CRADLE-TO-GRAVE TRACKING OF HAZARDOUS AND RADIOACTIVE MATERIALS FOR POLLUTION PREVENTION*

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ABSTRACT

As part of Sandia National Laboratories' (SNL) pollution prevention program, a system is under development to track the movement of hazardous and radioactive materials from procurement, through use, to final disposition. The information provided by this system will improve the flow and enhance the quality of data, avoid duplication of effort, facilitate timely and accurate reporting, better support the information needs of various Environmental, Safety, and Health (ES&H) programs, and allow waste to be minimized more effectively.

Such a comprehensive system will incorporate information from various sources and build upon existing databases. The components include the Chemical Information System/Material Safety Data Sheet (CIS/MSDS) system installed by AT&T Bell Laboratories (AT&T-BL) at SNL in Livermore, and a Waste Information System (WIS) developed in Livermore. At SNL, Albuquerque a bar code chemical waste tracking system is already in operation and being developed are Process Waste Assessments (PWA), a radioactive material tracking system, and a radioactive/mixed waste tracking system. A SNL and AT&T-BL joint project is addressing how PWAs will link raw materials to waste streams.

With a "cradle-to-grave" tracking system, it is possible to assess both financial and environmental life cycle costs. Once in place, this information will improve long-run efficiency and environmental protection, and provide benefits exceeding the initial demands placed upon personnel.

INTRODUCTION

Sandia National Laboratories is a research and development laboratory operated by Sandia Corporation, a subsidiary of AT&T, for the United States Department of Energy (DOE). SNL is facing increased environmental, safety, and health regulations, many of which are focused on the hazards associated with chemicals and radioactive materials. The need to have a better understanding of the movement of these materials through the laboratories has resulted in an initiative to develop a corporate-wide material tracking system. Maintaining a near real-time inventory of these materials, from procurement to final disposition is teh goal.

Several independent activities are providing the potential building blocks for the corporate-wide tracking system. The SNL site in Livermore, California, (SNL, Livermore) is in the process of implementing the AT&T-BL's CIS/MSDS system and currently has a Waste Information System in place. A Hazardous Waste Data Management System (HWDMS) is currently in place at SNL's Albuquerque, New Mexico, site (SNL, Albuquerque). Other key elements of the system include procurement, personnel, and facility databases.

The implementation of a "cradle-to-grave" tracking system has been defined in terms of overall customer needs and supplier services, which will require the integration of existing databases with new tracking components. The link between material inventories and waste generation will be made by the Process Waste Assessment (PWA). The PWA will examine waste generating processes by documenting the relation between chemical and/or radioactive material inputs and waste outputs. This information can then be utilized for pollution prevention projects. The focus of this report will be on the needs, requirements, and implications of a "cradle-to-grave" hazardous and radioactive material tracking system from a pollution prevention perspective.

DEFINITION OF A "CRADLE-TO-GRAVE" MATERIAL TRACKING SYSTEM

A "cradle-to-grave" material tracking system's primary function is to correlate personnel, hazardous and/or radioactive materials, and locations. Only with this data can a near real-time tracking and inventory system be maintained in a form useful for a broad array of ES&H programs. Within the database, personnel must be associated with the work locations which must be specifically identified by building, room, area, etc. Each chemical or radioactive material will then be linked both to responsible personnel and locations as it is tracked throughout its life cycle, ending in final disposition. As a result, the database(s) can provide answers to queries on matters such as: Where in Building 893 is there 2,3-Quinoxalinedithiol, how much is there, and who is responsible for it? Additionally, a "cradle-to-grave" material tracking system requires a knowledge of material application processes in order to understand the ways in which substances are transformed into wastes. When processes consume the materials, the procedure documenting input/output relations simulates a mass balance. Further, the word "tracking" implies that a system is inherently dynamic, initiated at procurement

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and continually maintained as items are stored, moved, used, released, or disposed of by waste management operations. Thus, the result will be the ability to acquire efficiently the information needed to protect the environment and human health and safety.

The SNL system will consist of five main components: CIS/MSDS, a radioactive material tracking system, HWDMS, a radioactive/mixed waste tracking system, and a PWA "hub." CIS/MSDS will track chemicals while the radioactive tracking system will perform a parallel function for radioactive materials. The PWA will then document how the two types of materials become wastes. When mixed wastes are produced, the radioactive/mixed waste system will track them, along with normal radioactive wastes. Hazardous chemical wastes will be handled by HWDMS (Fig. 1).

CUSTOMER NEEDS

Essentially, the "cradle-to-grave" tracking system will satisfy the need for accurate data on hazardous and radioactive materials and wastes. This need is a result of increasingly stringent regulations which are demanding more consistent and specific reporting. The annual Superfund Amendments and Reauthorization Act of 1986 (SARA) Title III Sec. 312 evaluates the "worst case scenario" for possible chemical emergencies by identifying the largest possible quantity of selected hazardous chemicals stored in a facility at a given time; SARA Title III Sec. 313 reports on hazardous or toxic releases into the environment. In order to comply with these and other regulations, SNL needs the data that a material tracking system would provide. Additionally, with location specific inventories, users will be encouraged to avoid stockpiling materials and order quantities with life cycle costs in mind. Currently, the chemical exchange program at SNL, Albuquerque allows personnel to transfer chemicals which are no longer needed to others who can use them. This program will be linked with the CIS/MSDS portion of the system in order to expand access and increase utilization, thereby reducing the number of items wasted due to excessive purchasing, cancelled projects, or other reasons.

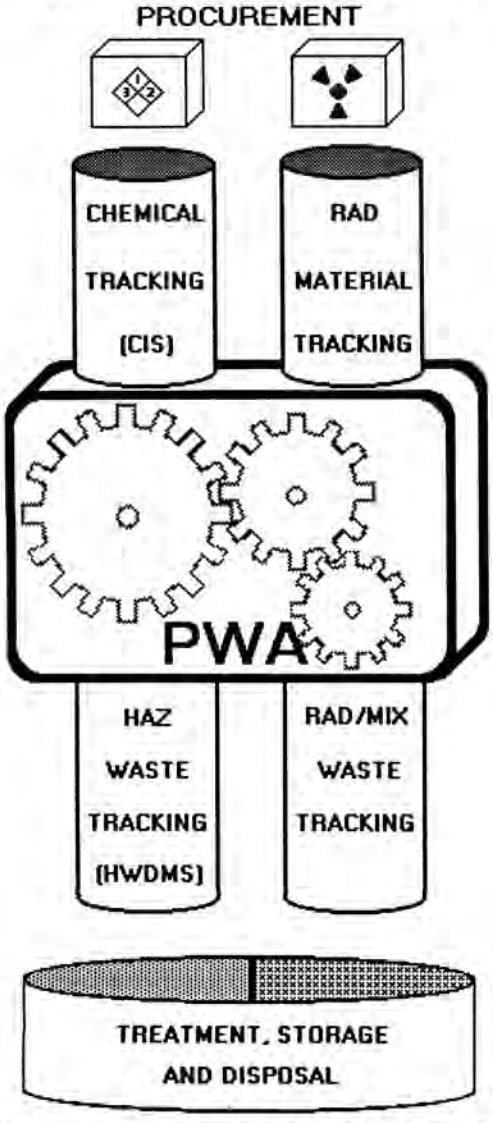

Fig. 1. Graphic representation of "Cradle-to-Grave" tracking system.

An integrated "cradle-to-grave" tracking system allows hazardous/radioactive waste personnel to characterize waste more accurately, since they will have information on the processes producing the waste. This system should limit the need for expensive analysis of unknowns; likewise, excessive waste generating processes will be evaluated by waste minimization teams and can be modified accordingly. At a lower level, ES&H coordinators and waste minimization representatives will be able to create local reports on waste generation to identify areas where reductions are possible. It is important for users of chemicals to understand that because the disposal cost of a chemical often exceeds its original purchase price, minimizing the amount of waste produced, in the long run, results in a more cost-effective facility.

There are other important customer needs for a comprehensive tracking system. Industrial hygiene and health physics personnel are concerned with particular types or levels of hazardous and radioactive materials which pose threats to human health and safety. They require the ability to perform personnel exposure queries and they must provide lab-wide access to a MSDS library. (*MSDS*: A document corresponding to individual safety or environmental hazards posing a threat to humans. SNL has mandated that there be an MSDS accessible within fifteen minutes for every hazardous material within a particular area.) Emergency preparedness and fire protection groups have been the main proponents of the system functioning near real-time. They must have immediate and accurate location data on hazardous, toxic, flammable and radioactive materials; the previous month's or year's inventory is not adequate for a crisis response.

SUPPLIER SERVICES

A corporate-wide material tracking system correlates large amounts of data. To avoid redundant information collection and to ensure accuracy, such a system must take advantage of available databases and be coordinated with other groups. Employees change offices, retire, are hired, or transfer to new positions. The personnel department at SNL maintains a personnel database which will be linked to the system in order to avoid material being "orphaned" by retiring researchers, and to enforce the principle that individuals are responsible for the entire life cycle of their materials unless "ownership" is officially transferred. Another resource is the

future SNL corporate space database. Linking this database to the material tracking systems assists in the identification of ES&H concerns when buildings are remodeled or reassigned. Additionally, this combination will aid emergency preparedness and fire protection units in the classification of buildings according to the types of dangers resulting from hazardous and/or radioactive materials.

The first step in a "cradle-to-grave" material tracking system is the entry of accurate and complete information at procurement. Logic dictates that manufacturers would best be able to provide that information in a consistent manner. Therefore, SNL is attempting to contract with its primary supplier to consolidate the purchase of chemicals. Consolidation will be tied to a requirement that description and requisition data be entered into the tracking system so that the information is available before delivery. This change will also improve procurement control and keep items from "slipping by" the system.

The main body of researchers and technicians who use chemical and radioactive materials will have several requirements placed upon them. When an order is placed, each item will be linked to a person in order to establish responsibility. However, materials do not necessarily remain at the location where originally delivered; they are transferred between labs, used, released, or disposed. By accessing the system from a local terminal, users will be able to document item transfers. If the maintenance of the system is to be near real-time, this requirement is a necessity. Additionally, with such access, a researcher will have the capability to search for a needed substance within their area to avoid unnecessarily ordering a duplicate quantity.

COMPONENT DESCRIPTIONS

The AT&T-BL CIS/MSDS package is currently being installed at SNL, Livermore, to improve material tracking and as a prototype for a component of the corporate "cradle-to-grave" material tracking system. The package consists of both an inventory/tracking and an MSDS library module within a relational database/UNIX® framework. CIS/MSDS relies on bar codes to uniquely identify individual chemical containers and locations. The database is maintained by registering "chemical transactions," i.e., each time a chemical item changes locations, its bar code along with the bar code identifying its new location is scanned, and recorded by CIS/MSDS. A bar code label (Fig. 2) is attached to each individual chemical container. Laboratories, storage cabinets, warehouses, and other structures used for chemical containment are also barcoded for identification. Inconsistencies in nomenclature are circumvented by keying on Chemical Abstract Service (CAS) numbers. Every pure chemical has a unique CAS number, and mixtures or commercial products are assigned pseudo-CAS numbers. Various tables with additional information are linked to the CAS numbers, including: ingredients, properties, vendors, synonyms, hazards, etc. An open architecture and technical support from trained AT&T-BL personnel are two of the most valuable features of the package. When requirements change or problems arise, modifications will be made easier because SNL has a source code license for the system and has contracted for ongoing support from AT&T-BL.

The user interfaces with CIS/MSDS via a computer network and is able to access data in several different formats. A

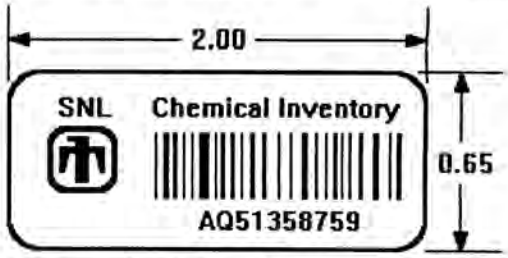

Fig. 2. SNL chemical information system container bar code (inches - not to scale).

bar code query returns the name, quantity, location, date transferred to that location, etc. A historical query chronologically lists the item's previous storage locations. A chemical location query display every bar code sorted by room number for a specific CAS or pseudo-CAS number. An inventory query lists all items in a particular location, with aggregate quantities for each type of chemical if desired. A potential exposure query reports on all locations to which a particular individual has been assigned and the chemicals in those areas. Each location also has a corresponding lab description screen giving information on function, site location, and equipment. Summary usage information is also available for any given time period, for example, over a calendar year to fulfill SARA Title III Sec. 312 requirements. All system reports are available on-line or as facsimiles.

The MSDS subsystem maintains a MSDS library by storing data as text or facsimile images. If an individual has access to a network terminal, they also have immediate access to the MSDS library. Searches are performed by chemical name or manufacturer and the actual MSDS can be printed or sent as facsimiles by the CIS/MSDS system. MSDSs can also be sent to a facsimile machine by touch-tone phone.

SNL, Albuquerque's HWDMS begins tracking hazardous waste when a Chemical Waste Disposal Request (CWDR) form is filed. This module, written in SQL and other Oracle® tools, is a comprehensive data acquisition and management system that uses barcoding for field tracking of waste packages. Similar to CIS/MSDS, each waste item and location within the waste facility is given an identifying bar code. The CWDR is imprinted with a bar code which matches the one attached to the collected waste item, and technicians carry portable bar code readers with information from the CWDR's during most phases of collection and shipment processing. Wastes are then loaded, according to hazard compatibility, into packing containers which are given new container number bar codes. These are likewise used for location identification and to generate manifest reports for disposal shipments. This system tracks wastes from the point of declaration, through storage, to final disposal.

A radioactive material inventory and tracking system and a radioactive and mixed waste tracking system modeled on the HWDMS are currently under development at SNL, Albuquerque

A joint AT&T-BL and SNL project is beginning to address the problem of how to link the CIS/MSDS and HWDMS components through PWAs. This will be particularly challenging to implement at a research and development laboratory, such as Sandia, where processes often are "one-time" experiments. Overcoming these difficulties will be a major objective of the joint project.

In the future, the entire system will be enhanced by incorporating Geographical Information System (GIS) capabilities. Maps will be combined with material, location, and *personnel* data to create a graphical interface database. This enhancement should be especially useful to emergency teams.

CONCLUSION

A "cradle-to-grave" material tracking system is essential if the life cycle costs of hazardous and radioactive materials are to be calculated and assessed to responsible personnel. Such a system consists of tracking components linked together by a procedure to document the relationships between material inputs and waste outputs. In order to minimize waste effectively, the profile of waste generation at a facility must be understood. With an understanding of the flow of substances in and out of an area, excesses can be exposed and steps taken to eliminate unnecessary risks and costs. In addition, the accurate information a material tracking system would provide is essential to ensure compliance with ES&H regulations and will facilitate regulatory reporting. The implementation of this project is being undertaken with the separate development of each tracking component, while the PWA is addressed with the cooperation of AT&T-BL. A comprehensive "cradle-to-grave" material tracking system will improve efficiency, thereby resulting in a more cost effective operations. With this project, SNL is furthering its commitment to the protection of the environment, as well as to the safety and health of its employees and the public.

REFERENCES

1. J. R. GUTH, 7712, SNL Memorandum, "Chemical Inventory/Tracking Planning Meeting," (25 September 1991).
2. J. R. GUTH, 7712, SNL Memorandum, "Minutes of 10/1/91 Chemical Inventory/Tracking Meeting," (1 October 1991).
3. J. R. GUTH, 7712, SNL Memorandum, "Brief Minutes of 10/3/91 Chemical Inventory/Tracking Meeting," (6 October 1991).
4. R. HARTLEY, "Proposed Chemical Tracking System for Sandia National Laboratories," an informal Sandia Report, (August 1991).
5. Sandia National Laboratories, "Chemical Hazard Communication," PG470028, Albuquerque, New Mexico.
6. S. K. PARKER, 7712, for J. R. Guth, 7712, SNL Memorandum, "Brief Minutes of 10/9/91 Chemical Inventory/Tracking Meeting," (10 October 1991).
7. Quotation In Response to Request for Quotation 90-6030, AT&T Bell Laboratories, (25 June 1991).