

# COMPREHENSIVE HAZARDOUS WASTE DATA MANAGEMENT USING SERIALIZED BAR-CODING

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## ABSTRACT

Hazardous waste management and minimization begins with comprehensive, accurate, and easily retrievable information about the waste: its origin, description, location, final destination, and handling costs. The more accurate the information, the easier it is to maintain effective waste management and minimization programs. At Sandia National Laboratories, Albuquerque, the Hazardous Waste Data Management Software (HWDMS) system was developed using a platform-independent, customized database and tools that allow retrieval of information in a wide variety of formats. The HWDMS is a comprehensive data acquisition and management system that uses bar-coding for field tracking of waste packages. With the use of unique, serialized bar codes and dual-entry data input, HWDMS is able to maintain the integrity of the database and to provide accurate data retrieval. The HWDMS gives the hazardous waste manager the tools necessary to effectively minimize and manage wastes from cradle to grave.

## INTRODUCTION

Developing a comprehensive hazardous waste management inventory tracking system and database is a task borne of necessity. Compliance with reporting requirements in the complex federal and local environmental regulations (1,2,3,4) and DOE orders (5,6,7) can be extremely difficult if even a portion of the process requires manual compilation of figures and information for reports or inquiries.

Sandia National Laboratories, Albuquerque, consists of hundreds of individual research laboratories that generate over 10,000 different waste streams, approximately 90 percent of which are small containers that are overpacked in lab packs (8). Spent solvents and waste oils make up the larger containers of waste. Sandia, Albuquerque, generates over 1,000 kilograms of hazardous waste per month, giving it large-quantity generator status with stricter regulatory requirements. The wastes are transported from satellite generators' accumulation points to the on-site, interim-status Hazardous Waste Management Facility (HWMF), where they are prepared for shipment off-site to a recycling, treatment, or disposal facility.

Sandia's hazardous waste management group, which includes Sandians and contractors, has developed a unique hazardous waste tracking system that truly tracks waste from cradle to grave. Using bar codes, individual waste packages are tracked from the generator locations, through the processes for the lab-packing or bulking, preparation of off-site shipments, and ultimate disposal. After struggling with an entirely manual process through the early 1980s, the Sandia hazardous waste managers used a set of dBASE® database files that tracked individual waste disposal requests and generators, and another database that identified containers pulled for waste shipments to a particular treatment, storage, or disposal facility (TSDF). The two databases were not networked; a labor-intensive effort was required to use the

databases for large tasks, such as preparing Biennial Reports (3). With these separate systems, waste could not be traced back to the generator until it had been lab-packed or bulked and the information was transferred from the waste disposal request to a drum content form (by hand). The laboratory waste managers and contractors began looking for solutions to this problem in 1989 and determined that a comprehensive data management system was not commercially available.

## HARDWARE AND SOFTWARE CONFIGURATION

Sandia's first computer-based waste tracking system at its HWMF became cumbersome to work with as reporting requirements and waste volumes began to increase in the late 1980s. Our Clipper®-compiled dBASE® system was a stand-alone system. The data we collected was put on single computers with no networking. A new in-house reporting requirement, monthly activity reports, made it critical to combine these databases into one database. This resulted in information being transferred by what we called a "sneaker-net." In other words, the two databases were combined at intervals instead of automatically. The result was the information reported was only as good as the last time the databases were combined, usually on a monthly basis. The process was lengthy and there existed the possibility of many errors being injected into the database, such as duplicate records, missing records, or inconsistent data between databases.

A team was formed to review the waste management process and to set requirements for the new database system. The team consisted of personnel with backgrounds in environmental records management, hazardous waste regulatory compliance, computer hardware and software, and computer networking.

Some critical requirements outlined by the team were (1) the database could not be dependent on any one platform or vendor; (2) the system would be designed to provide service

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to meet the group's needs for five years; and (3) the system had to be multi-user/multitasking with a short learning curve for the end user.

The team forecasted the five-year system needs and determined that these needs, coupled with the other requirements, eliminated the option of upgrading the original database system.

The decision was made to go with a Sun® platform, Oracle® RDBMS® and tools, Ethernet (IEEE Standard 802.3), and 3Com® EtherLink® cards. We utilized existing IBM® PS/2® systems for workstations. The final hardware configuration decided on was the Sun® 4/330® with 24 megabytes of random-access memory and a 669-megabyte hard drive (expanded to 1.9 gigabytes), 18 serial ports, 1 parallel port for an impact printer (to print multiply hazardous waste manifests), an Ethernet networking system, and 7 workstations. A hand-held Intermec® 9440 Trakker® equipped with 512K random access memory, a lithium battery backup, a 126X light pen, and an Intermec® 40D® base unit used for uploading and downloading data and battery charging was chosen as the bar-coding system.

Our next assignment was to find a software package that would track the waste packages from cradle to grave but would not impede our current operations. All the software we evaluated began tracking the waste from the lab-pack or bulk container. The team specified that tracking had to be started at the point of generation of the waste. We began by searching for a database software package that would be expandable and transferable between various platforms. We were unsuccessful in our search; we soon decided that we would have to develop the custom software from the ground up. We then looked for an Oracle®-based software development company. A contract was placed to provide this software.

#### THE ELEMENTS OF HWDMS WASTE TRACKING

The HWDMS system collects data starting with the Chemical Waste Disposal Request, an internal Sandia form imprinted with a unique bar code. The disposal request is completed by the waste generator, who certifies its accuracy and sends the form to the HWMF. All disposal request fields can be used alone or in combination to retrieve general or very detailed information about the generator or the waste. The HWDMS system is designed to maintain strict control of the waste's location and final disposition.

Upon receipt of the disposal request, waste management facility personnel review each bar-coded form for completeness and accuracy. Each line item is checked, and the waste packages are assigned an internal stream number; for example, a number for EPA corrosive liquids. The stream number may be retrieved from the HWDMS system using one of the many query screens. If a stream number does not exist, a new one is generated using a straightforward data entry screen.

Many of the database fields are filled with data from read-only "look-up" tables. These tables ensure consistent data entries and minimize the amount of redundant data. The disposal request is dual-entered (i.e., by two different entry clerks) into the system with error-checking to increase the degree of accuracy. These error checks are necessary to maintain the high data quality required for such a comprehensive system.

The disposal request information is then posted to permanent tables. Sandia's technical areas and buildings are

selected and scheduled for waste pickups. The location information is entered into the Trakker® for use by the waste pickup crew. At the generator's laboratory, the pickup crew verifies the information that has been downloaded to the Trakker®.

With the information loaded onto its portable Trakker® unit, the pickup crew has immediate access to all the data related to the waste. Any discrepancies are noted, and the data are changed at the generator's location. As the waste is collected, each container is assigned a unique bar code number by the physical application of a bar-code sticker. The bar code for each container is scanned and entered into the database. The waste package now has a unique identity: its bar code allows the user to look up the original disposal request and accompanying generator information, and it tracks the waste through the HWMF to its final destination.

The waste pickup crew then transports the waste to the HWMF, where the Trakker® data is uploaded to the on-site computer system in the administration area. The data is verified with the original pickup list data, and any discrepancies are printed (for example, when more packages of waste are picked up than were listed on the original disposal request). The discrepancies must be cleared before the data can be posted.

The HWMF contractor chemists in the waste repackaging areas then receive and segregate the waste into storage bays, using the information in the database hazard class field. The package bar code is scanned, along with the bar code assigned to individual storage bays. This process updates the location field for each package of waste.

The waste is then ready for lab-packing. The lab-pack container is assigned a temporary serialized bar code. The chemist scans the container bar code, then the individual package bar codes. When the lab pack is full, specific information about the lab pack (e.g., weight, reportable quantity, TSDF acceptance code) is entered into the portable Trakker®. The location field of each package is now changed to that of the lab pack container.

Permanent container labels are printed after the lab pack data have been uploaded to the main computer and the container content form is checked for accuracy. The container labels are 5- by 7-inch labels with the required U.S. Environmental Protection Agency and Department of Transportation data (9).

Once the permanent labels are affixed to the shipping containers, they are moved to the warehouse building on-site to await shipment to an approved TSDF. As before, the container bar code is scanned as it is stored to update the container location field.

A computer-generated shipment availability list allows for timely manifest generation. One step in the manifest preparation process is to determine what waste is on site and ready to ship. Through a query dialogue, a listing of all containers appropriate for a specific TSDF is generated. Containers can be marked for shipment, and a manifest can be generated with supporting documentation.

Weekly reports are generated to track manifests for which a return receipt has not been received from the TSDF. Direct costs, taxes, and miscellaneous costs are also collected for each manifest.

The system was tested during 1990 and 1991 by performing parallel data acquisition and retrieval using the existing

databases and the new HWDMS system for a period of one year on a select group of generators. This testing period was important for two reasons: to properly train waste management personnel and to work out any problems encountered in the use of an entirely new tracking system. The most important lesson learned during the testing phase was that the data acquisition and verification responsibility shifted heavily towards the beginning of the waste tracking process. The generators and the waste pickup crews identified and corrected waste identification problems early on, before waste was lab-packed and prepared for shipment. This front-end data verification markedly facilitated off-site shipments.

### SYSTEM QUERIES

The HWDMS system is a flexible database that allows for a specific waste package to be located at any stage of its management. Typical fields used are laboratory location, generator information, dates of request and pickup, DOT hazard class, waste description, storage location at the HWMF, type of DOT shipping container, off-site shipment date, manifest number, TSDF identification, and costs associated with shipment and disposal. Any number of queries can be made on these fields.

Waste managers can receive regular or ad hoc reports and charts describing the number of disposal requests received during a month, number or kilograms of waste handled, costs associated with managing a specific EPA waste code, and waste handling costs for a specific project.

### REPORTING REQUIREMENTS

The HWDMS facilitates preparation of a Biennial Report or an Exception Report (3) by reducing the labor-intensive work required to compile data from several different sources. Comprehensive data about the waste is accurate and retrievable, and this task can be done quickly. Waste minimization efforts are much more easily quantifiable when waste volumes and costs associated with each project are tracked. Reviewing operations for compliance with EPA hazardous waste permits requires up-to-date information on waste streams and volumes. Hazardous waste manifest preparation is simplified and mistakes are minimized with the use of the "look-up" tables. Finally, in the event of a facility emergency or disaster, access to the exact location and quantity of hazardous wastes can aid fire-fighting or spill cleanup efforts.

### SYSTEM FLEXIBILITY

One distinct advantage of the HWDMS system is its flexibility. The system is not platform-dependent; it can be used on many different platforms, from microcomputers to mainframes. Additionally, with ever-increasing reporting requirements and management's keen eye on disposal costs, it is easy to add new query fields and report-generating capability to the system. A wide variety of reporting formats are available.

### FUTURE USES

Sandia National Laboratories is managed for DOE by Sandia Corporation, a wholly owned subsidiary of American Telephone and Telegraph Company (AT&T). Working with AT&T, Sandia, Livermore, is in the process of implementing AT&T's Chemical Information System and Material Safety Data Sheet (CIS/MSDS) System, which tracks new chemical containers throughout their lifetime at a site using a similar bar-coding procedure. The CIS/MSDS system was developed

to support activity in the areas of emergency response, training, accident reporting, air emissions information, and Toxic Substances Control Act inventory compliance. The link between the CIS/MSDS system and the HWDMS system is the Process Waste Assessment, which identifies how wastes are generated from a particular process, with a given set of starting materials. When the systems are linked, we will then be able to track chemicals from initial purchase through processing and waste generation. The Process Waste Assessments will allow waste managers to target specific chemicals and waste streams for waste minimization and cost analysis. While the CIS/MSDS prototype is tested at the Livermore site, Sandia's waste minimization network members have begun to compile Process Waste Assessments for the larger and more toxic waste streams at Sandia, Albuquerque.

### CONCLUSIONS

The HWDMS is a comprehensive data management system developed in 1990 by Sandia, Albuquerque, and its contractor, Rinchem Company, Inc., after a thorough review of existing waste management software. It incorporates the best available technology and includes additional features, such as flexibility, that make it a versatile waste management tool. It provides cradle-to-grave detailed tracking of individual waste packages. HWDMS allows the hazardous waste manager to effectively minimize and manage hazardous wastes.

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### REFERENCES

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8. 40 CFR 265.316, Disposal of small containers of hazardous waste in overpacked drums (lab packs).
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