for a wide range of sample analyses (including metals) and provide a relatively inexpensive alternative to laboratory analysis. Analytical methods used should be appropriate for the sample matrix and for the parameter being analyzed and should provide the desired result. For example, analytical methods used for solid wastes should not be used for drinking water analyses. Many countries require regulated facilities to perform analysis using specified standard sampling and analysis procedures or methods.

The method detection limit is also an important consideration. It is important to use analytical methods with detection limits significantly lower than the adverse effect level being managed. For example, both flame ionization and graphite furnace atomic absorption spectrophotometry can be used for metals analysis. However, graphite furnace atomic absorption generally can detect parameters in lower concentrations than flame ionization. Therefore, graphite furnace may be the preferred method if the metals concentrations are relatively low. The analytical method used should achieve detection limits low enough to adequately characterize the sample in relation to applicable limitations. For example, if the drinking water limit for lead is 0.05 mg/l, the analytical method used should achieve a detection level at least as low as 0.05 mg/l.

4.3.2.2Costs of Sample Collection and Analysis

The cost of analysis varies, depending on the parameter being analyzed and the analytical method chosen. Generally, the cost of analysis increases with increasing complexity of analysis and analytical equipment needed for that analysis. Costs also increase as detection limits decrease. **Exhibit 4-11** provides a summary of the relative cost of analysis for different parameters commonly monitored.

Exhibit 4-11. Relative Cost of Analysis

Parameter	Low	Moderate	High
Metals:			
Test Kit			
Atomic Absorption			
Volatile/Synthetic Organics			
Gas Chromatography			
Gas Chromatography/Mass Spectrometry			
Phenols			
Biochemical Oxygen Demand			
Chemical Oxygen Demand			
Total Suspended Solids			
Coliform			
pH			
Turbidity			
Oil and Grease			
Radionuclides			
Whole Effluent Toxicity			

4.3.3 Monitoring Frequencies

Drinking water self-monitoring frequencies are generally based on factors such as the regulated parameter, population served by the drinking water system, and the drinking water source (that is, ground or surface water).

Exhibit **4-12** provides information on the monitoring frequencies in the drinking water program for several countries. Selected country examples that illustrate how these factors are used are provided:

United Kingdom: Self-monitoring is required at supply points and at consumer taps. Required self-monitoring frequencies for the different regulated parameters are based on the volume of drinking water distributed for domestic and food production purposes. Three levels of self-monitoring frequencies may be imposed: 1) reduced, 2) standard, and 3) increased. Reduced self-monitoring frequencies for certain parameters differ depending on whether ground water or surface water is used. Frequencies based on the criteria described above range from one to 365 samples per year. An example frequency table for drinking water monitoring is provided in Appendix C-1.

United States: Self-monitoring frequencies for microbiological parameters are based on the population served by the system. Self-monitoring frequencies for other regulated parameters may vary depending on whether ground water or surface water is used. Monitoring frequencies range from once every three years to 500 samples monthly. Frequencies may be reduced after initial monitoring if parameters are not detected, or are detected only at very low levels, well below adverse effects levels. Resampling at increased frequencies may be required if analytical results indicate that a violation has occurred.

Hungary: Hungary requires self-monitoring of various parameters (that is, microbiological, inorganic, synthetic organic, radionuclides, and other specified parameters) on a weekly basis. Self-monitoring is required for large water companies on a daily basis.

4.4SELF-MONITORING REQUIREMENTS FOR WATER PROGRAMS

This section discusses general design factors associated with designing or enhancing a self-monitoring program for water. It then provides a comparison of how selected countries use these design factors in their current program.

4.4.1Monitoring Parameters

Parameters are included in water self-monitoring programs because of their potential for adverse effects on waterbodies (that is, streams, lakes, rivers) including aquatic life and on human health of people using the water body for recreational purposes or as a drinking water supply. Specific parameters and the associated rationale for their inclusion in self-monitoring programs, are described in **Exhibit 4-13**.

Exhibit 4-14 presents the parameters monitored in selected countries' water programs.**Exhibit 4-13. Parameters Monitored in Water Programs**

Biochemical Oxygen Demand/Chemical Oxygen Demand. Soluble organics such as Biochemical Oxygen Demand cause depletion of dissolved oxygen in the receiving water. The Biochemical Oxygen Demand test measures the biodegradable organic carbon present in the wastewater. By definition, Biochemical Oxygen Demand is the quantity of oxygen required for the stabilization of the oxidized organic matter present after five days of incubation at 20°C. The Chemical Oxygen Demand test measures the total organic carbon except for certain aromatic compounds. Since the Chemical Oxygen Demand test is an oxidation-reduction reaction, other reduced substances such as sulfides, sulfites, and ferrous iron will also be oxidized and reported as Chemical Oxygen Demand.

Suspended Solids. Sedimentation of suspended solids can cause a buildup of decomposing organic matter in sediments, resulting in oxygen depletion. Suspended solids also interfere with light transmission and thus photosynthetic activity.

Coliform. The presence of coliform bacteria may indicate inadequate disinfection of wastewater prior to discharge.

Residual Chlorine. Chlorine disinfection of wastewater results in residual chlorine. Chlorine is highly toxic to aquatic life.

pH. Maintaining a certain pH of surface waters protects aquatic life and controls adverse chemical reactions such as the dissolution of metal ions. In addition, the toxicity of some substances is affected by pH.

Dissolved Oxygen. Maintaining adequate dissolved oxygen concentrations in receiving water protects aquatic life, enhances recreational use of the water, and reduces odors due to decomposition of organic matter.

Ammonia. Dissolved ammonia can contribute to oxygen depletion by nitrification. Un-ionized ammonia is also highly toxic to aquatic biota.

Oil and Grease. The presence of oil and grease may cause aesthetic problems in the receiving water.

Toxics Pollutants. Metals, phenols, volatile organic compounds, cyanide, pesticides, and PCBs may be toxic to aquatic life and may pose human health problems. Volatile organic compounds may also cause air pollution problems.

Whole Effluent Toxicity. Toxicity is a characteristic of a substance or group of substances that causes adverse effects in organisms. Adverse effects include increased morbidity (the rate of occurrence of disease), and mortality (the rate of occurrence of death), as well as those effects that limit an organism's ability to survive in nature, such as impaired reproductive ability. Toxicity of a substance is measured by observing the responses of organisms to increasing concentrations of that substance. Whole Effluent Toxicity is designed to evaluate the toxicity of the entire wastestream and not individual pollutants. Whole Effluent Toxicity tests are techniques to determine the toxicity of water or effluent by measuring the responses of organisms to solutions containing various percentages of effluent and dilution water. Whole Effluent Toxicity testing is useful in assessing environmental hazards, especially where the mix of potential problems is complex. Quantitative analytical tests cannot demonstrate the interaction of chemicals and are not sensitive to variabilities such as acidity, hardness, solubility, or the effects on living organisms. Whole Effluent Toxicity testing integrates these variables and can indicate when chemicals have reached toxic levels even if the identity of the chemical is unknown.

4.4.2 Monitoring Techniques

The monitoring techniques applicable in water programs are the same as those in drinking water programs. Refer to section 4.3.2 for a discussion of monitoring techniques and associated issues.

4.4.3 Monitoring Frequencies

Required self-monitoring frequencies for water discharges from entities may be based on several factors, including the type of entity (that is, specific processes and operations), the parameter being monitored, the size of the entity, the variance of the parameter being monitored, the degree of "change" resolution required, and the environmental and human health risk being managed. **Exhibit 4-15** presents a comparison of monitoring frequencies in water programs for selected countries. In some countries, the frequency may increase in cases where limits have been exceeded, and decrease in cases where the regulated parameters have not been detected for a defined period of time (see Canadian example below). In Hungary and The Netherlands, the frequency varies depending on the entity's parameters and can range in The Netherlands from once a year to daily. In Norway, the frequency varies and is specified in the permit.

The following are examples that illustrate how self-monitoring frequencies are established by selected countries:

- ***Canada:*** Canada requires self-monitoring for pulp and paper manufacturers and metal mining operations. Frequency of monitoring can range from continuously to monthly. Pulp and paper mills are required to monitor Biochemical Oxygen Demand three times a week, Total Suspended Solids daily, acute lethality weekly (using *Daphnia magna*) and monthly (using rainbow trout), and pH, flow, and electrical conductivity continuously. If a facility fails the monthly acute lethality test using rainbow trout, the test frequency is increased to weekly. In addition, pulp and paper facilities are required to self-monitor 2,3,7,8-TCDD and 2,3,7,8-TCDF during each month in which the chlorine bleach plant was operating. If no measurable concentrations are detected for three months, the frequency is dropped to quarterly. The regulated facility may have a qualified laboratory on-site to collect and analyze the samples or it may hire outside contractors to collect or analyze the samples.
- ***United Kingdom:*** Non-Integrated Pollution Control dischargers to waters regulated by the National Rivers Authority are not required to conduct self-monitoring. Instead, the National Rivers Authority monitors consented dischargers and recovers the associated costs through the Charging for Discharges Scheme. The frequency of National Rivers Authority sampling varies and may range from quarterly to weekly. Self-monitoring requirements for Integrated Pollution Control facilities are contained in authorizations, self-monitoring frequencies vary, depending on the type of facility.

- ***United States:*** Certain types of facilities (based on facility processes and operations) are required to obtain discharge permits that contain self-monitoring requirements. The frequency of self-monitoring required may depend on the type and size of entity, type of treatment used, discharge volume and characteristics, receiving stream characteristics, and the entity's compliance history. At a minimum, all permitted facilities are required to self-monitor once a year. **Exhibit 4-16** illustrates possible self-monitoring frequencies based on flow.

Exhibit 4-16. Self-Monitoring Frequencies in the U.S. Water Program

Plant Capacity (Million Gallons Per Day)	**Self-Monitoring Frequency**
0-0.099	Quarterly
0.1-0.99	Monthly
1.0-4.99	Weekly
More than 5.0	Daily

5 ANALYSIS OF REPORTING AND RECORDKEEPING REQUIREMENTS

5.1 INTRODUCTION

This section focuses on the reporting and recordkeeping requirements associated with self-monitoring programs. From the regulatory agency's viewpoint, there are several important reasons for establishing reporting requirements. The regulatory agency can:

- Ensure an entity is meeting its self-monitoring responsibilities.
- Determine the compliance status of an entity.
- Use the reported information to assist targeting efforts, identify problem areas earlier, and collect information on specific entities, industries, or sectors.

In addition:

- Reporting acts as a deterrent to noncompliance.
- A facility identifies itself as being subject to specific regulations.
- Information submitted on compliance is much more extensive than could be collected by an inspector at the site.
- Reporting compliance data to the regulatory agency directs the attention of a higher level of the facility's management to achieving and maintaining compliance.

Recordkeeping requirements may also be incorporated into environmental compliance and enforcement programs to ensure that specific information about a facility's operations or releases is available for an extended period of time in case it is required for an enforcement action.

The following sections examine the general design factors to consider when developing or enhancing a reporting program (Section 5.1) and compare the reporting requirements of several countries (Section 5.2). Section 5.3 discusses general design factors for recordkeeping and Section 5.4 compares recordkeeping requirements in several countries.

5.2REPORTING - DESIGN FACTORS

When designing or enhancing a reporting program, a regulatory agency must consider three general design factors: 1) information needs, 2) reporting frequency, and 3) reporting format.

5.2.1 Information Needs

The first and most important decision the regulator must make is: "What information do I need from the regulated community?" In any self-monitoring program, information that identifies a specific entity must be reported, including name, location, and any particular facility identification numbers (for example, permit numbers, hazardous waste generator identification number). In addition to this basic information, the ways of reporting information may include:

- Report all self-monitoring data.
- Report only data/information in response to specific compliance situations or occurrences.
- No reporting required, recordkeeping only.

The reporting requirements imposed by the regulatory agency depend primarily on the ultimate end use of the reported data. If the end use of the data is to assist the regulator in making compliance determinations, the reporting requirement may specify that all data from self-monitoring be reported. This level of information will allow the regulatory agency to make an accurate determination of compliance. It will also allow the regulatory agency to determine if an entity is conducting all of the required self-monitoring, and thus, presents a deterrence to noncompliance.

In some cases, reported data are used by the regulatory agency to identify and trigger follow-up actions, such as compliance inspections, or to identify entities or industrial sectors that require special attention (for example, compliance assistance). In these cases, it may only be necessary to report data that relate to specific situations or occurrences, such as noncompliance, exceptions, emergencies, or calamities. These reports notify the regulatory agency there may be a problem and allow tracking of the facility more closely and also the ability to respond to a threatening situation. In some situations, reporting may not be necessary and, in these cases, the regulatory agency may only stipulate recordkeeping requirements.

5.2.2 Reporting Frequency

The end use of the reported data (that is, the purpose of the data) determine the frequency of reporting. The regulatory agency must ensure that the timing of the reports supports its purpose (for example, determining compliance, targeting). The regulatory agency should determine how often it needs self-monitoring data to 1) achieve its environmental compliance and enforcement goals and 2) effectively track an entity's environmental trends and make accurate assessments of environmental performance, as well as compliance status. Reporting frequency may be:

- Annually or at other fixed intervals (for example, semi-annually, quarterly, monthly),
- In cases of noncompliance, exceptions, or other specific occurrences, and
- Immediately, in the case of emergencies or other calamities.

With fixed interval reporting, infrequent reporting may make it difficult for the regulatory agency to make accurate assessments of an entity's environmental performance, as the reports will not provide a cohesive, continuous picture of a facility over time. On the other hand, reporting too frequently may result in unnecessary burdens on both the regulatory agency and regulated entities and may also result in information being collected and submitted that has little added value. The regulatory agency must ensure the reporting intervals are appropriate to meet its goals. Interval reporting may also be dependent on an entity's compliance history or size. Entities with good compliance records may not be required to report as often as those with poor compliance records. Likewise, smaller entities (both in size and discharge amounts) may have less of a reporting burden.

Reporting in cases of noncompliance, exceptions, or other specific occurrences allows the regulatory agency to be informed of all situations out of the normal course of events. This enables the regulatory agency to take follow-up actions to ensure such a situation does not occur again. Requiring that emergencies and other calamities be reported immediately will ensure the regulatory agency is aware of threatening situations and has the ability to respond immediately if necessary.

5.2.3 Reporting Format

Format of the reported data refer to two things—whether the data are 1) submitted in electronic form or hard copy, or 2) submitted using a standardized format or form. Countries that have developed, or are developing, electronic information systems may require regulated entities to submit reports in a compatible electronic format. This will facilitate the reporting process for both the regulated entity and the regulatory agency and will also facilitate the regulatory agency's use of the data, as it will be more accessible and easier to locate and retrieve. If electronic information management systems are not available, reports can also be submitted in hard copy.

Another consideration is whether the format should be standardized (i.e, mandated use of specific forms). Standardized forms ensure that proper data are submitted and facilitate review by the regulatory agency. Nonstandardized reporting may result in incomplete, different, or incorrect data/information being submitted.

5.3REPORTING - COUNTRY COMPARISON

The following sections compare several countries' reporting programs. Section 5.3.1 examines information needs, Section 5.3.2 provides information on reporting frequency, and Section 5.3.3 discusses reporting format.

5.3.1 Reporting Information Needs

Exhibit 5-1 presents the information needs of several countries. Several of the countries required entities to submit all data and data relating to specific occurrences. For example, in Canada, entities in the air program must report all self-monitoring data and also submit other types of reports, including malfunction/breakdown reports, air pollution control equipment reports, release reports, and compliance reports. The United States water program is similar. Entities must submit all self-monitoring data in Discharge Monitoring Reports and must also submit noncompliance reports when permit limits for a specific parameter are exceeded.

In both India and Norway, regulated entities are required to submit annual reports that contain self-monitoring data for several different program areas. In India, all industries must submit an annual report that includes information on:

- Water and raw material consumption,
- Pollution discharged to the environment through water and air emissions,
- Total hazardous and solid wastes from processes and pollution control facilities, and
- Quantity of solid wastes 1) recycled or reutilized within the unit, 2) sold, or 3) disposed.

The report also solicits information on the characterizations of hazardous and solid wastes, disposal practices for the wastes, impact of pollution abatement measures on the environment and production costs, additional measures or investments proposed for environmental protection, and any other particulars for improving the quality of the environment.

Norway requires all industries regulated under the air, wastes (both hazardous and nonhazardous), and water programs to submit a similar report. An example of India's report is included as Appendix D-1.

5.3.2 Reporting Frequency

Exhibit 5-2 presents the reporting frequencies associated with self-monitoring requirements. In both Canada and the United States, reporting frequency may vary depending on the type of report and the compliance status of the entity. For example, in Canada, pulp and paper mills are required to report self-monitoring data on acutely lethal effluent monthly. Self-monitoring results for Biochemical Oxygen Demand and suspended solids must be reported annually. In the United States, if an entity has a good compliance history, it may be required to only report self-monitoring data semi-annually. However, entities with poor compliance records may be required to report monthly.

5.3.3 Reporting Format

Exhibit 5-3 provides a country comparison of the type reporting formats used. Those countries listed in both the standardized and nonstandardized columns currently use both types of reporting formats in the specific program area. One specific report may be standardized, while another is not. The same is true for hard copy/electronic.

Exhibit 5-3. Reporting Format

Program Area	Standardized	Nonstandardized	Hard Copy	Electronic
Air	Canada			
Germany				
India				
The Netherlands				
Norway				
United States	Hungary			
The Netherlands				
United Kingdom				
United States	Canada			
India				
The Netherlands				
Norway				
United Kingdom				
United States	United States			
Drinking Water	Germany			
The Netherlands	Hungary			
The Netherlands	Germany			
Hungary				
The Netherlands				
Solid Nonhazardous Waste		The Netherlands		
Norway				
Germany				
The Netherlands				
United Kingdom				
United States	The Netherlands			
Norway				
United Kingdom				

United States		
Hazardous Waste	India	
The Netherlands		
Norway		
United States	Hungary	
The Netherlands		
United Kingdom		
United States	Hungary	
India		
The Netherlands		
Norway		
United Kingdom		
United States		
Chemical/Toxic Substance		India
The Netherlands		
Norway		
United Kingdom		
United States	The Netherlands	India
The Netherlands		
Norway		
United Kingdom		
United States		
Water	Canada	
Hungary		
India		
The Netherlands		
Norway		
United Kingdom		
United States	Germany	
The Netherlands	Canada	
Hungary		
India		
The Netherlands		
Norway		
United Kingdom		
United States	Canada	
Multimedia	India	
Norway		India
Norway		

Those countries listed under both categories may require electronic for specific reports and only hard copy for others. It should be noted that several countries use electronic systems to manage the data once they are reported. This may result in more electronic reporting in the future. Electronic reporting is currently required in the United States air program for utilities. Detailed information on such reporting is found in the Appendix E-1.

5.4RECORDKEEPING - DESIGN FACTORS

When designing or enhancing a recordkeeping program, a regulatory agency must consider several general design factors, including:

- Why records should be kept by a regulated entity,
- What records should be kept, and
- What length of time should the records be retained.

Generally, records are kept to serve as a source of information in the event an enforcement action is necessary or review of data is necessary at some later date. Historic data on self-monitoring and reporting can be reviewed to help the regulatory agency determine the past performance of an entity and to allow the regulatory agency to determine if past practices and operations were appropriate and in compliance with environmental requirements. When identifying the records that must be kept by a regulated entity, the regulatory agency must ensure the data/information will be appropriate to meet its needs. In addition, the records must be kept a sufficient amount of time to ensure the data are available if needed.

5.5RECORDKEEPING - COUNTRY COMPARISON

Exhibit 5-4 compares the recordkeeping requirements across program areas of several countries. As shown, several of the countries have specific requirements for what types of records should be kept and for how long. Some of the countries that do not have specific requirements written into their statutes and regulations (for example, India) may have a clause that allows the head of the environmental agency to request information from a regulated entity. To produce such information on request, most entities incorporate their own system of recordkeeping. On average, the retention period for most records is 3 to 5 years.

In some instances, the recordkeeping requirements for regulated entities are specifically spelled out in permits or other type of operating authorization. In the UK water program, for example, recordkeeping requirements for Intergrated Pollution Control regulated facilities are spelled out in the authorization for that specific facility. Usually the retention time for such records is 4 years for specified records and 1 year for operational records. However, the timeframes are dependent on the specific authorization.

6 DATA QUALITY ASSURANCE, VERIFICATION, AND MANAGEMENT

6.1INTRODUCTION

There are generally two types of activities conducted to ensure the accuracy of self-monitoring data: 1) data quality assurance activities, and 2) data verification activities. Data quality assurance activities are conducted by a ***regulated entity*** to ensure self-monitoring data are accurate. Data verification activities are conducted by the ***regulatory agency*** to ensure self-monitoring data are accurate and representative. The following sections (Section 6.1 and 6.2) examine general design factors associated with these two types of activities and compare selected countries' programs. Section 6.3 of this chapter then discusses data management methods and compares several countries' data management procedures and systems.

6.2DATA QUALITY ASSURANCE ACTIVITIES - DESIGN FACTORS

To ensure the accuracy of self-monitoring data, the regulated agency may require a regulated entity to conduct various data quality assurance activities. There are several types of such activities and the regulatory agency must determine which ones will result in data of the highest quality. Activities the regulatory agency may impose include:

- Sampling and analyzing in accordance with established techniques,
- Conducting analysis using established laboratory practices,
- Conducting analysis at certified laboratories,
- Calibrating equipment in accordance with established techniques,
- Self-certifying monitoring data, and
- Participating in laboratory evaluations.

Any of the above activities, whether by itself or combined with others, chosen by the regulatory agency will help ensure accurate and valid data are submitted by a regulated entity. The activities selected will depend in large part on the environmental policies and procedures already developed within a specific country. For example, some countries may not have established techniques for sampling or analysis or may not have certification programs for laboratories.

6.3DATA QUALITY ASSURANCE ACTIVITIES - COUNTRY COMPARISON

Exhibit 6-1 provides information on the various data quality assurance activities required by selected countries. An example regarding data quality assurance activities in The Netherlands air program in provided in **Exhibit 6-2**.

The United States generally uses all of the various quality assurance activities in its various environmental programs. For example, in its water program, sampling and analyses must conform to approved test procedures established by EPA for (1) biological parameters, (2) inorganics, (3) non-pesticide organics, (4) pesticides, and (5) radiological parameters. It also contains the required containers, preservation techniques, and holding times for the above parameters. Calibration and performance techniques also must conform to the requirements established by EPA. Such techniques have been established for all the parameters listed above.

In addition, self certification is required for all reports submitted by a facility in the U.S. program. The report must be signed by an authorized person or their authorized designee and must include a certification stating, under penalty of law, that the information submitted is true, accurate, and complete. An example self-certification statement used in the U.S. pretreatment program is shown in **Exhibit 6-3**.

6.4DATA VERIFICATION ACTIVITIES - DESIGN FACTORS

To further ensure the quality of the reported self-monitoring data, regulatory agencies conduct independent data verification activities. These activities may include:

- Analyzing duplicate or split samples,
- Inspecting the laboratories that are analyzing samples,

- Inspecting the regulated entities, including their sampling and analysis procedures, and
- Random, unprogrammed check monitoring.

When analyzing duplicate or split samples, the regulatory agency should require the regulated entity to submit the split or duplicate samples for analysis. The regulatory agency can then conduct its own analysis and compare the results with the results from the regulated entity. Inspections of either laboratories or regulated entities will ensure the laboratory or regulated entity is conducting the sampling and analysis in accordance with established guidelines and

Exhibit 6-2. The Netherlands Air Program

Air emission measurements are carried out by an institution approved by the licensing authority and may be the facility or entity itself. Measurements conducted for enforcement purposes (for example, repeat measurements after emission standards have been found to have been exceeded) generally may not be carried out by the facility or entity unless such facility is the only institution qualified or certified to conduct the measurement and both regulatory agency and facility agree.

Measurements should be taken in accordance with procedures specified in Standards, such as Nederlandse Praktijkrichtlijnen (Practical Guidelines)(NPR), Nederlandse Voornormen (draft-standards) (NVN), Nederlandse Normen [Dutch standards (NEN)], European standards (EN) or International Standards (ISO). The standard methods are presented in Appendix B, page B-10. When there is no standard method, other measuring techniques may be used.

Exhibit 6-3. Example of U.S. Pretreatment Program Self-Certification Statement

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or person who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

procedures. Any of these activities, or any combination of them, can help the regulatory agency determine if the data being submitted by the regulated entity are complete and accurate. The activities a regulatory agency selects primarily depend on its capabilities and resources.

6.5DATA VERIFICATION ACTIVITIES - COUNTRY COMPARISON

Exhibit 6-4 presents a comparison of the data verification activities conducted by selected countries. In the United States, program-specific inspections (that is, of one media) can often involve collecting samples for analysis and evaluating the regulated entity's sampling and analysis procedures. An example of the different types of inspections conducted in the United States water program is shown in **Exhibit 6-5**.

Exhibit 6-5. Types of Inspections in U.S. Water Program

Compliance evaluation inspections verify compliance with permit requirements and reviews overall operation, maintenance, and sampling procedures.

Compliance sampling inspections include every component of the compliance evaluation inspection, but also include sampling by inspectors to verify the facility's sampling.

Performance audit inspections include every component of the compliance evaluation inspection, but also include an in-depth review of the facility's sampling procedures and a review of the laboratory that performs the analyses.

Laboratory inspections are National performance evaluations conducted annually of all laboratories that are used by major dischargers. In the evaluation, EPA prepares samples with known constituents and concentrations and sends them to the major dischargers, who then ask their laboratories to analyze the samples. The laboratories are asked to use the same personnel and methods they use to conduct regular analyses for the discharger. EPA then analyzes the results of the laboratories analyses with their own results.

6.6DATA MANAGEMENT - DESIGN FACTORS

Self-monitoring and reporting requirements result in large volumes of data being transmitted to the regulatory agency by the regulated entities. Because of these large volumes of data, it is imperative the regulatory agency have in place a system and procedures for managing the data. When enhancing or developing a data management system for its self-monitoring program, a country must consider certain factors, including:

- Current data management systems, and
- Public availability of the data in those systems.

Basically, there are two types of data management systems: 1) electronic and 2) hard copy filing systems. Electronic systems make data review, manipulation, and retrievability easier, but require more resources and expertise to develop and maintain. Hard copy filing systems require large amounts of space (for filing cabinets) and create a large paper burden on the regulatory agency.

Public availability is an important part of a self-monitoring program because it creates another deterrent to noncompliance. By allowing the public to access the data, it can monitor the environmental performance and compliance of a regulated entity.

6.7DATA MANAGEMENT - COUNTRY COMPARISON

Exhibit 6-6 compares the data management procedures and public availability of data across several countries and program areas. As shown in the exhibit, several countries now have electronic data management systems in place or under development. For example, The Netherlands is currently developing two data base management systems to manage its environmental permitting and monitoring data. While the systems are under development, it will continue to use its traditional means of data management. The United States hazardous waste program manages data in the Biennial Reporting System, which is a national data base that 1) provides an overview of the progress of the hazardous waste program by tracking generation, management, and minimization, 2) assesses the impact of regulatory decisions, and 3) provides data to develop waste capacity analyses. The system is updated every 2 years (biennially), as reports are submitted every 2 years. The States and EPA share the responsibility for ensuring the data quality of the system. Automated data validation routines and manual assessment analyses are completed on the data prior to public release. Information on several other United States data management systems is located in Appendix F-1.

One way of giving the public access to the self-monitoring data is to make the information in the data bases available on computer diskette or by communicating with regulatory agency computers through modems. The United States makes its data available through both methods. In addition, the United States has in place the Freedom of Information Act, which allows members of the public to request and receive information from the regulatory agencies.

Exhibit 6-6. Data Management Procedures and Public Accessibility

Country	Program Area	Data Management Method: Paper Copy	Data Management Method: Electronic (data bases)	Public Access to Data (Yes or No)
Germany	Air			Yes
	Drinking Water		[10]	Yes
	Solid Nonhazardous Waste			Yes
	Water			Yes
Hungary	Air			Yes
	Drinking Water			Yes
	Hazardous Waste			Yes
	Water			Yes
India	Air			Yes
	Hazardous Waste			Yes
	Chemical or Toxic Substances			Yes
	Water			Yes
Mexico	Air			No
The Netherlands	Air			Yes
	Drinking Water			Yes
	Solid Nonhazardous Waste			Yes
	Hazardous Waste			Yes
	Chemical or Toxic Substances			Yes
	Water			Yes
Norway	Air			Yes
	Solid Nonhazardous Waste			Yes
	Hazardous Waste			Yes
	Chemical or Toxic Substances			Yes
	Water			Yes

Exhibit 6-6. Data Management Procedures and Public Accessibility (continued)

Country	Program Area	Data Management Method: Paper Copy	Data Management Method: Electronic (data bases)	Public Access to Data (Yes or No)
United Kingdom	Air			Yes
	Solid Nonhazardous Waste			Yes
	Hazardous Waste			Yes
	Chemical or Toxic Substances			Yes
	Water			Yes
United States	Air			Yes

Drinking Water	Yes
Solid Nonhazardous Waste	Yes
Hazardous Waste	Yes
Chemical or Toxic Substances	Yes
Water	Yes

7 ENFORCEMENT OF SELF-MONITORING REQUIREMENTS

7.1 INTRODUCTION

For self-monitoring to work effectively, such programs must achieve a high rate of voluntary compliance. Ensuring such compliance entails tracking compliance with self-monitoring requirements and enforcing such requirements where necessary.

7.2 TRACKING OF NONCOMPLIANCE WITH SELF-MONITORING AND REPORTING REQUIREMENTS

Tracking noncompliance with self-monitoring and reporting requirements involves taking the actions necessary to determine whether those industries, facilities, or people subject to self-monitoring or reporting 1) have complied with their obligation to conduct the required monitoring and, if necessary, submitted required monitoring data and 2) are in compliance with the substantive environmental program requirements. For example, where determining violations of groundwater protection standards is the issue of concern, tracking activities should focus on ensuring that groundwater monitoring data are developed through sampling and that such data are submitted where it indicates impermissible levels of contamination.

Tracking noncompliance with self-monitoring requirements is important because it serves as a means of monitoring environmental compliance, provides the impetus for enforcement actions where necessary, and deters facilities that would ignore either the self-monitoring provisions or the more substantive requirements that the self-monitoring provisions track. Yet, the importance of tracking such compliance will vary depending on the objective of the program (for example, enforcement versus increasing awareness). **Exhibit 7-1** shows examples of programs that track non-compliance with self-monitoring and reporting requirements.

U.S. EPA has recently developed policies that go as far as encouraging facilities to conduct self-audits and self-report violations in exchange for reductions in penalties assessed for such violations. A second recent EPA policy also encourages small businesses to obtain assistance in discovering and remedying violations, again in mitigation of penalties. Tracking noncompliance with self-monitoring requirements is accomplished in a variety of ways. Tracking noncompliance with the monitoring or reporting requirement itself is accomplished either by reviewing reported data as they are submitted (for data that must be reported at established intervals) and evaluating records during inspections. With regard to determining substantive violations, in many instances the data are collected and organized into a data base. This is the case in Norway, where self-monitoring data are managed in a data base that identifies the facility, specifies discharge limits, specifies violations registered through self-reports, provides a summary of waste generation and discharge of pollutants, and provides statistical results of authority controls. A description of Norway's environmental data management system INKO SYS is contained in Appendix J. Similarly, the United States employs numerous data bases to aggregate self-monitoring and other compliance-related data. For example, the Permit Compliance System, developed to track compliance with discharge permit limits under the Clean Water Act, contains a variety of self-monitoring data, including permit limits and discharge monitoring data. Another means of tracking noncompliance with self-monitoring requirements involves routine review of such data by compliance staff.

Self-monitoring data that must be maintained pursuant to recordkeeping requirements are normally tracked through inspections. In preparation for an inspection, inspection teams review the recordkeeping requirements imposed on the facility so that required records are addressed as part of the inspection. Such records may also be requested by the regulatory agency to verify compliance or to help determine the need for follow-up inspections, or even help support general targeting strategies for compliance activities. In some cases, facilities are required to maintain records for a specified period (for example, 3 years) to preserve the regulatory agency's ability to track compliance. In other cases recorded data must submitted as a report.

Nearly all of the countries reviewed that impose self-monitoring requirements track compliance with these requirements. Canada, Norway, the United Kingdom, and the United States all track compliance with self-monitoring requirements in every environmental program under which such requirements are imposed. India indicated that it tracks such requirements in the following program areas (for example, air, hazardous waste, water).

7.3NUMBER AND TYPE OF ENFORCEMENT ACTIONS TAKEN FOR VIOLATIONS OF SELF- MONITORING AND REPORTING REQUIREMENTS

Where environmental programs track compliance with self monitoring requirements, noncompliance with such requirements may become evident. If so, the responsible regulatory agency will decide whether to implement an enforcement action to compel compliance. Such enforcement actions serve two functions: compelling compliance with the self-monitoring provisions (and related substantive requirements), and deterring violations of self-monitoring and associated requirements.

Preliminary data indicate that all of the countries surveyed that track self-monitoring and reporting requirements enforce these requirements. Canada (air, water); Germany (air, drinking water, solid wastes, water); India (air, hazardous waste, water); Mexico (air); the Netherlands (drinking water); Norway (air, solid waste, hazardous waste, chemical or toxic substances, water); the United Kingdom (air, pesticides, solid waste, hazardous waste, chemical or toxic substances, water); and the United States (air, drinking water, pesticides, solid waste, hazardous waste, chemical or toxic substances, water), all enforce violations of self-monitoring requirements.

The types of enforcement actions that are brought by these countries for violations of self-monitoring requirements include most of the enforcement mechanisms generally used in environmental programs. These include the following:

- Warning letters,
- Ticketing (field citations),
- Formal notices/letters of violation,
- Administrative orders/pollution fines and/or penalties,
- Administrative prosecution,
- Permit actions (withdrawal of permit, revocation of authorization),
- Prosecution: Civil (injunction, civil prosecution), and
- Prosecution: Criminal.

Based on available data, it is apparent that each country has its own hierarchy of enforcement mechanisms and criteria for determining when each is appropriate. In Norway, common enforcement actions that may be brought for violations of self-monitoring requirements include 1) formal letters pointing out the obligation to come into compliance, 2) pollution fines, reports to prosecuting authorities, and 4) withdrawal of discharge permits. Similarly, in the United Kingdom,[11] common enforcement actions brought for violations of self-monitoring requirements include 1) prohibition notices, 2) improvement notices, 3) enforcement notices, 4) revocation of authorization, and 5) prosecution.

In Canada, such enforcement actions may include: 1) warnings, 2) directions by inspectors, 3) ticketing, 4) orders by the Minister (for example, prohibiting activities, recalling substances or products, requiring more information, interim orders or immediate action), 5) injunctions, 6) prosecution, 7) penalties and court orders upon conviction, and 8) civil suit by the Crown to recover costs. Whereas, in the United States, such enforcement actions may include: 1) informal administrative actions (for example, warning letters, notices of violation), 2) formal administrative actions (for example, administrative orders, administrative complaints/litigation), 3) civil judicial actions (for example, injunctions, civil litigation), and 4) criminal judicial action (for example, criminal litigation).

All of these enforcement actions are administered consistent with each country's environmental policies. Generally, such policies provide that the more severe enforcement actions or fines are applied to the most serious violations, based on several factors. These factors include: the importance of the self-monitoring requirement to the integrity of the program; the likelihood that health, safety, or the environment will be endangered as a result of the violation; the anticipated or actual severity of that endangerment; and the compliance history of the company or facility. For example, a minor violation, such as the late submittal of a report will, generally, result in a less severe enforcement response (for example, warning letter or notice of violation). Conversely, a serious violation, such as the failure of a historically non-compliant facility to submit several months of reporting data that indicate substantive violations, may warrant the imposition of significant penalties. Program experience with self-monitoring and reporting requirements suggests that it is important to distinguish between self-monitoring violations that are minor or "technical" violations of the reporting requirements and those that constitute or hide substantive violations, in order to maintain an appropriate focus within the environmental enforcement program.

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GLOSSARY

Atomic Absorption Spectroscopy (AAS). This analytical method is especially applicable to the analysis of single metallic element in minor or trace quantities, or of multiple metallic elements, each one taken separately. The method is based on the absorption of electromagnetic radiation by vaporized atoms, with the absorption proportional to the concentration of atoms in a high-temperature chamber. Each atomic species responds to a distinct radiation energy level, therefore there is no significant error when a mixture of atomic spices are present in the heated chamber. This method can be applied in a semi-continuous manner for on-line emissions monitoring, or as a conventional laboratory analytical instrument.

Chemiluminescence. Chemiluminescence, which uses no external light source, measures light given off during specific chemical reactions. Its most common application is NO_x measurement, where the amount of light given off is proportional to the concentration of chemical reactants.

EPA Method 5 (or equivalent). The EPA Method 5 specifies the equipment, the emissions sampling protocol, and the method of analysis for analyzing a particulate source. Equipment operators must be highly trained. Variations of this method are applicable to polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans, and to multi-metals sampling and analysis.

Flame Ionization Detector (FID) Gas Chromatography. An FID is a device in which the measured change in conductivity of a standard flame (usually hydrogen) due to insertion of another gas or vapor is proportional to the concentration of the gas or vapor.

Fourier Transform Infrared Spectroscopy (FTIR). FTIR most frequently is used when a large number of compounds must be identified and quantified. The technology relies on a broad band of infrared light to provide simultaneous measurement of absorption at many wavelengths. The heart of an FTIR system is on the interferometer, which contains optics to precisely align and split the light beam. The beam passes through the interferometer, interacts with the sample and is captured by a light-sensitive detector. The detector translates the spectral information into an electronic signal. The key to obtaining consistently accurate readings from an FTIR is maintaining perfectly aligned optics. Most FTIR systems use a moving mirror to modulate light. In industrial environments, however, low-level vibrations can interfere with alignment. To combat this problem, an alternately designed FTIR system may use an interferometer that functions without moving mirrors.

High Pressure Liquid Chromatography (HPLC). HPLC was developed from column chromatography but it is faster, has a higher separation capacity and a lower limit of detection. The method is applicable to mixtures of organic compounds.

Inductively Coupled Plasma - Atomic Emission Spectroscopy (ICP). In this method, high-frequency energy is transferred by inductive coupling to a flow of inert gas such as argon which contains the sample as an aerosol. The energy heats the argon and sample to 10,000 K, causing excitation of the resulting free atoms and ions that emit light. The intensity of the light is measured and is related to the concentration of the emitting atoms. This method is specific for metals. The method allows simultaneous analysis of multiple metals compared to AAS which will analyze one metal at a time.

Infrared (IR) Absorption. IR, as an optical monitoring technology, identifies carbon dioxide (CO_2), carbon monoxide (CO), SO_2 and several hazardous air pollutants (HAPs) found in the infrared regions of the light spectrum. The middle range of the spectrum is most conducive to the absorption of water and CO_2. Most HAPs are better absorbed in ranges where water and CO_2 absorption is weak. Data collected on a chemical includes the optimum wavelength for its absorption, its absorption coefficient and its detection limit. Several factors can interfere with accurate measurements, including multiple absorption peak ranges of several compounds and high absorption of several chemicals at identical ranges.

Mass Spectroscopy (MS). Mass spectroscopy is a method for creating charged particles in a sample and then determining the masses and abundance of charged particles. The use of the method expanded greatly in the 1950's when its applicability to structural elucidation of organic and inorganic compounds was recognized. Mixtures of compounds can thus be analyzed quantitatively. Is frequently used in conjunction with other methods, as gas chromatography.

Non-Dispersive Infrared Spectroscopy (NDIR). NDIR is used to quantify CO, CO_2, ammonia, methane, total hydrocarbons, SO_2 and sulfuric acid. NDIR technology typically uses an optical filter to narrow a broad band of infrared light to the necessary wavelength. These systems often incorporate fixed optical filters, gas filter correlations or optical filter wheels. As a rule, NDIR systems are applied when only a few compounds must be analyzed.

Photoionization Detector (PID). An PID accomplishes the removal of one or more electrons from a vaporized atom or module by absorption of visible or ultraviolet light. The wavelength (energy level) of the light that accomplishes this is specific to the atom or molecule. This amount of ionization is proportional to the concentration of the chemicals in the sample. This method is applicable to VOCs and other organic and inorganic molecules.

Triboelectric Effect. When two materials are rubbed or collide together, a transfer of charge takes place from one material to the other. This is also referred to as frictional electrification. If a sensing probe is inserted in a stream of particles, a continual transfer of charge takes place as the particles collide with the probe. Because an electrical path to earth ground is provided, a small, essentially continuous signal is produced and no voltage exists at the probe. An electronic signal processing unit monitors the character and level of this signal, which correlates very closely with the actual mass flow rate.

Ultraviolet (UV) Absorption. UV absorption quantifies compounds whose infrared absorption is difficult to measure, such as NO, NO_x and SO_2. The UV absorption is proportional to the concentration of the pollutants present in the sample.

Visible Light Transmission. Visible light transmission, as its name implies, measures the visible light transmitted across a gas stream to a detector. Since particulates in the gas stream will reduce the amount of transmitted light, the technology determines opacity and, subsequently, quantifies particulates. As noted previously there is only a qualitative relationship between opacity and the quantity of particulate matter (PM). This is true for several reasons, as follows:

> The density of the particulate is an emissions stream can change with time, altering the mass of PM emitted, even if the PM size distribution remains unaltered.
>
> The size distribution of the PM can change with time, destroying any correlation between Opacity and PM that may have been established prior. If the size distribution of a PM stream slides toward larger quantities of smaller particles, opacity will increase (less light is transmitted).
>
> Color or reflectivity of the PM may also change with time.

APPENDIX A-1

U.S. PROGRAM REQUIREMENTS - AIRAPPENDIX A-2

U.S. PROGRAM REQUIREMENTS - WATERAPPENDIX A-3

U.S. PROGRAM REQUIREMENTS - DRINKING WATERAPPENDIX A-4

U.S. PROGRAM REQUIREMENTS - TOXIC RELEASE INVENTORYAPPENDIX A-5

U.S. PROGRAM REQUIREMENTS - SOLID WASTEAPPENDIX A-6

U.S. PROGRAM REQUIREMENTS - PESTICIDESAPPENDIX A-7

U.S. PROGRAM REQUIREMENTS - TOXIC SUBSTANCESAPPENDIX B-1

MASS-FLOW CHECK VALUES
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NORWAY'S INTERNAL CONTROL REGULATIONS

[1] Wasserman, C.E., *Principles of Environmental Enforcement*, U.S. EPA, Second International Conference on Environmental Enforcement, Proceedings, Vol. I., Budapest, Hungary (Sept. 22-25, 1992), pgs. 15, 79.

[2] The other methods include conducting inspections, relying upon citizen complaints, or conducting monitoring of environmental conditions near regulated facilities.

[3] Small businesses are defined differently within programs. For example, the U.S. uses number of employees as one criterion for determining what constitutes a small business.

[4] "Hungary," BNA Int'l. Env. Rep. (May 1994), p. 162.

[5] Section 1(3) of the United Kingdom's Environmental Protection Act of 1990.

[6] The Environmental Protection (Prescribed Processes and Substances) Regulations 1991 specifically defines the prescribed substances.

[7] Dr. Lucas Bergkamp, "Dutch Environmental Law: An Overview of Recent Trends," BNA Int'l. Env. Rep. (February 24, 1993), p. 145.

[8] Note that the TRI reporting is also premised on facility size and the amount of toxic materials managed -- which reflects how these factors are often combined within environmental programs. However, the primary criterion for determining reporting requirements is the specific chemical released.

[9] The term "inspection" when used in this context does not refer to an inspection performed by the regulatory authority. Rather inspection and monitoring refers to the assessment of emissions, emission-relevant parameters and/or the operation of control devices that are required as part of the license with respect to air emissions.

[10] Under development.

[11] Implemented pursuant to Integrated Pollution Control.