United States General Accounting Office

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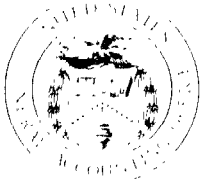
Report to the Chairman, Subcommittee on Environment, Energy, and Natural Resources, Committee on Government Operations, House of Representatives

February 1990

HAZARDOUS WASTE

EPA's Generation and Management Data Need Further Improvement



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GAO
United States
General Accounting Office
Washington, D.C. 20548

Program Evaluation and
Methodology Division

B-235931

February 9, 1990

The Honorable Mike Synar
Chairman, Subcommittee on Environment,
Energy, and Natural Resources
Committee on Government Operations
House of Representatives

Dear Mr. Chairman:

In a February 9, 1987, letter, you asked us to investigate the efforts of the Environmental Protection Agency (EPA) to improve the quality of information on hazardous waste generation and management capacity, and to determine how better information could be developed. We first briefed members of your staff on EPA's progress in revising the 1987 Resource Conservation and Recovery Act reporting system in March 1988. This report describes the final work carried out in response to your request.

As we arranged with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution of it until 30 days from the date of the report. At that time, copies of this report will be sent to interested congressional committees and the Administrator of the Environmental Protection Agency and will be made available to others upon request.

If you have any questions or would like additional information, please call me at (202) 275-1854 or Dr. Michael Wargo, Director of Program Evaluation in Physical Systems Areas, at (202) 275-3092. Other major contributors to this report are listed in appendix II.

Sincerely yours,

Eleanor Chelimsky
Assistant Comptroller General

Executive Summary

Purpose

The Environmental Protection Agency (EPA) and state environmental agencies share responsibilities for the national program of hazardous waste management. To perform their missions, these agencies need information about the production of hazardous waste, including minimization efforts, and the available means for safely treating, storing, recycling, and disposing of the material. However, in the past, national-level information about hazardous waste has suffered from serious deficiencies. In response to this situation, Representative Synar, Chairman of the Subcommittee on Environment, Energy, and Natural Resources of the House Government Operations Committee, asked GAO to evaluate EPA's efforts to acquire information about hazardous waste and to look for ways to develop better information.

Background

Several interrelated federal laws have established a comprehensive national program of hazardous waste management that is implemented by a partnership between the states and the federal government. The Resource Conservation and Recovery Act of 1976 and the Hazardous and Solid Waste Amendments of 1984 form the foundation for this program, but the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (known as Superfund) and the Superfund Amendments and Reauthorization Act of 1986 are also important parts.

Between 1976 and 1985, EPA developed an information system to provide information on hazardous waste that relied primarily on a joint federal-state data collection effort, known as the biennial reporting system, and on national-level sample surveys conducted by EPA. Recognizing that the information obtained from these efforts was inconsistent across states, flawed, and incomplete, EPA took steps to improve the quality of its data. GAO evaluated EPA's ongoing efforts in order to determine whether more valid and complete national information is likely to result in the future. GAO also made its own determination concerning the need for various kinds of information and about how best to obtain the data.

Results in Brief

EPA's efforts have not been successful enough to ensure the achievement of important national objectives. Important information gaps remain, problematic measurement and data collection procedures will limit the quality of some of the information that is produced, and the internal process for developing information systems does not fully assure complete and integrated data collection. The biennial reporting system still does not ensure that the states will collect or report to EPA all of the necessary data in a standardized way. These remaining problems will

significantly impair the state capacity assurances required by the 1986 Superfund amendments. Data from different sources and years will be used by different states, and states with missing data will have to use questionable assumptions provided by EPA.

Principal Findings

Information System Development

EPA has implemented information system development practices that are generally consistent with existing federal guidelines. However, some refinement is needed to ensure that the several data collection mechanisms used to collect hazardous waste information are fully integrated so that the data collected by each mechanism is consistent with, and can be used to supplement, data collected by the others. Specifically, clearer administrative responsibility for the coordination of data collection efforts is needed, and each stage in EPA's new life cycle management system needs to utilize more thorough assessments and have more complete documentation of the work that was done for major system components.

Need for Information

EPA has identified most of the needed categories of information, but there are three important exceptions. First, there is no provision for obtaining information (required for developing regulations) about the quantity and types of waste at Superfund and other similar sites that will ultimately require hazardous waste management. Second, no provision has been made for obtaining information on the quantity and types of some additional wastes that will ultimately require management, including the large volumes expected to result from the cleanup of leaking underground storage tanks. Finally, no provision has been made for obtaining information on the disposal capacity of salt domes or other geological formations that may be capable of preventing the migration of hazardous wastes.

Measurement Problems

EPA has improved the measurement instruments that it uses to obtain information about hazardous waste. For example, the problems in measuring the total amount of waste generated and in classifying the types of storage, disposal, and recycling technologies appear to have been successfully addressed. However, ill-defined categories of waste, imprecise measures, and weakly constructed questionnaire items indicate that not all measurement problems have been resolved. Indeed, the remaining

problems may produce significant errors in measuring the amounts of different types of waste generated, the capacities of various available treatment technologies, and the amount of waste eliminated by minimization efforts. GAO identified a four-class framework of treatment technologies—physical, chemical, biological, and thermal—that shows potential for further development. EPA could use this framework to develop a classification system of treatment technologies with mutually exclusive, exhaustive, and hierarchical categories. The development of such a system, combined with quantitative measures of waste characteristics, could help EPA resolve the remaining measurement problems.

Data Collection

EPA has also improved its data collection procedures. National surveys conducted directly by the agency use acceptable sampling techniques and uniform measurement instruments. However, the data collected for 1987 by the biennial reporting system will not yield complete and valid national-level information because of the continued use among the states of different data collection instruments and systems. In addition, the toxic chemical release inventory reporting system (required by the 1986 Superfund amendments) has not been designed to complement other hazardous waste data collection efforts, which means that the data cannot be used to address environmental problems within the Resource Conservation and Recovery Act program. Five other factors are likely to adversely affect future data collection and thus jeopardize information quality. First, EPA has not provided sufficient funding for states to collect and verify the data. EPA provides only 25 percent of the cost of the biennial reporting system rather than the 75 percent it generally supplies, in accordance with EPA guidelines, for other required activities. Second, EPA is not planning to conduct future national surveys using probability sampling, even though these have been its primary source of detailed national information: the biennial reporting system has not produced usable national information. Instead, EPA will rely primarily on the biennial reporting system conducted by the states. In GAO's view, combining national surveys conducted by EPA with a streamlined and standardized biennial census conducted by EPA or the states would be the most efficient approach. Third, federal recordkeeping and reporting regulations do not require hazardous waste handlers to provide the detailed data EPA requires and, fourth, they do not require states to use a specific data collection instrument to collect all necessary specific data elements, or to submit the data to EPA in a disaggregated form. Finally, EPA has limited authority under the Resource Conservation and Recovery Act to require states to collect standard data. The result of the current arrangements is that the federal information system must be pieced

together from separate state systems rather than, as suggested by the act, having the states add data to a minimum, consistent federal system.

Recommendations

In light of these findings, GAO makes several recommendations dealing with the internal process for developing information systems and their components, filling remaining information gaps, and developing measurement instruments—in chapters 2, 3, and 4, respectively. To correct the remaining data collection problems, GAO recommends in chapter 5 that steps be taken (1) to ensure that the toxic chemical release inventory can be used to supplement other hazardous waste data collection efforts, (2) to provide a level of federal support for state data collection in the biennial reporting system that assures valid and complete national data, (3) to modify federal regulations governing recordkeeping and reporting by individual handlers and state programs to ensure complete data, and (4) to use probability sampling more effectively in conjunction with the biennial reporting system.

Matters for Congressional Consideration

In addition to the improvements EPA can make, GAO believes a refinement in legislation may also be necessary to improve the quality of EPA's information. Under current law, responsibility for data collection, as well as for other regulatory activities, is shared by federal and state governments. The nonuniform data and procedures across the states, which are associated with a joint federal-state data collection effort, diminish the quality of national hazardous waste information. This problem could be corrected by separating the recordkeeping and reporting provisions of the act from other regulatory provisions and making EPA solely responsible for collecting the information required for developing and implementing the federal program. Uniform national data would then be ensured, but states would retain the authority to add data elements and to use supplemental data collection mechanisms to support their needs.

Agency Comments

GAO discussed its findings with EPA officials and has included their comments where appropriate. However, in agreement with the requester, GAO did not obtain official comments on a draft of this report. EPA officials have stated that they generally agree with our findings and noted that they have already taken steps that will at least partially address some of them. Since these actions were taken after we finished our field work, we could not evaluate them for this report. However, they are listed at the end of relevant chapters.

Contents

Figure

Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act, 1980 (also known as Superfund)
EPA	Environmental Protection Agency
GAO	General Accounting Office
HSWA	Hazardous and Solid Waste Amendments, 1984
NGA	National Governors' Association
RCRA	Resource Conservation and Recovery Act, 1976
SARA	Superfund Amendments and Reauthorization Act, 1986

Introduction

Valid national information on hazardous waste generation and management is essential for EPA and state agencies if they are to properly develop, implement, and evaluate the hazardous waste management program mandated by the Congress.[1] However, in the past, EPA was not able to develop and produce all the necessary information. As long as they lack this information, EPA, the Congress, and the public will remain uncertain about whether laws can be implemented effectively, whether progress is being made toward waste minimization, or whether generated wastes are being managed safely and disposed of securely.

On February 9, 1987, Representative Synar, Chairman of the Subcommittee on Environment, Energy, and Natural Resources, House Government Operations Committee, asked us to evaluate EPA efforts to improve information quality and then determine how EPA can better develop valid information. This report presents the results of our evaluation of the extent to which EPA efforts have improved the agency's ability to produce the necessary hazardous waste generation and management information. It also presents recommendations for further improvements.

The Nation's Comprehensive Hazardous Waste Management Program

Complex and interrelated provisions of several federal laws are the basis of a comprehensive national program for managing the threat of hazardous waste. The national program is administered through a partnership between the states and the federal government. The federal responsibilities are administered primarily by EPA's Office of Solid Waste and Emergency Response.

Subtitle C of the Resource Conservation and Recovery Act of 1976 (RCRA) provides the basic structure for managing hazardous waste in the United States. It prescribes activities to reduce the threat of hazardous waste from generation to final disposition. The Hazardous and Solid Waste Amendments of 1984 (HSWA) strengthened RCRA by further encouraging waste minimization, discouraging land disposal, and requiring the regulation of underground storage tanks.

The Comprehensive Environmental Response, Compensation, and Liability Act (commonly referred to as CERCLA or Superfund) is also an important part of the nation's comprehensive program of hazardous waste management. It requires EPA to create a National Priorities List and

[1] We use the term hazardous waste management throughout this report to refer to the numerous technologies used for hazardous waste minimization, treatment, storage, disposal, and recycling.

establishes a fund to clean up spills and uncontrolled waste sites that have been identified as priority problems. The Superfund Amendments and Reauthorization Act of 1986 (SARA) strengthened CERCLA by further encouraging permanent cleanups, requiring the application of relevant standards developed under other federal laws (such as the Safe Drinking Water Act), and requiring that cleanups meet relevant state standards. SARA also requires each state to assure "adequate capacity for the destruction, treatment, or secure disposition of all hazardous wastes [including CERCLA and RCRA defined wastes] that are reasonably expected to be generated within the state during the 20-year period following. . . [the assurance]."[2]

The enactment of SARA indicates a strong and growing connection between RCRA, Superfund, and other environmental, health, and safety legislation for managing hazardous waste. Its provisions emphasize the need to assure integrated and consistent protection across environmental programs and media (soil, water, and air). EPA has responded to this need by establishing a cross-media initiative designed to integrate environmental programs across media to ensure consistent protection. Consequently, it is important that the information collected by EPA support the interrelated objectives of these statutes.

The Problem of Data Quality

EPA has not been able to develop valid information about hazardous wastes to cover all the functions that the agency must carry out. By 1986, EPA had developed a complex information system aimed at supporting the requirements of the laws described in the preceeding section of this report. The system included several data collection mechanisms, each of which was designed to collect information deemed necessary on specific attributes of hazardous waste generation or management. For example, EPA established the RCRA reporting system (referred to by EPA as the biennial report), a mandatory biennial census of large quantity hazardous waste generators and management facilities, using the authority provided primarily by sections 3002 and 3004 of RCRA. EPA also conducted special sample surveys using the authority provided primarily by section 3007 of RCRA. These include both national surveys and smaller limited surveys for specific purposes. The Congress's concerns over the issue of data quality stem essentially from the inability of this information system to provide valid national data.

[2]Superfund Amendments and Reauthorization Act of 1986, Public Law 99-499, sec. 104 (K), 100 STAT. 1613, 1621.

Since 1986, EPA has taken steps aimed at improving the quality of hazardous waste generation and management information. These actions have produced three general changes: (1) implementation of new procedures for assuring that new or revised data collection mechanisms provide valid information, (2) implementation of an interim information system, and (3) plans for a permanent information system. The interim system relies on one-time-only national surveys of hazardous waste generators and management facilities, in addition to a partially revised RCRA reporting system. The permanent system will rely primarily on the fully revised RCRA reporting system and will also be able to utilize the toxic chemical release inventory reporting system required by SARA. It will not include major national surveys.

One important concern of the Congress is whether sufficient capacity exists to manage the hazardous waste that will be generated in the foreseeable future. There are three crucial types of capacity analysis. The first type (required by RCRA) is designed to examine whether sufficient capacity currently exists to implement the land disposal restrictions required by HSWA.[3] The second, an internal EPA initiative used for regulatory development and termed an integrated capacity analysis, is designed to assess the effects of all planned regulatory actions on the supply of management capacity and on all sources of demand for management capacity. The final capacity analysis (required by SARA) provides the basis for each state to assure that sufficient capacity exists to manage the hazardous waste (including RCRA and CERCLA wastes) that will be generated in the state for the next 20 years. Unless EPA's hazardous waste information system can provide valid data, it will be impossible to develop sound capacity assessments or to support other regulatory development activities.

Objectives, Scope, and Methodology

Objectives

The Subcommittee on Energy, Environment, and Natural Resources of the House Government Operations Committee asked us to evaluate EPA efforts to improve information quality and to determine how EPA can

[3]The 1984 amendments (HSWA) of RCRA banned the land disposal of hazardous waste that had not been treated in accordance with standards developed by EPA to ensure that it would not contaminate water supplies. HSWA requires EPA to determine that sufficient capacity of the relevant treatment technologies exists to implement the restrictions or postpone the requirements for up to two years.

better develop valid data. We translated the request into the following specific evaluation questions.

1. What problems have been identified with EPA's original hazardous waste management information system?

2. What steps have been taken by EPA to improve the quality of its hazardous waste generation and management information system?

3. Is the process EPA initiated to effect improvements consistent with generally accepted standards for developing information systems?

4. Has EPA identified the information on hazardous waste generation and management that is required by EPA and the states in order to support the program mission?

5. How well do EPA's measurement instruments actually measure the relevant attributes?

6. Are EPA's revised data collection methods and procedures likely to result in valid national information?

Scope

Information on hazardous waste generation and management is essential to determine whether sufficient management capacity exists to handle the hazardous wastes that are being produced now and that will be produced in the foreseeable future. However, our evaluation is not limited to the information needed for capacity analysis because information on hazardous waste generation and management is also used by EPA and state programs for other important activities such as enforcement. Different uses of generation and management information may require different information or different levels of specificity in the same information. For example, detailed data on the concentration of hazardous constituents in a quantity of waste may be necessary for some purposes, whereas only information on whether these constituents are present may be necessary for others. Since EPA uses specific generation and management information for multiple purposes, we could not fully evaluate EPA's need for generation and management information without broadening our scope to include consideration of all uses of this type of information.

Furthermore, we recognized that EPA possesses several mechanisms for collecting information and that states have additional mechanisms in

place. Specific information used for a single purpose is frequently obtained from multiple data collection mechanisms. Reviewing the quality of EPA's information on hazardous waste generation and management inevitably involved an examination of these mechanisms and how they functioned together to provide the needed information. Consequently, the scope of our study includes the entire system of data collection mechanisms and the several uses of the data by EPA and state agencies. Accordingly, we define valid information as information that is sufficiently accurate, detailed, and relevant for its various intended uses.

In sum, the scope of our evaluation involves the portion of EPA's hazardous waste information system that provides technical data on hazardous waste generation and management for multiple uses, including the overlaps between EPA and state needs. We examined the problems EPA experienced with its original information system until 1986 and evaluated EPA's ongoing efforts to correct them that were carried out from 1986 to August 1988. We could not evaluate more recent EPA actions. We did not examine computerized data management systems that only store administrative information, including the resource conservation and recovery information system and the comprehensive environmental response, compensation, and liability information system.

Methodology

To answer our evaluation questions, we applied generally accepted standards of information system design, as well as accepted conventions for measurement and data collection. Taken together, these principles constitute the yardstick we used to evaluate EPA's efforts. We believe that adherence to the principles is likely to lead to high quality information while lapses will probably have an adverse effect. Reliance on standards and conventions was appropriate in this study because the data collected by the new and revised data collection mechanisms developed by EPA were not ready for us to examine and seek to validate during the time frame of our field work.

To answer our first evaluation question concerning the problems that existed in the original information system (prior to interim system development), we reviewed the existing literature and interviewed EPA, state, and other experts who were familiar with the information system. We identified problems in the areas of systems development, information needs, measurement, and data collection. We also identified known gaps in the data that were collected. To identify the steps EPA has taken

to improve the hazardous waste information system, our second evaluation question, we interviewed EPA officials and reviewed EPA documentation.

We evaluated EPA's system development efforts (question 3) by applying existing, relevant federal standards for information systems development as normative criteria. These standards are contained in the Paperwork Reduction Act and the Federal Managers Financial Integrity Act, as well as in guidelines for implementing these laws developed by Presidential Councils, the Office of Management and Budget, the General Services Administration, and GAO.[4]

Determining whether EPA has identified the data needed to support the agency's hazardous waste mission in both the interim and permanent systems (question 4) required three steps. We first conducted a detailed examination of EPA program activities that are designed to achieve the program's mission. We conducted a series of semi-structured interviews with relevant division directors, each branch chief (or designated representative), and many section chiefs and project managers in the Office of Solid Waste and Emergency Response. Each branch prepared a list of the activities performed in each of its sections. During the interviews, we determined which activities used data on hazardous waste generation or management. We also identified the data that are required to perform the activity and any problems EPA personnel were experiencing with available information. Finally, we obtained and reviewed available samples of the products generated by the activities, using these data to further specify needed information. Because the scope of our project was broad, as previously discussed, we had to limit our data collection to one round of in-depth interviews. This step defined EPA's information requirements.

Second, to identify state data needs, we interviewed program officials in a judgment sample of both large and small states using semi-structured interview techniques. In addition, we attended meetings of the National Governors' Association (NGA) advisory panel devoted to the redesign of the RCRA reporting system. We also conducted a two-day workshop with selected state program experts from both large and small states to help identify state activities and data needs. (See appendix 1.) Each participant identified the activities for which data are required and any problems the states have experienced with available information. The

[4]See bibliography for detailed citations.

participants also provided documentation on the structure and organization of their programs, examples of data collection instruments that differ from those of EPA, and examples of the products produced by the activities that use these data. The participants also evaluated existing EPA data sets, which varied in breadth and detail of coverage, to determine the extent to which the data sets would be sufficient for the needs of their states. Finally, we compared the results of our analysis of EPA and state data needs to the revised data collection instruments EPA developed, to determine whether the agency has identified the required information.

Turning to measurement and data collection, we evaluated the extent to which EPA initiatives are likely to improve data quality. We also evaluated the new or revised data collection instruments EPA developed by applying generally accepted conventions of measurement as normative criteria to determine whether the measures are likely to result in valid and reliable data (question 5). The measurement conventions we applied can be found in numerous sources; three of these sources (Measurement in the Social Sciences: the Link Between Theory and Data, Measurement in the Social Sciences: Theories and Strategies, and Measurement Theory for the Behavioral Sciences) are listed in the bibliography.

Next, we evaluated the data collection methods and procedures that have been or will be employed in the interim and permanent information systems (question 6). In this analysis, we applied generally accepted conventions of data collection to determine the extent to which valid data are likely to result. We also examined whether the different data collection mechanisms are integrated so that they function together to provide valid data and whether data collection is fully supported by federal regulations.

We also examined the likely impact of remaining problems on each of the three types of capacity analyses discussed previously. We assessed the extent to which the necessary data will be supplied and the extent to which measurement and data collection problems will affect the quality of the capacity assessments.

The answers to questions 2 through 6 are conclusions about the likelihood that valid information will result from EPA improvement efforts. By comparing these conclusions to the problems identified in the original information system, we determined the extent to which improved data quality is likely. Identifying continuing and new problems in the interim and permanent information systems allowed us to identify areas where

additional improvements are needed. We determined how EPA could employ generally accepted standards in these areas to further improve data quality.

Strengths and Limitations

Our evaluation has two major strengths. The first is the systematic application of principles about information system design, measurement, and data collection. The second is the involvement of state program officials, as well as EPA officials. By involving state and EPA officials, it is possible to incorporate user participation and secure a greater degree of understanding about data needs and appropriate mechanisms for data collection.

Our evaluation also has two limitations. First, although it is often desirable to conduct several rounds of in-depth interviews to completely identify data needs, because the scope of our review was broad, we had to limit data collection to one round of interviews. Therefore, our results concerning EPA and state data needs should be considered preliminary. The second limitation of our study stems from the recommendation in the literature on the analysis and design of formal information systems that conclusions should only be drawn about independent systems, such as a business that is not a subsidiary of another.[5] The hazardous waste information system is not entirely independent in this sense, which made it difficult for us to determine the boundaries of the information system for our evaluation. We include the toxic chemical release inventory reporting system as a mechanism that can be relied on in EPA's permanent hazardous waste information system because it deals with hazardous waste and contains information important to the hazardous waste program. However, it should be noted that the reporting system was not mandated by RCRA, and the EPA office with the lead responsibility for implementing RCRA did not have the lead responsibility for developing this system. While it is appropriate for our purposes to treat this reporting system as part of the hazardous waste information system, it could also be viewed as part of other EPA information systems.

We obtained oral comments on a draft version of this report from EPA officials. Their comments have been incorporated where appropriate. Our review was conducted in accordance with generally accepted government auditing.

[5]Andre Blokdijk and Paul Blokdijk, Planning and Design of Information Systems (New York: Academic Press, 1987), pp. 39-40.

Report Organization

In chapter 2, we identify the problems experienced by the original information system and describe EPA's efforts since 1986 to improve the quality of its information on hazardous waste generation and management. We describe both the interim information system these efforts produced by August 1988 and the planned permanent information system. We also present the results of our evaluation of EPA's efforts to improve the information system development process. Chapter 3 presents the results of our assessment of the extent to which EPA has identified and made provisions for obtaining information needed to carry out activities mandated by federal laws pertaining to hazardous waste. In chapters 4 and 5, respectively, we present the results of our evaluation of EPA's measurement instruments and data collection methods. In each of these chapters, we also identify remaining problems, discuss our conclusions, and present recommendations concerning further improvements.

Initial Problems and EPA Improvement Efforts

This chapter presents the problems that were identified by EPA and other experts as contributing to low data quality in the original information system and describes EPA's efforts to correct them. In addition, we evaluate EPA's efforts to establish an improved information system development process.

Problems With EPA's Original Information System

In this section, we answer our first evaluation question: What problems have been identified with the original hazardous waste management information system?

Between 1976 and 1986, EPA established an information system to support the hazardous waste management program required by the Congress. The system included five data collection mechanisms, each of which provided some technical data on the generation or management of hazardous waste. The RCRA reporting system (also known as the biennial report) was the primary mechanism for periodic data collection, but EPA also relied extensively on special sample surveys for information not provided by the RCRA reporting system. Additional mechanisms included management facility operating and closure permit applications, manifests, and notifications of hazardous waste activity. While these additional mechanisms do not serve primarily to collect information on hazardous waste generation and management, they contain some technical data and therefore should be considered in the overall estimation of data availability. In the following subsections, we first describe each of the five data collection mechanisms and summarize the problems EPA experienced while using each of them. We then summarize the problems EPA experienced with the system as a whole—that is, problems that involve the joint functioning of the separate components.

Description of Original Data Collection Mechanisms

The RCRA Reporting System

Since its establishment in 1980, the RCRA reporting system has been the principal mechanism for the periodic collection of information on hazardous waste generation and management. In 1980, EPA published rules establishing the forerunner of the current system. These rules created an annual census of large quantity hazardous waste generators and management facilities to be conducted in each state. States that that had been authorized (see glossary) by EPA to operate their own hazardous waste program in lieu of RCRA could collect their own information as long as they met the general RCRA authorization requirements. That is, reporting requirements in authorized states had to be equivalent to, consistent with, and not less stringent than the federal reporting requirements; however, authorized states were not required to collect identical

information. Authorized states were to submit summaries of the information they collected to EPA. EPA collected the data, using its own instrument, in states that were unauthorized.

In 1982, EPA proposed to shift to a national, biennial sample survey. EPA preferred this approach over the state census because the agency thought the data would be more verifiable, contain more detail, produce better national information, and reduce the overall paperwork burden on industry. EPA stated specifically that, under the state census approach, "the variety of forms and data processing systems used by the states would probably preclude timely and efficient data analysis."[1]

According to the plan, EPA was to be solely responsible for the survey and thus would not have to rely on summaries or other information transfers from authorized states. States could continue to collect additional information from all hazardous waste handlers (see glossary), but they were no longer required to do so. The proposal provided for states to add questions, increase the sample size, and conduct the survey jointly with EPA to avoid any problems that might arise from differing state and federal authority.

The plan was flawed, however, in that it contained no specific provision for maintaining a current list of all handlers or the basic information required about each that is necessary for enforcement and other purposes. In addition, many of those who filed comments with EPA believed the plan would increase rather than decrease the overall paperwork burden on industry because, under the plan, states could maintain their existing reporting requirements. As a result of negative comments and the threat of litigation, EPA withdrew the proposal and instead issued rules in 1983 establishing the current biennial state census.

As established by current regulations and EPA policy, the RCRA reporting system consists of three tiers. First, federal regulations require handlers in unauthorized states to report directly to EPA, using a specific EPA data collection instrument. Authorized states may use their own instruments, which must collect information that is consistent and equivalent to the EPA instrument (but not necessarily identical). In the second tier, federal regulations require authorized states to submit summary reports to EPA. As established by EPA policy, the third tier of the RCRA reporting system

[1]EPA, " Hazardous Waste Management System: Standards Applicable to Generators of Hazardous Waste and Standards Applicable to Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Federal Register, 47:197 (October 12, 1982), p. 44933.

consists of the agency's compiling data and then publishing a national report.[2] EPA has completed three RCRA reporting cycles covering 1981, 1983, and 1985. However, in 1988, EPA documents stated that the RCRA reporting system had never produced valid national data. EPA officials now believe the report on the 1985 reporting cycle published in March 1989 contains "reasonably valid data" on the total volumes generated and managed. However, they acknowledged that the problems discussed later in this chapter prevented timely data analysis and that some of the problems could not be overcome.

Four additional data collection mechanisms in the original information system (through 1986) did or could have potentially provided information on hazardous waste generation and management. We briefly describe each of them in the following sections of this chapter.

Special Sample Surveys

EPA's original information system, which existed through 1986, relied on national probability sample surveys for more detailed and uniform information than that provided by the RCRA reporting system. EPA also has conducted other smaller surveys for more limited purposes. EPA conducted a major national survey of hazardous waste generators and management facilities (originally intended as the first biennial survey), covering calendar year 1981, to support the regulatory impact analyses required by Executive Order 12291. Since then, EPA has used the survey data extensively for developing regulations.

The remaining data collection mechanisms were not designed primarily for collecting generation or management data to characterize the regulated population. However, they do contain some information on hazardous waste generation and management, and therefore should be considered in the overall estimation of data availability.

[2]Although HSWA does not require a formal report to the Congress, the language of the conference committee report strongly implies that the Congress will mandate a periodic report if the RCRA reporting system does not prove satisfactory. The conference committee report concluded that since EPA had begun a program (the 1983 cycle of the RCRA reporting system was then under way) to provide the needed information to the Congress and the public, a "formal report to Congress" is not needed. The report adds that the "administrator is expected to continue this program and to seek more accurate data than has been available in the past" (Hazardous and Solid Waste Amendments of 1984 Legislative History, U.S. Code Congressional and Administrative News, 98th Cong., 2nd sess., 1984. Public Law 98-616, p. 5700).

Operating and Closure Permit Applications

Hazardous waste management facilities are required to seek and obtain operating and closure permits.[3] Federal regulations specify a two-part permit application. Part A of the permit application is a standard form that contains specific information listed in federal regulations. For example, Part A includes the types and quantities of hazardous wastes the facility plans to manage and a description of the processes to be used to manage the waste, including the design capacity (see glossary). Part B of the permit application contains extensive additional, but not standardized, information designated in federal regulations.

Manifests

To track the cycle of hazardous wastes, RCRA requires each consignment of hazardous waste shipped off-site for management (including CERCLA and corrective action wastes) to be documented in a manifest. The hazardous waste manifest contains information on the type, quantity, and disposition of the hazardous wastes shipped away from the point of generation. The receiving management facility must retain a copy of each manifest and return copies to the transporter and the generator, who must also retain them.

Notification

Federal regulations require handlers of hazardous waste to inform EPA or authorized states of their regulated activities. Upon initial notification, EPA assigns the handler an identification number. This is the principal mechanism for identifying the regulated population. The federal notification document contains information on the type of regulated activities and the type of regulated wastes handled.

Problems With the Data Collection Mechanisms

EPA experienced problems with all the previously discussed data collection mechanisms. Based on existing literature and interviews with EPA, state, and other experts familiar with the system, we divided the problems EPA experienced with each data collection mechanism into three general areas: (1) information requirements, (2) measurement, and (3) data collection. Table 2.1 summarizes the problems EPA experienced with the RCRA reporting system in each of these areas. Table 2.2 summarizes the problems EPA experienced with the additional data collection mechanisms and notes the area(s) in which problems were experienced.

[3]In addition to a permit to operate a management facility in an approved manner, each facility must have an approved plan for how the facility will eventually be closed—to ensure that it does not become an uncontrolled hazardous waste site—and a post-closure plan for monitoring. Facilities that are closed continue to require monitoring by their owners. Facilities that recycle hazardous wastes do not require operating permits, but most require storage permits. A limited number of recycling operations are exempt from all permit requirements.

Table 2.1: Problems With the RCRA Reporting System

Problem type and specific problem	Problem description
Information requirement	
No information on management characteristics of wastes	EPA and most states did not collect information on the characteristics of wastes that determine appropriate management practices
No information on amount managed and disposed of by each management and disposal technology	The EPA data collection instrument did not obtain information on the amount of each type of waste managed and disposed of by each management and disposal technology, such as landfills
No information on amount of management capacity	The EPA data collection instrument did not obtain information on available management capacity
No quantitative information on waste minimization efforts	The EPA data collection instrument did not obtain quantifiable data on the extent of waste minimization or the specific efforts to reduce waste generation
Measurement	
Inadequate measure of waste type	Handlers reported similar wastes as different EPA-defined waste types (EPA waste codes); many handlers and states reported wastes as mixed, which prevents calculation of amounts of each type
Inadequate measure of the amount of wastes generated and managed	Some wastes were not counted, and others were counted more than once
Inadequate measure of management technologies	Types of management technologies were not sufficiently specified; EPA could not determine intermediate treatment steps or how much waste was managed by what types of technologies
Inadequate measure of regulated status	EPA and state data collection instruments did not adequately update notification forms, which prevented EPA from developing an accurate list of active handlers
Data collection	
Inconsistent data processing systems across states	Few states automated the RCRA reporting system, and many had low quality control; the data received by EPA varied in timing, form, and quality
Inconsistent data collected across states	Lack of a uniform data collection instrument and inconsistent EPA guidance caused the collection of inconsistent data because (1) some states and EPA regions instructed handlers to report wastes treated in exempt processes and some did not, (2) some states had more stringent definitions of hazardous waste, and (3) some states used differing measures; in addition, summary data concealed differences so that EPA could not separate state from RCRA regulated wastes

Table 2.2: Problems With Special Surveys, Permit Applications, and Manifests

Source	Use	Problem
Special sample surveys	EPA has relied on special sample surveys for information not provided by the RCRA reporting system	Sample surveys do not provide the information that is needed on all handlers and quickly become out-of-date (data collection problems)
Operating and closure permit applications	Management facilities are required to obtain a permit detailing activities likely to be performed	Permits are not required for generators (data collection) and are not accurate reflections of many actual activities (information requirements); some valid data are included (such as limiting conditions of operation), but the permits are not accessible because they are retained by state and local offices
Manifests	In order to track its movement, each consignment of hazardous waste shipped away from the generating facility is manifested	Manifests are not uniform across states and contain different information in different states (information requirements and measurement), federal regulations do not require the return of manifests to EPA or state programs, and most hazardous waste is managed at the generating facility where manifests do not apply (data collection)
Notification	Hazardous waste handlers are required to notify EPA or states of regulated activities and type of waste handled	Notification contains limited information (information requirements) and is often not updated to reflect current regulatory status, activities, or wastes handled (data collection)

Problems With the Information System as a Whole

EPA experienced problems at the overall information system level. We defined system-level problems as those that affected more than one component of the system or those that involved the joint functioning of system components. The first system-level problem was the lack of integration among system components—that is, the different data collection mechanisms failed to function together to produce information. For example, EPA officials explained that handlers often used a variety of codes from different data collection mechanisms to complete portions of the RCRA reporting system data collection instrument and that this caused problems in interpreting the responses. In addition, some states used manifest data, which was inconsistent across states, to prepare part of the information for their RCRA reporting system submissions. The problem thus created consisted of a lack of system integration, involving the use of inconsistent data collection instruments and systems among states, between EPA and states, and for both states and EPA over time.

The second type of system-level problem involved EPA's internal process for developing and modifying its information system. Specifically, problems in the area of system development included (1) the lack of a comprehensive plan to coordinate data collection efforts, (2) the lack of a comprehensive evaluation of existing regulatory development data, (3) isolated data collection efforts that were narrowly focused and resulted in duplication of effort, and (4) data planning and collection responsibilities that were divided among program offices with inadequate integration of data collection efforts (including cross-media data collection efforts). System development problems such as those just described are associated with individual data collection mechanisms, as well as the information system as a whole. Therefore, although it was not possible to demonstrate that system development problems caused the specific problems just discussed, such a connection is plausible.

Table 2.3 indicates the major problem areas that affected each individual data collection mechanism and the original information system as a whole. Through 1986, these problems had prevented EPA from determining with reasonable certainty how much hazardous waste of what type was generated, how it was managed, whether sufficient management capacity existed, or whether progress was being made in reducing waste generation.

Table 2.3: Problems With Individual Data Collection Mechanisms and the Original Information System as a Whole

	Problem area			
Data collection mechanism	**System development**	**Information requirements**	**Measurement**	**Data collection method**
RCRA reporting system		X[a]	X	X
Special sample surveys				X
Permit applications		X		X
Manifests		X	X	X
Notification		X		X
The system as a whole	X			X

[a]An "X" indicates that a problem existed.

EPA Actions to Improve the Information System

This section addresses the second evaluation question: What steps have been taken by EPA to improve the quality of its hazardous waste generation and management information system?

EPA initiated 13 efforts to improve the information system that have directly affected the quality of hazardous waste generation and management information.[4] Four of these efforts were aimed at improving the overall system development process, while the remaining nine were aimed at specific components (such as data collection mechanisms) or parts of components. Of these nine efforts, three were undertaken cooperatively with the National Governors' Association (NGA), while the remainder were internal EPA initiatives. These actions resulted in two general outcomes: (1) the establishment of data collection mechanisms to serve national objectives temporarily until permanent mechanisms become fully functional and (2) the development of plans for the permanent mechanisms. We refer to these outcomes as EPA's interim and permanent information systems. The interim system includes a partially revised RCRA reporting system in combination with one-time-only national surveys of hazardous waste generators and management facilities. The permanent system will rely primarily on a fully revised RCRA reporting system and can also draw on the toxic chemical release inventory reporting system required by SARA. The reporting requirements for the toxic chemical release inventory reporting system are to be phased in during the interim phase and will become fully functional in the permanent phase by 1991. The permanent system will not include the national sample surveys contained in the interim system but will continue to include the more limited scope surveys included in the original information system.

Table 2.4 depicts the original problem area(s) that each of the 13 actions were intended to improve. Table 2.5 describes the four system development efforts. Table 2.6 describes the improvement efforts undertaken cooperatively by EPA and NGA, while table 2.7 lists the six improvement efforts implemented solely by EPA. Table 2.8 shows the status of each new or revised data collection mechanism in the interim and permanent information systems.

[4]EPA has initiated numerous other efforts to improve its information system that are not directly related to the quality of technical data on hazardous waste generation and management. An evaluation of these efforts was beyond the scope of our report.

Table 2.4: Problem Areas Addressed by Each EPA Improvement Effort

Improvement	Problem area			
	System development	Information requirements	Measurement	Data collection
1. Evaluation of the data collection activities	X[a]			
2. Establishment of a central coordinating office	X			
3. Establishment of a data collection tracking system	X			
4. Development of a life cycle management system	X			
5. Redesign and evaluation of the RCRA reporting system for 1987		X	X	X
6. Development of the SARA capacity assurance requirements		X		
7. Development of the Toxic Chemical Release Inventory System		X	X	X
8. Review of a sample of completed forms to assess 1985 RCRA reporting cycle		X	X	X
9. Development of a hazardous waste management simulation model		X	X	X
10. Conduct of a national survey of hazardous waste management facilities		X	X	X
11. Conduct of a national survey of hazardous waste generators		X	X	X
12. Redesign of the hazardous waste manifest		X	X	X
13. Development of a new measure of hazardous waste type			X	

[a]An "X" indicates that a problem area was addressed.

Table 2.5: Specific Activities to Improve the EPA System Development Process

Improvement	Purpose	Result
1. Evaluation of data collection activities and data sources	To improve the coordination of future data collection activities by providing a framework for collecting all of the office's regulatory development data and to assess past and current activities	A complete listing of data sources relevant to decision making was developed; all activitities were assessed, as were their interrelationships with each other; recommendations on how to improve data collection activities, individually and in relation to one another, were developed and proposed
2. Establishment of a central coordinating office	To establish an organization that could centrally control all information-system-related activities	A coordinating office for information system activities was established within the Office of Solid Waste; responsibility for all components of the hazardous waste information system was transferred to this office
3. Establishment of a data collection tracking system	To establish a mechanism designed to monitor the relationship and efficiency of data collection activities	A fully functional tracking system was established that lists all data collection activities approved by the Office of Management and Budget
4. Development of a Life cycle management system	To assure that information systems developed meet the requirements	EPA implemented a life cycle management system covering hazardous waste information system development

Table 2.6: EPA/NGA Improvement Activities

Improvement	Purpose	Result
1. Redesign of the RCRA reporting system	To revise the major reporting component of the information system and to develop a partnership with the states for its use	A policy decision was made that the revised system will be the single permanent routine data collection mechanism; the effort also resulted in the development of a plan for fully revising the reporting system and interim procedures used for the 1987 reporting cycle—national surveys such as those conducted during the interim phase will be discontinued, but EPA will continue to use limited scope surveys sponsored by the substantive divisions
2. Development of SARA capacity assurance requirements	To meet the requirements of SARA, specifications needed to be developed on how the capacity assurance analyses were to be performed and what data were required	Data requirements to support the technical analyses were developed, and the technical analyses to be conducted were defined
3. Development of a toxic chemical release inventory system	To develop a system which would provide both public information on the use and management of toxic chemicals, and data for regulatory decision making	EPA has promulgated final rules for the establishment of the inventory reporting system; the system is a mandatory census of firms that manufacture, process, or use toxic chemicals

Table 2.7: EPA Improvements Developed Internally

Improvement	Purpose	Result
1. Conduct survey to assess 1985 RCRA reporting cycle	To confirm the 1985 RCRA reporting cycle data and assess their problems	A sample of 1985 hazardous waste handlers was developed; problems in the areas of data accuracy and data completeness were identified
2. Develop hazardous waste management simulation-model	To develop a simulation model that could be used to estimate volume managed by each technology	Development of an assumption-driven model that determines (1) appropriate treatments, (2) sequence of treatments, (3) overall volume reduction associated with treatment, and (4) amount of waste treated in each treatment sequence
3. Conduct survey of hazardous waste management facilities	To collect detailed data on 1986 waste management activities to support capacity assessments required by land disposal rules of HSWA	Partial results of survey were used to support the first third of the land disposal restrictions; survey was completed after our evaluation data collection was concluded
4. Conduct survey of hazardous waste generators	To collect detailed data on the nation's hazardous waste generators	Results were not available until after our evaluation data collection was concluded
5. Redesign hazardous waste manifest	To address problems in data collection, measurement, and requirements area	Initiative postponed
6. Develop new measure of hazardous waste type	To improve reliability, validity, and usefulness of the measure	Initiative discontinued

Table 2.8: Interim and Permanent Status of New and Revised Data Collection Mechanisms

Data collection mechanism	Interim phase	Permanent phase
National survey of hazardous waste management facilities	Implemented and completed by late 1988	No further national surveys conducted
National survey of hazardous waste generators	Implemented and completed by 1989	No further national surveys conducted
RCRA reporting system	Partially revised system implemented for 1987 cycle; completion originally planned for 1989 now planned for 1991	Fully revised system to be implemented
Toxic chemical release inventory reporting system	Final regulation published; system partially implemented	System fully implemented

Evaluation of Efforts to Improve the System Development Process

This section addresses our third evaluation question: Is the process EPA initiated to effect improvements consistent with generally accepted standards for developing information systems?

Of the four efforts aimed at improving information system development shown in table 2.4, the first three were aimed at increasing the level of overall information system integration and coordination among development projects, while the final effort was aimed at planning specific information system components to assure that they fully support the program mission. Our evaluation of these four efforts is given below, while evaluations of the other improvement activities are presented in succeeding chapters.

Overall Information System Integration and Coordination

The Evaluation of Data Collection Activities

The EPA evaluation includes a comprehensive listing of existing data bases and provides the foundation for developing a plan for coordinating data collection activities. The draft report contained six recommendations for improving the management and dissemination of existing and ongoing information activities. The responsible EPA official explained that these draft recommendations were not final and that alternative recommendations were being developed in conjunction with the contractor. The evaluation represents a significant accomplishment both because it systematically catalogues existing data sources and because it is a step toward establishing a comprehensive plan for data collection.

The Central Coordinating Office

The establishment of a central data coordinating office in EPA's Office of Solid Waste, which administers RCRA, is also an important accomplishment because it establishes a known authority and responsibility for developing integrated information systems and fosters a supportive attitude. Such practices are recommended by the Office of Management and Budget, the General Services Administration, and GAO systems development guidelines for implementing the Paperwork Reduction Act. The evaluation of data collection activities, discussed previously, indicated that increased coordination was not achieved without difficulty. However, staff gradually began to recognize that the existence of a central focal point facilitated the interactive agreement necessary for meeting complex data needs. All 13 of the improvement projects we discussed above had some contact with this central data coordinating office. Such contact helped reduce duplication and helped increase both the extent to which single data collection efforts met the needs of multiple users and the extent to which multiple data collection efforts complemented one another.

The central coordinating office, however, has not yet completely corrected the problems of the past. EPA has still not developed a comprehensive data collection plan. The previously discussed evaluation of data collection activities concluded that without such a plan to act as a "forcing function" for coordination and integration, data collection efforts, many of which are performed by EPA contractors, could continue to be isolated.

The central coordinating office also did not have full authority to develop new data collection efforts. This office had to rely on contributions from the budgets of the divisions to develop information sources. That is, the budget for information system development was not separated from the substantive divisions. Other offices continued to have primary responsibility for developing key aspects of the information system. In addition, there was no prime contractor with overall responsibility for the hazardous waste information system. EPA officials stated that these factors contributed to a lack of integration, including conflicting plans and duplication of effort.

One important instance of a lack of integration of data collection efforts was that the plan for the 1987 RCRA reporting cycle was finalized before the requirements for SARA capacity assurance were developed, even though one important purpose for redesigning the reporting system was to provide information for capacity assurances. EPA officials stated that they were forced to "jury-rig" different data collection mechanisms in order to develop the data necessary for the capacity assurances required by SARA. EPA officials also observed that the timing of HSWA and SARA requirements complicated their efforts. (We discuss the relationship between data collection efforts and intended uses further in chapter 5.) EPA officials stated that another important instance of lack of integration was that divisions offering funding for a specific data collection project have not always followed through with the funds to complete it.

In addition, the Office of Toxic Substances and the Office of Solid Waste did not fully integrate the toxic chemical release inventory reporting system required by SARA with the other reporting systems related to hazardous waste. This jeopardizes EPA efforts to achieve its cross-media objective (discussed earlier) and contributes to the continuing isolation of data collection efforts. Officials in EPA's Office of Solid Waste pointed out that this data collection mechanism is not intended primarily to implement RCRA, although it does capture information about hazardous waste. This is all the more reason for ensuring that the data collected

can be used to supplement efforts that are primarily intended to implement RCRA.

The Data Collection Tracking System

The data collection tracking system, part of the office's Information Collection Budget program, was intended to list all information requests submitted for Office of Management and Budget approval, the level of effort required, and the funding approved by this agency. Such a system has real potential for helping to assure the integration of data collection efforts. However, the system is not fulfilling this potential for three reasons. First, it is incomplete because some projects or revisions to ongoing projects are not included. Second, the system is not organized for maximum impact on coordination and integration because submission of documentation to the system occurs too late in the planning process for it to be effective. Finally, the system lacks adequate coordination authority in that the staff who operate the tracking system are not responsible for working with the program offices to coordinate and integrate data collection efforts.

Planning Specific Information System Components: the Life Cycle Management System

Life cycle management is a standard approach to developing and revising information systems or components. It is based on the concept that all information systems progress through the same basic stages from initial development to operation and maintenance and, finally, termination. The President's Councils on Management Improvement and on Integrity and Efficiency view the concept of life cycle management as the conventional approach to developing information systems that "evolved because of the need for managers to assess the totality of work to be undertaken, and to develop plans accordingly."[5] EPA's fiscal years 1987-89 Information Resources Review Plan now requires life cycle management.

Life cycle management requires specific documentation (that is, reports on specific topics) for each stage of the cycle, the level of which should be commensurate with the importance of the information system. Although the number of stages varies in different applications, the basic documentation is standard and includes a needs statement, a feasibility assessment, a risk analysis, a cost benefit analysis, and a system decision paper. The life cycle management system is new and thus only covered one of the major data collection efforts we identified—the redesign

[5]President's Council on Management Improvement and President's Council on Integrity and Efficiency, Model Framework for Management Control Over Automated Information Systems (Washington, D.C.: U.S. Government Printing Office, January 1988), p. 22.

of the RCRA reporting system. The other major data collection efforts developed by this office—that is, the national surveys of hazardous waste generators and management facilities—were not covered. The planning documentation did, however, discuss the relationship between the national surveys and the RCRA reporting system. We reviewed the implementation of the life cycle management system for the RCRA reporting system according to the federal guidelines discussed earlier. Since the RCRA reporting system is crucial for providing hazardous waste generation and management information, we discuss the life cycle management documentation for the system in detail.

The life cycle management system, as implemented, is consistent with EPA policy and other federal guidelines. It includes all the required documentation. Although it does not include a separate risk analysis document, risks are discussed. Risk analyses are important because they assess the extent to which the organization will become dependent on the system, the consequences of failure, how failure can be avoided, and the type of backup that should be required.

The implementation of the life cycle management system has the potential to assure that information system planning supports the mission of the organization. EPA's use of the system was especially strong in the area of incorporating user participation. EPA ensured that the views of state program users were incorporated by working with an advisory council, composed primarily of state program personnel, that was established by NGA to assist in the revision of the RCRA reporting system.

The documentation of the analyses performed, however, was limited, given the importance of the system and the extent to which the agency will depend on it. Even though the system is crucial, summary documentation (brief statements indicating what analyses were performed and the conclusions) would have been satisfactory if more in-depth work had been cited. However, the additional work that was cited contained only general statements and, in some cases, EPA officials stated that no more in-depth work had been conducted. In the following paragraphs, we summarize the limitations of the documentation provided for the 1987 revision of the RCRA reporting system.

The needs statement, which documents problems in the existing information system and the need to redesign it, did not include a complete analysis of existing problems. Since the document states that the RCRA reporting system has never produced valid national data, it would be expected that the existing problems would be thoroughly assessed.

Neither the report on the evaluation of a sample of the completed forms from the 1985 RCRA reporting cycle nor the NGA reports cited in the needs statement contained a systematic assessment of previous problems.

The RCRA reporting system was vulnerable to problems caused by the differences between the various state data collection systems and procedures. And, although the many differences between state procedures remain a feature of the revised system, they (and their implications for the revised system) were not thoroughly assessed. Since the revised system relies on the same existing state systems that have produced significant problems in the past, the lack of a careful analysis of how the revised system would solve past problems is a notable omission. In addition, there was no assessment of the extent to which EPA will be dependent on the adequate functioning of the RCRA reporting system. This indicates that the risks associated with the revised system were not completely addressed.

EPA's cost benefit analysis considered only two alternatives to the current approach to collecting generation and management information for regulatory development purposes: (1) relying entirely on national surveys sponsored by EPA, and (2) relying entirely on an expanded RCRA reporting system. The possibility of using a more effective combination of these strategies than was used in the past was not examined in the feasibility study.

EPA chose to eliminate national surveys—such as the surveys of generators and management facilities employed in the interim phase—primarily to save costs. No weight was given to the fact that the RCRA reporting system had not produced valid national information in a timely manner or that the plan would make EPA totally dependent on an untested entity.

Perhaps most importantly, the life cycle management documentation did not contain a systematic analysis of the required information. The documentation lists 17 standard management reports that are needed, but it does not link the reports to either program needs or specific data elements. The requirements analysis report cites NGA background reports as providing additional information on the development of the data collection instrument. However, while the NGA reports do contain additional information, it is general information rather than a detailed analysis of EPA or state program information needs. And, while the

Office of Management and Budget approval package for the RCRA reporting system included somewhat more detail, the discussion there is also general in nature.

The NGA advisory council repeatedly requested that EPA prepare an analysis of the needs to be served by each proposed data element. EPA officials promised to prepare such a report for the final meeting of the NGA advisory council (in October 1987) before the beginning of the 1987 reporting cycle. According to EPA officials, however, time pressures prevented its accomplishment.

The documentation focuses on EPA's need for regulatory development data but does not analyze state data needs. EPA recognized that states have different information needs and that the revised RCRA reporting system would require states to collect information they do not need. The system concept report, part of the life cycle management system, states that

"Core data items [required from states] are those items which are collected by implementors and transmitted to oversight [EPA]. Implementors generally, but not necessarily, have interest in these items. Implementors have a responsibility to validate core data items" [emphasis added].[6]

Requiring the states to collect information essential to EPA but not needed by the states is not consistent with the two-domain concept that was incorporated into the plan for revising the RCRA reporting system.[7] The concept is based on the premise that the information transferred to EPA is a subset of the information needed by the states. Despite this recognition and the known potential for conflict over this point, no systematic assessment of the specific differences between EPA and state data needs or their implications for the RCRA reporting system was conducted. In addition, the incentive for states to maintain data integrity, enhanced by state ownership and control of the data (an essential part of the two-domain concept), is jeopardized if states do not need the data for their own purposes. EPA officials pointed out that the data to be included in the implementor domain was subject to negotiation between EPA and state representatives and thus did not need to be a subset of the data needed by the states.

[6]Office of Solid Waste, EPA, "Biennial Report Information System, System Decision Paper I: Concept Development," unpublished (November 30, 1987), p. 6.

[7]The two-domain concept was developed specifically for a new overall data management system, termed the resource conservation and recovery information system, and then applied to the RCRA reporting system.

The life cycle documentation did not address the question of whether appropriate legal authority was in place to support the revised system or whether additional regulations were needed. Yet authorized states remain uncertain about whether they have the legal authority to collect additional data from handlers using the RCRA reporting mechanism. EPA remains uncertain about whether authorized states can be required to collect the data deemed necessary in a standard form or provide disaggregated data to EPA.

Authorized states are uncertain whether RCRA's section 3007 authority is applicable to states and whether it is sufficient to enable them to collect the new data included on EPA's 1987 revised data collection instrument. We discussed this issue with an EPA official in the Office of the General Counsel. He indicated that section 3007 provides the authority for EPA and authorized states to obtain any information that handlers possess as long as it used for the purposes specified in RCRA, although he acknowledged that this application of section 3007 might have to be tested in lengthy litigation. However, their authority under section 3007 cannot be used by EPA or authorized states to require that handlers develop new information in order to complete reporting instruments (such as performing tests on waste streams that are not already specifically required by applicable federal or state recordkeeping regulations).

EPA's plan for the revised RCRA reporting system includes requiring states to obtain data that are identical to that included on EPA's revised data collection instrument (but not to use the instrument itself) and to submit data to EPA in a disaggregated form. We asked the EPA official in charge of the RCRA reporting system whether authorized states could be required to provide uniform disaggregated data to EPA. He expressed concern about whether EPA could require authorized states to provide uniform data in a disaggregated form. He stated that EPA was currently working on this issue but would not have additional authority in place for the 1989 reporting cycle. As described previously, existing federal regulations specifically require authorized states to submit summary reports (rather than disaggregated data) but do not specifically require authorized states to collect data that are identical to that contained in EPA's data collection instrument. Without these requirements, the same problems of inconsistent measures and definitions across states can recur in the new, revised system. We believe these legal questions could and should have been resolved prior to the start of the 1987 reporting cycle.

Summary and Conclusions

Before we began our evaluation, EPA had developed an information system that included five data collection mechanisms that provided some information on hazardous waste generation or management. EPA experienced specific problems with the individual data collection mechanisms or with the information system as a whole in four areas: (1) system development, (2) information requirements, (3) measurement, and (4) data collection. Through 1986, these problems had prevented EPA from determining with reasonable precision or certainty how much of what type of hazardous waste was generated, how it was managed, whether sufficient management capacity existed, or whether progress was being made in reducing hazardous waste generation.

EPA initiated 13 efforts to improve the hazardous waste information system that directly affected the quality of its information on hazardous waste generation and management. In this chapter, we presented our evaluation of EPA efforts to improve the information system development process; efforts aimed at improving specific information system components are discussed in subsequent chapters. Four information system development problems have been identified: (1) lack of a comprehensive plan to coordinate data collection efforts; (2) no comprehensive evaluation of existing regulatory development data; (3) isolated data collection efforts that were narrowly focused and resulted in duplication of effort; and (4) data planning and collection responsibilities that were divided among program offices, with inadequate integration of data collection efforts (including cross-media data collection efforts).

EPA's evaluation of data collection activities has fully corrected the second of these problems. However, the improvement efforts we evaluated are not likely to prevent the problem of the isolated development of data collection efforts needed to ensure integrated data collection that fully supports the program mission. No overall data collection plan has been developed. The central coordinating office does not have full authority to develop data collection efforts and did not use a central prime contractor for developing systems. The coordinating office had to rely on contributions from the budgets of program offices, other offices continued to have responsibility for improvement projects, and the tracking system does not provide a mechanism for ensuring consistency. These factors also contribute to the possibility both of failure to collect needed information in some areas and of redundant data collection in others.

The principal planning mechanism (the new life cycle management system) is a major improvement, but it needs refinement to ensure that it accomplishes its intent. In the one applicable case where it was used, the

analysis and documentation were inadequate given the importance of the system. Important potential data collection alternatives were not considered, the analysis of costs and benefits was inadequate, previous problems with the data collection mechanism were not systematically examined, and specific information needs were not systematically identified. Finally, the legal authority for collecting new information was not clarified.

Our findings show that EPA has established an improved information system development process that is largely consistent with federal guidelines and EPA policy. Our findings also show that further improvements are needed. EPA should develop a comprehensive plan for data collection. The life cycle management system should require complete and detailed documentation for major information system components. Placing the final authority for developing information system components in the central coordinating office, which would have control over the information system development budget and use a prime contractor when appropriate, is an additional step EPA should consider in order to achieve an overall information system that effectively supports the program mission.

EPA officials indicated that in general they agreed with our findings and are already taking steps that at least partially address some of them. They stated that a survey of the states to determine what state officials believe their data needs are has now been completed, that the central coordinating office now has its own budget that is supposed to be adequate for system development (although the office may still obtain additional funding from substantive divisions), and that they now have a prime contractor for the RCRA reporting system. We did not, however, evaluate EPA's recent activities.

Recommendations

We recommend that the Administrator of EPA direct that the Assistant Administrator for Solid Waste and Emergency Response take appropriate steps to enhance its information system development process and fully ensure that data collection efforts complement each other and support the program mission. Specifically, a comprehensive data collection plan should be developed. Steps should be taken to improve the assignment of responsibilities for planning and directing the development of information system components by increasing the authority of the central coordinating office to develop data collection efforts and ensure consistency. Finally, the life cycle management system should be refined

to ensure the complete and detailed analysis and documentation of each stage of the cycle for major system components.

EPA Information Needs

This chapter addresses our fourth evaluation question: Has EPA identified the information on hazardous waste generation and management that is required by EPA and the states in order to support the program mission? We identify those activities conducted by EPA and the states that need generation and management information, present our assessment of the information needed for each activity, and compare these needs to EPA's new and revised data collection instruments. The comparison shows the extent to which the agency has provided for the obtaining of necessary information, including the information that was identified as missing in the original EPA information system.

Identification of Activities

EPA's need for information on hazardous waste generation and management is broadly determined by statutory goals, objectives, and requirements. Specific information needs are a function of the activities conducted by EPA and the states to accomplish this mission. To identify these activities, we first asked each of the 38 potentially relevant EPA branches to enumerate its activities. This resulted in a universe of 616 distinct activities. We then asked each branch chief to identify the activities that require information on either hazardous waste generation or management. In addition, we reviewed the activities not identified in the second step to guard against oversight and misunderstanding, and reviewed reports and documents that resulted from the activities to further specify information requirements. This "bottom-up" approach enabled us to obtain a detailed understanding of specific program activities and their information needs. We also interviewed directors of key divisions with policy responsibility for the development of generation and management information.

With respect to state data needs, it was necessary to identify only those activities with consistent information needs across all states, since states and EPA share the results of national data collection efforts for these activities. While authorized states use generation and management information to support many activities, their activities and information needs are not generally consistent. This is so because (1) states may implement federal requirements in various ways as long as the results are consistent with and equivalent to federal requirements and (2) in addition to implementing federal requirements, states may develop additional requirements and establish activities with their own unique information needs. We included only those activities with consistent information needs across all states because these can be used to form the foundation of a national information system, while activities with inconsistent information needs cannot.

EPA and state agencies have different responsibilities, which are divided along functional lines. All authorized states have primary responsibility for implementing the federal program (such as issuing permits and conducting inspections). EPA regional offices assume this responsibility in unauthorized states and for Hazardous and Solid Waste Amendments of 1984 (HSWA) provisions that become effective in authorized states without the modification of state laws and regulations. EPA headquarters has the primary oversight responsibility for monitoring the performance of the state agencies, administering the overall national program (such as allocating funding to states), and developing federal regulations pertaining to hazardous waste management. The state activities we identified as having consistent information needs are those implementation activities required of all states by EPA.

We identified 10 activities performed by all states or EPA that require periodic collection and maintenance of hazardous waste generation or management data. Table 3.1 lists the activities we identified in each functional area and shows the organizational responsibility for each.

Table 3.1: Program Activities That Require Generation or Management Information, by Function and Responsible Organization

Function and activity	Responsible organization	
	State	EPA
Implementation		
1. Prioritize inspections	X[a]	
2. Prepare enforcement cases	X	
3. Provide technical assistance	X	
Administration and oversight		
4. Develop SARA capacity assurance	X	X
Regulatory development		
5. Regulatory policy assessment		X
6. Technology assessment		X
7. Capacity assessment for implementing land disposal restrictions		X
8. Integrated capacity analysis		X
9. Risk assessment		X
10. Regulatory impact analysis		X

[a]An "X" indicates the location of primary responsibility.

Information Requirements for Implementation, Administration, and Oversight Activities

Implementation Activities

Implementation activities are those that are conducted to carry out existing state and federal laws and regulations concerning hazardous waste management.[1] Our panel of state experts identified five implementation activities that require information on hazardous waste generation or management: (1) prioritizing inspections, (2) preparing enforcement cases, (3) providing technical assistance, (4) assessing fees for hazardous waste handlers, and (5) issuing permits for management facilities. Of these implementation activities, assessing fees and issuing permits do not require national information. Fees are not required by the Resource Conservation and Recovery Act of 1976 (RCRA) and are assessed at the state level. Fees are set on the basis of the amounts and types of waste generation and waste management activities, but there is extreme variation in how states assess these fees. Permits consider facility and waste characteristics but are issued on a facility-specific basis. Consequently, permit issuance and fee assessment do not require information on the regulated population as a whole and therefore do not contribute to the foundation of a national information system.

Prioritizing Inspections

State agencies do not have the resources to inspect every hazardous waste handler. Therefore, agencies must decide which facilities to inspect. EPA has recently begun to establish general guidelines for states to use in prioritizing inspections. The major priority is environmental significance—that is, the potential for harm resulting from the activities conducted at each facility. For example, EPA has specifically identified management facilities with incinerators, facilities with land disposal units (especially those nearing closure), and facilities with ongoing corrective actions as high priority facilities for the purpose of inspection. EPA has determined that these attributes of management facilities post high risks to human populations and the environment. RCRA also requires annual inspections of commercial facilities receiving wastes

[1]To facilitate recordkeeping relevant to all activities, EPA assigns an identification number to each handler. Similarly, all activities require that EPA describe the regulatory status of each handler and the reason for nonregulated status.

defined by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), and thus these facilities receive a high priority. Once the priorities are established, states need to target the high priority handlers for inspections. States need information on each handler about the types of management technologies used, the source of wastes (such as whether the waste originates at a CERCLA site), whether the technology is commercially available, the permit status (interim, final, or nearing closure), whether ongoing corrective actions exist, and whether facilities are government owned.

EPA enforcement officials explained that states will also have to prioritize inspections of generators and management facilities in terms of the environmental significance of large quantities of wastes, particularly hazardous wastes, and wastes that require specific treatments according to the land disposal restrictions. Thus, the states require from each facility information on waste characteristics of sufficient detail to identify the treatment technologies required by the land disposal restrictions. This required information includes the identity of the regulated waste streams (as defined by EPA waste code), information on the physical and chemical form of the waste, and the concentrations of hazardous and nonhazardous constituents that determine the way a waste is treated—that is, its treatability. (See glossary entry for Treatability Analysis.) It also requires information on the presence of other particularly hazardous constituents that do not affect the selection of management technologies (including metals and nonmetals). Although state and EPA officials could not identify all these constituents, they would include chemicals such as methylene chloride, a known carcinogen.

Preparing Enforcement Cases

Information on hazardous waste generation and management is required for prioritizing and preparing enforcement cases. First, state agencies use information on the types of wastes generated and managed to prioritize their responses to emerging enforcement actions, which may result from public complaints or inspections. For example, if a complaint is received indicating the possibility of illegal dumping at a facility, state agencies use information on the type of wastes handled at the facility (and the degree of hazard they represent) to prioritize the enforcement case. With respect to CERCLA and corrective action sites, enforcement officials identify responsible parties by reviewing information on the origin, volume, and treatability characteristics (as defined by EPA waste code) of specific regulated wastes received at a particular site. Information on management technologies is also necessary to determine how the

wastes were handled at the site. The most detailed information necessary for this activity is the identity of major hazardous constituents present in a quantity of waste. This information is necessary to enable states to identify parties that sent waste with specific constituents to particular facilities.

Providing Technical Assistance

States have increasing responsibilities for providing technical assistance to waste generators as a result of the alternative management required by the land disposal restrictions. States are beginning to provide technical assistance to generators in locating appropriate facilities for managing (including recycling) specific types of waste. In order to provide this assistance, states require information on the specific management technologies available at each facility that provides commercial waste management.

Table 3.2 summarizes the data needs we identified for each implementation activity and shows that the data requirements across the activities are quite similar. These data are needed on every handler because implementation activities involve all handlers; thus, the use of probability samples would not be possible.

Table 3.2: Types of Information Required for Implementation Activities

Type of information	Activity: Prioritize inspections	Prepare enforcement cases	Provide technical assistance
Regulatory status			
EPA ID number	X[a]	X	X
Type of status	X	X	X
Reason for nonregulated status	X	X	X
Wastes and waste characteristics			
Each regulated waste stream (as defined by EPA waste code) present in a quantity of waste	X	X	
Quantities	X	X	
Chemical and physical form for treatability analysis	X	X	
Concentrations of hazardous and nonhazardous constituents for treatability analysis	X	X	
Major additional hazardous metals present	X	X	
Major additional hazardous nonmetals present	X	X	
Waste management			
Treatment technologies	X	X	X
Storage technologies	X	X	X
Disposal technologies	X	X	X
Types of recycling	X	X	X
Commercial status	X		X
Permit status	X		X
Waste source			
Originating facility		X	
CERCLA, corrective action	X		

[a]An "X" indicates that information is required.

Administrative and Oversight Activities

Administrative activities are those required to operate EPA or state agency programs but not directly associated with implementing existing laws and regulations. Oversight activities are those conducted by EPA to determine whether the states are implementing the federal program adequately and whether the overall national program is effective. The activities conducted by EPA or states in these areas that use generation or management data are (1) allocating resources required for program activities, (2) monitoring state agency performance, (3) evaluating the effectiveness of the national program, and (4) developing the capacity

assurances required from each state under the Superfund Amendments and Reauthorization Act of 1986 (SARA). At the present time, however, only the capacity assurances each state must develop require a national information system. State data needs for allocating resources appear to be minimal and inconsistent across states, while EPA does not use generation or management data for this activity. EPA and most states have not conducted program evaluations. Finally, EPA does not use generation or management information for monitoring state agency performance.

SARA capacity assurance does require consistent national information. EPA is responsible for establishing consistent data and analysis requirements across all states, but the states are responsible for developing their own assurances. The states require an extensive amount of data to conduct the required analysis. Our panel of state experts indicated that SARA capacity assurance is the major driving force behind the increased need for information on hazardous waste generation and management. Since these data needs are both extensive and similar to those of other capacity analyses conducted by EPA for developing federal regulations, we discuss the information needs for SARA capacity assurance in the following sections of our report in conjunction with the other capacity analyses EPA conducts to support the development of federal regulations.

Information Requirements for Regulatory Development Activities

Developing federal regulations calls for different types of analysis that use information on hazardous waste generation and management. Five types of analysis are used in the process of developing federal regulations, although not all these types are required in every case: (1) regulatory policy assessment, (2) capacity assessment (land disposal and integrated), (3) risk assessment, (4) technology assessment, and (5) regulatory impact analysis. Usually, regulatory policy analysis is a qualitative consideration of legal and regulatory issues that does not require generation or management information. However, the assessment of regulatory policy concerning waste minimization does require generation and management data. Capacity assessments, policy assessment for waste minimization, and risk analyses require extensive generation and management information. Technology assessment, used to identify best demonstrated available technologies, requires less extensive data, which are fully provided by the data needed for capacity assessment and risk assessment. The cost benefit analyses required for the regulatory impact analysis under Executive Order 12291 use the same generation and management data as those required for risk assessments. Thus, from an information requirements perspective, the essential types of analysis to

examine are capacity assessment, waste minimization, and risk assessment. Since waste minimization data are also required for capacity assessment, we discuss them together. In the following section, we provide a detailed discussion of their data needs.

Capacity Assessment and Waste Minimization

Capacity Assessment

Three types of capacity assessment are currently conducted. First, HSWA requires EPA to determine whether sufficient capacity exists to implement the land disposal restrictions required by HSWA. If sufficient capacity does not exist, the regulations must be postponed. Second, EPA is conducting an integrated capacity analysis to determine the effects of proposed regulations on waste generation and management capacity over the next three to five years. This is an internal analysis that is used in risk assessments and regulatory impact analyses but will not result in a specific published report. Finally, SARA requires each state to assure that sufficient capacity will exist to manage the hazardous wastes produced in the state for the next 20 years. In each case, whether sufficient capacity exists is determined by comparing the amount of capacity required to manage hazardous wastes to the amount available for that purpose. We contrast the data needs for each type of capacity analysis according to the three major stages of any capacity analysis: (1) the determination of required capacity, (2) the determination of total capacity, and (3) the determination of whether available capacity is sufficient.

The Determination of Required Capacity. This involves two basic steps: (1) identification of the volumes of waste covered or affected by the capacity assessment and (2) analysis of the treatability of the affected waste and determination of the required capacity for each type of management technology.

It is first necessary to determine the volume of waste covered by the analysis. For the land disposal restrictions, these are termed "affected wastes" because only certain wastes (as designated by EPA waste codes) are affected by each requirement. This requires data on the volume of each waste stream currently managed that would be affected by the land disposal restrictions.

Only the proportion of the affected waste streams that is actually land-disposed is subject to the requirements. This includes residuals from prior treatment (secondary generation) of affected waste streams and agents added during management, as well as wastes that were land-disposed without prior treatment (primary generation). Thus, information on the volume of each affected waste stream disposed of by each current land disposal technology is essential. Land disposal technologies include landfills, surface impoundments, and waste piles.

Finally, since some affected wastes are already treated to a level that would meet the treatment requirements, it is necessary to determine the proportion of land-disposed, affected wastes that already meet the treatment standard. This determination requires information on each type of management technology the affected waste streams were subjected to prior to land disposal, in order to identify the proportion that would not have met the requirement.

The analysis for the land disposal restrictions requires a "snap shot" analysis. Information on the volumes of wastes that will need to be treated in the foreseeable future is not required. Thus, information on currently managed CERCLA, corrective action, and closure site wastes is required, but information on the total volume of these wastes that will ultimately require treatment is not.

The integrated capacity analysis must identify the volumes of primary and secondary generation of all wastes from all sources that are currently treated and that will require treatment in the foreseeable future. Thus, the integrated capacity analysis requires information beyond that required for implementing the land disposal restrictions. In addition to currently managed wastes, the analysis requires information on quantities of waste at CERCLA sites, corrective action sites, and closure sites that will require treatment over the time frame of the analysis. The integrated capacity analysis also requires information on the volumes of waste that will become subject to management requirements as a result of new regulations currently under development. Additionally, information is needed on potential forms of waste management—including underground vaults, salt domes, and other geological formations used for disposal—that prevent the migration of wastes.

Finally, the integrated capacity analysis requires information on the extent of waste minimization. This information is necessary to determine the impact that waste minimization efforts will have on the volume

of waste that will require additional capacity. We discuss the data needs for waste minimization in the next section of our report.

SARA capacity assurance requires all the information necessary for the integrated capacity analysis. In addition, it requires information on state-level imports and exports in order to determine the quantities of waste managed within each state, the volumes of wastes exported to specific states, and the volumes imported from specific states.

The second major stage of the analysis of required capacity, termed treatability analysis, is the same for all types of capacity analysis. The purpose of the treatability analysis is to determine the required capacity of each type of management technology by assigning each quantity of affected waste to appropriate management technologies. In this way, the required capacity of each type of technology is defined.

The type or types of treatment technology required by a specific volume of waste is determined by its physical and chemical characteristics, including the presence and concentration of some hazardous and some nonhazardous constituents. Treatability analysis sorts wastes into groups based on these characteristics and assigns the volumes to specific treatment technologies or combinations of technologies. In order to perform the analysis, information is required on the physical and chemical characteristics of each volume of waste, including the concentration of some hazardous and nonhazardous constituents that determine applicable treatment technologies. Technical reports prepared for EPA list approximately 60 characteristics that are used to determine accurately the type of treatment technology applicable to a given quantity of waste.

Determination of Total Management Capacity. This stage is the same for each of the three types of capacity assessment. It requires information on (1) current total capacity and (2) future total capacity.

The determination of current total capacity requires three types of information: (1) the capacity of individual units of equipment, (2) the management technology or technologies used in each unit, and (3) schematic diagrams showing how the units are linked together into process systems. A process system is a number of linked units performing one or more management technologies in series. The analysis also requires information on those units of equipment that are shared by one or more process systems. This requires detailed design and operational information on unit process capacities (including ancillary equipment),

throughput operations, and amount of downtime per operating period. This information allows the capacity of each management technology and each system to be calculated.

The determination of future total capacity requires information on future plans and an assessment of regulatory changes. Current management facilities may plan to increase or decrease total capacity, and parties that do not currently manage hazardous waste may plan to. Moreover, these plans are themselves contingent on regulatory changes. In addition, some types of equipment can be quickly converted to another management technology.

The analysis of future changes also requires an assessment of the effects of regulatory changes. For example, changes in minimum technology requirements have led to the closure of many surface impoundments, which decreases total hazardous waste management capacity. The location standards and other minimum technology requirements may also decrease total management capacity. Information on design characteristics of management units and permit status is required to determine the capacity that currently meets each alternative proposed standard.

Determination of Available Capacity. Available capacity is the difference between the total and the utilized amount of management capacity. Utilized capacity includes that portion used by nonhazardous wastes managed in hazardous waste facilities and by agents added to hazardous waste during management (such as reagents and stabilizers). Hazardous waste management capacity is sufficient if available capacity is equal to or greater than required capacity.

For the land disposal restrictions, available capacity is calculated by first determining the proportion of the total capacity of each alternative technology that is already utilized for the treatment of other hazardous and nonhazardous wastes. Then, the amount of waste restricted from land disposal is apportioned to determine if sufficient capacity exists to implement the regulation. The analysis must be conducted on a facility basis for on-site and captive systems (that is, those that are not commercially available). Any portion of the affected waste that exceeds the capacity available at that site or those of subsidiaries must be assigned to commercial facilities. The data must be of sufficient detail to identify captive facilities (owned by the same company) and units of equipment that are partly or completely available for commercial waste management.

For the integrated capacity analysis, the changes in total capacity of all types over the time frame of the analysis are compared to the changes in total demand from all sources (including nonhazardous waste and agents added during management) for the same period. The analysis must also avoid including capacity that is only available to a single firm or a limited number of firms with capacity that is available to any firm.

SARA capacity assurance requires the same comparison as the integrated capacity analysis discussed previously, except that it is required on an individual state basis rather than a national basis. This means that in addition to the analytic techniques already discussed, the analysis requires information on the origins and destinations of the types and amounts of wastes imported into and exported from each state. This information is required to show whether each state has within its borders sufficient capacity to manage the waste imported into the state and the waste both generated and treated within its borders. This information is also required as a basis for agreements with other states concerning imports and exports.

Waste Minimization

EPA is currently assessing existing waste minimization efforts in order to establish national policy—that is, whether and what type of regulations may be needed. As previously discussed, data on waste minimization are also required as a component of some capacity assessments in order to project future demand for waste management capacity. The information requirements for assessing waste minimization efforts can be divided into two categories: (1) the extent and (2) the determinants of waste minimization.

Extent. To assess the extent of waste minimization that has been achieved requires knowledge of both the absolute and relative change in the quantity and toxicity of waste generated. Information on the absolute reduction requires data on the total quantity and toxicity for at least two years to observe any change. An important consideration here is that the quantity of waste may be reduced by removing water or other harmless constituents while the quantity of hazardous constituents remains the same, thus increasing the toxicity of the waste. Sound information on the change in toxicity requires detailed quantitative information on the change in concentration of each hazardous constituent.

Since the overall volume of waste generated varies with the volume of useful production, information on the absolute change in waste generation alone is insufficient. It is also necessary to know the relative change

in waste generation per unit of production. This requires information on the quantity of production in each year. However, the types of units produced may result in different quantities of hazardous waste. Therefore, useful information on relative waste generation requires data on the amount and toxicity of the waste generated for each type of product in each year.

Determinants. Information on the determinants of waste minimization is necessary to assess areas where interventions might further reduce waste generation. In addition to the waste stream (as defined by EPA waste code) involved, this requires detailed information on the characteristics of the waste and the production process that generated it because the feasibility of waste minimization varies with the type of waste and the specific industrial process. Waste minimization practices are also more feasible for recurrent industrial hazardous waste generation than for other sources of waste. Additional sources of waste for which waste minimization practices are less applicable include one-time-only generation (such as decommissioned equipment that is contaminated); off-specification chemical products that require disposal; and wastes from CERCLA sites, corrective action sites, closure sites, or those produced by the cleanup of leaking underground storage tanks.

Table 3.3 summarizes the information we identified as needed for capacity assessment and waste minimization policy assessment. The just-concluded discussion shows that the information needed for capacity assessment and waste minimization policy is more extensive than that required for implementation activities. However, since the information is only used to characterize the regulated population and is not needed for every handler, sample surveys are possible.

Table 3.3: Types of Information Required for Capacity Analyses and Waste Minimization Policy Assessment

Type of information	SARA[a]	INTEG[b]	HSWA[c]	WMPA[d]
Regulatory status				
EPA identification number	X[e]	X	X	X
Type of status	X	X	X	X
Reason for nonregulated status	X	X	X	X
Wastes and waste characteristics				
Each regulated waste stream (as defined by EPA waste code) present in a quantity of waste	X	X	X	X
Quantities	X	X	X	X
Physical form data for determining treatability of wastes	X	X	X	X
Chemical characteristics for treatability analysis	X	X	X	X
Concentration of hazardous and nonhazardous waste for treatability analysis	X	X	X	X
Waste management				
Treatment technologies	X	X	X	
Storage technologies	X	X	X	
Current disposal technologies	X	X	X	
Potential disposal technologies (geological formations)	X	X		
Types of recycling	X	X	X	
Residual waste generation	X	X	X	
Type of equipment	X	X	X	
Ancillary equipment	X	X	X	
Capacity of each unit of equipment	X	X	X	
Design characteristics affected by proposed regulations	X	X	X	
System diagrams	X	X	X	
Type of management system (technologies and equipment)	X	X	X	
Capacity of management system	X	X	X	
Quantity hazardous waste managed by each technology or system of technologies	X	X	X	
Quantity of nonhazardous waste managed by each technology or system of technologies	X	X	X	
Quantity of agents added during management	X	X	X	
Planned capacity changes	X	X	X	
Commercial status	X	X	X	
Permit status	X	X	X	
Imports and exports				
Originating facility identification	X			
Destination facility identification	X			
Waste source				

(continued)

Type of information	SARA[a]	INTEG[b]	HSWA[c]	WMPA[d]
Routine industrial production	X	X		X
One-time-only generation, including decommissioned equipment, off-specification product, CERCLA, corrective action, closure, and other remedial action	X	X		X
CERCLA volumes requiring management	X	X		X
Corrective action volumes requiring management	X	X		X
Additional sources affected by pending regulations	X	X		
Waste minimization				
Waste stream affected	X	X		X
Specific industrial process	X	X		X
Total waste volume change	X	X		X
Total production change	X	X		X
Specific product change	X	X		X
Specific waste volume change	X	X		X
Concentration of each hazardous constituent				X

[a]SARA = SARA capacity assurances

[b]INTEG = integrated capacity analysis

[c]HSWA = HSWA capacity analysis for land disposal restrictions

[d]WMPA = Waste Minimization Policy Assessment

[e]An "X" indicates that information is required.

Risk Assessment

EPA currently uses comparative risk assessment techniques to analyze potential regulatory requirements by determining whether land disposal is actually more hazardous than the demonstrated alternatives. For example, air emissions from incineration of a waste could be more hazardous than the soil and groundwater contamination from land disposal. EPA's current use of risk assessment, however, has a limited role in risk management decisions. Continued land disposal of untreated waste would not be permitted even if all demonstrated alternatives to land disposal were identified as more hazardous. As already mentioned, the data requirements for risk assessment also provide the data needed for the remaining regulatory development activities, including technology assessments and regulatory impact analyses.

Complete risk assessments generally consist of four analytic stages: (1) hazard identification, (2) dose-response estimation, (3) exposure assessment, and (4) risk characterization. Basically, the first two stages determine the probability of an adverse health or environmental incident from exposure to precise amounts of substances identified as hazardous.

Exposure assessments determine the amount of the hazardous substances to which populations are actually exposed. The final stage characterizes the risk of individuals or populations based on the work completed in the first three stages.

Information on the generation and management of hazardous waste must be collected and maintained by EPA to support the exposure assessment portion of these risk assessments. The other risk assessment stages rely on different types of data. In order to estimate exposure, EPA must know the volumes of waste that are land-disposed and the volumes that would be treated by each alternative technology or combination of technologies for each proposed alternative regulation. In addition to the information needed for capacity analysis, more detailed data on the characteristics of the wastes are required. Information is required on waste characteristics that determine the mobility or rate of migration of hazardous constituents through a medium and on the concentration of each hazardous constituent. Whereas some chemical and physical form parameters (such as solubility) that determine the appropriate treatment also affect mobility, EPA documents note that additional parameters (such as the rate of biodegradation) are also required. While knowing the concentration of some hazardous and nonhazardous constituents is necessary to determine the appropriate alternative treatment, the concentration of all hazardous constituents is required for complete exposure assessments. When EPA does not have the necessary data, assumptions based on engineering judgments are used to complete the exposure analysis.

In addition to the amounts and characteristics of the wastes involved, releases to the environment and subsequent exposure are determined by characteristics of management technologies and equipment. This requires much of the same data necessary for the capacity assessment because it is necessary to assign the wastes that are currently land-disposed to types of alternative technologies. In addition, detailed data are required on the design of equipment and materials of construction in order to estimate the magnitude of releases from different types of equipment under different regulatory scenarios. Information on the types of monitoring methods are also required since releases are affected by the stringency of monitoring.

Finally, detailed site-specific geohydrologic and other environmental data pertaining to waste management are necessary for determining the speed and concentration of wastes that move through different environmental media and ultimately reach human populations. These data

include, for example, actual releases, the types of soil underlying facilities, the height of seasonal water tables, groundwater flow rates, latitude and longitude, and the distance of waste handling areas from the nearest residence, surface water, wells, or property boundary. These data are used in conjunction with fate and transport models to estimate likely human and environmental exposures.

Table 3.4 summarizes the data requirements for risk assessment and the additional remaining regulatory development activities. The foregoing analysis shows that risk assessments, which also support cost benefit analyses, require extensive information in addition to that required for capacity assessments. Because these data are used to characterize aspects of the regulated population as a whole, probability sample surveys are possible (since information is not necessarily required for every handler).

Table 3.4: Types of Information Required for Risk Assessment and Remaining Regulatory Development Analysis

Type of information	Technology assessment	Risk assessment	Regulatory impact analysis
Regulatory status			
EPA identification number	X[a]	X	X
Type of status	X	X	X
Reason for nonregulated status	X	X	X
Wastes and waste characteristics			
Each regulated waste stream (as defined by EPA waste code) present in a quantity of waste	X	X	X
Quantities		X	X
Physical form data for determining treatability of wastes	X	X	X
Additional physical form data for determining mobility of wastes		X	X
Chemical characteristics for treatability analysis	X	X	X
Additional chemical characteristics for determining mobility		X	X
Concentration of hazardous and nonhazardous waste for treatability analysis	X	X	X
Concentration of all hazardous constituents		X	X
Waste management			
Treatment technologies	X	X	X
Storage technologies		X	X
Current disposal technologies		X	X
Potential disposal technologies (geological formations)		X	X
Types of recycling		X	X
Residual waste generation		X	X
Type of equipment		X	X
Ancillary equipment		X	X
Capacity of each unit of equipment		X	X
Design characteristics affected by proposed regulations		X	X
Design characteristics for estimating releases		X	X
Types of monitoring methods		X	X
Construction material		X	X
System diagrams		X	X
Type of management system (technologies and equipment)		X	X
Capacity of management system		X	X
Quantity hazardous waste managed by each technology or system of technologies		X	X

(continued)

Type of information	Technology assessment	Risk assessment	Regulatory impact analysis
Quantity nonhazardous waste managed by each technology or system of technologies		X	X
Quantity of agents added during management		X	X
Planned capacity changes		X	X
Commercial status	X	X	X
Permit status		X	X
Geohydrological and environmental data			
Soil types		X	X
Groundwater flow rates		X	X
Proximity to water source		X	X
Height of water table		X	X
Distance from management units to property line		X	X
Distance from property line to nearest potential human exposure		X	X
Actual releases to environment		X	X
Latitude and longitude		X	X
Waste source			
Routine industrial production		X	X
Specific industrial process		X	X
One-time-only generation, including decommissioned equipment, off-specification product, CERCLA, corrective action, closure, and and other remedial action		X	X
CERCLA volumes requiring management		X	X
Corrective action volumes requiring management		X	X
Additional sources affected by pending regulations		X	X
Waste minimization			
Waste stream affected		X	X
Total waste volume change		X	X
Total production change		X	X
Specific product change		X	X
Specific waste volume change		X	X
Change in concentration/amount of each hazardous constituent		X	X

[a]An "X" indicates that information is required.

The foregoing analysis shows that data with different levels of detail, which correspond to different sets of activities, are needed. The least detailed level of data is required for implementation activities, but this information is needed for every handler because the information is used

to monitor individual handlers. The data required for capacity analyses are much more extensive than those required for implementation activities. However, sample surveys are possible because the information is needed to characterize aspects of the regulated population, not to monitor each handler. Sample surveys are also possible for risk analyses, the most detailed level of necessary information, for the same reason. We discuss the feasibility and design of sample surveys further in chapter 5 when we discuss data collection issues.

Comparison of Information Needs With Data Collection Instruments

Our first concern was to determine whether the EPA improvements addressed the information gap problems identified in the original system. Consequently, we compared the four new and revised EPA data collection instruments to the data gaps identified in chapter 2 to determine if they had been closed. To determine whether EPA had provided for the collection of the information we have identified through our requirements assessment, we compared the results of our assessment with the four new or revised data collection instruments. We defined a data gap as any situation in which EPA had not made provisions to collect the data that we identified as necessary.

Overall Assessment

The four new or revised data collection instruments developed by EPA include those developed for (1) the revised RCRA reporting system, (2) the generator survey, (3) the management facility survey, and (4) the toxic chemical release inventory reporting system. Table 3.5 combines the information needs we identified in the above information requirements analysis across all activities and indicates the information that is provided by each of the new or revised data collection instruments. The information included on the 1985 RCRA reporting system instrument is included as a baseline.

Table 3.5: Comparison of Information Needs With the Information Gathered by the New and Revised Data Collection Instruments, Using the 1985 RCRA Reporting Instrument as a Baseline.

	Data collection instrument[a]				
Type of information	**1985**	**1987**	**TSDR**	**GEN**	**TCRI**
Regulatory status					
EPA identification number	X[b]	X	X	X	X
Type of status	X	X	X	X	
Reason for nonregulated status		X	X	X	
Wastes and waste characteristics					
Each regulated waste stream (as defined by EPA waste code) present in a quantity of waste	X	X	X	X	
Quantities	X	X	X	X	
Physical form data for determining treatability of wastes	[c]	X	X	X	X
Additional physical form data for determining mobility of wastes				X	
Chemical characteristics for treatability analysis	[c]	X	X	X	
Additional chemical characteristics for determining mobility				X	
Concentration of hazardous and nonhazardous waste for treatability analysis	[c]	X	X	X	
Major additional hazardous metals present		X	X	X	
Major additional hazardous nonmetals present		X	X	X	
Concentration/amount of all hazardous chemicals present					X
Management data					
Treatment technologies	X	X	X	X	X
Storage technologies	X	X	X	X	X
Current disposal technologies	X	X	X	X	X
Potential disposal technologies (geologic formations)		[d]	[d]	[d]	[d]
Types of recycling		X	X	X	X
Residual waste generation		X	X	X	
Type of equipment			X	X	
Ancillary equipment					
Capacity of each unit of equipment	[c]		X	X	
Design characteristics affected by proposed regulations			X	X	
Design characteristics for estimating releases				X	
Type of monitoring methods			X	X	
Construction material			X	X	
System diagrams			X	X	
Type of management system (technologies and equipment)		X	X	X	
Capacity of management system	[c]	X	X	X	
Quantity hazardous waste managed by each technology or system of technologies	[c]	X	X	X	
Quantity nonhazardous waste managed by each technology or system of technologies		X	X	X	
Quantities of agents added during management			X	X	

(continued)

Type of information	Data collection instrument[a] 1985	1987	TSDR	GEN	TCRI
Planned capacity changes		X	X	X	
Commercial status		X	X	X	
Permit status		X	X	X	
Imports and exports					
Originating facility identification	X	X			
Destination facility identification	X	X			
Geohydrologic and environmental data					
Soil types				X	
Groundwater flow rates				X	
Proximity to water source				X	
Height of water table				X	
Distance from management units to property line				X	
Distance from property line to nearest potential human exposure				X	
Actual releases to environment				X	
Latitude and longitude				X	
Waste source					
Routine industrial production		X	X	X	
One-time-only generation, including decommissioned equipment, off-specification product, CERCLA, corrective action, closure, and other remedial action		X		X	
Total CERCLA and total corrective action volumes that will require management		[d]	[d]	[d]	[d]
Additional sources affected by pending regulations (underground storage tanks)		[d]	[d]	[d]	[d]
Waste minimization					
Waste stream affected	[c]	X		X	
Specific industrial process	[c]	X		X	
Waste volume change	[c]	X		X	
Production change	[c]	X		X	X
Change in concentration/amount of each hazardous constituent	[c]			X	X

[a]1985 = 1985 RCRA reporting instrument
1987 = 1987 RCRA reporting instrument
TSDR = National Survey of Management Facilities (TSDR survey)
GEN = National Survey of Generators
TCRI = toxic chemical release inventory reporting instrument

[b]An "X" indicates the presence of the required information.

[c]Information gap orginally identified in chapter 2

[d]Remaining information gap

In chapter 2, four information gaps were identified in the original EPA information system: (1) physical and chemical management characteristics of a waste, (2) amount of waste actually managed or disposed of by each management technology or series of technologies, (3) available management capacity, and (4) the extent of waste minimization. Each of these gaps is indicated in table 3.5 by a superscript C. There are more

than four information types thus indicated because knowledge of more than one attribute is necessary to fill each gap. Table 3.5 shows that EPA has eliminated all of the gaps that were identified in chapter 2. Table 3.5 also shows that the vast majority of the information we identified as necessary in our complete information requirements analysis is addressed in one or more of the data collection instruments.[2] If the information is included on one or more of the new or revised instruments, EPA has identified the required information.

Table 3.5, which is based on our complete information requirements analysis, also shows that some information we identified as necessary is not included in any of the data collection efforts. Each area where an information gap remains is indicated by a superscript D in table 3.5. The three areas where information is lacking are (1) the quantities and types of waste present at CERCLA and corrective action sites that will ultimately require treatment and secure disposal at RCRA regulated facilities, (2) the quantities and types of waste from the cleanup of leaking underground storage tanks that will be subject to the requirements of Subtitle C under the expanded organic toxicity regulation, and (3) the management capacity of salt domes and other geological formations. Complete information in these areas is not available in any other existing sources, will be difficult to obtain, and will seriously jeopardize the achievement of important national objectives until it is obtained.

Implications for the Interim and Permanent Information Systems

The lack of information in these areas in the interim information system will primarily affect SARA capacity assurances, EPA's integrated capacity analysis, and EPA regulatory development activities, including risk assessments and regulatory impact analyses. As discussed previously, this information is necessary to fully determine whether sufficient capacity will be available in the foreseeable future and the risks, costs, and benefits posed by alternative regulatory approaches. In addition, the planned permanent information system contains no mechanism for providing this information.

Currently, the primary source of data on CERCLA site wastes is the records of decision developed immediately before the start of a cleanup. Records of decision are agreements between the federal government and the other relevant parties concerning a specific site. These documents,

[2]The four initial information gaps were identified before our complete information requirements analysis was conducted. Therefore, there could have been—and in fact were—more information gaps than were identified in chapter 2.

produced in the final stage of investigating sites for cleanup, contain estimates of the volumes of waste to be managed and the management technologies required. However, records of decision only exist for 100 of the 890 sites on the National Priorities List, and this list does not include additional sites that states have designated for cleanups. Other data are available for many additional sites from other stages of the investigation of specific sites, such as the regulatory investigation and feasibility study stage.

Adequate data on the volumes of waste from corrective action sites that will need treatment are also lacking. The only data available for corrective action sites are found in corrective measure studies. Similar to records of decision, these studies are only available for a limited number of potential corrective action sites.

According to the EPA official we interviewed on this subject, wastes generated from the cleanup of underground petroleum storage tanks are not currently regulated as hazardous wastes. Accordingly, no effort has been made to assess the volumes of soil contaminated with substances such as benzene and toluene. The revised organic toxicity regulation under development at EPA, however, will capture much of these wastes as hazardous waste. Although the process would be difficult and expensive, the volumes of these wastes could be estimated by a survey.

No data currently exist on the potential capacity of geological formations that could be used for waste disposal. If it can be shown that waste will not migrate from these formations, their use could help alleviate potential capacity shortfalls. EPA officials stated that one geologic formation (a demonstration project operated by the Department of Energy) is currently receiving low level radioactive wastes mixed with hazardous waste, that permit applications have been submitted for two geological formations to operate as disposal facilities with no migration variances (see glossary), and that there are numerous other promising geological formations. The potential capacity of these geologic formations could be estimated on the basis of a sample of known formations.

The data just discussed could be used to significantly improve EPA's understanding of the amounts of waste that will require management in the future and when it is likely that these wastes will need treatment. However, we recognize that it is not possible to develop information on future waste management needs with the same precision as is possible for currently generated wastes and present management practices.

Summary and Conclusions

Our analysis shows that EPA has extensive needs for hazardous waste generation and management information. The information requirements can be divided into three groups based upon the amount of detail required.

All the data gaps identified in the original information system are filled by one or more of the new or revised data collection instruments. The vast majority of the additional data needs we identified have also been addressed by one or more of the instruments developed by EPA. This represents a significant accomplishment by EPA. However, we also found that three information requirements have not been satisfied. Without this information, EPA regulatory development research and national capacity analyses, including SARA capacity assurances, will be significantly flawed.

Recommendations

We recommend that the Administrator of EPA direct the Assistant Administrator for Solid Waste and Emergency Response to take appropriate and feasible steps to fill remaining information gaps, including (1) the volumes of waste located at CERCLA and corrective action sites that will ultimately require management capacity, (2) the volumes of waste that will require management capacity under proposed regulations (including the large volumes of waste expected from the cleaning up of leaking underground storage tanks), and (3) the potential disposal capacity of salt domes and other geological formations that are capable of preventing the migration of wastes.

Assessment of Measurement Instruments

This chapter addresses our fifth evaluation question: How well do EPA's measurement instruments actually measure the relevant attributes? We evaluated the measures used in the four new and revised instruments in order to determine whether they are likely to produce the needed information identified in chapter 3. We applied relevant, generally accepted measurement conventions developed to help assure that measures are reliable and valid. (The reliability of a measure is the extent to which it produces the same result when repeatedly applied to a characteristic of an object. The validity of a measure is the extent to which it actually measures the attribute about which information is needed.) We also discussed potential measurement problems with EPA and other experts familiar with the hazardous waste system and the activities for which the data will be used.

Since the instruments EPA developed use similar or identical measures of basic attributes, we reviewed each type of measure across all four instruments. Table 4.1 summarizes the overall results of our analysis of the measures used to provide the information identified as necessary in chapter 3, and it also shows the areas where measurement problems persisted. (The measurement problems originally identified in the 1985 RCRA reporting instrument are included as a baseline.)

Table 4.1: Required Information Types for Which Measurement Problems Exist, Using the 1985 RCRA Reporting Instrument as a Baseline.

	Data collection instrument[a]				
Type of information	**1985**	**1987**	**TSDR**	**GEN**	**TCRI**
Regulatory status					
EPA identification number					
Type of status	X[b]				
Reason for nonregulated status	X				
Wastes and waste characteristics					
Regulated waste stream present in a quantity of waste	X	X	X	X	
Quantities	X				
Physical form data for determining treatability of wastes		X	X	X	X
Additional physical form data for determining mobility of wastes					
Chemical characteristics for treatability analysis		X	X	X	
Additional chemical characteristics for determining mobility					
Concentration of hazardous and nonhazardous waste for treatability analysis		X	X	X	
Major additional hazardous metals present					
Major additional hazardous nonmetals present					
Concentration and range of all hazardous chemicals present					
Management data					
Treatment technologies	X	X	X	X	
Storage technologies	X				
Disposal technologies	X				
Types of recycling		X	X	X	
Residual waste generation					
Type of equipment					
Ancillary equipment					
Capacity of each unit of equipment			X	X	
Design characteristics affected by proposed regulations					
Design characteristics for estimating releases					
Construction material					
System diagrams					
Type of management system (techniques and equipment)					
Capacity of management system		X	X	X	
Quantity hazardous waste managed by each technique or system of techniques					
Quantity nonhazardous waste managed by each technique or system of techniques					
Planned capacity changes					
Commercial status					
Permit status					
Imports and exports					
Originating facility identification					

(continued)

Type of information	Data collection instrument[a] 1985	1987	TSDR	GEN	TCRI
Destination facility identification					
Geohydrologic and environmental data					
Soil types					
Groundwater flow rates					
Proximity to water source					
Air emissions					
Distance from management units to property line					
Distance from property line to nearest potential human exposure					
Actual releases to environment					
Waste source					
Routine industrial production					
Specific industrial process					
One-time-only generation, including decommissioned equipment, off-specification product, CERCLA, corrective action, closure, and other remedial action					
CERCLA volumes requiring management					
Corrective action volumes requiring management					
Additional sources affected by pending regulations					
Waste minimization					
Waste stream affected					
Specific industrial process					
Waste volume change					
Production change		X		X	X
Change in concentration/amount of each hazardous constituent		X		X	

[a]1985 = 1985 RCRA reporting instrument
1987 = 1987 RCRA reporting instrument
TSDR = National Survey of Management Facilities (TSDR survey)
GEN = National Survey of Generators
TCRI = toxic chemical release inventory reporting instrument

[b]An "X" indicates that a measurement problem exists.

Table 4.1 shows that the vast majority of measures developed by EPA contained no identifiable measurement problems.[1] Two major problems in the baseline 1985 RCRA reporting instrument have been corrected in the new and revised measures. Over- and undercounting of total waste quantity have been dealt with by employing several corrective techniques, including dealing with generated wastes and managed wastes in different parts of the instruments. The revised instruments also contain items that thoroughly address regulatory status and the reason (if any) for nonregulated status. The less significant original problems with the

[1]Measurement problems may exist that cannot be detected prospectively but only by empirical tests of reliability and validity once the results of the data collection efforts are complete.

measures of disposal technologies have also been corrected. As indicated in Table 4.1, we found persisting measurement problems in the areas of waste type (presence of regulated waste, physical form, chemical characteristics, and concentration), treatment technology, capacity (total possible capacity of a management technology), and waste minimization (for example, production change). These measures were inadequate in each instrument in which they were included. The measures of waste type and treatment technology had been identified as problematic in the original 1985 RCRA reporting instrument, while those of management capacity and waste minimization involve areas where no quantitative data had been previously collected.

Measuring the Type of Hazardous Waste

EPA's new and revised measurement instruments continue to use the RCRA waste codes as a measure of waste type. As indicated in chapter 2, this measure had suffered from misclassification and lack of information describing waste characteristics. To correct these problems, EPA developed additional measures of waste type that attempt to obtain information on the specific attributes of a quantity of waste that characterize its type.

The measures are intended to provide data on waste characteristics that are not systematically addressed by the RCRA waste codes, including the following:

- chemical constituents, such as the specific hazardous or nonhazardous substances that determine the appropriate type of treatment technologies;
- amounts of specific chemicals found in a quantity of waste—that is, the concentration of specific hazardous or nonhazardous substances that determine the appropriate type of treatment technologies;
- chemical form, such as degree of acidity (pH); and
- physical form, such as whether the waste is a solid or liquid.

EPA has developed two new types of measures of waste characteristics. The first type consists of qualitative variables or classification systems that include categories such as metals and nonmetals. The second type consists of quantitative or continuous variables such as the concentration of water, solids, or specific hazardous chemicals. The basic qualitative measure of waste type was developed by EPA for use in the national survey of management facilities. This measure attempts to classify wastes according to their treatability. The basic measure is shown in figure 4.1.

Figure 4.1:Basic EPA Measure of Waste Type From the National Survey of Management Facilities

WASTE DESCRIPTION CODES

These waste description codes were developed specifically for this survey to supplement the descriptions listed with the RCRA waste codes.

RCRA F, K, P, and U WASTE CODES

A01 K waste, exactly as described*
A02 F001-F005, as a spent solvent (organic liquid)
A03 F001-F005, as a still bottom (organic sludge)
A04 F006-F028 waste, exactly as described*
A05 Wastewater by mixture, rule containing F, K, P, or U
A06 Soil or cleanup residue contaminated with F, K, P, or U
A07 P or U, as a concentrated off-specification or discarded product
A08 Empty containers that held a P or U waste
A09 Incinerator ash from the treatment of F, K, P, or U
A10 Solidification residual from the treatment of F, K, P, or U
A11 Wastewater treatment residual from the treatment of F, K, P, or U
A12 Other

*"Exactly as described" means that we need no further clarification of the description provided in the list of RCRA waste codes in Appendix C of the Instructions booklet.

RCRA D WASTE CODES

INORGANIC SOLIDS—Waste that is primarily inorganic and solid, with low organic content and low water content

B01 Soil or debris contaminated primarily with solvents, oil, or other organics
B02 Other contaminated soil or debris
B03 Salt of a strong acid
B04 Salt of a strong base (solid NaOH, KOH, etc.)
B05 Sulfate or sulfite
B06 Cyanide salt
B07 Chloride, fluoride, bromide salts
B08 Nitrate, phosphate, or urea salts
B09 Other metal salt
B10 Strong oxidizer salt
B11 Strong reductant salt
B12 Solid explosive or propellant
B13 Solid spent filters
B14 Dry fly ash, metal oxide, or ores
B15 Solid metal scale, filings, or scrap (crushed drums)
B16 Inorganic paint or pigment solids
B17 Batteries and battery parts, casings, cores, etc.
B18 Other inorganic solids

ORGANIC LIQUIDS—Waste that is primarily organic and is highly fluid, with low inorganic solids content and water content

B19 Halogenated solvent
B20 Nonhalogenated solvent
B21 Waste oil
B22 Any organic liquid with PCBs
B23 Any organic liquid/solution of other toxic organics
B24 Organic paint or coating (lacquer, varnish, epoxies)
B25 Paint thinner or spent petroleum distillates
B26 Reactive or polymerizeable organic liquid
B27 Other combustible organic liquid
B28 Other organic liquid

ORGANIC SLUDGES—Waste that is primarily organic, with moderate inorganic solids content and water content; potentially settles into phases

B29 Still bottoms of halogenated solvents or liquid
B30 Still bottoms of nonhalogenated solvents or liquid
B31 Oily sludge
B32 Sludge with PCBs
B33 Sludge with other toxic organics
B34 Organic paint sludge
B35 Sludge with petroleum distillates
B36 Reactive or polymerizeable organic sludge
B37 Resins or viscous, nontarry organics
B38 Tars or tarry sludge
B39 Biological sludge
B40 Other organic sludge

INORGANIC LIQUIDS—Waste that is primarily aqueous and is highly fluid, with low-to-moderate suspended inorganic solids and organic content

B41 Solvent-water mixture
B42 Oil-water emulsion or mixture
B43 Concentrated water solution of organics
B44 Wastewater with trace organics
B45 Concentrated spent acid with no metals
B46 Spent acids with metals
B47 Concentrated noncorrosive, aqueous solution of metals
B48 Wastewater or dilute solution with metals
B49 Caustic aqueous waste with metals only
B50 Caustic aqueous waste with cyanides and metals
B51 Caustic aqueous waste with cyanides only
B52 Caustic aqueous waste with sulfides
B53 Concentrated waste caustic
B54 Aqueous waste with strong oxidizers
B55 Aqueous waste with strong reductants
B56 Aqueous waste with explosives
B57 Waste liquid mercury
B58 Other aqueous waste with high dissolved solids (brine)
B59 Other aqueous waste with low dissolved solids content
B60 Other inorganic liquid

INORGANIC SLUDGES—Waste that is primarily inorganic, with moderate organic content and/or water content; potentially settles into two phases

B61 Inorganic sludge contaminated primarily with solvents, oil, or other organics
B62 Highly acidic sludge with metals
B63 Other highly acidic sludge
B64 Metal hydroxide sludge
B65 Sulfide sludge
B66 Sulfate or sulfite sludge
B67 Cyanide sludge
B68 Other caustic sludge
B69 Sludge with strong oxidizers
B70 Sludge with strong reductants
B71 Sludge with explosives
B72 Brine sludge (with high chloride, fluoride, or bromide)
B73 Nutrient sludge (with high nitrate, phosphate, or urea)
B74 Spent filtering aids
B75 Wet scrubber sludge (fly ash), metal oxides, or ores
B76 Sludge of metal scale, filings, or scrap (crushed drums)
B77 Inorganic paint or pigment sludges
B78 Other inorganic sludges

ORGANIC SOLIDS—Waste that is primarily organic and solid, with low inorganic content and water content

B79 Solid waxes or polymerized organics
B80 Spent carbon contaminated with toxic organics
B81 Reactive organic solid
B82 Halogenated off-spec or discarded solid organic chemical
B83 Organo-nitrogen organic chemical (nitrogen pesticide)
B84 Phosphoro-thioate organic chemical
B85 Miscellaneous off-spec organic chemical
B86 Other organic solid

Source: EPA, National Survey of Hazardous Waste Treatment, Storage Disposal, and Recycling Facilities, OMB No. 2050-0063 (expired December 1987).

Initially, this measure was intended to be used in conjunction with the RCRA waste codes. That is, it was intended to fill information gaps left by the RCRA waste codes; it was not intended to be a separate exhaustive measure of waste characteristics. This approach is a significant improvement because it does provide more information than the RCRA waste codes alone. However, since it was used in conjunction with the RCRA waste codes, it is not fully satisfactory because it remains vulnerable to the misclassification resulting from use of the RCRA waste codes, which have not been corrected. Later versions of the measure are designed to be used independently of the RCRA waste codes. This solves the problem of contamination by misclassification of wastes resulting from use of the RCRA waste codes. However, the measure remains inadequate in other respects.

All versions of the basic measure of waste type assume that treatability is a single attribute. As discussed in chapter 3, the treatability of a waste is the result of the joint occurrence of categories or values of several independent attributes, including physical form, chemical form, and the concentration of specific hazardous and nonhazardous constituents. That is, waste with a specific combination of values of each of these independent attributes is amenable to specific types of treatment technology.

Combining independent attributes leads to complex and redundant classification systems. For example, combining the measures of three independent attributes with 10 values each would produce a measure with 1000 categories, each representing a unique combination of the ten values of each attribute (10 x 10 x 10). Only 30 categories would be necessary if each attribute were measured separately. The separate simple measures can be crosstabulated to reproduce the full 1000 unique combinations.

The basic EPA measure contains 98 categories that mix chemical and physical form, and type and concentration of constituents. Whether a quantity of solvent waste is halogenated is addressed five different times because it must be repeated in combination with other attributes such as organic liquids, solids, and sludges that may contain halogenated solvents. The pH of a quantity of waste is addressed by 12 separate categories because it is first broken down by whether the substance is acidic or caustic and then cross classified by whether it is a liquid or solid, whether it contains metals, whether it contains cyanide, or whether it contains both cyanide and metals.

A long, complex, and redundant measure is burdensome to respondents and can be expected to produce low reliability because respondents are not likely to interpret the measure in the same way. Separate simple measures of independent attributes help reduce respondent burden and increase reliability.

When complex measures result from mixed attributes, efforts are sometimes made to collapse or eliminate some combinations that are not deemed relevant for a specific use of the measure or other practical reasons. This can be a problem in that different versions of the measure may not be comparable. The various versions of the EPA measure are not comparable because they have been shortened in different ways. For example, the basic measure distinguishes between liquids, solids, and sludges according to whether they are primarily organic or primarily inorganic, but does not include gases. The version used in the national survey of generators adds organic and inorganic gases. The version in the 1987 RCRA reporting instrument differentiates between wastes that are primarily organic or inorganic but combines solids and sludge into one category and does not differentiate between organic and inorganic gases in the same way as the generator survey. The measure used in the toxic chemical release inventory instrument does not distinguish between organic and inorganic substances (although the chemical names will help in this regard), does not distinguish between solids or sludges, and does not ask for total quantities of each waste stream. The result is that the different versions of the measure are not comparable. Quantities of organic solids and sludges cannot be compared because solids and sludges are not consistently distinguished in the different versions of the measure. In addition, the subcategories and descriptions differ and combine noncomparable wastes in residual categories. Simple, separate measures of each attribute would facilitate standardized measures and assure comparability because there would be less pressure to simplify the categories further.

Even well designed qualitative measures of hazardous waste types, however, will result in the assignment of quantities of waste to inappropriate treatment technologies because the categories of qualitative measures (such as "primarily organic," "highly fluid," or "moderate inorganic solids content") cannot capture the necessary detail. For example, some wastes may be classified as a liquid that actually are too viscous to be subjected to treatments designed for liquids, while some wastes may be classified as a sludge that could be treated as liquids if they become more fluid when heated. More accurate quantitative measures or continuous variables, such as the total suspended solids, are

required to precisely assign quantities of waste to appropriate treatments.

EPA has included some quantitative measures of waste characteristics in the 1987 RCRA reporting instrument and more on the instrument used for the national survey of generators. These measures can be used to characterize the type of waste without relying on the RCRA waste codes or the qualitative measures of waste type. They are the most appropriate measures of waste characteristics and are significant improvements over earlier RCRA reporting instruments and the new qualitative measures discussed previously because this type of measure significantly increases reliability and accuracy. However, if handlers are not required by federal regulations to conduct the tests and keep records of the results, it is likely that many respondents will not be able to provide the requested information. We discuss this as a data collection problem in chapter 5.

Measuring the Type of Treatment Technology

The EPA measures of the type of treatment are qualitative measures that classify the type of technologies applied to treat a waste prior to final disposition (that is, disposal, recycling, or discharge to publicly owned treatment works or surface water under National Pollutant Discharge Elimination System permits).[2] Quantitative measures cannot be used to measure treatment type because there are unavoidable qualitative differences between treatment technologies. Thus, qualitative measures or classification systems are appropriate.

The new and revised measures of treatment types are a significant improvement over those used in the 1985 RCRA reporting instrument because the categories are much more detailed. However, the measures are not fully satisfactory because they mix independent attributes in the same way as the measures of waste type already discussed. Specifically, they mix aspects of the type of waste and the disposition (for example, recycling) of a waste with the technology used to treat it. As previously discussed, this increases the likelihood of misclassification, reduces the comparability of the separate versions of the measure, and leads to low reliability.

Our analysis of EPA technical documents indicated that treatment technology is a good candidate for a general classification system with a

[2]In some cases, such as the use of hazardous waste as a fuel, the treatment (incineration) itself represents recycling (a form of disposition).

mutually exclusive and hierarchical structure. Our review also revealed that, through repeated efforts, EPA is slowly moving in this direction. Successive versions of the measure have come closer to being a true general classification system, and the 1987 RCRA reporting system instrument measure is the closest yet.

Technical studies of the types of hazardous waste treatment conducted for EPA show that there are more than a hundred different technologies that can be used to treat hazardous wastes. Based on our review of this technical literature, we identified four generic classes of treatment technology: (1) physical, (2) chemical, (3) biological, and (4) thermal. Indeed, our conclusion that treatment type is amenable to the construction of a general classification results from this four-class framework—that is, no treatment technology can be a member of more than one of these four classes, and every treatment technology must belong to one of them.

In addition, there are subtypes of each major class of treatment technology, and no technology can be a member of more than one subtype. For example, chemical precipitation is a subtype of chemical treatment that consists of several specific techniques, such as lime and soda ash treatments. None of these treatments can be a member of any other subtype. This allows a potential classification system with several orders or levels of detail. Aggregation to a higher level when appropriate for practical purposes is straightforward. The resulting measure could become standard across all EPA data collection efforts because the categories would be mutually exclusive and hierarchical, and all attributes of treatment technology would be ordered. In efforts where less detail is required, any of the more detailed categories of the measure could be omitted as desired. The results would remain comparable with other applications at the next higher level of aggregation.

The current measures of treatment technology partially reflect this structure, but they also include categories based on the type of waste treated (wastewater treatment) and the disposition of waste (recycling as opposed to disposal). This introduces mixed attributes in the same way as the measures of waste type discussed previously. Although some treatments tend to be used more frequently for wastewater treatment or when wastes are recycled, EPA officials stated that the same technologies can be used for other purposes. In addition, whether a waste is a wastewater or something else has (or should have) already been determined as part of the measure of waste type (for example, concentration of water). There is no reason to introduce the question of waste type again as part of the measure of how the waste was treated. Whether and how

a waste is recycled or disposed of after treatment should also be measured separately as a type of disposition, and not mixed with the type of treatment technology.

Measuring Management Capacity

EPA uses many different measures to assess the capacity of different treatment technologies. As discussed in chapter 3, this involves measuring characteristics of the equipment in which a technological process is conducted. These characteristics include feed rates, ancillary equipment (such as pipes and storage areas), necessary downtime, and other factors, depending on the specific type of equipment and process. In all but two cases, we did not identify any significant threats to validity or reliability. First, the measure of the total capacity of some types of incineration does present a problem because it did not take into consideration the effects of different uses of incineration. For example, cement kilns and industrial boilers use hazardous waste as a fuel. The primary purpose is to produce heat for an industrial operation, not to destroy hazardous waste. Thus, the amount of hazardous waste necessary to produce the needed heat may be less than the total amount of waste that could be incinerated, because demand for the primary product may be less than the maximum output. Wastes with different heating values would also need to be used in different amounts to produce the required heat. This lack of specificity means that respondents can easily interpret the measure differently, which reduces reliability. In addition, if respondents assume either unlimited demand for their principal product or low heat-producing wastes, capacity could be significantly overestimated. This potential problem would be eliminated by making the measure more specific.

Second, it is important to distinguish between the maximum physical capacity to treat wastes and the maximum amount allowed by the EPA operating permit, which may be significantly less than the physical maximum. Respondents to the survey of management facilities were asked to report the total amount of waste that could have been treated during the year, assuming existing operating constraints, equipment, and an unlimited supply of waste. EPA officials indicated that constraints specified in the operating permit were supposed to be included by respondents, although they were not specifically listed in the survey instrument. However, they acknowledged that some respondents based their answers on maximum physical capacity rather than the maximum allowed by their operating permit. For example, one facility reported a large capacity to stabilize wastes prior to land disposal even though the

operating permit restricted the amounts that could actually be land-disposed. EPA officials also stated that this overreporting of capacity could not always be detected because in many cases there would be no identifiable inconsistency in the responses. EPA officials acknowledged that future efforts should specify that available capacity includes the constraints imposed by the operating permit, as well as purely physical or technical constraints.

While this specific problem was addressed in the 1987 RCRA reporting instrument, the measure suffers from another problem that can produce overreporting of capacity. Specifically, respondents are asked to calculate the total capacity of treatment systems rather than (as in other versions) to provide information on each unit of the treatment system, which permits EPA to calculate the capacity of treatment systems. The danger here is that different facilities may calculate system capacity in different ways, thus reducing the reliability and validity of the measure.

Measuring Waste Minimization

Three of the four instruments we evaluated attempt to measure the amount of hazardous waste minimization that has occurred. Each of these attempts to measure the amount generated per unit of production over time in order to develop information on progress toward minimizing waste generation. Relative waste minimization is important because the absolute volume of waste generated over time varies with the amount of production. Therefore, in addition to the absolute amount generated, it is useful to measure the amount generated per unit of production to control for annual variations in the amount of production. However, the problem we find with such relative measures of waste reduction is that they produce misleading results.

The first step in measuring relative waste minimization is to calculate the ratio of production quantity in one year to that of the preceding year. For example, if a tool manufacturer produced 1,200 tools in 1986 and 1,000 tools in 1987, the production ratio would be 1,200 to 1,000 or 1.2. The next step is to calculate the ratio of the amount of hazardous waste produced during the production of the tools over the two years. If the firm produced 12 tons in 1986 and 10 tons in 1987, the ratio would be 12 to 10 or 1.2. The ratio of the two ratios represents the firm's progress toward minimizing waste generation per unit of production. In this case, the ratio is 1.2 to 1.2 or 1, representing neither an increase nor a decrease in the amount of waste generated per unit of production between 1986 and 1987 (even though there was an absolute decrease of 16.6 percent).

If the firm had produced only 9 tons of waste in 1987, an absolute decrease of 25 percent, the result would have been

- a production ratio of 1,200 (1986) to 1,000 (1987) = 1.2
- a waste generation ratio of 12 to 9 = 1.333
- a waste reduction ratio of 1.2 to 1.33 = .90.

Accordingly, this result would be said to represent a 10 percent reduction in the amount of hazardous waste generated per unit of production.

The foregoing measure is inadequate because it does not account for the specific types of tools (the production mix) produced during a given year. For example, the company in the preceding example may have lost a contract for a specific type of tool in 1987. If the production of that tool generated more hazardous waste per unit than the production of other tools, the results of the production ratio method will be misleading. It will appear that relative waste minimization has occurred when in fact it did not. In the preceding example, the appearance of waste reduction was produced because in 1987 the firm did not produce the product that generated hazardous waste at a greater rate than the other products. During the next year, if the company returned to its original production level and mix by producing that tool again, the production ratio method would produce the following results:

- a production ratio of 1,000 (1987) to 1,200 (1988) = .833
- a waste generation ratio of 9 to 12 = .750
- a waste reduction ratio of .833 to .750 = 1.111.

This result would create the appearance of an 11.1 percent increase in the amount of hazardous waste generated per unit of production when in fact no change had occurred. Instead, the company merely returned to its previous production level and mix. In addition, real increases or reductions in relative hazardous waste generation would be mixed with, and thus obscured by, incidental changes such as these.

It could be argued that these incidental changes would average out on an industry-wide basis and that the resulting information thus would give relatively valid information on waste minimization for an industry. In some industries this may in fact be true, but in other industries it is likely that the production mix does vary from year to year, depending on seasonal or other market factors. The problem is also more pronounced in certain industries where waste streams are not often separated according to the specific product produced.

We also found problems with the measures of the change in toxicity over time. The measure is a qualitative one and therefore does not provide any quantitative information on changes in toxicity (as measured by concentration of constituents). It provides information only on whether the concentration of hazardous constituents in general has increased or decreased and whether less hazardous constituents were substituted. It provides no information on how much the concentrations changed. The resulting data could only show the percent of cases in which waste minimization resulted in increased concentration. Correcting these problems would require measures that address the precise production mix and the waste associated with each product, as well as detailed data on the concentration of hazardous constituents. These detailed data could be collected from a sample, which would avoid the larger burden of collecting the information via a census. However, as noted previously, aggregating these data to create a meaningful comparison across production processes and industries would remain difficult.

Implications for Capacity Analysis

The measurement problems just discussed will produce some error in specific areas of the capacity assessments conducted by EPA and states. However, without the actual data resulting from the use of the measures to supply information about actual (versus prospective) reliability and validity, we cannot estimate the magnitude of this error.

As discussed in chapter 4, the capacity analysis for the land disposal restrictions involves identifying the volumes of wastes covered by a specific restriction that are currently land-disposed. The identification of covered wastes is based on the RCRA waste code reported by respondents. Since the use of these codes results in misclassification, there will be error in determining the volume of waste that represents a given code and is thus subject to specific restrictions.

All capacity analyses involve the process of determining the volumes of wastes amenable to specific types of treatment. The qualitative measure used to characterize the treatability of wastes is likely to result in some misclassification that will affect the volumes of waste assigned to specific types of management technologies. This in turn will affect all three types of capacity analyses since all data collection instruments use this qualitative measure. However, the problem will be minimized in those instances where the alternative quantitative or continuous variables are used.

Misclassification errors resulting from the mixture of attributes in the qualitative measure of treatment technologies lead to potential inaccuracies in the determination of total capacity of specific treatment technologies. Because this problem exists in all variations of the measure, this potential will be present in all the capacity analyses EPA performs.

The total capacity of some types of incineration (such as cement kilns or industrial boilers) may be overestimated because EPA did not control for the heat value of the waste incinerated or the variation the demand for products produced with the aid of some types of incineration. This potential overestimation problem will be present in all types of capacity analysis.

An assessment of the impact of waste minimization practices is necessary for integrated capacity analyses and SARA capacity assurance because the degree of waste minimization achieved will affect the capacity required in the future. However, since none of the measures of waste minimization controls for product mix or includes quantitative measures of toxicity, all capacity analyses will have misleading estimates of the extent of waste minimization.

Summary and Conclusions

The measures included in EPA's revised data collection instruments are much improved. The problems of undercounting and overcounting the total volume of wastes generated have been corrected. The previous problems with the measures of waste management technologies, with the exception of those involving treatment technologies, have also been fully corrected. In addition, significant improvements have been made in the measures of waste and treatment type, although these improvements have not completely eliminated the original problems.

There still remain some measurement problems that may produce significant errors in determining the volume of each type of waste generated, the type of treatment technologies used, the total capacity of management technologies (such as some types of incineration), and the degree of waste minimization. The RCRA waste codes, which are used on all data collection instruments, will continue to produce inaccurate counts of the volumes of regulated waste streams due to misclassification. The qualitative measure of waste type EPA developed to supplement the RCRA waste codes, although an improvement over past methods, has not fully solved the problem. The mixture of independent attributes creates a complex and redundant measure that can significantly reduce reliability because respondents are likely to interpret it differently. Qualitative

measures are also much less accurate than available quantitative measures. On some instruments, EPA has included the preferable quantitative measures; these represent an important improvement over the qualitative measures. EPA should continue to expand the use of quantitative or continuous variables for measuring waste characteristics.

Although EPA has developed new, much improved measures of the types of management technologies, misclassification remains likely due to the mixing of attributes. The development of a true general classification system with mutually exclusive, exhaustive, and hierarchical categories would fully correct the remaining problem.

In general, waste management capacity is now measured well. However, the measure of the capacity of cement kilns and similar forms of incineration was not sufficiently specific to assure that respondents will interpret the question in the same way. If respondents assume either unlimited demand for their product or waste with a low heating value, the capacity of this form of incineration could be significantly overestimated. Some overestimation of capacity is also likely in some versions of this reporting instrument because some respondents may not have considered permit restrictions in reporting maximum capacity.

Finally, the measures of the extent of waste minimization developed by EPA will not produce valid data on changes in waste generation per unit of production. The measures do not account for the production of different products from one year to the next that may generate unequal amounts of hazardous waste. The results will be misleading because incidental changes in production will be mixed with, and thus will obscure, actual waste minimization. Moreover, the qualitative measure of toxicity can only show the percentage of cases in which waste minimization led to increased concentration, not the amount of change in toxicity over time. In order to correct these problems, EPA should measure the volume of waste produced by each type of product and the concentration of each toxic constituent. These detailed data could be collected from a sample, which method would be preferable to the larger task of collecting the information via a census.

Recommendations

We recommend that the Administrator of EPA direct the Assistant Administrator for Solid Waste and Emergency Response to assure the use of the most appropriate measures of the relevant attributes of hazardous waste generation and management. Specifically, quantitative measures should be used to measure waste characteristics (such as those

needed for assessing management capacity or waste minimization), and in addition, a true general classification system should be developed for treatment technologies.

Assessment of Data Collection Methods and Procedures

This chapter addresses evaluation question six: Are EPA's revised data collection methods and procedures likely to result in valid national information? We determined whether the data collection problems identified in the original information system have been corrected in the new and revised data collection mechanisms and whether any new data collection problems exist.

Data Collection in the Interim Information System

The 1987 RCRA Reporting Cycle

The RCRA reporting system is a census of large-quantity hazardous waste handlers. For a census to yield valid data, it is essential that the regulated population be accurately identified and that every member of the reporting population respond in the same manner. The types of data collection problems encountered in the past have included (1) inaccurate identification of the regulated population, (2) inconsistent information, and (3) quality control.

The major steps EPA took to correct these problems for the 1987 cycle included developing the revised 1987 reporting instrument (and its data definitions), which was used voluntarily. The complete revised instrument was used for the 1987 cycle in 16 states, including the 5 remaining unauthorized states and the 10 states that used the instrument voluntarily.[1] The remaining 34 states used the instruments they had used in the past, and were required to obtain the information that was included in the 1985 RCRA reporting instrument. EPA initially required states to forward to EPA disaggregated data (needed for data analysis and quality control) rather than the summaries that were required in the past.[2] Finally, EPA provided assistance to states to process the data collected into the format required by EPA. We evaluated the likelihood that these actions would correct past data collection problems and the likelihood that they would create additional problems in the areas identified.

[1]The District of Columbia also used the entire instrument, and EPA administered the complete instrument in one authorized state and four territories.

[2]Ultimately, the submission of disaggregated data was made voluntary. Thus, states may submit aggregated data in a form that is consistent with the summaries required in the past.

Identification of the Regulated Population

As discussed in chapter 2, previous cycles of the RCRA reporting system did not adequately update the notification forms used by waste handlers to notify EPA of their activities. EPA thus was unable to develop accurate lists of active hazardous waste handlers. As discussed in chapter 4, the new information on regulatory status included in the instrument for the 1987 RCRA reporting cycle fully corrects this problem. If accurate data on regulatory status are collected in all states, the regulated population would be adequately identified for the first time. However, the consequences of the voluntary use of the revised data collection instrument, which we will discuss next, are likely to interfere with the accomplishment of this and other goals.

Information Consistency

Thirty-five states (70 percent) elected not to use the complete revised data collection instrument in the 1987 reporting cycle.[3] Although EPA refers to the 1987 cycle as a pilot test of the revised instrument, the 1987 cycle is one of the principal sources of data that will be used to support important national initiatives, including SARA capacity assurance. It therefore is essential that it produce valid national data. States electing not to use the new reporting instrument used those they had used in previous reporting cycles. Some of these states used the instrument EPA developed for the 1985 reporting cycle, and some used their own instruments.

EPA's requirement that authorized states not using the revised instrument provide the information that was sought on EPA's 1985 data collection instrument cannot produce valid national information because that instrument did not collect certain important information. Thus, major gaps will exist for waste characteristics, waste management, and available capacity in all states that did not use the revised instrument.

Because many states used the 1985 EPA data collection instrument for the 1987 cycle, the same measurement problems as were discussed previously are likely to recur. Since other sources of national data exist for management and capacity issues, these measurement problems will affect the data on waste volumes and types most significantly. As discussed in chapter 2, these problems involved misclassification of RCRA waste codes, reporting wastes as mixed waste, incomplete identification of RCRA waste codes that apply to a given quantity of waste, the absence of waste characteristics data, and under- and overcounting of the total

[3]Eighteen of the 35 elected to use the waste minimization portion of the form; EPA administered the waste minimization portion of the instrument in all states that did not elect to use it because the information was mandated by HSWA; and EPA administered the entire revised instrument in one of the 35 nonparticipating states.

volumes of waste generated and managed. As reported in chapter 2, the 1985 EPA instrument and state instruments did not contain items that accurately identified regulatory status. Therefore, the information obtained using these instruments in the 1987 cycle will have the same limitations.

In response to our inquiries on this subject, EPA officials explained that the states will be expected to perform the necessary quality control work to assure that the data gathered are valid. However, since problems such as overcounting are inherent in the measures used on EPA's 1985 measurement instrument, quality control work cannot correct them. EPA officials explained, however, that their use of the term quality control includes using additional data or recontacting facilities to compensate for measurement problems. The instructions for state submissions, however, acknowledge that securing valid data will not always be possible.

Finally, there are no federal regulations that require states to collect specific federal data elements. Therefore, EPA's requirement that states provide these data elements is questionable.

EPA officials indicated that state submission of disaggregated data rather than summaries of the data collected would correct the major problems experienced in previous cycles. Disaggregating data is an effective method of (1) separating formerly aggregated state regulated wastes and RCRA wastes in cases where explicit codes are used to identify each in the raw data, and (2) separating formerly aggregated RCRA defined wastes. It is also needed for EPA analyses. Although an important improvement, disaggregated data cannot solve all the major problems experienced in the past. The measurement problems identified earlier cannot be resolved by using disaggregated data. For example, since respondents often did not include all applicable waste codes, disaggregated data will only partially solve the problem. In addition, EPA officials explained that some states continued in the 1987 cycle to give inconsistent guidance to handlers on whether to report hazardous wastes treated in units that are exempt from RCRA regulations. These include (1) waste waters that are treated under National Pollutant Discharge Elimination System permits and discharged into surface water or to publicly owned treatment works, and (2) the waste handled by a limited number of recycling operations. The inconsistent reporting of these large volumes of exempt waste water created major discrepancies in the 1985 cycle. These wastes cannot be distinguished on the basis of RCRA waste codes because the distinction is based on how the waste was treated.

EPA's original requirement that states submit disaggregated data is also questionable. EPA has limited ability to require states to submit disaggregated data because federal regulations continue to explicitly require states to submit summaries. EPA has now relaxed the requirment to submit disaggregated data for the 1987 cycle because of limited resources and a request from the states that aggregated data be allowed. This may have an adverse impact on the quality of the data, for the reasons discussed previously, in states that use EPA's 1985 forms and do not submit disaggregated data.

Most importantly, much of the new information included in the revised reporting instrument is not fully supported by federal or state recordkeeping and reporting regulations. Although full authority is granted by RCRA sections 3002, 3004, and 3007 to collect this information, this authority has not been fully implemented in federal regulations. That is, federal regulations do not require handlers to keep records of many of the requested data elements. Without additional regulations, handlers may not be able or willing to provide the requested data. This problem is likely to affect information on quantitative measures of waste characteristics, wastes treated in exempt units, nonhazardous constituents of hazardous waste, and nonhazardous wastes treated in RCRA permitted units. EPA officials noted that the waste minimization and capacity items are also not specifically covered by federal regulations.

Finally, small quantity generators—generally defined as those that produce less than 1,000 kilograms of waste in a given month—are not required to complete the revised data collection instrument.[4] Although they produce a small percentage of the total waste, they are by far the largest class of generators. EPA currently estimates that there are 100,000 small quantity generators. Although it may be overly burdensome to include all small quantity generators in a census, some routine information that would characterize their activities is necessary. Some states, however, do require small quantity generators to report, which will create further problems. In fact, because the 1985 EPA instrument does not separate amounts generated by month and does not include accurate data on regulatory status, it is likely that it will not be possible to accurately separate small quantity generators and thus produce consistent national counts.

Quality Control

EPA initially planned to develop an automated data management system and a national repository for the data collected from the RCRA reporting

[4]They are, however, required to confirm their status as small quantity generators.

system. These activities would be a major accomplishment because they help transform the data collected into a consistent usable form. However, due to limited resources, EPA will not provide all of the software planned for the system. In addition, these technical assistance activities are applicable primarily to states that voluntarily adopted the revised reporting instrument. Furthermore, since not all states will supply disaggregated data, the national repository will not contain the complete disaggregated data, as was called for in the original plan. Finally, EPA is not requiring any substantive verification, such as on-site validation. Adequate verification should include on-site validation, in which the completed data collection instrument would be checked against the handlers' records, for a small sample of those reporting. The results of this effort would then be used to estimate reporting error and noncompliance in the reporting population.

EPA is conducting a review of the mechanisms and instruments in states that do not use the EPA instrument. One of the purposes of this effort is to determine the extent to which existing data in the states can be transformed into the data elements on EPA's new instrument. However, while this review will provide valuable information for the future, it cannot solve the problems of the 1987 cycle.

EPA's plan for developing accurate information depends largely on the extent of the quality control work that is performed by the states to detect and correct reporting inconsistencies, as well as the measurement problems that stem primarily from the measures in the 1985 instrument and the lack of supporting federal reporting and recordkeeping requirements. EPA officials explained that the states are expected to perform the necessary quality control work to provide accurate information. However, EPA officials agreed that the agency has not provided the necessary funding or incentives to permit and encourage states to perform this work. EPA documents indicate that the agency pays for approximately 25 percent of the cost of the RCRA reporting system, while the states pay appproximately 75 percent to meet their own needs. However, according to EPA guidelines, grants to states are to provide 75 percent of the funding for federally required activities. Since the RCRA reporting system effort is mandated by federal regulations, we see no reason why EPA should not provide 75 percent of the funding. Agreements with states now include specific mention of the importance of the RCRA reporting system. This is a step toward increasing the incentive for states to collect accurate data. However, without adequate funding, it is not likely to be an effective one.

The National Surveys

As discussed previously, EPA developed and implemented two national surveys: the survey of generators and the survey of management facilities. As we did in the case of the RCRA reporting system, we evaluated the two national surveys developed by EPA in the three technical areas in which problems were encountered in past data collection efforts: (1) identification (and sampling) of the regulated population, (2) consistency of information, and (3) quality control.

Identification and Sampling of the Regulated Population

In addition to the identification of the regulated population (discussed earlier) required for a census, surveys must draw a sample from the population that provides the necessary precision for state or national estimates of population characteristics. The initial identification of the regulated population for both national surveys was based on information submitted on notification forms, which included handlers who were not active and did not include those who had not filed notification forms. However, steps were taken to mitigate this problem in developing the sampling frames. The survey of management facilities was further based on those handlers who had obtained permits.[5] In addition, a "screener survey" preceded the survey of management facilities that was, in part, intended to accurately identify the population of management facilities and the management activities performed by each. Both surveys also included regulatory status questions. The sampling frame for the generator survey included all of the approximately 41,000 handlers who reported generating large quantities of hazardous wastes in 1985. (This group included all management facilities with the exception of those that only store hazardous waste.) However, although small quantity generators were thus theoretically excluded, many small quantity generators who could not be distinguished from large quantity generators were actually included in the sampling frame. Of course, this group was not required to complete the survey instrument. Further, since the sampling frames for the two surveys do not include generators who failed to notify or all those not reporting in 1985, small quantity generators, some recycling facilities, or those generators who began or resumed generating hazardous waste in 1986, the sampling frame for the surveys is likely to be slightly smaller than the total regulated population. This will result in some undercounting of the total amount of hazardous waste generated and total management capacity. We do not

[5]The sampling frame included all facilities with RCRA permits. This group includes the majority of recycling facilities. A limited number of specific types of recyclable materials and facilities that only recycle on-site without storing wastes prior to recycling are not covered by these requirements. In addition, some off-site recycling facilities do not have permits because they contend that they do not store wastes prior to recycling. These facilities were not included in EPA's sampling frame and may represent a significant amount of available capacity in some states.

consider this a significant data collection deficiency because for technical reasons perfect sampling frames are rare. However, in publishing the results of these surveys, EPA should include an assessment of the sampling frame and note that the statistics do not include some members of the regulated population.

Both national surveys used stratified sampling—that is, probability sampling in which different proportions of different groups of the population are sampled to assure adequate coverage and precision at the lowest cost. The stratified sample for the survey of management facilities included two major strata: (1) facilities that treat, dispose of, or recycle hazardous wastes regulated under RCRA and (2) facilities that only store hazardous wastes. The sample included 100 percent of the members of the first strata—that is, all of the approximately 2,500 facilities that treat, dispose of, or recycle hazardous wastes. The second strata, composed of the 682 facilities that only store hazardous wastes, was further stratified according to the overall volume of waste stored. All seven of the largest storage facilities were included. Approximately 110 of the remaining 675 facilities were sampled, with approximately a 16 percent chance of inclusion. Adding the resulting 117 storage facilities yielded a total sample of approximately 2,617.

The sample for the generator survey was stratified by size of generator and state. The 1,000 largest generators (that is, those that produce the vast majority of all hazardous waste) and all management facilities were sampled at the rate of 100 percent. The remaining generators were further stratified by size, and the larger of these were over-sampled. Stratifying the sample by state meant that 50 separate samples of approximately 200 generators each were included. (All generators were included in small states with fewer than 263 generators.) The total sample was approximately 10,000, which represented slightly less than 25 percent of the sampling frame.

Given the many uses to which these surveys will be put (due, in part, to the absence of other valid data), we conclude that the size of the samples is not excessive. For example, the sample sizes for both surveys were increased from the original sampling plan in order to provide data to assist the states in developing the capacity assurances required by SARA. In general, it takes a much larger sample to provide estimates for 50 states that all have the same precision as one national estimate.

However, we believe it would have been more efficient for EPA, and less burdensome for the regulated community, to have developed two samples for each survey—a larger sample for developing those estimates needed for each state and a smaller subsample for developing those estimates needed only at the national level. The larger samples would have been identical to those actually used for the two surveys discussed previously and would have been used to provide only the information necessary to assist states in preparing the SARA capacity assurances. The smaller subsamples would have been used to provide equally precise national estimates for the more detailed information needed by EPA for developing regulations. The smaller samples would have been similar to those EPA originally planned. For example, before increasing the sample sizes to provide precise estimates for each state, more strata were sampled at less than 100 percent, and separate samples were not developed for each state. Overall, 6,000 generators and 800 management facilities were added to the two samples discussed previously to develop precise state estimates. However, it is likely that all of the largest generators and commercial management facilities would have to be included in both the larger and the smaller samples, as was the case in EPA's original plan. The use of two samples would have been especially efficient for collecting data to characterize the approximately 100,000 small quantity generators, because while these data would not have been needed for each state, they could have been included in the smaller national sample. The use of two samples appropriately stratified by size and type of activity would reflect the different levels of detail of the required information that we discussed in chapter 3. EPA's decision to use only one sample is, in this case, understandable in view of the time constraints under which the surveys were developed.

Information Consistency

The problems involving the lack of consistent data that affect the RCRA reporting system are not present in the special surveys. Since EPA conducts the survey on its own without having to interface with state data collection systems, every respondent in the sample received exactly the same data collection instrument. Although a rudimentary research procedure, this is one of the major strengths of these data collection efforts in comparison with the RCRA reporting system.

However, the lack of federal recordkeeping and reporting requirements is likely to affect data quality adversely. The surveys were conducted under the authority provided by RCRA section 3007. According to EPA officials in the Office of the General Counsel, section 3007 authorizes EPA to require handlers to provide any information that is available at

the facility, but it may not be used to require handlers to develop information that is not already available. Therefore, without conducting an inspection of each facility, EPA cannot determine whether the facility actually does not have the information or simply neglected to provide it. The official also stated that such inspections would overload EPA's enforcement resources and diminish the credibility of the agency because it could not enforce its requirements. Yet, it is also the case that extensive missing data or nonresponses can invalidate an otherwise flawless data collection effort.

Quality Control

In a sample survey, one of the most important parts of processing the data collected is the quality control work done to verify the accuracy of the data obtained. We reviewed the methods and procedures used to ensure data integrity in EPA's surveys and discussed these with responsible EPA officials. The EPA effort to ensure complete and consistent responses for the survey of management facilities was extensive. Each completed questionnaire was reviewed by technically qualified personnel. When problems were detected in the responses, the facilities were telephoned for additional information. This effort was possible because all quality control work was sponsored directly by EPA. The agency did not have to rely on complex efforts to ensure that 50 separate data collection systems performed the necessary quality control work. The ability to ensure quality control is a second major strength of EPA-sponsored sample surveys.

As with the RCRA reporting system effort, however, the surveys did not use on-site validation to assess data quality. When conducted on a small subsample of respondents such on-site validity studies are an effective tool for quality control.

Ensuring that the results of a data collection effort are available for use in achieving agency objectives requires practical arrangements that ensure proper timing. Thus, in order to ensure that partial results of the survey of management facilities were available when needed to support regulations required by HSWA, EPA developed two separate quality control efforts and two separate data bases. Although cumbersome and not recommended as a standard practice, the effort ensured that the data were available to meet agency objectives. This shows that when they are sponsored directly by EPA, extraordinary efforts to ensure the timeliness of data are possible.

Similar arrangements, however, were not made to ensure that the results of the generator survey were made available in a timely manner.

Consequently, the results of the generator survey will not be ready for use by states in preparing the capacity assurances required by SARA. EPA officials explained that the 1987 RCRA reporting cycle prevented them from expediting the generator survey. However, because there are no other data of comparable quality, this unavailability of the generator survey results will have unfortunate consequences for the quality of state assurances of capacity under SARA.

Implications for Capacity Assessments

We examined the implications of the just discussed data collection problems for the three major capacity analyses that must be conducted using data produced by the 1987 RCRA reporting system and the national surveys.

The capacity analyses performed entirely by EPA (the integrated capacity analysis and those performed for the land disposal restrictions) rely entirely on the national surveys of generators and management facilities. The foregoing assessment of data collection methods shows minimal problems stemming from data collection. Some missing data on waste characteristics stemming from lack of federal reporting and recordkeeping requirements may affect the treatability analyses that can be performed on the basis of these surveys. The fact that small quantity generators were excluded may also affect these analyses somewhat.

SARA capacity assurances, however, must rely on some information provided by the RCRA reporting system. The survey of management facilities data has now been made available to the states to use in developing the required capacity analysis. Therefore, the information on the amounts and characteristics of wastes must come from the RCRA reporting system. However, because the 1987 RCRA data collection instrument was not used by all states, EPA cannot require states to use the information provided by the instrument in preparing the capacity assurances. In addition, since some states may not have the results of the 1987 RCRA reporting cycle completed in time, EPA is allowing states to use 1986 or 1985 data if the state believes it is of higher quality than the 1987 data. The result is that the capacity data will cover 1986 for all states while the data on waste generation will vary between 1985 and 1987 and will be obtained from data collection instruments with the different sources of error discussed previously. As already has been shown, the data provided in past reporting cycles and instruments was seriously flawed.

EPA has provided states not using the revised RCRA reporting system instrument with default factors to apportion total quantities of each waste code reported to specific treatment types. The default factors are based on assumptions about the proportion of the reported volume of waste that will require a specific type of management. The default factors use several other sources of information and attempt to represent the typical distribution of treatability groupings. However, EPA acknowledges that these factors do not reflect the treatability groupings of wastes generated in a particular state. Instead, they reflect typical national treatability groupings.

Two options for conducting the treatability analysis are provided for states that use the revised instruments. The first option is more accurate because it relies on the quantitative measures of waste characteristics discussed in chapter 4. However, since handlers are not required to have this data available, states may have to use the less precise qualitative measures of waste characteristics.

In addition, since the national survey of management facilities covers 1986, states using generation data from other years will have to make adjustments to the capacity information taken from the survey of management facilities in order for it to be consistent with the generation data. The way these changes will be made will differ across states due to the different years and data collection instruments involved.

The EPA project manager for the SARA capacity assurance initiative stated that the foregoing data limitations will make interstate agreements difficult to achieve. Officials representing importing states may not have sufficient confidence in the information to use it as the basis for agreements that may appear as blanket acceptance of continuing imports.

State and EPA experts believe the SARA data collection plan is as good as it can be, given the available data and the time frame. However, state experts indicated that the level of detail in the assurances would not be sufficient to enable waste management companies to determine whether, or where, to locate additional capacity. This raises the question of the level of detail and accuracy that is sufficient for the purposes of SARA capacity assurance. EPA did not address this important question in the guidelines published in the Federal Register. Our work shows that SARA capacity assurances will be seriously limited by data collection methods that resulted in the use of data from different instruments

from different years across different states. These problems, in conjunction with the remaining data gaps and measurement problems discussed previously, will seriously threaten the validity of the assurances that can be provided. Due in part to these limitations, EPA is planning to require that capacity assurances be submitted periodically.

Data Collection in the Permanent Information System

This section presents the results of our evaluation of the quality of the data likely to be produced by the data collection mechanisms used in the permanent information system. We assessed whether the issues affecting data collection in the past or during the interim phase have been resolved in the permanent information system as it was planned in August 1988. As discussed in chapter 2, the primary difference between the interim and permanent information systems is that the permanent system will not include further national surveys but will continue to include the more limited scope surveys contained in the original information system. Thus, the RCRA reporting system will become EPA's principal mechanism for collecting regulatory development data. The permanent information system will also be able to draw on the information provided by the toxic chemical release inventory reporting system. These data collection mechanisms will have to support state implementation activities, additional capacity assurances, and all EPA regulatory development activities.

We found six factors that are likely to affect adversely the quality of the data provided by the permanent information system: (1) continued lack of support for the RCRA reporting system, (2) phaseout of national surveys despite continuing need, (3) lack of integration of permanent data collection instruments, (4) incomplete federal recordkeeping and reporting requirements for handlers, (5) inconsistent requirements for state programs, and (6) the problematic relationship between EPA and the states under RCRA.

Continued Lack of Support for the RCRA Reporting System

In the past, EPA has not provided sufficient funding for the RCRA reporting system. EPA officials told the states that the agency could not guarantee additional funding for the 1989 cycle, despite its expanded size and importance. As discussed previously, EPA officials stated that EPA pays 25 percent of the cost of the reporting system, although EPA generally funds required activities at the rate of 75 percent.

In addition, despite the fact that EPA's plan for data collection relies heavily on incentives for states to collect and verify the data, few incentives have been provided. State program experts indicated that one important incentive would be to include specific indicators related to data collection in the mechanism for monitoring state program performance. State experts indicated that since data collection is not among the things specifically monitored (such as the number of inspections performed) data collection and quality control suffer. However, if EPA were to increase the funding for the RCRA reporting effort to 75 percent of the estimated cost and include specific indicators of quality control work in monitoring state performance, improved quality control would be likely.

Phaseout of EPA-Sponsored National Surveys

In the past, national surveys have been the primary source of useful national data that the agency has been able to obtain. The RCRA reporting system has never produced complete and valid national data. We believe it is unwise to abandon EPA-sponsored national surveys without having a proven alternative.

In addition, there are two factors that lead us to the conclusion that combining intermittent EPA-sponsored national surveys with the RCRA reporting system census will continue to be appropriate. First, the data required for many activities are not required for every handler; only the more limited data necessary for implementation purposes are required for every handler. Appropriately stratified probability samples, such as those discussed earlier, would be sufficient for collecting the data required for capacity assurance and regulatory development. Second, the amount of quality control work necessary to ensure the accuracy of the data from a census is extensive and may exceed state and EPA resources.

To minimize the regulatory burden, we believe the RCRA biennial census should collect only that information that is needed for ongoing routine implementation purposes from every handler. These data are needed primarily by the state programs and EPA regional offices. These data also would enable the development of more refined stratified samples. According to EPA's plan in effect in August 1988, the permanent RCRA reporting system was to collect data necessary for regulatory development. As was discussed in chapter 2, this is not consistent with the two-domain concept for structuring the RCRA reporting system because it asks states to collect information that is used primarily by EPA. In addition, the 1987 RCRA reporting instrument does not provide the level of detail that is necessary for regulatory development. That is, the level of

detail in the revised instrument is greater than states need for implementation purposes and not great enough for many regulatory development purposes. The effects of this policy concerning the RCRA reporting system are (1) to shift a portion of the responsibility and the cost of data collection for EPA's regulatory development activities to the states and (2) to make EPA even more dependent on a diffuse and hard to manage system that has repeatedly failed to provide valid national data.

These problems would be corrected by combining the two types of sample surveys discussed previously with the census provided by the RCRA reporting system. Three data collection instruments would then be used during each cycle. The first would collect basic implementation data from every handler in the full census conducted either by the states or directly by EPA. The second would collect the additional information required for capacity assurances from a sample designed to assure adequate precision for each state. Finally, the third would collect the most detailed and burdensome data required for regulatory development from a smaller subsample sufficient to assure adequate precision only at the national level. The result would be that the least burdensome data would be collected in the census and the most burdensome from the smallest national sample, with the sample portions of the system being conducted entirely by EPA. This alternative would incorporate the best features of EPA's 1982 proposal as discussed in chapter 2.

Based on the foregoing factors, we believe that a streamlined biennial census focusing on the implementation data needed from each handler, in conjunction with simultaneous sample surveys sponsored by EPA, would be the most effective and efficient approach to data collection. Such an approach would reduce the extensiveness of quality control problems and reduce reliance on a diverse and hard to manage reporting system. It would also avoid the complicated and expensive process of developing entirely separate national surveys. The data elements could also be relatively standard from cycle to cycle (with only the sample changing), thus eliminating the problem of potential inconsistency from one questionnaire to the next. Used in conjunction with on-site verification from a small subsample, such an approach would ensure collection of the valid information needed to implement the program called for by the Congress.

Lack of Integrated Data Collection Mechanisms

The different data collection mechanisms included in the permanent information system have not been designed to work together as an integrated information system. Specifically, EPA has not designed the toxic

chemical release inventory reporting system so that it complements the revised RCRA reporting system. This failure to integrate mechanisms results in duplication and lost opportunities for maximizing available information.

The information provided by the toxic chemical release inventory reporting system will not be consistent with the other data collection mechanisms we have discussed. The National Governors' Association has concluded that a consequence of this lack or integration may be a duplication of effort that still will not produce results that are comparable to, or useful in conjunction with, other data collected by EPA.

First of all, there is a significant overlap between the reporting populations for the toxic chemical release inventory reporting system and the RCRA population. Avoiding duplication requires careful coordination between the reporting systems to ensure that members of both populations are not required to provide the same information twice. EPA has already developed standard techniques for avoiding duplication that involve including a question on one instrument that asks if the facility has completed the other. If the response is "yes," only the nonduplicative information is required. However, this technique cannot be used effectively on account of a second problem—that is, that the instruments used in the two systems measure some of the same attributes in different ways. These differently measured attributes include the waste characteristics that determine appropriate management methods, the management methods actually used, and some of the information on waste minimization. In this way, information that is essentially duplicative is rendered noncomparable. However, the standardized measures discussed in chapter 4 would help eliminate this problem.

In addition to duplicating some information, an important opportunity is missed here for using the results of the two systems to complement each other. The toxic chemical release inventory reporting system will obtain information that the RCRA data collection mechanisms do not that could be useful for regulatory development. SARA requires the system to obtain information on the amounts of specific chemical substances and on the efficiency of the methods used to treat wastes. Risk assessments require detailed data on the concentration of toxic constituents of waste streams and, although not essential, information on treatment efficiencies would be useful. Data on the concentrations of toxic substances in RCRA regulated wastes would also be helpful to enforcement officials. Although the toxic chemical inventory reporting system provides this information, it cannot be used to supplement other RCRA information because it is not

cross-referenced to the total quantity of the RCRA regulated wastes in which these chemicals are found. Consequently, EPA cannot use the data in conjunction with data collected on RCRA regulated wastes. As a National Governors' Association evaluation of the final regulation states: "Given the current designs of both the ... [toxic chemical release inventory] and ... [the revised RCRA reporting system instrument], an important informational advantage ... is being passed up."[6]

Incomplete Recordkeeping and Reporting Requirements

According to existing federal regulations, hazardous waste generators are not required to perform any tests to determine either whether a waste is hazardous or what type of waste it is unless information from other sources (such as product labels or the RCRA waste code descriptions) is not sufficient to make this determination. Generators are, however, required to keep records of any tests that are conducted, although these tests are not standardized. Conversely, management facilities must perform extensive tests (if generators do not) in order to determine appropriate management methods. Management facilities are also required to keep records of the results of tests that are performed. However, no standard tests are required. In addition, management facilities are not required to return copies of the test results to generators.

The foregoing regulations are responsible for important data collection problems discussed earlier in this report. Handlers who do not conduct the tests necessary to provide the requested quantitative data on waste characteristics included on new and revised data collection instruments cannot be required to provide the information. As previously discussed, the qualitative data EPA sought on the new and revised measurement instruments do not require additional testing. However, these qualitative measures are much less accurate than quantitative measures. This problem would be corrected if EPA standardized the tests management facilities are already required to perform, and required management facilities to return copies of the tests to generators. We believe this would be a relatively minor change to current regulatory requirements and would produce a large increase in useful information available to EPA, state programs, the Congress, and the public. Such recordkeeping requirements would also enhance EPA's ability to collect information on surveys, reduce the complexity of data collection instruments, reduce

[6]National Governors' Association, "Comparison of Final Toxic Chemical Release Inventory Reporting Form With 1987 Biennial Hazardous Waste Report Questionnaire Package" (Paper provided to the Annual/Biennial Hazardous Waste Report Advisory Council, June 1988), p. 2.

the amount of quality control required, and greatly facilitate on-site validation.

EPA could use the authority provided by section 3007 of RCRA to collect samples of wastes and other information from handlers directly. If EPA used this authority, it would not need to develop additional recordkeeping regulations. However, it would be unreasonable for EPA to rely on inspections for primary data collection activities since this could reduce resources available for enforcement. EPA also has the authority to promulgate additional recordkeeping regulations that would require every handler to keep all records that EPA might need in the future. However, this approach seems unreasonably burdensome and inefficient since EPA might never need much of the information and, in any case, much of the information would not be required from every handler.

The establishment of two kinds of recordkeeping requirements could solve the problem. The first kind would pertain to those records that, like existing regulations, are required to be kept routinely by every handler of a particular class. This type of regulation, as discussed earlier, should standardize the tests that management facilities are already required to perform, and require generators to retain copies of these tests.

The second type of regulation would mandate additional records, data elements, or tests that EPA may require. However, no individual handler would be required to perform these tests or keep records of these data elements unless directed to do so by EPA for a specific time and purpose. This would enable EPA to collect the needed data from a sample of the regulated population without requiring every handler to routinely maintain records that are only needed from some handlers some of the time.

These regulatory changes would improve both the RCRA reporting system and national surveys. In addition, since failure to provide the requested information would be a clear violation of federal regulations, EPA's ability to enforce reporting requirements would be greatly enhanced. We believe that such a regulation is necessary to ensure timely and accurate national information. If EPA finds it does not have authority under current law to develop such a regulation, the agency should seek legislative refinement.

Inconsistent Requirements for State Programs

Federal regulations governing the RCRA reporting system remain inconsistent with EPA's expectations for states. In the permanent system, EPA expects the states to submit disaggregated data rather than aggregated summaries of the data. However, existing federal regulations explicitly require states to submit summaries rather than disaggregated data. We believe federal regulations should be modified so that they are consistent with EPA's expectations and needs. In addition, existing federal regulations, which provide that state programs shall develop reporting requirements that are equivalent to federal rules, do not require states to collect data identical to those contained in EPA's data collection instrument. Yet, without such a requirement, EPA has limited ability to ensure that uniform data elements are actually collected.

Based on the foregoing factors, we believe EPA's 1982 assessment of the RCRA reporting system remains valid; that is, the variety of data collection and processing systems used by the states will probably continue to preclude timely and efficient data analysis. We believe that an effective strategy will require modification of federal regulations so that they are consistent with EPA's expectation that states collect identical data elements and submit the data in a disaggregated form. However, requiring states to collect specific data elements may conflict with the process for authorizing and revising state programs required by RCRA.

The Relationship Between EPA and the States Under RCRA

EPA's ability to ensure that states collect identical data in a timely manner is limited by RCRA itself. EPA must authorize a state program if its statutes and regulations are equivalent to, consistent with, and not less stringent than applicable federal standards. Accordingly, RCRA does not require state programs to be identical to the federal program, and state data collection efforts are subject to this same general requirement. However, in order for technical data elements to be consistent with one another, they must be identical. Therefore, we conclude that RCRA does not provide a clear basis for EPA to require states to collect identical data in a timely manner.

EPA might successfully argue that in order to be consistent, data elements must be identical. In fact, EPA has done this to a limited extent. Based on the need for consistency, federal regulations (1) require state programs to use a national manifest form with required federal data elements and (2) prohibit states from requiring additional information. However, as discussed in chapter 2, the manifest form contains numerous optional state data that continue to differ across states and, in part, prevent the manifest from being the primary data collection instrument

EPA originally intended it to be. Furthermore, requiring states to use a standard data collection instrument would not fully solve the problem. There is insufficient time between reporting cycles for EPA to issue new rules to make necessary modifications to the instrument (or supporting recordkeeping rules) and for states to modify their regulations accordingly. A streamlined state census in conjunction with EPA-sponsored sample surveys, as discussed earlier, would minimize but probably not eliminate this problem. Finally, EPA is limited in its ability to compel authorized states to collect standard data.

EPA can withdraw authorization but this is time-consuming and disruptive. The EPA representative of the General Counsel's office with whom we discussed this issue stated that EPA would not withdraw a state's authorization if the state did not collect identical data elements because it would be too disruptive for the overall national program. He stated that valid national data are vital but not worth the disruption that would be caused by withdrawing state authorizations.

RCRA does provide EPA with another alternative. EPA could promulgate federal regulations that would enable the agency to conduct a periodic census on its own authority in authorized states. However, EPA unsuccessfully tried a similar approach in 1982. The agency received critical comments when it proposed to conduct a biennial sample survey under its own authority. Those people who filed comments with EPA believed that an overall increase in regulatory burden would occur because many states would continue to maintain duplicate reporting systems under their own authority.

The result of the current arrangements is that the federal information system must be pieced together from separate state systems rather than, as suggested by RCRA, having the states add data to a minimum, consistent federal system to support their own more stringent rules or unique needs and interests. Available remedies either limit EPA's ability to obtain consistent data in a timely manner or make EPA appear to be adding additional information to state systems.

We considered two possible remedies to this impasse, both of which would require legislative refinements. First, EPA would be more able to ensure the collection of consistent data without causing major disruptions if it had authority under RCRA to withdraw authorization for a specific program activity (rather than only for the program as a whole). Such authority would also be consistent with the way EPA initially grants authorization; that is, authorization is granted on the basis of

specific program activities that correspond to specific federal regulations. However, this possible remedy has a major limitation in that it would increase the potential for EPA to dictate all program elements to the states.

The second remedy we considered was to place the recordkeeping and reporting provisions of RCRA that enable EPA to develop an information system in a section of the act separate from those that authorize substantive standards applicable to hazardous waste handlers. Accordingly, federal recordkeeping and reporting requirements would take effect in authorized states upon promulgation in the way that HSWA requirements now do.[7] This remedy would solve all four of the foregoing problems—consistency, duplication, timeliness, and enforcement—since the new information system would be independent of state authorization. EPA would then be responsible for conducting the national RCRA reporting system with its own resources under its own authority in all states. EPA could delegate the responsibility for operating the system to a state, but the delegation of this authority would be independent of authorization. States would retain the authority to add data elements that reflect different program needs or more stringent regulations but not to modify federal data elements. States could also continue to collect data more frequently and continue to use their current supplemental data collection mechanisms (such as manifest tracking systems), but there would be only one basic national RCRA reporting system. In effect, this would locate control of the national information system in EPA yet allow states the same flexibility to collect additional information needed to support their own more stringent regulations or unique needs and interests. Some increased reporting burden might occur in states that have extensive supplemental data collection mechanisms. However, this is consistent with RCRA, which permits state requirements to be more stringent than federal requirements.

Summary and Conclusions

EPA data collection methods and procedures have improved in important ways. The most recent national surveys used accepted stratified sampling techniques, and the same data collection instrument was used for each respondent sampled. These are basic and sound methods of data collection. However, because of the continued use of different data collection instruments among the states, the 1987 RCRA reporting cycle cannot produce complete and valid data. Some of the same problems that

[7]EPA was able to administer the waste minimization portion of the 1987 instrument in all states because it was mandated by the 1984 amendments.

characterized previous reporting cycles continue to affect data from states using old instruments. In addition, the new information requested on the revised instrument is not fully supported by federal regulations.

Data collection problems will not seriously jeopardize the two types of capacity analyses performed directly by EPA. The integrated capacity assessment and the assessments performed to support the land disposal restrictions rely entirely on the national surveys, which had minimal data collection problems. However, SARA capacity assurance will be seriously impaired because of its reliance on the RCRA reporting system and the fact that data from different years and different data collection efforts will be used. Necessary data will be entirely missing in states that did not use the revised RCRA reporting system instrument, and previous measurement problems will persist. EPA has attempted to compensate for the missing data by providing states with assumptions based on engineering judgments. However, EPA acknowledges that these do not reflect actual state conditions. The resultant uneven quality of the data will seriously weaken confidence in the SARA capacity assurances. Although state and EPA experts we interviewed believed the capacity assessments will be as good as possible given the available data and the time frame, state experts indicated that the level of detail will not be sufficient for waste management companies to determine whether or where to locate additional capacity.

Our overall conclusion is that data collection problems will threaten the quality of the data produced by the permanent information system. EPA has not supplied the same 75 percent of the funding for the RCRA reporting system that it provides for other required program activities, nor has it provided effective incentives to the states, even though EPA intends the system to be the single routine mechanism for providing regulatory development data. Rather than conduct further national surveys, the agency plans to have states collect regulatory development data needed by EPA in the RCRA reporting system—this despite the fact that the RCRA reporting system (1) has never produced valid and complete national data, (2) sample surveys in conjunction with the RCRA reporting system would be more efficient and effective, and (3) the revised instrument is more detailed than necessary for implementation purposes (although less detailed than needed for regulatory development). We believe it is unwise to abandon EPA-sponsored national surveys without a proven alterative. In addition, the toxic chemical release inventory reporting system has not been designed to complement other data collection mechanisms that provide information on hazardous

waste generation and management. Moreover, existing federal regulations are inconsistent with EPA expectations for state data collection and do not support the collection of new information. Finally, EPA's ability to require states to collect standard data is limited by the authorization procedures established in RCRA. The result of the current arrangements is that the federal information system must be pieced together from separate state systems rather than, as RCRA suggests, having the states add data to a minimum, consistent federal system.

EPA officials generally agreed with our findings and stated that the agency has already taken steps that at least partially address some of our findings. These steps include increasing the role of limited scope sample surveys[8], planning to begin revision of the federal regulations in the fall of 1989, and creating a more streamlined RCRA reporting instrument. Since these actions were taken after we finished our field work, we could not evaluate them for this report.

Recommendations

We recommend that the Administrator of EPA direct the Assistant Administrator for Solid Waste and Emergency Response to

- ensure that state data collection and quality control efforts receive fully adequate support and include specific indicators related to data collection and verification in the agency's mechanism for monitoring state performance;
- use probability sampling rather than a census of waste handlers whenever feasible for routine national data collection and quality control to ensure that EPA obtains the information necessary to develop regulations efficiently and without unnecessary data collection burden;
- ensure that the toxic chemical release inventory reporting system complements other hazardous waste data collection efforts so that the data it provides on toxic chemical concentrations can be used to their maximum potential; and finally,
- amend federal recordkeeping and reporting regulations so that states are required to collect and provide standard data elements in a disaggregated form and hazardous waste handlers are required to provide sufficiently detailed data.

[8]EPA is not now planning further national surveys like the current surveys of generators and management facilities.

Matters for Congressional Consideration

In addition to the improvements EPA can make, we believe a refinement in legislation may also be necessary to improve the quality of EPA's information. Nonuniform data and procedures across the states, which are associated with a joint federal-state data collection effort under RCRA, degrade the quality of information about hazardous waste. Under current law, responsibility for data collection, as well as other regulatory activities, is shared by federal and state governments. This problem could be corrected by separating the recordkeeping and reporting provisions of the act from other regulatory provisions and making EPA solely responsible for collecting the information required for developing and implementing the federal program. Uniform national data would then be assured, but states would retain the authority to add data elements and to use supplemental data collection mechanisms to support state needs.

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Glossary

Authorized State	RCRA encourages EPA to authorize states to operate their own hazardous waste programs in lieu of RCRA. In order to obtain authorization, states must develop laws and regulations that are consistent with, equivalent to, and not less stringent than the provisions of federal law and regulations. States are not required to have identical program elements and are explicitly permitted to have more stringent requirements as long as they do not interfere with interstate commerce. EPA operates the RCRA program in unauthorized states.
Best Demonstrated Available Technology	A term used by EPA to refer to the technology-based performance standards required by HSWA for the treatment of hazardous waste restricted from land disposal.
Biennial Report	The term used by EPA to refer to any or all of the three tiers of the reporting system for collecting hazardous waste generation and management data under sections 3002 and 3004 of RCRA. RCRA does not require EPA to publish a report on the biennial census. In this report, we refer to this system as the RCRA reporting system.
Classification System	See Qualitative Variable. Also see General Classification System.
Commercial Status (Waste Management Facility)	Designates treatment, storage, disposal, or recycling facilities that accept wastes on a commercial basis from facilities not under the same ownership.
Cross-Media Management Initiative	A comprehensive EPA effort to track and manage the effects of pollutants across all environmental media (including air, water, and soil) and EPA program areas.
Data Collection Mechanism	We define a data collection mechanism as a component of an information system designed to collect technical data, which embodies scientific measurement instruments and methods of data collection. The federal data collection mechanisms evaluated in this report also must be authorized and fully supported by applicable federal and state laws and regulations.

Design Capacity	The amount of hazardous waste a unit of equipment is technically designed to process. This may differ from the amount the unit is allowed to process according to its operating permit.
General Classification System	One of two basic types of classification systems: special and general. A special classification system contains discrete values of one attribute that are mutually exclusive and exhaustive so that each individual in a category is equal to the others, no individual can be classified in more than one category, and all individuals can be classified. A measure of religion (such as Protestant, Catholic, Jewish, Other, None) is an example of a special classification system. These systems are also commonly referred to as discrete or qualitative variables, or nominal scale measures. In contrast, general classification systems are taxonomies. In addition to being mutually exclusive and exhaustive, they are hierarchical and order all attributes of a class of objects. The additional criteria of a general classification system mean that there are subtypes within major types and that no category can be a subtype of more than one major type.
Hazardous Waste Handler	The owner or operator of any site or facility that generates, transports, stores, treats, disposes of, or recycles hazardous waste. Specific federal regulations exempt some sites and facilities from some or all regulation. These exemptions include businesses that generate very small quantities of hazardous waste, facilities that store hazardous waste for fewer than 90 days, and recycling facilities.
Hazardous Waste Management	The use of specific technologies and procedures for waste minimization, treatment, storage, disposal, or recycling.
Interim Hazardous Waste Information System	The results of EPA improvement efforts implemented between 1987 and 1990. The principal data collection mechanisms in the interim phase include the partially revised RCRA reporting system and the national surveys of hazardous waste generators and management facilities.
Information System	The organizational subsystem in which the observation, recording, storage, retrieval, transmittal, analysis, and presentation of information occurs. The information system includes both formal and informal, as

	well as automated and manual, systems. Our evaluation focused on the generation and management portion of EPA's larger formal hazardous waste information system.
Information System Component	A specific part of a larger information system. Typical components include computerized data bases and data collection mechanisms.
Management Capacity	Refers to the capacity to treat, store, recycle, and dispose hazardous waste. Capacity refers to individual units of equipment, specific management technologies conducted in the equipment, and the linkage of units of equipment into systems that apply more than one management technology in series.
Management Facility	A facility that treats, stores, disposes of, or recycles hazardous waste. Generators who store hazardous waste for fewer than 90 days before shipping them off-site for further storage, treatment, disposal, or recycling are not considered management facilities.
Management Technology	A single treatment, storage, disposal, or recycling technique applied to a waste in one or more management units.
Management Unit	A single piece of equipment in which one or more management technologies occur. Incinerators, tanks, distillation towers, waste piles, surface impoundments, and landfills are considered management units.
Management System	Multiple management technologies applied to a waste in one or more management units. In some cases, EPA has designated specific types of management units (such as incinerators) as systems.
Manifest	A control and tracking document that accompanies all transportation of hazardous waste. It identifies the volume and type of wastes being transported from one facility to another, as well as the management technologies to which it should be subjected prior to final disposal.

No Migration Variance	The 1984 amendments or RCRA banned the land disposal of hazardous wastes unless the wastes are treated to reduce their toxicity or mobility or unless it can be shown that the disposal unit completely prevents migration of the waste from the unit. In cases where a land disposal unit is shown to prevent migration, a variance may be given to allow the unit to accept hazardous wastes. Such a variance is referred to as a no migration variance.
Permanent Hazardous Waste Information System	The results of EPA improvement activities that will be fully implemented after 1990. The data collection mechanisms in the permanent phase include the fully revised RCRA reporting system and the toxic chemical release inventory reporting system.
Permit Status	Designates the type of authorization EPA has granted the facility for the management of hazardous waste. Facilities must comply with either interim permit standards (40 CFR 265) or final permit standards (40 CFR 264).
Qualitative Variable	A discrete variable or nominal scale measure composed of categories that measures the types of a larger class of attributes. The resulting measure is also referred to as a classification system.
Quantitative Variable	A continuous variable that measures the extent to which a single attribute is possessed by developing a metric with equal intervals.
RCRA Reporting System	A term used in this report to refer to the national system for collecting data on hazardous waste generation and management authorized by sections 3002 and 3004 of RCRA. EPA refers to this system as the biennial report.
Residual Waste	The wastes remaining after treatment by a specific treatment technology or process, such as incinerator ash or sludge from settling tanks.
Treatability Analysis	A type of analysis performed to determine the most appropriate treatment technology or technologies for a given type of waste. It is based on

	the physical and chemical form of a quantity of waste and the concentration of certain hazardous and nonhazardous constituents.
Waste Minimization	Refers to practices to reduce generation and/or the recycling and treatment of wastes that lead to overall reductions in the volumes of hazardous waste that ultimately enter the environment.

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