Improving the Biennial Report: Options and Challenges

Prepared For

United States Environmental Protection Agency,
Office of Planning, Analysis and Accountability and
Office of Solid Waste

April 2003

NOTE: This report was prepared for EPA by external consultants in order to provide an overview of issues concerning the Biennial Report. The information and recommendations it contains do not necessarily represent EPA viewpoints or policy directions. This is the final version of the report.

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1. Overview

Since 1981, the Environmental Protection Agency (EPA) has collected information from hazardous waste generators, as well as from waste transport, storage, and disposal facilities (TSDFs). Using a mandatory data collection form, regulated facilities have reported information on their waste quantities and management methods to the states every two years. This information is then sent to EPA. The effort is commonly referred to as BRS (for Biennial Reporting System), or simply BR (for Biennial Report). We use the terms interchangeably. States have had the option of requiring more extensive and/or frequent data collection from facilities, and many have done so.

While the BRS has yielded a great deal of information used by EPA, the states, and other parties, the system suffers from a number of problems that limit the utility of the data collected. These include high costs to collect and process the data; delays of 2-3 years between generation and availability of data; substantial data inaccuracies; conflicting requirements among states and between the states and the federal government; and a lack of integration of related hazardous waste reporting requirements.

1.1 Research Approach

As part of its ongoing effort to evaluate the effectiveness of various programs, EPA has asked Industrial Economics, Inc. and Earth Track, Inc. to conduct a review of the BRS. The study has focused on identifying elements of the program that are working well, and those that need improvement. In addition, we have attempted to identify possible options for improving the system. This is not a new challenge; the Agency has examined aspects of both the BRS and hazardous waste reporting in general over the past several years. To benefit from the Agency's past work, as well as that by various other agencies, we began our task with a review of the existing literature. Among the federal efforts examined were WIN/Informed; rulemakings related to RCRA burden reduction, the Cross-Media Electronic Reporting and Record-keeping Rule (CROMERRR); and proposed modifications to the hazardous waste manifest system. EPA's Information Collection Requests relating to both BRS and the manifest system, as well as state programs, including those summarized by the National Governor's Association in the late 1990s were also reviewed.

This baseline informed our subsequent work, for which we relied heavily on conversations with individuals involved with many different aspects of hazardous waste tracking and reporting. These people (listed in Appendix C), represented a range of stakeholders including state and federal government officials; small and large waste generators; transporters; and tracking software designers. We also examined models outside of the hazardous waste sector to identify alternative systems that might be applicable to the existing hazardous waste data system.

Since previous analyses had already evaluated many of the details regarding BRS data elements, our work focused more on the strategic level. Specifically, we were interested in issues such as what an ideal reporting system would look like and how views on this differ across stakeholders; barriers to change; and data on how potential innovations are working in

practice. An example may be useful to illustrate this distinction. Many earlier reports have noted that shifting to electronic reporting will improve both the timeliness and accuracy of hazardous waste data. In our analysis, we wanted to examine these views in more detail, evaluating any groups that disagreed with this assessment, and whether there were constraints to being able to realize these potential efficiencies in practice. A common thread in our analysis has been an attempt to understand techniques currently in commercial use and that appear directly applicable to improving the BRS, and then to evaluate why these approaches have not been widely adapted. Better understanding some of these key barriers can help delineate a road map for future improvements.

Our findings are presented in brief below, and in more detail in Chapter 4 of the report.

1.2 Findings in Brief

Our research suggests that once there is fairly wide agreement on what an optimal waste tracking system should look like. Differences in viewpoints tend to focus more on the timing, rigidity, and detailed structure of moving from the current system to an "ideal" future system. We present our findings in terms of defining the problem and its potential solutions; some of the challenges of moving to a new system; and potential next steps.

1.2.1 Defining the Problem and the Solution

- **EPA and industry differ in how they view waste reporting and evaluate reforms.** EPA, perhaps due to the specific areas in which it has regulatory authority, tends to promote reforms that are narrower in scope than what industry finds most useful. For example, EPA may focus on trying to standardize hazardous waste manifests, while industry (and to some extent the states as well), focus on the overall reporting burden in how they develop their staff and their systems. This latter approach cuts across multiple EPA rules and often multiple regulatory agencies as well. One implication is that industry perceives some Agency initiatives as affecting such a small part of their overall reporting burden that they are of relatively little interest. To the extent that EPA is able to incorporate a more holistic view of the problem in developing reform proposals, it may have greater success engendering support for its efforts from these other sectors.

- **Various sectors share a common vision**. Despite wide variance in existing programs, and somewhat differing views on pending reform efforts, participants from all three main interest groups (EPA, the States, and private industry) shared a remarkably common vision of what an optimal reporting system should look like. General attributes of such a system are increased standardization in data and data formats; increased flexibility and openness in system technical parameters; full automation; centralization of data flows; and much greater ability to extract information from this centralized data to meet a variety of reporting burdens now addressed through multiple reports.

1.2.2 Challenges in Implementing Change

Moving from the current to the optimal system is challenging. Themes we heard from multiple parties suggest a number of the key steps and areas requiring EPA attention.

- **Standardization of data elements and reporting protocols is foremost step to achieving cost savings** Without standardization, many respondents felt that automation would yield little in efficiency gains and be markedly more difficult to achieve.

- **Automation of reporting can only succeed if it is universally adapted.** While many parties are improving administrative efficiency by automating processes within their firm or state, system-wide automation was viewed very differently. We heard from many people that unless all participants in the system were required to shift to electronic reporting, many of those that did move forward with automation would be required to maintain both paper and electronic systems. Specifically, firms involved with multiple state government agencies, government agencies dealing with multiple firms, and waste service companies dealing with multiple firms would all likely face higher costs rather than lower ones from these dual systems. As states and small business interests often favor a voluntary phase in, this issue is an important area of conflict between stakeholders.

- **Improved data could better demonstrate the economic benefits of automation to resistant stakeholder groups.** One way to convince smaller businesses and reluctant states to move forward with both standardization and automation is to do a better job quantifying the benefits of this new strategy. We found little documented information on this during our research. In some cases, the direct benefits of automation (e.g., reduced data entry costs) had been estimated, but more often the data were sparse and incomplete. In the more difficult arena of measuring the strategic value to government or industry of more accurate, more timely information, we found almost nothing. Yet, in the general logistics industry, the strategic value of this type of information is proving to be of enormous value (for example, UPS helped Ford Motors improve tracking of unsold vehicle inventory, reducing annual financing costs by over $100 million per year).

- **Despite large potential benefits from change, many institutional and political barriers remain.** Some of the most relevant ones include**:**

    - **Fragmented decision making power**. Between states and firms, there are hundreds of individual decision makers who must agree on a common plan forward. This structure favors an approach that can be adopted piece-meal by different groups, though the economics of automation favor an approach adopted universally.

    - **Insufficient integration between potential public sector beneficiaries.** Many groups benefit from accurate hazardous waste data. These include policy makers, enforcement staff, emergency responders, and the public. Yet, reforms tend to focus on one group or another, rather than to examine the best approach, and the overall benefits, in a holistic manner. A more integrated approach would likely be able to show a higher potential payback.

    - **Things work well enough as they are**. Many participants in this system have established methods that allow them to meet, more or less, the requirements they face.

Whether in a firm that has built an internal data system for millions of dollars, or a state government that has specialized data collection to track waste fees, many groups will resist having to make significant system changes without sound evidence of a high return for doing so.

- **State and federal interests may conflict**. States do not want to give up control of data elements, reporting formats, or resources associated with these programs. Not all of these issues are easily soluble.

1.2.3 Potential Next Steps

- **Improve data standardization.** Data elements, data and reporting formats, technical standards, and cross-use of core data across reporting formats all need to be streamlined and standardized.

- **Replace BRS with expanded manifest data**. There was widespread support for this across all constituent groups. Some states (e.g., TX) are already effectively doing this.

- **Work to quantify benefits associated with better information**. Without this, pushing change will be much harder.

- **Improve the use of BRS data** It makes little sense to ask for information if you are not ready to use it, and much of what is now collected is not well utilized. Much more attention should be paid to the use of data, and the design of query routines and exceptions reporting.

- **Develop standing committee to focus on data and technology standards**. Hazardous waste reporting, and environmental reporting in general, is a moving target. Technologies change, as do regulations at both the state, federal, and international level. EPA has in the past set up multi-year workgroups to focus on these issues. It may make sense to establish a standing group to set the open standards to which all participants must abide. This could be modeled on the Financial Accounting Standards Board (FASB), which studies particular issues in accounting (environmental reporting) and then issues rulings on them which all organizations must follow. FASB' focus is on ensuring that decentralized reporting follows standard approaches so that the resulting reports are accurate and transparent.

1.3 Structure of the Report

Chapter 2 of this paper examines the existing data systems in more detail, providing an overview of structure and challenges for both the BR and closely related hazardous waste manifest system. An important element of this presentation is an evaluation of current system costs. While not complete, this information is the best measure currently available for the potential market to firms or government agencies that can introduce technologies and standards that improve system efficiency. Chapter 3 looks to other models, synthesizing information on related systems deployed in other settings with our stakeholder interviews, in order to identify

promising (and troublesome) reform options. "Other settings" includes information associated with EPA reform initiatives; state programs; general logistics operations; and views on the "ideal" system if one were unconstrained by the financial, institutional, or regulatory barriers. Importantly, the chapter classifies these efforts along a continuum of automation and data integration opportunities in order to see patterns and gaps in what has been tried to date. Chapter 4 lays out options for the road forward for BRS, highlighting those that seem most promising. In addition, we identify a number of issues that are not currently attracting much attention, but where we believe additional analysis could improve the efficiency and accuracy of hazardous waste data collection efforts.

The report also contains three appendices. Appendix A presents detailed summaries of research and interviews we conducted to gauge the views of groups with potentially different interests in the question of BRS reform. These include a small and a large generator of hazardous waste; a third party waste service provider; state regulatory agencies; and top tier logistics firms outside of the realm of hazardous waste. The main report is only able to extract some of the information these groups gave us; reading the details can provide many additional insights. Appendix B provides detail on our calculations for the estimated costs of complying with the BR and the hazardous waste manifest regulations. Appendix C is a listing of the individuals we contacted to support our research.

2. Review of Existing Federal Systems on Hazardous Waste Data Collection

Data on hazardous wastes are used by EPA as well as by other agencies such as the US Department of Transportation (DOT) to meet a variety of public needs. Data required by emergency responders should there be an accident is collected on a shipping paper that follows the wastes. This data collection is conducted under the auspices of DOT.

EPA collects a wide range of data relating to hazardous wastes, and estimates that they receive more than 300 different types of notifications, reports, certifications, demonstrations and plans from generators and treatment, storage and disposal facilities (TSDFs) to show compliance with RCRA or to request permits or variances from the law. (64 FR 32862). Data collection most closely linked to BRS addresses three core areas:

- **Safe and proper management.** The Agency uses "cradle-to-grave" tracking of shipments via a waste manifest to ensure wastes are managed properly rather than dumped. This protects both human health and the environment. Other more specific reports, such as paperwork related to the land disposal ban (LDR) for certain wastes fit into this same general category. Concerns over homeland security by some parties have heightened the desire for tight controls over hazardous materials.

- **Trends measurement and analysis**. The core function of the Biennial Report (BR) is to provide trend information on the quantities, type, and management of hazardous waste in the United States. These data help EPA evaluate the capacity of the waste sector; to evaluate trends in generation and treatment; and to track interstate and international movement of wastes. (67 FR 52721).

- **Enforcement**. A third use for hazardous waste data is for enforcement and for targeting inspections. Both manifests and the BR are used to achieve this aim; however, supplemental and/or more timely information is often obtained as well.

Although the primary focus of this analysis is on the BR, there is much overlap between data collected through the BR and other required reporting by generators and TSDFs. In addition to hazardous waste manifesting, there is a wide range of related data that must be reported to specific states. Because of this overlap, firms generally view any reform discussion relating to the BR through the prism of how it affects their overall reporting burden.

As a result, reform to the BR requires first a general understanding of the strengths and weaknesses in some of these reports, and areas where state and federal efforts overlap. Exhibit 1 provides a brief summary of the main limitations in the current hazardous waste data system , as well as current and comparative system costs. This Exhibit is useful in demonstrating areas where BRS and the manifests don't overlap, as well as in highlighting the challenge in trying to eliminate report variation between the states and the federal EPA.

Exhibit 1
Current Hazardous Waste Data Collection: Challenges and Costs

Category	Biennial Report	Federal Manifest	State Variations
Data Gaps	-Small quantity generator wastes not tracked.	-On site management not reported.	-Widely differing definitions of who must report. -Manifests often have more required data fields.
Data Accuracy	-Many users/developers have concerns about errors in data reporting, transcription that are not caught. -Once federal report compiled, no additional corrections are made even if large errors found. -Companies may not review data particularly carefully.	-Generally viewed as successful in highlighting lost/missing shipments. -Little supplemental use of data in the manifests.	-States often use manifest data for levying waste taxes. -Other detail often not used. -Many state forms not compiled/reported to federal government.
Data Timeliness	-Data are 2-3 years old by the time they are made available.	-Users feel that broken links usually visible within short time frame. -Additional information usually never made available.	
Average Cost of System (2002$)	Total: $18.7 million per year $/respondent: $1,800	Total: $380 - $785 million per year $/manifest: $75 - $154 Four estimates using varying methods, assumptions. Lower end tends to exclude more IT costs, state costs.	
Cost of Commercial Logistics (2002$)	Not applicable	Average of $5.05 per shipment at UPS and Fedex. As % of HW data cost: 3.3 - 6.7%	
Sources	Interviews with EPA staff, private firms, states. See Appendix B for additional detail on cost information.		

Exhibit 2 provides a more extensive summary of existing programs and program weaknesses. The Exhibit also identifies planned changes in data systems now underway in a series of EPA rulemaking efforts. In both the BR and the manifest areas, similar problems exist with regards to high costs, low accuracy, and long delays. Though not identical, there is also a wide degree of overlap between the data gathered on the BR and that on the HW manifests or DOT shipping paper. For this reason, many of the state and private sector tools to increase the efficiency and accuracy of hazardous waste information cut across strict regulatory demarcations. The discussion in this report does the same.

Exhibit 2
Summary of Existing Reporting Process, Problems, and Reform Proposals

Purpose	Process	Problems	Proposals
Biennial Reporting System (BRS)			
-Track trends in haz waste generation, movement, treatment for use in policy planning. -Authority: Sections 3002 and 3004 of RCRA.	-Biennial survey collected from generators, transporters, TSDFs by States. -Following comment period, formal data set submitted to EPA and compiled into national data set.	-*Economics*: costly to carry out • Much of the data collected duplicates information already reported on HW manifests. • State-by-state variations in collected data drive costs up. -*Accuracy*: very little quality assurance done on data sets: • Different users often define same wastes differently. • Large unexplained variances year-to-year and between tons generated and tons managed data. • Data gaps: onsite SQGs not tracked. • Biennial collection also makes trends harder to discern. -*Timeliness*: often 2-3 years late. Difficult to base policy decisions on such old information.	-*Standardization*: • Reduce and/or standardize data elements collected. -*Automation/Accuracy*: • Allow electronic storage and reporting of data. • Establish formal BRS users group to more effectively identify data flaws and corrections. -*Integration*: • Replace BR entirely with slightly modified versions of the hazardous waste manifest or TRI. • Modernize data aggregation process to use electronic methods, more advanced error detection.
Hazardous Waste Manifest System			
-Ensure chain of custody on HW movement and treatment; identify incomplete or problematic shipments. Careful control ensures proper management to protect human health and the environment. -Provide data usable for emergency response, though this function served primarily by a separate DOT shipping paper.	-Multi-part paper manifest follows each shipment; signed copy returned to generator upon receipt (though not validation) of shipment at final TSDF site. -Exceptions reports collected by the federal government; use of other manifest data widely by state.	-*Economics*: • Extremely expensive and inefficient process, with estimated system costs of between $75 and $154 per manifest (excluding actual transport costs). • Wide variation in formats, data elements across states. -*Accuracy*: most users felt the manifests did a relatively good job identifying missing shipments, though no quantitative data. -*Timeliness*: most data contained in manifests is never used. Exceptions data does arrive within a	-*Standardization*: • Require single standardized manifest for the entire country. • Promote development of non-governmental systems through licensing manifest printing, establishing open standards for reporting via the internet. -*Automation*: • Allow electronic manifests, including electronic signatures and e-transmission to regulatory

Purpose	Process	Problems	Proposals
		reasonable time-frame.	authorities. -*Integration*: • Expand mandatory data elements somewhat to allow manifest data to replace BRS. • Shift main data portal from the states to the federal government to more effectively integrate reported data.
Other Related Issues:			
1) *Department of Transportation hazardous materials manifest*: to provide standardized data on shipments for emergency responders.	-Paper form stored in truck during shipment.	-Data overlap with manifest, but not completely. -Data are not also accessible electronically, for responders to access even prior to reaching accident site.	-*Integration*: • Establish national uniform manifest to meet both DOT and RCRA requirements. Care needed to ensure appropriate information from both is captured.
2) *Land Disposal Regulation notifications*: additional paperwork associated with manifest to ensure compliance with land disposal bans on certain hazardous wastes.	-Current systems are paper.	-Some industries state that the LDR paperwork if sometimes more burdensome than the manifest itself.	-*Integration*: Industry commentators on proposals to modify the manifests have advocated the effort include wide range of related forms, such as LDR, PCB continuation sheets, etc.
Sources: Data synthesis derived from many of the EPA reports and rulemakings listed in the Reference section, as well as from interviews with individuals listed in Appendix C.			

2.1 Biennial Report: Process and Efficacy

Data used to generate the BR is collected from generators and TSDFs primarily at the state level, where States and EPA regions convert them into a standardized electronic format. These data are maintained in RCRAInfo, a database residing on centrally managed servers at EPA's National Computing Center. Once an initial version of the national database is compiled, EPA Headquarters coordinates a data quality review with the states and EPA Regions. This process identifies cases where the state or Region may want to confirm that data were correctly entered, and where they should contact a respondent to confirm what they reported and provide them with the opportunity to submit an updated report if the original contained errors. Following the submittal of revised data, no further changes are made to the database and it becomes the final version. (67 FR 52721)

Our research highlights many challenges with the current BR process. These include issues regarding time lags (section 2.1.1), accuracy problems (section 2.1.2), cost (section 2.1.3), data precision (section 2.1.4), and the process of data improvement (section 2.1.5). Many of these problems arise from the process by which the report is produced. The parties with the specific knowledge to provide accurate data do not necessarily have the incentive of the ability to do so. Regulatory agencies expend a great deal of time and resources to compile the existing data flow into a usable format. As a result, there are sometimes insufficient resources left over for ensuring high quality information. Finally, data users have not demanded these weaknesses be addressed. These issues are described in more detail below.

2.1.1 Timeliness

With biennial reporting, plus one year of processing time, compiled information is often already three years old at the time it is released. EPA staff indicate that this delay affects the utility of information for planning purposes. This is especially true for more time-sensitive data applications such as inspections targeting and enforcement. Total quality management efforts within the private sector provide an instructive example of the value of rapid feedback. When factories were able to detect errors quickly after products were made, they were much more able to trace the *causes* of those defects, and subsequently to refine the production system to prevent the mistakes in the first place. Where too much time passed, engineers were not able to link the mistake to the conditions that caused the mistake.

Hazardous waste data are similar: if the Agency can detect patterns in generation, shipment, treatment or disposal in near-real time, it can more easily develop new regulatory approaches and identify system failures, thereby enhancing the protection of human health and the environment. In the current system, data are not accessible until two or three years after waste generation, limiting EPA's ability to link anomalous patterns in wastes to specific actions of the firms.

2.1.2 Data accuracy

Notwithstanding the delay in receiving information, the data are often of poor quality. Solving this problem requires attention at all stages of the BRS, from reporting facilities up to those working with aggregated data from States at the national level. In practice, such coordinated focus does not occur. Errors crop up at each level. Data contributors may lack the incentive and/or ability to ensure the final data attributed to them in State compilations are accurate. States themselves have widely varying data quality and quality assurance programs. Finally, there are weaknesses in data screening at the federal level as well.

- **Data contributor quality issues.** Most firms report as required to the states. Errors creep into this process in a number of ways.

    - **Flawed submittals.** Submittals may be flawed, but go to a state with no capacity to check the information and flag problems. For example, in both mandatory and voluntary fields within BRS, there are a surprisingly high number of blank cells.

    - **Errors at time of data conversion; limited verification later.** Data submittals may be accurate, but become corrupted at the state level when rekeyed or put through an electronic conversion program. While states do have a window for firms to view and correct the data, and firms are required to certify the data, we have some evidence that this system does not work quite as well as planned. Companies we spoke with, including some very large ones, do not normally expend much additional time rechecking information after states or the federal government have processed it. In some circumstances, data aggregation done by the state destroys the plant-level resolution on wastes. Since data within many firms are collected at the plant level, and these staff are the ones called upon to verify submittals, the aggregation routines make it impossible to match the data in the government systems with the information originally submitted from the plant-level. Furthermore, since the firms generally see little economic value for the data (they rely on their internal data systems for strategic and capacity planning), there is no business incentive for them to expend resources evaluating and/or correcting BRS data that the receiving agency may have corrupted. The important point is that an absence of industry comments on data within the systems doesn't necessarily mean the information is correct.

- **State government quality issues**. Most of the BR surveys from firms are sent in paper or electronic form to state regulatory authorities for processing. The Environmental Council of States estimates that roughly 92 percent of the data in BRS comes through the states.[1] If the states were able to ensure clean information, errors flowing to the federal level would be much smaller. However, both state and federal contacts acknowledge that the process of quality assurance/quality control (QA/QC) varies widely across states. Some have automated checks and careful review of reports; others have almost none. As a result, data reaching the federal level is of widely varying quality.

[1] Environmental Council of States, "Information on States and Environmental Protection," 2001. Obtained from http://www.sso.org/ecos/states/stateinfo.htm on March 18, 2003.

- **Federal government data quality issues**. EPA data quality issues stem from three sources: insufficient screening of data received from the States; an inadequate effort to reconcile data problems that are discovered; and an absence of audit data from which to build a more effective quality assurance program.

    - **Insufficient screens of submittals.** An EPA contractor does evaluate these submittals for some types of errors. However, an EPA staff person said that these screens often missed things he saw as important, such as confirming that large variances in reported wastes within a state across periods were real, rather than the result of data errors.

    - **Inadequate reconciliation of data anomalies.** All wastes generated must be managed somewhere; thus, the tonnage for each should be equal. (In actuality, since some smaller generators who do not need to file a generator report may manage wastes onsite, the tons managed might be slightly larger than the tons generated). An EPA staff person says this is not the case, and that disparities can sometimes be enormous. For example, in one reporting cycle, BRS suggested 40 million tons had been generated, but only 35 million managed, meaning over 12% of the hazardous waste stream was unaccounted for. While he had some hypotheses for what could have caused the error, he said EPA had never been able to figure it out for sure. Were the errors concentrated in a certain type of waste, industry, or geographic area? Was there double-counting or lost shipments? Errors on this level of magnitude call into question much of the ability to use the resultant data for any planning purposes, and suggest much additional work is needed on understanding the data flows.

    - **Lack of audits.** Periodic audits of submitted data can help EPA identify how widespread errors are, as well as where they are concentrated, in order to develop a plan for addressing weaknesses. An analysis of BRS conducted by the Agency in 1999 noted that there had been no data audits of the system since 1985. (BRS99, 15). EPA staff believe there have been no audits subsequent to the report either, summing to a period of close to 20 years.

2.1.3 Costs of Completing the BRS

In our interviews, EPA staff often raised the cost of completing the BR as an issue of concern. Efforts to streamline the BR have been driven in large part by an effort to reduce the burden on reporters. Surprisingly, however, none of the firms we spoke with were even able to tell us how much they spent on complying with the requirement. This disparity results from the fact that hazardous waste reporting is a far more complex operation than simply completing the BRS forms. Numerous federal requirements must be met, as do extensive and sometimes overlapping reporting to the many states in which the firms do business. Complying with all of these other reporting requirements is normally the responsibility of the very same people who compile the BRS data, and their costs are combined as well. While the private sector does complain broadly about the cost and complexity of reporting (as indicated through both their conversations with us and written comments on EPA proposed rulemakings), they were not able to provide BRS-specific numbers.

Information on costs is available from various EPA data collection requests. A 2000 Information Collection Request (ICR) pegged the annual cost (all in 2002$) at $10.6 million for respondents and an additional $8 million for states/agencies. (ICR 976.10). This totals $18.6 million per year, or more than $37 million per reporting cycle. Using the Agency's data for the number of respondents, the reporting costs almost $3,700 per respondent, with 57% of the cost falling on the respondent itself and the remaining 43% falling on EPA and states. Actual costs of hazardous waste trends reporting will be higher than this since the federal ICR does not capture the costs for states to collect information above and beyond the federal requirements (e.g., every year rather than every two).

It is useful to remember that from the perspective of the private firms, it is the full hazardous waste reporting burden, not BRS alone, that is driving their perceptions of the cost and headache associated with hazardous waste tracking. Adding even one additional reporting burden, the hazardous waste manifest, demonstrates this point clearly. As shown in Exhibit 1, the national cost for BRS is less than 10 percent of the *lowest* estimate for the national cost of the manifest system ($370 to $785 million per year). The cost per manifest is between $75 and $154 (see Appendix B for more details). Whereas this costs measures only the data and paper flows associated with hazardous waste movements (actual transport of the waste is extra), the full cost delivered cost per package for top tier logistics firms such as Fedex and UPS is only $5.05. This means that the existing system for tracking hazardous waste is at least fifteen times as expensive as the cost to track *and* deliver standard commercial packages. In fact, the paperwork costs of the manifest system are actually higher than the cost to dispose or treat the wastes themselves for certain categories.[2] Clearly, there seems to be much room for improvement.

2.1.4 Data Precision

Whereas data accuracy addresses the question of how closely the reported or aggregated data match what is actually occurring at respondent sites, data precision evaluates gaps in coverage, even for accurately reported information. We have identified four areas where imprecise information reduces the value of the data set.

- **Definitional problems.** Different parties often describe the same wastes with different waste codes, or different mixtures of waste codes. This impedes the ability to show clear trends for these wastes in the aggregate data sets.

- **Lack of detailed constituent data.** While the physical form of a particular wastestream can be determined (e.g., liquid, sludge, or soild), there is no way to assess the concentration of a constituent or the mixture ratio of multiple constituents. In addition, constituents below hazardous waste reporting thresholds are not reported at all.

[2] Average prices in January 2002 to incinerate drummed non-halogen liquids was $105.50 per drum; to landfill bulk debris with treatment ($159.44/ton), bulk without treatment ($82.43/ton), drummed with treatment ($112.14/drum), drummed without treatment ($103/drum). See Environmental Technology Council, "Janauary 2002 Incincerator and Landfill Cost Data," obtained from http://www.etc.org/costsurvye6.cfm on March 18, 2003.

- **Gaps in who must report.** The BR does not require that small quantity generators (SQGs) report on wastes. Some of these wastes are captured indirectly if they are shipped offsite for treatment or disposal, but they show up on the "Waste Received" form, which has somewhat less data than the generator (GM) form. The potential elimination of the GM report may increase these gaps, since a number of on-site generators may escape reporting (i.e., if the wastes are also managed onsite by LQGs).

- **Lack of sectoral data.** Many data fields on BRS have historically been voluntary, with the objective of reducing the overall burden of the collection effort. Data coverage on the voluntary fields is normally much worse than on the mandatory fields, and use of these fields for a full sample analysis is rendered impossible. One gap of particular note was the voluntary use of the Standard Industrial Classification (SIC) code. Although a different industrial classification code was finally made mandatory in 2001, it is very difficult to use BRS for sectoral analysis prior to 2001, reducing the usefulness of this information in identifying differential pollution prevention performance.

2.1.5 Sharing Technical Knowledge and Iterative Data Corrections

Any complex system requires continuous efforts to monitor and correct for problems. This can involve formal auditing, a corrections period, and informal information sharing.

Correcting errors. According to EPA staff, states will generally have a corrections period for the information they have received from generators and TSDFs, during which time the reporting entity is supposed to confirm or correct data in the State records. Unfortunately, our interviews suggest (see 2.1.2) that many firms and States do not invest much in achieving data accuracy during this stage. After that period ends and the information is sent to EPA for compiling, the report is complete "as is." No further corrections are made, regardless of how large they are.

EPA staff noted that in some cases they would modify internal versions of the database to correct for these known errors, but that the database available to the public would remain unchanged. This procedure differs from the one employed by the Toxic Release Inventory. According to one staff person at EPA, TRI routinely updates its datasets as errors are brought to their attention. Yet the TRI approach creates the opposite problem, where data are modified without a clear edit record that can be viewed later. This staff person was not sure why a procedure to modify underlying data in a way that remained visible to subsequent users had not been developed for these situations.

Formal data audits. As noted above, there does not appear to have been a formal data audit of BRS in 18 years. Normally, such audits would provide important information on the types of errors that are most common, providing important feedback on how to correct them. Without them, it is quite difficult to gauge whether the proposed reforms are addressing all causes of inaccuracy, or only some of them.

- **Informal review: user group model**. The lack of a formalized BRS users group to share information on problems and errors in the dataset, as well as to share information on new

query techniques that could make the data more valuable to all users was raised as a problem by one EPA employee. He thought that establishing such a group would make a good deal of sense. Under the current system innovation has come slowly. For example, waste quantity is reported in one of seven units of measure. It took until the 1999 report cycle for conversion routines to be built into the system, finally making comparison and analysis of the data much less tedious. It is conceivable that formalizing a users group, with a place to centralize data on errors and approaches, could accelerate this innovation.

2.2 Impact of Data Limitations on Achieving BR Objectives

How do these limitations affect the ability to use BR data? The BR provides information on the quantities, type, and management of hazardous waste in the United States. The Agency's own filings in the Federal Register (67 FR 52721) outline four major purposes of the information collection effort: to help EPA and the states to understand available capacity to treat, store, dispose, and recycle hazardous wastes; to provide information for analysis of trends in waste generation, waste treatment, recycling, and source reduction; to target facility inspections; and to understand how much waste a state receives from out of state or sends out of state. It is useful to examine these objectives in greater detail:

- **Understanding hazardous waste management capacity.** Soon after the passage of RCRA, EPA expended a great deal of effort to evaluate whether there was sufficient capacity to handle the wastes defined as hazardous and being segregated for more careful treatment. EPA conducted surveys of capacity and monitored treatment and disposal prices. This requirement is much less important today since, for most sectors of the marketplace, capacity is in surplus and prices are stable or falling. Thus, achieving this objective is not affected by limitations in the BR.

- **Analyzing trends in generation, treatment, recycling, and source reduction.** Though market capacity may not be a problem, trends analysis remains quite important to most of the government policy makers with whom we spoke. At the state level, a commonly expressed drive for data was to ensure accurate collection of waste taxes. Federal policy makers were interested in broad trends in waste generation by industry or region. Despite frequent questioning to both EPA staff and private firms, we were unable to identify very many cases where detailed BR data were being used in policy analysis, due at least in part to weaknesses in the data set. The level of aggregation, for example, can make it difficult to use the information for identification of source reduction opportunities.

- **Inspection targeting.** Several people we spoke with noted that the BR data were not particularly useful for inspection targeting, due to concerns over both accuracy and timeliness. We also heard from a number of EPA and state personnel that there is little cooperation between the policy staff (at OSW) and the enforcement staff within OECA in terms of collection, evaluation, and use of hazardous waste data. This underscores the potential benefits to all parties associated with facilitating multiple-uses for the same core data.

- **State imports/exports of hazardous wastes**. Again, core weaknesses in the data set limit its usefulness for this purpose. As with inspection targeting, data delays and accuracy are large constraints in tracking import and export patterns. Because data quality can vary widely state-by-state, it is unlikely that existing information on interstate movements provides a very accurate picture of the overall pattern of waste shipments.

3. Lessons from the Field

There have been numerous efforts within both state and federal agencies, and private firms, to improve hazardous waste reporting. Much has been done and much written about these topics, and we have tapped into three important areas of innovation. First, EPA's research and regulatory initiatives over the past years have evaluated a range of policy and technical aspects of hazardous waste reporting. Second, State innovations have also proliferated, as states have worked to obtain the data they needed for local decision making and to reduce their cost to meet federal requirements. Finally, private sector firms and third party software vendors have adopted solutions spanning a range of technical sophistication in their tracking and reporting on both hazardous waste and other commodity movements. We have supplemented the review of previously published reports and regulatory analysis with our own conversations with key stakeholders. Some of their input filled in gaps from the existing studies; others allowed us to generate five new case studies. Groups represented in the case studies are a large generator (DuPont), a small generator (CIL Anodizing), states with advanced tracking programs (MI and TX), a third party service provider (Safety-Kleen), and cutting edge logistics firms (UPS and FedEx). The detailed write-ups of these cases can be found in Appendix A. The level of detail varies depending on how many individuals/resources were available; however, they provide a rich source of additional insights in total.

To fully utilize a large information set, we had to structure it to identify patterns across programs, initiatives and studies that help inform policy makers. To address this challenge, we identified two major parameters by which to organize these examples, based on the dominant themes that emerged from many of our conversations. The first was that paper systems were inefficient, difficult to use, and often infuriatingly redundant in the data they required to be filled in. A second theme was that independent of the automation, the lack of standardization in regulatory requirements drove costs and complexity way up, and that poor data integration made the information that was collected far less valuable than it could be.

We have arrayed the programs we reviewed against these parameters, as seen in Exhibit 3.[3] Each axis of the matrix picks up one of these major themes as a continuum: data automation on one side and data standardization/integration on the other. The matrix moves from poorly automated/highly non-standard systems in the lower left to progressively more automated and integrated data further out. Existing applications may be fairly efficient in one parameter, but fairly inefficient in the other. The most efficient systems can be found in the upper right hand corner of the matrix.

[3] One caveat is in order: programs were placed on the matrix using best judgment, often with limited information. We hope that those with more detailed knowledge on programs will let us know of any corrections.

The purpose of the Exhibit is to help identify patterns, and from those patterns to be able to make more reasoned statements about the hazardous waste reporting landscape. Rather than just including existing hazardous waste tracking and reporting regimes (federal, state, and private), it was important also to show proposed or envisioned systems. This addition is necessary in order to identify areas of agreement or conflict in terms of the in-process changes to the system, and in terms of the ideal system "vision" for key stakeholders. To capture this vision, we often asked during our interviews what a system would look like if our respondent could design it him or herself, unconstrained by political or technical barriers that may loom large right now.

The following discussion is based on programs and initiatives shown in Exhibit 3, as supported by our literature review and interviews. The matrix approach makes patterns more evident and allows us to reach a range of conclusions regarding common visions for future systems, areas of conflict, and barriers to innovation in the current marketplace.

Exhibit 3
Innovation in Data Automation and Integration*

Data Automation

	1) State-specific format	2) Some state variation in fields, formats	3) Multi-report output	4) Uniform nat'l data format	5) Open standards for reporting	6) Single portal from which all reports derived	7) Sophisticated query/ exceptions reporting from portal
Bar coding of shipments, forms							FedEx, UPS
Real-time tracking of waste movement						EPA3 Vision	
Sub-reports auto-derived from manifests					TX vision, EPA2 Vision, DOD Vision, WIN Recs.	NY Vision, DuPont Vision	
Integrated firm/gov't e reporting			TerraLink, Finger Print		CROMERRR, Uniform Manifest	CDX, EPA1 Vision	
Gov't template ability to import from intra-firm systems			MI, McClennan AFB, OSW Burden Reduction		Safety Kleen Vision		
Intra-firm electronic systems			DuPont, Safety-Kleen, Syngenta, Envectra				
"Smart" Templates, w/ help, error detection		FL					
Templates for electronic data collection		Riverside Co., CA	CA DTSC				
Paper conversion to machine readable docs							
Manual with subsequent conversion to PDF		NY, PA					
Manual collection, paper records							

[----------DATA ELEMENTS----------] [------DATA TRANSFER------] [--ANALYSIS--]

Data Standardization and Integration

KEY

CDX - Central Data Exchange
CROMERRR- Cross-Media Electronic Reporting and Record-keeping Rule

DOD - US Department of Defense

DTSC - Department of Toxic Substances Control
EPA# - Each number refers to a different EPA respondent.

UPS - United Parcel Service

"Vision" - respondents ideal system

WIN - Waste Information Needs initiative

***Additional information on most of these programs can be found in Appendix A.**

Source: Earth Track, Inc.

3.1 Future HW Tracking and Reporting: Areas of Agreement and Disagreement

Despite representing different stakeholder groups, the individual respondents generally agreed as to the makeup of an ideal system. Common elements in these visions include full electronic reporting with seamless or near-seamless links between state and federal agencies, and between private firms and regulatory agencies. In addition, people supported the idea of replacing proprietary systems and standards with open ones, relying on commercial infrastructures such as the internet, XML, and cellular, rather than value added networks and EDI. They recommended a central role for government in standard setting, but that such standards should allow broad flexibility in the platforms or software used to meet them. More detail on elements of these visions, and remaining areas of conflict, are presented below:

- **Importance of standardization**. There is broad support for standardization. The push for standards goes beyond just ensuring a single set of data elements is required nationwide, but includes reporting forms and electronic reporting formats. It also includes allowing a reduced data set to be used for many more purposes. For example, nearly all groups favor replacing BRS with a slightly expanded manifest. However, while the EPA and private firms both want a uniform set of reporting inputs, many states want to retain their authority and independence to gather particular data.

- **Federal versus state data portal.** While all parties agreed that an improved linkage between data users is needed to leverage efficiency and data value, there was not agreement concerning which party should serve as the lead. Firms liked the standardization and simplicity that a single federal portal would bring. While EPA's WIN/Informed initiative is currently assuming the use of state portals that send information onto EPA (see EPA, 1/16/02), in our conversations a number of EPA staff favored a federal portal. States, on the other hand, feared the loss of quality, control, and federal funding should the portal become federal rather than state.

- **Optimal frequency of reporting.** Disagreements also surround the appropriate frequency of reporting. There is broad support at both the federal and state level for more frequent filing, as it allows a more timely and accurate picture of current operations. Some firms, on the other hand, argue increased reporting would be too costly. This issue warrants additional research, as our interviews suggest that the main reason frequent reporting increases costs is because firms need to carefully check all data prior to "closing out" a reporting period. It may not necessarily follow that reporting each transaction (e.g., the manifest data) would add the same additional costs as does monthly reporting, since this alternative might not require the same attention on compiling data for a monthly report.

- **Real-time tracking seen as secondary issue.** While many people thought applying real-time tracking approaches to hazardous wastes was an interesting idea, both this and implementing machine-readable shipments was viewed as a second-tier issue. They felt

it would be too complicated and expensive to implement, and was offered fewer immediate benefits that would basic report standardization and e-reporting.

3.2 Current Systems: Potential Barriers to Innovation

Given the number of states and private firms that have developed their own internal reporting systems, one would expect them to be widely dispersed across the Exhibit 3 matrix. In fact, they are not. This suggests that there may be other constraints that make more extensive innovation unattractive for them at this point in time. First, the baseline situation:

- **Most state automation projects are quite limited in scope**. Visually, this can be seen through clusters of them in the lower left quadrant of the table. Some merely convert paper forms into scanned images of those forms -- easier to access and store, but providing very little in terms of enhanced ability to analyze data. Even those states that have developed quite sophisticated tools to help in-state reporting using electronic templates with built in error-detection routines tend often not to achieve efficiencies in terms of data standardization or integration concerns. For example, the Michigan *e-waste* program, while well recognized by peers, does not address such critical integration issues as uniformity with other states, centralization of data nationally, or value-added uses for the data collected.

- **Systems in use even at large firms do not represent cutting edge applications of technology.** Internal systems now in use by firms involved with hazardous waste management are clustered about half-way out on each axis. Firms have an internal database from which they can extract waste data to meet most or all of the reporting requirements for the state and federal regulatory authorities. However, the extraction of these data is automated only sometimes (a fairly high level of effort by specialized staff is commonly needed to pull out what is needed). In addition, some of the large firms we spoke with, such as DuPont and Syngenta, have plant-level systems, not company-wide systems, for tracking, storing, and reporting on their hazardous waste activities. Query routines and exceptions tracking are in place, but often at a fairly low level, or for within a plant rather than company-wide.

The reasons for these choices seem to differ in the state versus the private sector. The primary purpose of many of the state efforts is to reduce the intra-state burden of collecting and storing hazardous waste data for state needs and federal requirements. As a result, an inward focus is not surprising. Furthermore, few states have much control over issues of national standards or integration. Finally, cash to invest in the systems is often a problem. Unlike private firms, even large cost savings from past system development don't necessarily mean that funds are available to finance incremental improvements.

Private sector firms do face some of the same barriers, in terms of having little influence on the shape of state or federal regulatory demands. However, in theory these firms would benefit from any cost savings the systems would engender, implying a strong incentive to innovate. It is difficult to tell whether the absence of more advanced systems is the result of a lack of understanding of the benefits of upgrades on the part of the firm, or because they have determined that the benefits are actually small. More detail on the private sector issues:

- **Limited value of automation without standardization.** Continual demand to learn new state regulations and modify state-level reporting increases the premium on site-specific knowledge and makes economies of scale in system development harder to obtain. DuPont actually tried a single national system about 7 years ago, and discontinued it due to a lack of interest. Safety-Kleen went so far as to say they would get very minor benefits from automation unless standardization came first. They added that standardization needed to include both the data elements and the reporting formats, and that states needed to be more careful in retaining plant-level resolution in submitted data in order to facilitate firm confirmation of submitted data later.

- **Failure to examine strategic benefits of HW data.** Costing of data systems in both the private sector and the states tended to be haphazard and incomplete, even in terms of tracking direct costs and benefits. More than once, we were told that a system "obviously" saves money, though they couldn't prove it quantitatively. Neither firms nor state governments paid much attention to the strategic benefits of HW data company-wide. We believe that the absence of such evaluations generates an artificially low value of more automated and integrated systems. This conclusion is based on the fact that these types of applications are among the most profitable for cutting edge logistics firms UPS and Fedex.

- **Private sector priority on meeting multiple reporting/business objectives through a single system.** This perspective helps explain why both private firms and third party software designers are all producing systems that can generate multiple types of reports, even though these reports are highly variable state-by-state. Business applications of the system focus on exceptions reporting of value to the firm's regulatory compliance (e.g., is a shipment late or lost), rather than more nuanced evaluations of patterns (e.g., how is waste generation varying across our plants for a particular production line).

- **Third party systems not yet on-point.** Third party systems in the hazardous waste realm, like the internally-developed systems at firms such as DuPont, are constrained by the complexity and variability in the regulatory world in which they must operate. Only the general logistics firms such as FedEx and UPS have fully conquered the complicated general problems associated with data automation and integration. However, in their case, they have (by choice) not adapted these breakthroughs to the specialized world of hazardous waste.

- **Few policy initiatives focus solely on BRS.** While looking only at the plots on Exhibit 3 does not make this point clearly, it is nonetheless the case that few of the programs shown there are focused solely on the BR. Most of the state and private sector initiatives incorporate some mixture of manifesting and trends reporting. Even the "vision" programs identified by EPA staff tended to incorporate multiple regulatory obligations from a core data set rather than biennial reporting or manifesting alone. Conversations with private firms especially underscored their feeling that regulatory reforms focusing on BRS alone are not expected to yield much of a change in costs or level of effort to these parties.

3.3 Where is More Information Needed?

Exhibit 3 contains lots of white space. To some degree innovations will accelerate both automation and integration, explaining a general clustering of all programs along the center line between the lower left and upper right sides of the chart. However, other gaps indicate areas needing increased attention. In some circumstances, there may be no activities in a particular realm at all. In others, some programs may be present, but a certain group of stakeholders may be missing entirely. Some of the key gaps are discussed below:

- **Lack of strategic use of data.** "Exceptions reporting" refers to culling massive amounts of data in order to find patterns that are importance to the data user. Well-designed query routines match observed behavior against expected behavior (e.g., completed waste loops, current generation versus a prior reporting period, etc.) and highlight the exceptions to what is expected. We did find some level of exceptions reporting at both firms and states. Often, these focused on late or missing shipments, or on errors identification numbers entered. This issue aside, we saw little evidence of attention to sophisticated query and exception reporting approaches within firms or state/federal regulatory agencies. The WIN/Informed process did look quite carefully at many of the data elements now collected, we didn't see attempts to map out how to sort data to identify broader patterns: who is generating far above or below the norm for their sector; what patterns in waste data are linked to poor general regulatory compliance; etc. We saw even within large companies with a large EHS staff a focus on data gathering to meet basic reporting requirements. In some cases, detailed data did not even get aggregated to the corporate level -- a prerequisite to identifying promising company-wide applications for source reduction.

- **Limited integration of firm and government data systems.** Many current state programs do a fairly poor job facilitating inexpensive integration of existing private sector data into the required/requested public formats. This may result from the fact that some of the state software is still relatively new; however, it was an important complaint from our private sector contacts.

- **EPA's regulatory initiatives address only some industry concerns.** The Burden Reduction project, CROMERRR, and Uniform Manifesting all take important steps at accelerating integrated and automated reporting. However, they appear to stop short of achieving the ability to extract multiple required reports from a core data set, a central objective of reforms we heard from private firms. Identifying whether there are regulatory or institutional constraints to a more holistic approach, or a simple oversight, would be useful.

- **More detailed evaluation of existing systems needed.** We were surprised to discover that firms in two of our case studies (UPS and Safety-Kleen) had considered providing their logistical/waste tracking systems to outside customers on a commercial basis. With many firms already having sunk millions of dollars into their existing systems (billions in the case of UPS and Fedex), there are wide ranging opportunities to provide capabilities to third parties at a much lower cost than if these groups were to try to create this capability internally. More careful evaluation of these opportunities would likely be a fruitful area for further EPA research.

- **More strategic benchmarking needed.** The case study of Fedex and UPS indicate how advanced logistical systems can be, and how basic information on transactions and product (waste) movements can be transformed into a strategic asset to help firms optimize their operations. These firms have already addressed many of the technical problems that would face a modernized hazardous waste tracking and reporting system: cellular networks, electronic signature protocols, real-time tracking of shipments via the internet, advanced query capabilities. Establishing a relationship with these firms, even if on an advisory level, could provide tremendous benefits going forward.

3.4 Summary

Despite the many past and present initiatives relating to hazardous waste reporting and tracking, there are a number of themes that come up frequently. Identifying areas of common agreement, as well as points of friction, is extremely helpful in being able to highlight the most promising options for reform. Some activities are already entrenched within the agency due to in-process regulatory reforms. However, the additional information presented here, and the options outlined in Chapter 4, may help the Agency to leverage these existing initiatives into becoming even more effective.

4. Options for EPA

Our review confirms that stakeholders question the utility of the current system -- biennial reports that are expensive, slow, and inaccurate. In fact, we have identified a number of options for capitalizing on areas of agreement in the short-term, and building the institutional capability and knowledge base for achieving broader improvements in the future over the medium and longer term. These options are discussed below.

4.1 Expand the Frame of Reference for BRS Reform

Regulatory authority and rulemakings are by nature narrow. However, a common view expressed by our contacts in both industry and the states is that the problem is not BRS in isolation; rather it is the whole range of reporting complexity associated with hazardous wastes. This broader landscape, encompassing state and federal reporting and technical standards, for a range of hazardous waste requirements, needs to be the backdrop for specific reform proposals.

4.2 Actions for the Short-Term: Focus On Common Areas of Agreement First

Areas with fairly broad consensus right now offer a promising opportunity for the Agency to move forward in the short-term. Some of these opportunities may leverage efforts already underway (e.g., to reduce the burden of the BR, standardize manifests, and to implement expanded (if not universal) electronic reporting). Some of the other items address important areas of disagreement that need resolution if future changes are not to be slowed.

4.2.1 Emphasize standardization before automation

Low levels of automation can occur within an organization regardless of the levels of standardization across institutions. Similarly, implementation of e-reporting may be able to provide some cost savings even with widely varying standards. However, many respondents suggested that the cost savings from automation would be greatly leveraged by the adoption of uniform and universal standards for required waste information, forms, and electronic reporting formats. As the electronic reporting elements of the Uniform Manifest rule are bogged down somewhat by concerns over signature security, some within EPA have suggested that standardization could proceed on a faster track, independent of e-reporting. This strategy is strongly supported by our interviews. There are, of course, some caveats:

- **Go beyond data elements.** Efforts to standardize need to include multiple reports and reporting formats at all levels of government.

- **Deal with state concerns early.** If a federal form and/or a federal portal are to be used, state opposition to these trends should be dealt with early, and in an up-front way. There is strong evidence from the way firms such as UPS and Fedex have structured their data centers that centralization (i.e., a federal rather than a state data portal) is the preferred approach. In terms of state versus federal control of data specialization, this is a difficult

issue with no immediately clear solution. At the very least, the details of the trade-offs for particular options should be fleshed out.

4.2.2 Integrate as many reports as possible

The more that data collected on a transactional basis (e.g., the manifest) can support required reports, the better the system will be. Depending on the level of overlap between reports, this integration can be easy or quite difficult.

One suggestion was to replace the BR with a manifest-oriented system. We heard support for this from both state and federal government officials, and from businesses.[4] Some state systems are already generating part or all of the required BR dataset for users. The key in such a replacement is making careful decisions on how one system (e.g., manifests) needs to be modified to retain important elements of the old one (BR). We heard the following views on what the BR has but manifests don't; some of these have already been incorporated into new mandatory elements of the uniform manifest:

- Smaller number of waste codes (three) can reduce what is know about the waste.
- Less precise (some said "inadequate") descriptions of source codes, form codes, and management codes.
- Less extensive narrative fields.

In addition to data elements, there was a concern that this shift would require changes in the way states currently track manifests. Specifically, while 30 states collect full manifest information, the other 20 track only exceptions. This would need to change if important data on hazardous waste trends for these states were to be captured.

A second area of overlap involves the DOT shipping paper. It is fairly easy to imagine a hazardous materials shipping paper and a hazardous waste manifest blending into a single document. This is, in fact, happening to some degree in the uniform manifest effort. While DOT may still require a paper form on each vehicle, an integrated system might nonetheless offer efficiencies to transporters. As with the BRS/manifest overlap, care is needed to capture all relevant data fields from each form. Paper forms, aside, however, it is useful to look at this issue more strategically. UPS can transmit detailed information on the contents of ocean-borne vessels in advance to the US customs service. Fedex does a similar trick with its incoming planes, with detailed information fed to ground-based logistics and analytical systems. Both have achieved gains in efficiency and control of shipments from these systems. There is no reason such a process can't occur for shipment, giving emergency responders detailed, real-time information on cargo *before* the reach the site.

[4] A related suggestion to replace the BR with data TRI (initially proposed in the BRS Burden Reduction project) did not have very much support in either our interviews or literature review. Aside from obvious differences in how information is reported (BRS is total quantities, while TRI is constituents of concern only), commenters noted that there are important differences in the universe of facilities covered, the frequency of reporting, what is reported, and how facilities are defined.

4.2.3 Use open standards, standardized system whenever possible

There was widespread agreement that the narrower the mission of the government in tracking waste data the better. Use the internet, not proprietary data networks. Use XML as a programming language, not Electronic Data Interchange, which can be expensive to develop and in some cases proprietary. Importantly, many wanted EPA to be language neutral: define what data had to be reported, and let it arrive in whatever form works, so long as it can be automatically integrated with the main data set. This approach also realistically recognizes that technical standards continue to change, so the systems should be flexible.

4.3 Medium Term: Build a Case for Further Improvements

Making a convincing argument for why firms or states should spend time and money to change their hazardous waste data systems is critical if the political coalitions needed for widespread standardization and automation are to be built. Yet, some of the information needed to make this case does not seem to exist now. For example, there is broad support for the general concept of automation. There was also a recognition that piecemeal adoption of e-reporting would force many to run both a paper and an electronic system; as a result, the shift to e-reporting should be mandatory. Yet, a clear economic case for such a changeover has yet to be made. Recognizing these gaps provides an opportunity to fill them in, expediting the transition to a more effective system. The following data need to be available for any proposed change:

- **Definition of baseline.** An important element of demonstrating the value of improvement is to have accurate baseline information on the quality of enforcement, emergency response, policy planning. More precise metrics of error rates, time from generation to availability, cost per transaction, etc. need to be developed. More extensive audits of existing systems may prove a useful mechanism to obtain clarity on particular strengths and weaknesses of the systems.

- **Direct economic benefits.** How big are they? By looking at the problem of hazardous waste tracking and reporting more broadly (all the reports, trends analysis plus enforcement plus homeland security, etc.) one can generate a more accurate estimate of the savings having better data.

- **Strategic economic and environmental benefits.** Beyond reduced administrative or data entry labor costs, what strategic gains can be expected from much improved information? How will firms or governments be changed in the range or accuracy of their abilities to promulgate better policies, leverage enforcement, or identify the high-hazard subset for additional scrutiny? This case has not been made, but is critical if broader reforms in how information is tracked are to take effect.

4.4 Longer-term: Develop Capacity to Address Continual Change

There have already been many internal and cross-institutional workgroups addressing various aspects of environmental data. However, EPA should consider a more integrated approach than past efforts, perhaps modeled on the Financial Accounting Standards Board (FASB). FASB is an independent entity with an external board of trustees, all of whom are

skilled in the field of corporate accounting. FASB' mission is to "establish and improve standards of financial accounting and reporting for the guidance and education of the public, including issuers, auditors and users of financial information." (FASB, 2003). Stated somewhat differently, FASB establishes rules for conveying financial data in a standard and transparent manner, so that all of the stakeholders that rely on that information to make important decisions are able to trust what they see. Users of environmental data would benefit similarly from such as structure.

FASB has three other features applicable to the hazardous waste data issue. First, it's external board could copied to bring in a range of external expertise to address the problems of hazardous waste reporting. Rather than just civil servants, as have often comprised past data efforts, expertise in the areas of computerization, automation, and logistics could be tapped as well. Second, FASB continually evaluates, addresses, and issues rulings about challenging problems that threaten to undermine the accounting system. There are and will be a range of such issues that continually arise with waste reporting as well; having a standard board rather than having to recreate a new one every time, would be advantageous. Third, FASB separates standard evaluation and setting from implementation. It may make sense for EPA to have similar independence for any group charged with setting standards for data elements, reporting formats, etc.

4.5 Conclusion

A wide range of stakeholders support reform and improvement of the Biennial Report, as they do not feel the current report adequately or efficiently serves their needs. However, reform would best be done in the broader context of hazardous waste reporting overall, rather than in isolation. Most states and private firms already integrate their data collection efforts to some degree, with single systems meeting a variety of regulatory objective and required reports. Regulatory reform efforts that more closely reflect how their systems have evolved offer them more opportunities for realizing benefits.

Despite numerous efforts over the past ten years to automate hazardous waste data collection and tracking, the technical opportunities remain large. None of the programs we evaluated had the degree of automation or integration that is currently found in common carriers, such as UPS or Fedex. The market for innovation also appears quite large, with current spending on BRS and the hazardous waste manifest estimated as high as $800 million per year in direct cost savings alone. Were the strategic value of better information -- reduced enforcement costs, higher recoveries, improved emergency response, more streamlined hazardous waste shipments -- included as well, the market would likely be well over $1 billion per year.

EPA focus on areas of common agreement, as well as attention to resolving a handful of areas that appear to exist between key stakeholder groups, can help accelerate the pace at which some of these gains can be obtained. So too would creating an expanded base of information to convince skeptical stakeholders that new investment in their own internal systems will be economically justified. Finally, an effort to build a continuing and robust capacity, one that taps outside areas of expertise to address both emerging issues and standard setting, would be worth pursuing.

Appendix A:

Detailed Information on Case Studies

A1: DuPont

(Large generator with its own internal systems)

DuPont is a global company with many chemical-related production facilities. Annual revenues in 2002 exceeded $24 billion.[5] The firm has 135 manufacturing and processing facilities worldwide, and close to 80 research and development sites.

The firm has made clear and visible commitments to improvements in environmental performance at the highest level of the firm. Chad Holliday, Jr., DuPont's CEO, is co-author of a book published last year called *Walking the Walk: The Business Case for Sustainable Development*. DuPont publishes and promotes a Global Progress Report each year, presenting compiled environmental data from their worldwide operations. They also recently joined the Global Reporting Initiative, an effort to achieve transparent and standardized reporting by corporations on environmental and other social factors. This commitment does seem to have made an impact on environmental performance. According to a syntheses of a variety of environmental data compiled by Environmental Defense, some Company plants within the US perform near the top for their sector. However, others perform at much lower levels, suggesting continued room for improvement.[6]

Given DuPont's very visible stance on environmental performance and past efforts to track global hazardous waste generation, we were interested in learning their views on US hazardous waste reporting requirements generally, and on BRS in particular. We were also interested to learn about their internal systems for tracking hazardous waste data. As our interviews consisted of only three people in a firm with over 75,000 employees, it is important to acknowledge that our findings likely do not represent the complete picture of DuPont's environmental reporting, though it does provide a useful snapshot.

Summary of Key Findings

- **Local control of data systems for hazardous waste.** Despite the firm's global compilation of environmental data, the real tracking of hazardous waste occurs at the plant level. In part, this mimics the wide ranging independence that the plants have in other areas of their operations, and in terms of their financial performance. In part, however, it also reflects the need to understand the minutiae of state reporting requirements, which of course vary widely

[5] "Profile - E.I. DuPont de Nemours," March 24, 2003. Obtained from Yahoo! Finance, http://biz.yahoo.com/p/d/dd.html.

[6] See for example, hazard-weighted TRI data for the DuPont Dow Elastomers Pontchartrain Site (low performing); versus the Dupont Dow Elastomers in Deepwater, NJ and the Dupont Agricultural Caribe Inds. in Puerto Rico. Environmental releases data by facility from Scorecard (www.scorecard.org), run by Environmental Defense. Data are from 2000 reports, the most recent on their site as of March 2003.

across plant locations. A third factor, which staff felt was the most important, was the need to link environmental costs to specific product lines in order to ensure accurate cost accounting and pricing of those items.

- **Virtually no structure to the data added by headquarters.** Despite the apparent opportunity to achieve cost efficiencies by developing environmental reporting systems company wide, DuPont has no plans for such an effort. In fact, they did have a single cross-cutting system about seven years ago, but discontinued it due to a lack of interest from the plants. The corporate system did not adequately incorporate plant-specific requirements. DuPont staff said that until there was a single national standard for reporting, a corporate system would not make sense.

- **BRS costs have not been estimated.** BRS reporting is one of many requirements for the Environment, Health and Safety staff. DuPont's environmental budgets handle all environmental compliance functions under the same umbrella; the costs have never been disaggregated to reveal specfic BRS or manifesting costs.

- **Improving the BRS**. Call participants said that they had developed workable systems to meet the requirements of the BRS, and didn't have any major problems with its requirements. However, they did say that their jobs would be much easier if there were a uniform set of requirements across the states, and that a fully electronic system could then be implemented. This uniformity needed to include multiple regulatory requirements, not just BRS, and to standardize electronic reporting formats as well as data elements.

- **DuPont tracking systems remain manual; use of data limited.** The firm continues to rely on paper manifests rather than electronic ones. Personnel are well trained to identify problems in shipments, such as loads that are missing or delayed, based on this paper flow. Waste data are captured electronically for cost accounting and other reporting purposes. However, the firm does not analyze this information to identify pollution prevention or other such opportunities. Rather, information is used to help them optimize their waste management vendors and bring down costs. For example, procurement staff can obtain data on all wastes managed in a particular way (e.g., incineration) across the firm, and use this information to optimize vendor relationships.

Overview of Existing Systems

DuPont environmental staff at the plant level have wide latitude to choose and develop their own systems in the RCRA area. Their objectives are twofold: to ensure their data systems are appropriately tailored to meet specific state-level reporting requirements; and to accurately track environmental costs back to specific product lines in order to price those products properly.

Attributing Waste Management Costs to Specific Products

DuPont is divided into Strategic Business Units, or SBUs. An SBU is product- or product-line focused, but may rely on a variety of firm resources to make these products. Thus, within a given production plant, multiple SBUs may be using the equipment at different times.

Each SBU has its own Environmental, Health and Safety group. Each plant also has a lead in this area, responsible for meeting a variety of federal, state, and local regulations, including those on hazardous waste reporting. Because SBUs share production facilities, the firm must also determine how to allocate the byproducts of that production to the products being manufactured.

This allocation is done by assigning each SBU its own set of internal waste codes. For example, the Polymer Unit might have waste codes that all begin with "P". Even if multiple SBUs generate the same waste, specific amounts of waste (and the costs of managing them) will be allocable to specific SBUs and product budgets. A single waste may have an internal waste code, a state waste code, and an EPA waste code. A core function of DuPont's internal system is to keep track of them all. According to staff, its internal production and cost accounting objectives are the prime drivers of how their environmental data collection system is structured. Regulatory requirements are secondary.

Plant-Level Tracking for Detailed Regulatory Compliance

Tracking of hazardous wastes remains the responsibility of the plant of origin, mimicking the approach used on federal manifests. This also avoids double-counting wastes within the corporation (i.e., when wastes are shipped to another DuPont facility). The generating plant tracks the wastes until their final disposal whether this occurs at a DuPont or a third party facility. (For liability reasons, they try to manage final disposal/treatment within DuPont whenever possible). The costs associated with managing the waste are assigned to the point of generation as well, providing an incentive for source reduction at the point of greatest influence.

Individual plants collect information as needed to meet their individual reporting requirements to states and other government entities using systems of their own design. They design their own methods to extract data from their databases for reporting requirements. The plant staff did not recall any efforts by the firm to standardize these systems, thought they did acknowledge that it was possible for data to be reported by different plants using slightly different methodologies. However, a staff person involved at the corporate level with using plant-level environmental data said that DuPont did try to develop a centralized environmental reporting/compliance tool about seven years ago, but that plant managers found it too general and rigid to meet their specific needs. It was therefore discontinued. He added that a combination of highly decentralized control of production, plus varying state and local regulatory requirements, make it difficult to reap economies of scale in having a uniform system.

Company-Wide Tracking of Environmental Data

To identify general trends in its environmental performance, and to meet reporting commitments it has made for its annual performance report and GRI, DuPont does aggregate the environmental data provided by all of its plants. This process is supported by a general web-based application to collect relevant environmental data from each facility, primarily on hazardous waste, air toxics, greenhouse gas emissions, and energy consumption. Each facility, using hazardous waste definitions per their state or country, report to Corporate, where they are aggregated into company totals.

Corporate level used of environmental data are twofold:

- **Trends assessment.** Company-wide company-wide totals are used to assess company-wide progress against corporate goals and targets.

- **Support intra-firm staff networks.** Internal networks assemble detailed data on certain types of environmental activities to help improve company-wide performance in particular areas. For example, a Waste Emissions Network combines managers and technical people to share technology and trade knowledge about emissions across the firm. The Waste Services Automating Subcommittee uses specialized data on waste shipments to streamline the facilities handling DuPont's waste, thereby leveraging its purchasing power and decreasing both the number of disposal facilities used (from 500 to 3000) and the liability associated with longer shipment distances.

DuPont staff felt that RCRA-related aggregations were fairly straightforward, as there was not much interpretation that went into the numerical values. For TRI reporting, as well as that for greenhouse gases, estimation techniques and measurement accuracy were both more difficult and variable. Thus, corporate staff had to spend more time on verifying consistency in the numbers in those areas.

However, even in the RCRA area, the trends assessment information is somewhat approximate. For example, current numbers don't adjust emissions for production levels; thus declines may be the result of production levels as much as of improved environmental management. However, the firm does very carefully examine year-to-year variance, seeking explanations for the 20 largest shifts in reported values (either up or down). This evaluation helps DuPont ensure higher quality results, and to identify areas that may require more attention either to replicate at other plants (large declines) or to address through process improvements (large increases).

One important limitation expressed to us is that the current numbers also don't provide much resolution of the underlying data behind them, as much of the detail remains in the individual plant databases. Staff involved with using the plant data would like to see a greater ability to "dig deeper" into the plant-specific numbers in future years, and to expand the ability for one-time data entry for facilities -- thereby minimizing data entry costs and maximizing the utility of the data reported.

Views on Hazardous Waste Reporting

Varying, complex, and conflicting requirements across states was the largest complaint about hazardous waste reporting, driving compliance costs up significantly. DuPont used the example of a shipment that travels through six states on its way to disposal, noting that each state might have different requirements for the manifest information that must accompany the shipment. Varying definitions of solid and hazardous waste across regulators were also difficult to keep track of. To deal with regulatory complexity, DuPont licenses third-party software that tracks these rules. However, this software "does *not*, however, allow us to punch in the route and get in

return a single manifest that has all the required information. We have to piece it together ourselves for each shipment."

In large part because of the varying standards, e-manifesting is not yet happening at DuPont. The firm continues to rely on multi-part paper manifests, but acknowledges that it is very rare for a shipment to slip through the cracks. Perhaps because they have a dedicated staff to handle environmental reporting, DuPont has not found their current system or BRS reports to be problematic. Required reports (including BRS) can be generated in a semi-automated way by querying one or more database to get the information needed. "Sometimes it takes a bit of work to pull different information from different places, but this is fairly minor since we do capture most of what we need," said one staff person.

The costs of improved systems were not something that our contacts had considered in detail. They operated under broad environmental budgets to handle all environmental compliance functions under the same umbrella. They had never disaggregated the costs of meeting specific requirements, such as BRS reporting or manifesting.

This being said, call participants did have a vision for a future waste reporting system that they said would make their lives much easier. Components of that system are as follow:

- One set of waste codes for all reports, and consistent requirements and manifests from state-to-state. This, more than standardizing or automating BRS alone, was of interest.
- Tracking/reporting software that is cheap, adaptable, secure, and could link to internal databases.
- Digital signatures are secure and widely accepted
- Real-time tracking of wastes was not seen as a priority, since they felt they already did a good job of auditing waste flows with the current system.
- Similarly, they did not think trying to replace BRS requirements by relying on a modified TRI report was a good idea, since they saw very little overlap in the data reported under the two EPA programs.

A2. Safety-Kleen

(Waste Service Company)

Safety-Kleen (SK) provides waste management and transport services to 300,000 customers in virtually every state in the country. Most of its customers are small and mid-sized businesses, often exempt from hazardous waste provisions as either a Small Quantity Generator (SQG) or a Conditionally Exempt Small Quantity Generator (CESQG). However, a subset of its customers are large enough to require their own reporting. The firm handles 1.2 million manifested shipments annually. This includes some international shipments, of which most involve Canada.

Safety-Kleen has five major service lines. The parts washers and parts washing solvents group handles delivery, pick-up, and recycling of solvents (both aqueous and organic) and parts, mostly at very small businesses. Disposal services for dry cleaners; silver and chemical recovery for film operations; used oil pick-up and re-refining; and pick-up of industrial waste (both hazardous and non-hazardous) comprise the firm's other areas of activities.

Information here is the result of telephone interviews with SK staff, plus information submitted by the firm in comments to EPA.

Key Findings

- **Standardization more important than automation**. Reporting standardization will yield the most immediate cost savings to SK. Automation without standardization is of limited benefit, and may actually drive costs up.

- **Proliferation of reporting formats, not just data elements, expensive**. Standardization needs to include the various e-reporting mechanisms as well as the data collected and paper manifest formats. A proliferation of unique state systems for reporting manifest and/or BRS data adds another level of complexity to the one of tracking the different data element requirements.

- **Favor single data portal, replacing BRS with manifest data**. Shipping to a single federal portal would be much easier than having to report to all of the states, who in turn report to the federal government. The call participants' ideal system would be single federal portal that was able to extract all of its needed data based on manifests (recognizing new data elements would need to be collected on the manifests).

- **More frequent reporting not costless**. Frequency of reporting, even when data are stored electronically, does drive costs up as the firm needs to "close-out" each period. This close-out procedure, like the parallel financial close-out firms must do, requires additional time and manpower every time it is done, even if the period being closed-out is short.

- **Current reporting costs are high**. While SK didn't have exact information on their costs, they were sure that they were quite high, and thought that $80-$100 per manifested shipment (the figures from EPA's own ICRs) would be plausible.

- **SK already provides some data services to small business customers; has considered providing more**. SK already provides compiled information to many of its customers that helps them meet their various reporting requirements. In addition, they have in the past considered the possibility of licensing their tracking/reporting systems to other firms, but not explored the option in great detail.

Overview of Existing Systems

SK relies on careful tracking of all manifest-related data in a centralized firm-wide data system. Frequent manual edits and additions to that information keep it updated, and supplemental data gathering allow them to meet other reporting requirements such as BRS. Their system has exceptions reporting and is sometimes used to provide data to clients that they need for their own reporting obligations.

Manifest Data at the Core

Data associated with waste manifests lie at the core of Safety-Kleen's tracking system. Data on the customer relationship are entered once and then are available for subsequent transactions. Whenever possible, the firm provides pre-populated manifests to accompany a shipment, based on clients' past waste generation trends (e.g., three drums a month of waste oil). The ability to do so varies somewhat by company product line. For example, the parts washing area is quite standardized, so it is straightforward to pre-populate the manifests. If the real waste differs from the predicted waste, SK personnel hand write the correction on the manifest. The modification is later entered into their data system. Though this process of continually entering any modifications or additions into the main SK database by hand does require staff effort to keep data accurate and up-to-date, SK staff felt that it was manageable. Thus, although paper manifests accompany the shipments, the data they contain is also captured electronically.

The same basic process is used to track shipments whether they go to a SK-owned TSDF, or to an independent third party. If the waste remains internal to the firm, the receiving branch closes the waste shipment loop and keys it into the system. Shipments outside the firm are keyed in by the last SK handler, noting which TSD received it and when.

Given the level of manual key entry required, and the number of shipments handled, we asked whether the firm would consider automating much of this data entry via a scanning/barcode system. We were told that they are moving in this direction. However, the system to be installed will track primarily sales info, and will not likely capture manifest data. It is still in the test phases.

Abiding by Regulatory Requirements

Because SK does business in nearly every state, and its trucks often cross state lines, staying on top of the widely varying regulatory requirements and definitions of hazardous waste in each state is one of their most challenging tasks. They have noted in comments to EPA that they face a "staggering" variability in reportable data elements, including variation in BRS codes, state waste codes, hazardous waste codes, and in the chemical data requested by different regulatory authorities. Similar waste streams often have many different state waste codes. SK estimated 1,715 for the country overall, with only three states (CA, NY, and TX) comprising 96% of these. (SK, 10/4/01, 6, 9, 10). To ensure regulatory compliance, SK has 50 EHS managers. Each state has an assigned lead staff person to ensure that all state regulatory requirements are tracked and met.

Meeting Reporting Requirements

With a centralized data system containing a great deal of its shipment data, SK has invested in routines to extract information from its core mainframe data system into the formats required by many of the regulatory authorities with which it deals. For example, SK has automated data extractions that cover most manifest formats, allowing them to fill in the proper form. This capability allows them to complete the pre-populated manifests described above. The firm has also developed various query routines for preparing required reports, such as required annual reports for every state.

The company has developed supplemental information gathering to support the requirements of BRS, but can't simply extract all of the data from their manifests. Staff felt that their current system worked fairly well, and that they would not receive very large incremental benefits from formally ending the BRS and relying only on manifest data. This was because they had already done many of the steps that such a regulatory change would entail (automating linkage and conversion from core data set to state-specific requirements), thereby obtaining a good portion of the efficiency gains.

Identifying Problems (Exceptions Reporting)

SK staff said that their data systems have evolved over the past fifteen years to meet the needs of their core business rather than to meet any specific environmental objectives. Without this system, they didn't think they would have been able to survive.

Part of that evolution has been the establishment of exceptions reporting to that highlights real or potential problems with shipments by screening the company database. Some of the assessments that they can do include:

- Verification of client's reported EPA IDs and addresses (through verification with RCRIS, which they download a monthly update)
- Comparisons of manifest data to sales data (i.e., sales receipt and manifest should agree), in order to identify potential disparities in wastes shipped.
- Shipments in transit over a certain time threshold.

System Costs

As already noted, SK's data system was established to allow it to remain in business. So too with its tracking of manifests. However, while they could potentially calculate its internal costs per manifest, or per BRS reporting cycle, they never had. Their system has been developed incrementally over a 15-year period; as a result, they don't have a "before" and "after" scenario to evaluate system costs and benefits. In terms of BRS, the cost elements identified included regulatory staff, field staff, data entry staff, IT staff, and an annualized system cost. They have six full time staff people who do nothing but environmental reporting. As a ballpark, they said that it was "safe to say that we're in the millions of dollars annually" to comply with biennial reports (and their state equivalents). They said that an estimate of $80 per manifest[7] didn't seem that unreasonable, given all the steps that go into the process, though they couldn't speak to the state/agency portion of that total.

We asked them why this value was so much higher than the full cost to track and deliver a shipment by FedEx or UPS (under $7/shipment). They said that the general couriers didn't care very much about contents, and don't have to worry about differing state requirements. In contrast, tracking what was in a shipment was critical for the hazardous waste industry, as was demonstrating compliance with so many different standards. SK thought that having to collect so much info on what was in the shipments was a substantial part of their costs.

Problems with Current System

Because the firm deals with so many regulatory agencies and reporting requirements, we were interested to hear their critiques of these systems:

- **Report format standardization is often overlooked.** Non-uniform manifests and data elements are only one part of the waste equation. A parallel exists in the realm of e-reporting formats for state BRS submissions. There are three major software programs used by most states (BRS software, Waste reporter, Easy Track), and a handful of state-specific software packages (e.g., STEERS). Each package requires them to translate and export data differently. Developing these routines can be expensive. To address this problem, SK staff recommended the following steps to streamline BRS:

    - **Standard transmission format** for all states.
    - **Functional data import capability.** The capacity to easily import data for multiple facilities under the SK umbrella easily into the standardized reporting format (some current programs don't do this).
    - **Retention of data resolution.** Once reported to the state, some of the state systems aggregate the facility-specific data, and the more detailed resolution is lost. An ideal system would retain this resolution, since SK has its individual facilities conduct QA/QC on the data. With all the information comingled, they can't do this effectively.

[7] This value, which we presented to them for reaction, includes private, state, and federal costs of the manifest system, based on EPA ICRs.

- **Standard data elements.** One staff person said that he'd heard something about EPA trying to design the manifest using DOT regulatory authority so that the interestate commerce clause would preclude state modifications. He didn't know if this would actually happen or would even be legal, but very much supported the objective of this effort.

- **Expand manifest data to allow manifests to meet BRS requirements.** Areas specifically mentioned included waste descriptions, such as form code, source code, or management code.

Related to these general themes, the call participants gave us their views on state initiatives to automate waste reporting and tracking. Whereas DuPont found the Texas STEERS system innovative and easy to use, SK's perspective was very different. They commented that the system was rather burdensome, used lots of proprietary codes, and was PC-based rather than platform neutral. There were also a number of system incompatibilities between STEERS and SK's internal system. First, STEERS relied on manifest-level data, which was difficult for SK to export from their system to the State of TX. Second, the STEERS program had a fairly extensive level of error checks before it would accept data. Because these error checks were different from the ones SK used itself, they found that the data conversions required a large level of manual effort.

The SK staff acknowledged that part of their problem with the TX system might be influenced by the fact that they had lots of customers there and had to do expensive programming to report lots of information to the State. They spoke favorably of South Carolina, where quarterly reporting to the state enabled them to waive having to do separate reporting for BRS. In contrast, they noted that PA required quarterly reports to a host of agencies, but then required annual reports as well. They didn't understand why the state couldn't get what it needed from the many reports they had already sent.

The general theme that emerged from these discussions was that the more domains of variance any state system had, the more expensive it was for them to comply; and that while meeting the requirements for one non-standard state was doable, dealing with scores of them was extremely difficult.

Views on the Future of Hazardous Waste Tracking and Reporting

SK felt that data standardization was far more critical than data automation in terms of easing their regulatory burden. They did not feel that existing state systems provided a model for how to proceed.

SK's Ideal System

SK's ideal system would involve three main components:

- **Standardized federal portal**. Rather than using states as the conduit for data that is later aggregated by the Federal government, SK favored a single federal repository with a uniform reporting/transmission format for all of the states. States could query the federal database as

necessary or desired to advise their decision making. SK personnel acknowledged that many states would not support this approach.

- **Single entry reporting.** The manifests would capture whatever data elements were needed to meet the required reporting formats. Whether or not this required adding new data fields to the manifests, it would greatly simplify the tracking and reporting that private firms needed to do. Whatever reports were needed could easily be generated from this core information.

- **Automation**. To increase efficiency and reduce errors, transmissions would be electronic rather than on paper.

Moving Towards Automation

- **Standardization must precede or occur currently with automation.** While SK was not averse to automation of hazardous waste reporting (it was one component of their "ideal system"), it took second place to standardization. Staff reasoned that they have already adapted to a paper-based system, and to the current requirements of the BRS, and their system works. In contrast, it state-by-state variation in manifests, reporting formats, and e-reporting systems could be eliminated, they would realize large cost savings. In fact, they said that unless variation/incompatibility problems associated with divergent reporting content and standards were addressed first, the gains associated with electronic reporting for BRS would be quite small.

- **Automation does not make more frequent reporting costless.** Proposals for automating reporting are often linked to more frequent reporting to regulatory authorities. In theory, this would reduce the data delays that now affect the aggregation of BRS data. According to SK, however, more frequent (e.g., monthly) reporting would be expensive, whether it was paper or electronic, state or federal. This is because they need to go through a close-out period on the reports to clean up any inconsistencies. They said the process is similar to that used when firms "close out" a period of financial reporting. This process is time consuming and expensive. One SK staff person used this point to explain why the situation in SC, where the firm sends quarterly reports but no annual report, since the state generates the annual report. He said that not having to do an annual report did save them money since if SK had to do the annual, they would run an entirely new report, not just sum the four quarters. Furthermore, the new report would have to be reconciled against the each of the quarterly reports and verified.

- **Automation must be mandatory if costs are to decline.** In regulatory comments (SK 10/4/01, 2), SK noted that automation should have a lead time of sufficient duration to allow participants to gear up for the change, but that it must be mandatory in order for any of the potential efficiencies of the changeover to be realized.

Automation Start-up Costs and Small Business

One common criticism of attempts to implement e-reporting is that there will be substantial start-up costs. Furthermore, since many of these costs are fixed (e.g., new computer

system and software), they will create a disproportional burden on small firms who have relatively few waste shipments. Since SK services these exact types of companies, we were interested in their view on this issue.

Strategic value of new information. One hypothesis we presented to them was that automation would give the smaller firms information of such improved quality that it would generate strategic gains to them in terms of their operating efficiency. One call participant felt that SQGs had very few reasons to analyze their wastes for any reason, and didn't see any immediate strategic benefit of them doing so. Systems that required them to spend time tracking would, he thought not be something they would adopt voluntarily. Rather, they would need to be forced. He said that many firms SK serviced still didn't even have a PC or an internet connection. He pointed with disdain to a system in Ontario that required use of a PC to do the required reporting. The officials argued that since business owners without a PC could e-submit from their public library, there was no barrier to adaption. SK pointed out that requiring a small business owner to leave his premises to report on waste shipments was actually a very big burden.

Other sources of value-added, such as using the data to optimize systems to minimize waste shipments, thereby saving customers money, was not responded to. The call participants noted that SK itself benefits when more waste is generated, not less, so didn't think they would likely use their internal data system to reduce their customer demands for their firm.

Using SK as a third party data tracking firm. Another idea presented to the SK staff was reducing the cost of automation to small business by relying on third parties such as SK to track wastes and support reporting, rather than developing that capacity internally. This would bring costs down in theory because the high fixed costs of systems within a small firm would be spread much more broadly by the third party (e.g., SK), allowing a much lower cost per transaction.

SK generally agreed with this concept, though said that not all of the service providers would be of adequate size develop the systems either. They also said that sometimes generators used more than one service, so all providers would need to have a compatible system in order to be able to provide a complete picture for the generator. In terms of larger firms, such as SK, licensing their own systems to other firms, they said that in principle it could be done, and that they had even discussed it. SK said that they already helped clients with data in two ways: they provided pre-populated manifest forms to many smaller clients; and provided (upon request) an annual summary report of SK pickups from facilities of their larger customers.

One concern some call participants had with full licensing of a tracking system was that if the firms were competitors or potential competitors, they would be averse to releasing information on customers, routes, etc. that might be used competitively against them. We did not discuss whether a system might be structured to overcome this concern (e.g., system provider would license tracking technology but would have no access to the competitive data).

Experience with Electronic reporting

- None of the call participants had reported via EPA's CDX, and were not familiar with how it worked.
- Most of their electronic reporting in states was done using e-mail or disk-based systems. They did not think they had been using XML, but did favor easy-to-use internet-based reporting protocols.
- They didn't have any idea about the reliability of the electronic reporting, other than that the states haven't been complaining to them when they ship in the information. Normally, after it is shipped in, they hear nothing more about it.

A3. Texas and Michigan

(States with innovative HW reporting systems)

States have been the focal point of hazardous waste data collection for many years. Faced with costly and complicated data collection requirements, from both state and federal regulators, innovation in data collection, storage and reporting, it is not surprising to see a strong interest in system innovation. These efforts range from fairly simple modifications of federal reporting requirements, to the introduction of semi-automated data submittal routines, to more extensive systems such as in Texas that allow electronic signatures and already replace the BRS. As we were unable to survey all of the state efforts, we reviewed past state-level case studies and spoke with people involved with programs that others believed were innovative: Texas and Michigan. Of the two, the Texas program is older and further along.

Our interviews with state programs have been supplemented with some written materials, and with feedback on using some of the systems by firms we spoke with during the course of our research. In addition to what the systems actually do -- perhaps even more important -- are the insights gained into the interaction of federal and state views on how the systems should be structured and who should decide.

General Findings

- **State solutions often address more than one reporting requirement**. State agencies are the nexus for multiple federal and state hazardous waste reporting requirements. Thus, their reporting solutions often address multiple objectives. For example, both MI and TX have a manifest-oriented data collection that allows automated data extraction of BRS requirements.

- **State solutions vary widely**. State systems vary in level of automation, software used, degree of error detection, required reporting formats, and ease of use. Even the most advanced systems, such as Texas, are not universally acclaimed by users. Variation in data elements and reporting formats across states makes compliance for interstate firms challenging and expensive. Examples such as Texas, however, do suggest that some of the challenges facing other states in terms of electronic signatures or error detection are soluble.

- **States are protective of their control of report content and data.** Whereas both federal government officials and private sector personnel strongly favor report standardization and centralization, the states do not. They fear losing access to key state-specific data elements they need for state policy planning; control of the quality of delivered services and level of support; and loss of sovereignty and funding were data to go to a federal rather than a state portal.

- **Analysis of benefits of state systems has been fairly limited thus far.** Both TX and MI do have some rough estimates of cost savings, but these are not as detailed as they could be. Furthermore, they focus mostly on reductions in administrative time spent on data entry or error correction. There has been little attention on the strategic benefits of more accurate,

more timely information in terms of state environmental policy development and enforcement.

- **State systems sometimes lose data resolution.** As they compile information from disaggregated plants or shipments, information on the constituent components are often rolled into aggregate numbers that impede the ability of the data submitters to verify the information later.

Michigan *e-waste* System

The Michigan *e-waste* system allows TSDFS to report information to the state via computer disk on two categories of hazardous waste: waste received from offsite facilities and waste generated and managed on-site. Waste generated onsite but shipped offsite is in the planning stages, but awaits further development funding. The software is used to collect manifests and monthly operating reports (MORs). The *e-waste* system disks accept either manually entered information, or data in a comma-delimited .txt format. The disk is then mailed to the state; lack of clarity on electronic signatures precludes electronic transmission, though the programs hopes this feature can be implemented once the signature issue is resolved.

- **Voluntary system.** Reporting using *e-waste* remains voluntary, with about 20 of the state's 70 commercial TSDFs using it. The program coordinator believes this number will rise once they can handle waste streams generated onsite but shipped offsite. However, there is recognition that in the interim, the State needs to support both an electronic and a paper-based system, which is expensive.

- **Data consolidation.** MI has modified their state manifests to include generation and management codes. This allowed the manifest data reported to the state to replace separate BR compilations. TSDFs can, but are not required, to report monthly. Frequent reporting reduces incremental BR reporting.
  - TSDFs without e-reporting (onsite generation shipped offsite) become *de facto* generators, and are required to mail a hard-copy manifest to MDEQ in the same manner that traditional generators do.
  - Data are aggregated by BRS waste code once submitted to the State. As a result, data resolution is lost.

- **Exceptions reporting**. The Michigan system has built-in edit checks for waste ID number and waste codes, flagging entries with illegal characters or entry lengths. It also verifies waste imports/exports to ensure the transporter is licensed in MI. Facilities with recurring errors targeted for inspection.
  - **More work needed on facility IDs.** System has had problems verifying facility identification numbers. The State would like to develop a live link to RCRAInfo to facilitate this verification for TSDFs prior to data submittal.

- **System benefits**.

- **Cost savings.** The program manager believes there have been "huge savings" in MI for both the State and TSDFs, though the amount has not been quantified in detail. Manifest data entry costs have been cut in half. Based on savings in data entry within the state alone, they expected a payback of less than three years on their initial $100,000 investment.

- **No evaluation of the system's strategic value.** Michigan has focused primarily on the cost reduction elements of the new system. It has not looked at the strategic value of the improved data in policy planning and enforcement.

Texas STEERS System

The State of Texas Environmental Electronic Reporting System (STEERS) is a state-developed software program to assist regulated entities in filing required hazardous waste-related reports to the state. Data can be entered into the state's software package manually, or loaded from existing company electronic files. The system is widely used within the State, and makes production of state-required reports much easier for the regulated community, and much more accurate for the State. Monthly summaries (basically pared-down manifests)

- **Data consolidation.** Texas collects manifest-level data from TSDFS, with an expanded range of data elements to allow generation of BRS. The system has an internal application to complete BRS for all facilities by querying STEERS. According to the program manager, "Most facilities in TX don't even know what the Biennial Report is." STEERS can also generate monthly summaries, which are essentially aggregations of pared-down manifests.

- **System benefits**

    - **Cost savings.** The annual savings in data entry costs, once STEERS was up and running, are estimated at $60,000. TSDFS also save money, since prior to the establishment of the system, they used to pay third parties to assemble and report their data to the state; this is now done automatically through the STEERS system. How this compares to the system's development costs is difficult to gauge, since internal labor was used for development, where the level of effort is more difficult to aggregate. The Program Manager estimates that the STEERS web site alone cost $300,000 to develop.
    - **Strategic Value of Better Data**. A lack of resources have prevented STEERS from examining the strategic value of better data to State operations or increased data access to the public. In addition, while TSDFS report monthly, generators report only annually. This lag limits the theoretical uses of the improved data somewhat.
- **Electronic reporting.** Texas has solved the problem of electronic signatures by collecting a real signature at the time the partnership agreement between the State and STEERS user is signed. Subsequent transactions are secured using a personal identification number (PIN). This signature, kept on file, serves as a blanket signature--the PIN serves as its surrogate for all transactions.
- **Ease of use.** Granted a sample of two does not a survey make, DuPont and Safety-Kleen had very different takes on the STEERS system. DuPont, which decentralizes environmental reporting to the plant and state level, spoke very highly of the system, saying it made their

job in Texas much easier. In contrast, Safety-Kleen found the non-standard nature of both the forms and the format, in combination with error checking routines that didn't mesh with their own internal checks, frustrating to use. Perhaps the issue is that even an effective system within a single state can become problematic to interstate commerce when firms must deal with many different systems and formats.

Views on Future Systems

Texas has strong views on possible options to eliminate state-specific data blocks of to shift the primary reporting site from the states to the federal government.

- **Substantial funds already invested in developing existing state system**. TX was a frontrunner in the innovative waste reporting realm. Their system was developed in advance of any federal guidance or standards for electronic systems. It would be unfair for the federal government to now impose standards that require major modifications to the TX system.

- **State-specific data elements remain essential**. TX, like many states, collects more information than required by Federal statute. For example, rather than grouping "flammable and corrosive" as a single element, it tracks them discretely. TX is very reliant upon these elements for policymaking needs (e.g., capacity planning for landfills), so a national system that excluded state elements would cripple the TX program. The Program Manager favored an XML-based national system that had the flexibility to allow for state codes, and argued that even if state codes were restricted from the federal forms, Texas would likely implement a separate state system for Texas reporters so they could continue to obtain the supplemental information.

- **Federal rather than State data portal raises a host of federalism concerns.** Besides essentially usurping current state power in acting as the reporting agency, would the federal government then withhold the funding associated with current state operation of the data systems? How would they parse out the funding that states would keep? How would this affect jobs and salaries at states? If they are the main data portal, is the Federal EPA also ready to provide technical support for a national system to every TSDF in the U.S.?

A4. Brief Summary of Other Hazardous Waste e-Reporting Initiatives

(Data sources used may not reflect the current status of all programs)

Florida

Florida was the first state to develop and use a diskette program for collecting BR data. Containing help screens, look-up tables for common data elements (e.g., SIC Codes), and automated error-checking capabilities, the program is sent to the largest 200 generators in the State; it is made available to other generators by request. The software saves data from previous years as a template, facilitating data entry and minimizing re-transcription.. A new version of the software, currently in development, will include utilities for automated state data transfer.

Florida began piloting the program in the 1991 reporting cycle; by 1995, more than 50% of reporters used the software, at a cost savings of over $20,000 to the State. In addition to the noted cost savings, FDEP has realized significant improvements in data quality. (*NGA, 1999*)

FingerPrint Electronic Reporting Software

At least nine states use this commercial software package. Reporters install the generator versions on their computers, and it serves as a simplified data-entry tool. The software provides data quality checks and provides help screens. Once data are validated, the software creates a file, which is in turn mailed to the State (some states allow for internet-submittals; this is not part of the generic software package). States install the regulator version of the software, which allows import of the facility data; data-quality checks; and creation of BR flat files for transmittal to EPA. (NGA, 1997).

New York

Manifest information is manually entered by the State. The original manifest forms are then scanned into an electronic image storage system, where manifest images are made available to department personnel and law enforcement officials (NYDEC, 2003). New York is piloting an EDI-based electronic reporting program for Discharge Monitoring Reports, but does not explicitly discuss expanding electronic reporting into the hazardous waste realm. (NGA, 1999)

Pennsylvania

PADEP's Electronic Document Management System (EDMS) is essentially a system for scanning paper documents, storing them digitally, and retrieving them on demand. It will use document management, imaging, workflow, and forms processing to improve business processes. While the concept is mature, implementation of EDMS is ongoing. PADEP hopes to pilot the system by June 2003.

EDMS names several benefits, including:

- facilitated document availability
- reduced mis-filing
- concurrent access to documents

- more timely service to customers
- reduction/elimination of photocopies
- increased storage capacity
- disaster recovery

PADEP plans to commence the EDMS project by piloting it in the realm of storage tank registration, which includes sorting/logging registration forms; registration of tank technical reviews; and QA/QC of reviews and data. (PADEP, 2003) When the system is expanded to BRS, quarterly fee assessment, and summary reporting, PADEP projects savings of $100,000 annually. (Yuengling, 2003)

California

The Hazardous Waste Tracking System (HWTS) can be used to create, submit, and correct manifests via the DTSC website's FTP server As of January 2003, one hundred small companies had been issued ID numbers and granted access to the online system. Interest in the system is widespread: over 3,000 companies have requested access. (Note: even with HWTS, generators must still produce a paper manifest to accompany waste during shipment. TSDFs then submit manifests to DTSC in paper form.)

The electronic submission system, in its first year of operation, is expected to be responsible for a 20% decrease in paper flow between generators and the DTSC. This reduction is expected to reach 40% in the second year and 70% in the third year. The state currently expends around $700,000 per year to capture data from manifest documents. It is expected that, with the electronic system, 10% of these costs will be cut in the first year of operation, 20% in the second, and at least 30% in the third. Data are also made available more quickly (i.e., next-day turnaround) than under the previous system, when generators had 60 days to submit manifests to the state and data were manually processed and verified.

California's hopes to bring electronic reporting to TSDFs by adding an electronic signature feature to on-the-road manifests. Ideally, TSDFs would send electronic signature data to DTSC verifying that the accuracy of the received manifest. This would eliminate the need to physically collect manifests, which should match the original copy submitted by the generator. (Bohon, 2003)

McClellan Air Force Base

McClellan used a commercial software package, TINIA, that tracked and controlled the ordering, licensing, issuing, and disposal of hazardous materials and wastes. (EPIC Alliance, 1995) The software met a wide range of hazardous-waste related needs, including tracking hazardous materials inventory; completing Material Safety Data Sheets (MSDSs); licensing shops to use particular materials; tracking materials distribution; and tracking hazardous waste disposal data, air emissions data, permit data, and personnel records, such as training and personnel protection equipment requirements. The system also supported emergency responders, and facilitated "just-in-time" ordering of hazardous materials, saving money, and reducing both aggregate demand for hazardous materials, and dispersed inventories.

Cost savings for some materials reductions were estimated at over $130,000 per year. However, a broad review of cost savings was never documented, staff involved noted that visible and widespread efficiency gains were observed (*Gronstall, January 2003).*

The program's Administrative and Compliance Reporting Function (ARC) was used to process a wide spectrum of reports on McClellan's compliance with state and federal laws. The ARC saved money by keeping McClellan in compliance and avoiding fines, and aided compliance with a variety of statutes including SARA amendments (MSDS in system), RCRA, California Title 22 (equivalent to 40 CFR), and a variety of OSHA regulations.(Gronstall, January 2003). Plans to implement bar coding for inventory tracking, and control, and more efficient labeling of hazardous materials and generation of hazardous waste-related reporting were never implemented. (Gronstall and Prall).

McClellan's system was selected by Dept of Defense (DoD) as one of the 2 best hazardous waste management systems in the nation (along with Norfolk naval base). A plan to combine the two into a DoD-wide management system was derailed due to conflict over which of the two systems would be implemented. In 2001, DoD issued a directive that all Commands were free to develop and deploy their own hazardous waste management systems, which effectively killed the effort to have a uniform national system. (*Gronstall, January 2003)*

TerraLink

TerraLink is a windows-based environmental management software suite that encompasses various aspects of hazardous waste management. It comprises three major components:

- **Cradle to Grave.** Facilitates user access to waste information. Functions include paperwork management; electronic information exchange; electronic report submission for CERCLA and RCRA; e-manifesting; and inventory control (with the foundation for wireless bar coding).

- **Manifest and Profile.** Web-enabled waste tracking and inventory management.

- **TerraLink Automated Exchange of Information (TAXI).** TerraLink's proprietary extension of XML, TAXI provides standard data formats and transport mechanisms specifically tailored for hazardous waste information.

GreenSuite

GreenSuite is a web-enabled EHS Solution currently used in a variety of industry sectors, from electric utilities to test and measurement products. At one coal-fired electric utility, GreenSuite manages data from Continuous Emission Monitoring Systems, supporting real-time analysis. Plant personnel use GreenSuite to proactively avoid permit exceedances. (Farley, 2003) GreenSuite's capabilities encompass several areas (Vertical Suite, 2003):

- Product stewardship, including product handling and hazard assessments
- Incident tracking and prevention for environmental releases and worker injury
- Personnel health and safety, including scheduling and monitoring of industrial hygiene

- Hazardous materials and waste, including tracking, storage capacity, distribution, use, movement, and disposal
- Environmental releases, capturing data necessary for Agency release reporting
- Regulatory requirements, managing internal and external reporting
- Facilities management, including enterprise and site-specific reference data

A5: Federal Express and UPS

(National transport firms with broad experience with real-time tracking)

Whereas the other government and private entities we spoke with measure their investments in hazardous waste tracking and reporting systems in the hundreds of thousands of dollars, or a most a few million, Federal Express and UPS are in a totally different league. Their information technology budgets are over $1 *billion* per year each. The FedEx IT department alone employed 5,000 in 1998. (Ng, 3). Both firms are global logistics leaders, and have innovated time and again in terms of real-time tracking through the internet, exceptions reporting, cellular logistics, and machine-readable shipping information.

It is conceivable that many of these systems could be applied by one or both of these firms fairly directly to the hazardous waste market, perhaps through technology licensing. Unfortunately, our contacts with both firms suggest that neither has a near-term interest in this market. However, we were told that UPS has considered it in the past. Regardless of whether either firm ultimately expresses an interest in serving this market directly, their approaches to tracking materials and generating accessible real-time data provide valuable insights into the creation of an optimal waste tracking system.

Summary of Key Findings

- **Technologies exist to solve many of the challenges facing automated waste tracking and enhanced reporting.** Cellular networks, electronic signature protocols, real-time tracking of shipments via the internet, advanced query capabilities: common roadblocks in the realm of hazardous waste have already been solved by the top tier logistics firms. So too have they begun to use the core transactional data on shipments and shipping to identify value-added services to customers.

- **Costs of these services are much lower than the current cost of a hazardous waste manifest.** However, transactional volume is much higher as well. Whether or not these technologies can be readily deployed in the hazardous waste sector depends on how unit costs for the hazardous waste market -- with fewer, more complicated shipments -- would play out. Adaption of existing technologies to a new market of hazardous waste would be the most promising solution, as the cost to develop the many overlapping technical systems and networks would continue to be amortized across regular package shipments.

- **Many of the elements of the future "vision" for hazardous waste data collection have been themes for both UPS and Fedex.** These include reliance on standard and public systems whenever possible; reduction in the variety of technologies and protocols used (standardizing systems has led to large cost savings); and centralization of core functions such as data management. The ability to communicate logistics and cargo data ahead of the transport also offers great potential for emergency responders.

- **Some areas of emphasis not currently central in the hazardous waste reinvention efforts have been critical to the logistics firms.** These include a continuous and high level commitment to technical innovation and reinvention; careful and ever expanding measurement of system performance and exceptions reporting; continued expansion of access to shipment data to clients; and a gradual expansion of value-added uses of the raw logistics data to improve the overall operations of client businesses.

- **Neither UPS nor Fedex seemed interested in licensing their technologies to the hazardous waste sector at this time.** However, the Agency should continue to enter a dialogue with these firms, and with others with similar (if somewhat less advanced) capabilities. Their knowledge can help EPA develop much better solutions, and the conversations can help the Agency identify and address any barriers to having some of these firms apply their expertise directly to the logistics and reporting on hazardous wastes.

- **Some barriers to accepting advanced logistics for hazardous waste may also exist.** Conversations with one staff person at the American Trucking Associations suggested that, in his view, there wasn't a high demand by truckers or their customers for more accurate or more rapid data on waste shipments. Demand would be further weakened if applying these logistics systems was expensive. Additional research, involving a wider range of transporters, would be needed to more carefully assess the barriers and leverage points to the adoption of these types of systems.

Overview of Market and Firms

The global logistics market, of which both UPS and FedEx are a part, is estimated at $3.2 trillion per year and growing. The package delivery sub-segment is roughly $60 billion per year. UPS is the dominant player, though UPS' shipments declined 2 percent in 2002, due to inroads made by FedEx. (Buss). In terms of revenues, UPS earned over $30 billion in 2001, versus $19.6 billion for FedEx. (FedEx 2002 Annual Report; UPS 2001 Annual Report).

Both firms provide air and ground transport, though FedEx has historically been primarily an air freight firm (70% of total revenues); UPS has been primarily ground. (Tatge). Despite the launch of FedEx Ground, UPS continues to be the largest player overall. This is illustrated by number of packages handled. As of November 2002, FedEx Ground was handling 2.6 million packages per day, versus nearly 13.6 million per day for UPS on average, and 25 million packages per day peak (Hesseldahl, Nelson). UPS serves 8 million customers per day (Nelson), and its web site receives more than 60 million hits per day at it tracks more than 5.5 million shipments daily. (Dukcevich). In contrast, even the highest estimates for hazardous waste manifests are slightly over 5 million *per year.* UPS revenues approach $135 million per day. Thus, the highest estimate we came across for the gross direct cost of the current manifest system to all parties ($785 million per year) is equal to less than one week of UPS' revenues.

With scale and automation comes efficiency. Credit Suisse First Boston estimated that FedEx Ground had an average unit cost per delivered package in 2000 of $4.77, for which it charged customers an average of $5.45. For UPS ground, average costs and charges per package were $4.97 and $5.61 respectively. (Tatge). Ground shipments are a much closer parallel to

hazardous waste shipments than would be air freight. A comparison of the two sectors in terms of costs is astonishing. UPS and FedEx can track *and deliver* a package for less than $5. In contrast, EPA estimates that the data component alone for hazardous waste manifesting (excluding the costs to actually move the wastes) is between $80 and $140 per manifested shipment. (See Appendix B for calculation details).

Technology and Business Process Trends

Technology within these firms serves three core purposes: it allows optimization of all logistics, including pickup, transport, and delivery; it facilitates real-time tracking of shipments; and it provides near-real time access to data for customers and staff. Over time, both firms have been exploring options for applying their logistical expertise and data tracking capabilities to strategic, value-added functions for their clients. The high profitability of these new services suggest a possible parallel with hazardous waste tracking as well: that strategic application of accurate, real-time data on wastes can have higher economic returns than the direct cost reductions associated with automating logistics.

Technology Overview

Both Fedex and UPS use bar coding of packages to minimize data entry and errors on shipments and to facilitate rapid processing and reporting of data about the shipments. The machine readable codes uniquely identify a shipment, but also link to a range of shipment-related information. The FedEx barcode label, for example, includes information such as the destination, the type of service, and the delivery commitment time. (Brewin and Rosencrance). This information is scanned by employees using scanners hooked onto their fingers or wrists, or handheld scanning wands. Data on pickups and deliveries are transmitted once on the truck back to the company's data nodes, where it is retransmitted to one of the firm's global data centers. Gradually, more and more of the data links are being replaced by cellular communication. (Nelson)

For example, at Fedex, handheld wireless wands scan each package 10 to 20 times as it passes through the FedEx network. (Tatge). UPS drivers use a Delivery Information Acquisition Device (DIAD) to collect customer information and signatures electronically. (Ross and Weill). Centralization of this data is used to do far more than simply allow users to watch their packages move. Data collected by Fedex drivers through ring scanners allows them to continually reconfigure their ground network. (Tatge). The tracking information also plays a large role in routing a package. At Fedex, the data route the package to the proper conveyers at an airport; help adjust routing to deal with issues such as weather events that interfere with normal shipping; and centralize data on any inbound shipments that are subject to customs duties. Shipments are weighed, and the computer helps ensure they are loaded properly onto air shipping containers to achieve a balanced load. (Brewin and Rosencrance).

A review of a range of sources on both of these firms suggests the following technology and business process trends:

- **Continuous investment, technical replacement**. For both firms, high and recurring expenditures on IT is part of staying in business. Managers recognize that a continual process of upgrade, renewal, and innovation is needed in order to remain competitive. UPS, for example, has spent about $1 billion per year on IT since 1985. It's focus has often been on company-wide standardization and cost cutting. UPS upgrades equipment in cycles, rather than on an as-needed basis. These cycles are often every five years, and allow new technologies to be integrated across the company in a step-wise fashion. (Nelson).

- **Focus on wireless**. Trucks are on the road most of the day; thus tracking shipments requires the ability to communicate with these fleets in real time. Both firms have invested heavily in improved and more flexible wireless technologies. These approaches connect not only the trucks to the core firm networks, but workers working in sorting or logistics hubs as well. As noted below, both firms had to initially set up proprietary wireless networks, and are now being able to migrate much more generally to commercial networks.

- **Equipment standardization for cost reduction and maintenance**. During capital replacement cycles, UPS has focused on company-wide standardization of technologies and protocols. (Nelson). Wireless is a good example. UPS is upgrading its wireless platform to Bluetooth and 802.11b short-range wireless protocols, at a cost of $100 million. However, anticipated savings via consolidated wireless platforms that require fewer repairs and less IT support are expected to have a 16 month payback. Existing systems were varied and often incompatible, making them difficult to upgrade. (Nelson).

- **Balancing efficiency from centralization with flexibility in deployment**. There are large economies of scale from having massive facilities with very high utilization rates. However, this is balanced against the desire for flexibly deploy assets to meet changes in supply or demand.

    - **Centralization of data management, sorting, and transport hubs.** Both firms have adopted a mixture of the two approaches, with centralization evident in data processing and transport. For example, UPS has only two worldwide data centers, one in GA and the other in NJ. Transport routes use a hub and spoke approach, rather than point-to-point shipments in order to more effectively achieve economies of scale.

    - **Decentralization of route optimization**. However, while there are set routes for delivery and pickups, the firms are continually reconfiguring these routes at the margins to more effectively meet demand. Centralized technology plays a central role in this optimization. For example, data on pickup locations is centralized, then routed to the closed trucks to optimize pickups. (Brewin and Rosencrance). Fedex trucks have "Digitally Aided Dispatch System" (DADs), an onboard computer, mounted to the steering wheel. The DADs notifies drivers regarding pickups, which it can do because the vans are tracked via a global positioning system (Tatge). Similarly, the real-time tracking system helps Fedex to more tightly manage its huge sorting facilities. (Brewin and Rosencrance). FedEx vans have GPS so they can be tracked enroute. (Tatge).

- **Movement from proprietary networks/standards to open networks/standards whenever possible**. While both firms have been early innovators in logistics and wireless communication, proprietary networks are expensive. Thus, whenever possible they have opted to migrate to open, standard approaches. Fedex has begun using the commercial wireless network to track packages, using the FedEx Power Pad. Using the public network will save the cost of "operating much of the wireless network that it has for more than a decade." Will continue to supplement the commercial GPRS (general packet radio system, used for enhanced cellular services) with its own towers as needed. (Hesseldahl). Both firms also rely on the internet for many of their package tracking applications.

- **Minimize manual data entry.** Barcoding of packages provides an efficient mechanism to track shipments without requiring time-consuming and error-prone rekeying. Both Fedex and UPS provide customers with decentralized systems that can print out machine-readable shipping labels. Use of these labels often gives customers a discount at well.

- **Careful and continuous measurement of performance**. The frequent scanning of packages allows automatic reading and recording of many attributes associated with the shipping process. At the crudest level, the shippers (and the customers via the tracking web sites), can tell where a shipment disappeared if it did not arrive. However, many other applications are far more advanced. For example, bar coded packages are linked to computer logistics systems so that a warning is signaled were a FedEx package to be put in the wrong shipping container at an airport (Brewin and Rosencrance). At UPS, an onboard computer helps track fuel consumption in trucks. (Nelson). Fedex loads manifest information on air shipments into its critical Inbound Control System. In addition to sending data into the tracking system, this system feeds information into a performance database and flags problems relating to items such as the amount/reasons for delays and mechanical problems. (Brewin and Rosencrance). The ultimate goals of these measurements is improved performance and profitability. In recent years, FedEx developing tools to facilitate calculation of package-level profitability. (Alliger and Kad, 2).

- **Technology and human vigilance for safety.** Carrying millions of packages per day requires continued vigilance to ensure that nothing hazardous or illegal is transported. Fedex uses a mixture of technology and human observation to screen for dangers. Suspicious items are screened with x rays, or ripped open and inspected. "At its 27 ground hubs, an automated sorting system relies on information picked up by cameras and laser scanners as packages whiz by at 540 feet per second. Human vigilance plays a big role. Every package requires an airbill or label with an account number and return address. Customers paying cash must provide photo ID." (Tatge). Approaches such as these have become more important in the post 9/11 era.

Value-Added Services Using Basic Logistics Data

As these logistics firms gathered more and more data about the shipment patterns for particular customers, they realized that they could grow what they do for customers to include enhancing supply chains, expediting or tracking shipments across borders, and improving

inventory management. While not always easy to develop, some of these applications have been highly profitable.

UPS, for example, has begun to offer customers a range of services, such as preparing and financing shipments, tracking deliveries and consulting on supply-chain management issues. (Buss). Revenues from non-package services were $2.4 billion in 2001, but were growing at a rate of about 30% per year. (Buss). For example, an online tracking system developed for Ford to track automobiles once they leave the plant freed up idle inventory worth $1 billion, reducing annual carrying costs by $125 million. (Buss, Schonfeld). UPS has also taken over inventory management on imported product. (Buss).

A6. CIL Anodizing, Inc.

Lawrence, Massachusetts
(Small generator)

To obtain an unfiltered view of the challenges and goals of streamlined HW tracking and reporting as it applies to small business, we wanted to speak with the people grappling with these issues first-hand. We needed a firm that was large enough not to be exempt from BRS, but small enough where learning the complying with the regulations could be a substantial economic burden. Ideally, we also wanted a firm that was not relying on Safety-Kleen for waste disposal services, as this would have overlapped with other project research. We spoke with two staff members at CIL Anodizing, a metal finishing firm in Lawrence, MA to get their perspectives. Discussions with a larger sample would likely broaden the ability to generalize from our findings.

Background

- CIL specializes in the processing of aluminum parts for the aerospace, military ,and commercial industries. They provide anodizing, plating, painting, and powder coating services.

- The firm employs roughly 50 people

Existing Systems

CIL has a developed a fairly sophisticated barcode-based HW management system that tracks all onsite chemicals and waste. The system captures purchasing, inventory, job tracking, tank information, and chemical interactions. The system was developed in-house over the course of 2 years, and was essentially a response to failed third party systems (for which CIL had paid $40,000). The system enables queries to produce a variety of reports for company use (e.g., tracking chemical consumption against work flow, looking for discrepancies).

- **System led by production demands; compliance was secondary.** While the system was initially developed to aid in production, CIL added features to assist with compliance. This added further value to the system, because CIL was contracting with a consultant to handle their hazardous waste reporting (and subsequently was able to compete Agency reports with in-house staff and resources).

- **Manifest data input manually.** For compliance purposes, CIL manually inputs manifest data. This allows for summary reports that serve as a precursor to BRS. Despite the manual entry, reporting is much less burdensome than it once was. Staff noted that TRI once necessitated spending "weeks" in the Records Room sorting through a year's worth of purchase orders.

- **CIL data formats not easily converted to government formats.** Currently, the biggest "bottleneck" comes in transcribing CIL's internal summaries into BRS. (Contacting service providers to get missing data also requires substantial resources.) The company cannot directly upload its data to the state or federal systems because its internally-developed system is incompatible with the government system. They do not have sufficient resources to "upgrade" to a costly system that is compatible with the government systems, and pointed out that such a system might not meet their internal needs as effectively.

- **Government requirements are driving their record keeping in the hazardous waste area.** Staff noted that if the government required less, CIL would track less. But it would still track many non-mandatory elements for internal needs.

Vision for improvements to hazardous waste tracking/reporting

- **Flexible, yet functional**. CIL would favor a system relying on the internet for data collection and transmission. This would serve as a lowest-common-denominator approach, and small firms wouldn't need to invest in costly new systems to participate. CIL would be willing to modify its internal system to be compatible IF the benefits of doing so were significant.

- **Tier II as a possible software solution**. If States/Feds move towards a software-based system, they should look at the Tier II reporting software, which minimizes data re-entry by saving boilerplates across years and across forms

- **Integrated reporting.** CIL anticipated significant benefits were the regulatory agencies to integrate reporting for all (or at least several) of the core hazardous waste statutes.

- **Interest in e-manifesting likely to vary by firm**. For CIL, they viewed e-manifesting as a logical step for them, given their existing system. However, they felt that many other small companies might be perfectly content with their present system. Especially given the state of the economy right now, they felt that many firms would be unable/unwilling to bear the transition costs.

Appendix B:

Cost Estimates for BRS and Manifesting

Exhibit B-1
Costs of Biennial Report

	Annual Cost (2002$)	Cost Per Cycle (2002$)	Notes
I. Summary			
Total respondent burden	$ 10,607,616	$ 21,215,232	
Total state/agency burden	$ 8,052,025	$ 16,104,050	
	$ 18,659,641	$ 37,319,282	
Est. number of respondents	$ 10,157	$ 10,157	page 19
System costs/respondent	$ 1,837	$ 3,674	
II. Detail on Respondents			
Gather information and prepare Site Identification Form	$ 148,820	$ 297,640	
Gather information and prepare Form GM	$ 3,254,405	$ 6,508,811	
Gather information and prepare Form WR	$ 4,855,720	$ 9,711,440	
Gather information and prepare Form OI	$ -	$ -	
Submit report to the State or Regional EPA Office	$ 46,309	$ 92,618	
Read the 2001 Hazardous Waste Report instructions	$ 1,407,160	$ 2,814,320	
Maintain a copy of each form for three years	$ 913,783	$ 1,827,565	Note (1)
Respondent Total	$ 10,607,616	$ 21,215,232	
III. Detail on State and Agency Costs			
Develop 2001 Report forms and instructions	$ 21,681	$ 43,361	
Distribute and collect Report forms and instructions	$ 305,428	$ 610,856	
Develop computer capabilities required to compile nationa	$ 261,211	$ 522,422	
Key entry of report submissions	$ 531,404	$ 1,062,809	
Prepare the National Report and other Analyses	$ 54,475	$ 108,951	
Perform quality assurance	$ 6,494,555	$ 12,989,111	
Assist respondents	$ 346,896	$ 693,791	
Store the data	$ 36,375	$ 72,750	
State and Agency Total	$ 8,052,025	$ 16,104,050	

Notes and Sources

(1) EPA accounts for both paper and electronic file storage, which they estimate will have the same costs.

(2) US EPA, *Supporting Statement for EPA Information Collection Request 976.10: The 2001 Hazardous Waste Report* , September 19, 2000, Exhibits 1 and 2.

(3) Dollar conversions use GDP implicit price deflators from: http://w3.access.gpo.gov/usbudget/fy2004/erp.html

Exhibit B-2

Estimated Direct Costs of Hazardous Waste Manifest System

Data Scaled to 2002$

Information Collection Activity	1999 ICR Source (1)	2002 ICR Source (2)	Burden Reduction Baseline	LMI Cost Estimate	Cite
I. Private Sector Burden					
A. Operating Costs Modeled by EPA					
Generators			$ 53,245,480	$ 264,913,175	
Read the regulations	$ 7,870,845	$ 11,210,493			
Manifest completion	$ 18,805,303	$ 21,154,943			
Special manifest requirements for exporters	$ 332,786	$ 412,950			
Manifest transmittal and recordkeeping	$ 12,070,204	$ 14,956,471			
Exception report completion, submission, and recordkeeping	$ 509,120	$ 609,032			
Transporters		$ -	$ 46,180,335	$ 46,172,278	
Read the regulations	$ 37,691	$ 38,126			
Manifest completion, transmittal and recordkeeping	$ 26,353,497	$ 32,242,843			
Notification of discharge of hazardous waste	$ 56,913	$ 63,518			
TSDFs		$ -	$ 94,388,432	$ 107,965,354	
Read the regulations	$ 48,545	$ 47,886			
Manifest completion, transmittal and recordkeeping	$ 56,680,568	$ 70,948,833			
Discrepancy report completion and submission	$ 3,090,860	$ 3,709,554			
Unmanifested waste report completion and submission	$ 19,484	$ 24,580			
Total Operating Costs	$ 125,875,817	$ 155,419,232	$ 193,814,247	$ 419,050,808	
B. Capital Costs Modeled by EPA (All Regulated Groups)					
Annualized startup capital costs (file cabinets)*	$ 221,849	$ 350,251	$ -		
Total Private Sector	$ 125,392,833	$ 155,769,483	$ 193,814,247	$ 419,050,808	
Manifests assumed to generate these values	$ 1,795,865	$ 2,204,816	$ 2,433,118	$ 2,900,000	Note [c]
EPA Estimated cost/manifest	$ 70	$ 71	$ 80	$ 145	Note (d)
C. Incremental Private Sector Administrative Costs Not Modeled in ICRs					
Tracking state requirements	$ 628,658	$ 628,658	$ 628,658	$ 628,658	Source (5)
Correcting errors resulting from state-specific requirements	$ 908,345	$ 908,345	$ 908,345	$ 908,345	Source (5)
Training employees on state-required information	$ 1,800,155	$ 1,800,155	$ 1,800,155	$ 1,800,155	Source (5)
Total	$ 3,337,158	$ 3,337,158	$ 3,337,158	$ 3,337,158	Source (5)
Manifests used to generate these values	2,221,520	2,221,520	2,221,520	2,221,520	Source (5)
Hours estimated by ETC	$ 53,353	$ 53,353	$ 53,353	$ 53,353	Source (5)
Incremental cost/manifest	$ 1.50	$ 1.50	$ 1.50	$ 1.50	Source (5)
Adjusted private cost/manifest	$ 71	$ 72	$ 81	$ 146	
II. Public Sector Costs					
Agency Burden	$ 272,137	$ 341,153			Note (e)
State & Agency burden	$ 6,633,539	$ 8,269,313	$ 6,497,086	$ 24,235,809	Note (f)
Public cost/manifest	$ 4	$ 4	$ 3	$ 8	Note (g)
III. Overall Cost					
A. Estimated full administrative costs of manifesting					
Gross cost, EPA Estimates plus ETC adjustments	$ 132,026,372	$ 164,038,796	$ 200,311,332	$ 443,286,617	
Tot. cost/manifest	$ 75	$ 76	$ 84	$ 154	
Gross cost using ETC manifest numbers	$ 381,754,535	$ 386,343,298	$ 426,690,662	$ 785,690,617	
Avg. cost/burden hour	$ 44	$ 55	$ 67		Note (h)
B. Comparison with private sector costs of logistics services					
Avg. cost/ground shipment, FedEx and UPS	$ 5.05	$ 5.05	$ 5.05	$ 5.05	Source (6)
Full delivery costs by majors as a percent of data tracking and reporting for HW	6.7%	6.6%	6.0%	3.3%	

	1999 ICR Source (1)	2002 ICR Source (2)	Burden Reduction Baseline	LMI Cost Estimate	Cite
IV. Distribution of cost by industry segment					Note (i)
Generators	30%	30%	27%		
Transporters	20%	20%	23%		
Treatment, Storage, Disposal Facilities	45%	46%	47%		
Public sector	5%	5%	3%		
	100%	100%	100%		
V. Projected Savings from Manifest Standardization & Automation			EPA 12/02, p. 32.		
Low End estimate (assuming 25% shift to e-reporting)					
Total savings			$ 24,186,000		
Savings per manifest			$ 10		
% Cost reduction			12%		
High End estimate (EPA plus ETC, assuming 50% shift to e-reporting)					
Total savings			$ 38,976,158		
Savings per manifest			$ 16		
% Cost reduction			19%		
VI. Input Assumptions					
Total Burden Hours	2,920,383	3,612,539	4,615,000		
Total number of manifests in EPA ICR calculations	1,795,865	2,204,816	2,433,118	2,900,000	
Number of manifests produced by Safety Kleen in 2002		1,200,000			Source (7)
Number of manifests produced by SK in 2001		1,879,680			Source (5)
Number of manifests estimated by Environmental Technology Council		5,090,000			Source (5)

Notes

(a) Dollar conversions use GDP implicit price deflators from: http://w3.access.gpo.gov/usbudget/fy2004/erp.html

(b) Both scenarios project savings. Conversations with industry suggest that adoption rates less than 100% would drive costs UP and dual paper and electronic systems would be required.

[c] LMI manifest count from Mark Eads, EPA.

(d) LMI unit cost does not match their estimate of $519/manifest. Their value appears to include lots of double-counting.

(e) EPA Burden only

(f) 2001 values scaled based on ratio of EPA only data between the two ICRs

(g) Uses joint state/EPA line item only

(h) Uses actual (EPA +ETC universe)/ actual (EPA +ETC hours)

(i) Based on EPA data only; not information on which sectors bear incremental costs identified by ETC.

Sources

(1) Exhibit 15 from the Supporting Statement for Information Collection Request Number 801: Requirements for Generators, Transporters, and Waste Management Facilities Under the RCRA Hazardous Waste Manifest System, October 22, 1999.

(2) "Supporting Statement for Information Collection Reguest Number 801.14: Requirements for Generators, Transporters, and Waste Management Facilities Under the RCRA Hazardous Waste Manifest System," January 31, 2002.

(3) EPA 12/00. US EPA, Economics Background Document: Economic Analysis of the US EPA's Proposed Modifications to the RCRA Hazardous Waste Manifest System, December 19, 2000, pp. 18, 19, 24, 25.

(4) Daley, Carol Ann et al. Hazardous Waste Manifest Cost Benefit Analysis, prepared by Logistics Management Institute for the US EPA, October 2000, pp. 3-6, 3-7.

(5) ETC. Environmental Technology Council, Comments on F-2000-UWMP-FFFFF, Hazardous Waste Manifest Proposal, November 6, 2002, pp. 2,3. RCRA-2001-0032-0095.

(6) Tatge, Mark. "Start the Ground War," Forbes, November 26, 2001, p. 146.

(7) Conference call with Safety-Kleen staff, March 2003.

Appendix C

List of Contacts

Name	Affiliation	Date of Contact
Balbus, John	Environmental Defense	February 21, 2003
Bohon, Jim	Department of Toxic Substances, California EPA	February 3, 2003
Bolse, Elizabeth	Michigan Department of Environmental Quality	March 4 and 7, 2003
Buchler, Jim	EnVectra, Inc.	January 16, 2003
Darveau, Linda	Office of Policy, Economics, and Innovation, US EPA	March 24, 2003
Dissanayake, Thilanka	CIL Annodizing, Inc.	March 28, 2003
Drescher, Sharon	Syngenta, Inc.	March 5, 2003
Eads, Mark	Office of Solid Waste, US EPA	January 17, 2003
Farley, Mark	Vertical Suite, Inc.	March 3, 2003
Fusco, Mike	Safety-Kleen	March, 12, 2003
Groce, Bryan	Office of Solid Waste, US EPA	January 17, 2003
Gronstall, Don	McClellan Air Force Base	January 22, 2003
Gunnulfsen, Jeff	Synthetic Organic Chemical Manufacturers Association (SOCMA)	January 15, 2003 and March 5, 2003
Hessling, Michael	Office of Policy, Economics, and Innovation, US EPA	March 24, 2003
Hubbard, Stacey	Riverside County CA Waste Management Department	January 13, 2003
LaShier, Richard	Office of Solid Waste, US EPA	January 28, 2003
Leopard, Matthew	Central Data Exchange, US EPA	January 17, 2003
Levy, Dave	Office of Solid Waste, US EPA	January 27, 2003
McCarty, Bud	North Carolina Department of Environmental Resources	March 17, 2003
Mongan, Ed	DuPont, Inc.	March 17, 2003
Moskowitz, Richard	American Trucking Association	March 4, 2003
Nass, Bob	Safety-Kleen	March 12, 2003
Nelson, Beverly	Vertical Suite, Inc.	January 29, 2003
Ogle, Jessica	STEERS Project Manager,	March 17, 2003

Name	Affiliation	Date of Contact
	Texas Commission on Environmental Quality	
O'Neil, David	CIL Annodizing, Inc.	March 28, 2003
Peterpaul, Joseph	DuPont, Inc.	March 5, 2003
Prall, Mike	McClellan Air Force Base	January 22, 2003
Probst, Kate	Resources for the Future	January 22, 2003
Shafer, Ron	Office of Environmental Information, US EPA	February 26, 2003
Terrell, Doris Ann	DuPont, Inc.	March 5, 2003
Turner, Karen	Safety-Kleen	March 12, 2003
Yuengling, David	Concurrent Technologies Corp.	January 31, 2003

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