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MATERIAL SAFETY DATA SHEETS: THE MARTIN MARIETTA ENERGY SYSTEMS, INC., EXPERIENCE

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Summary

Martin Marietta Energy Systems, Inc. (Energy Systems), has devised a computer-interactive system that contains more than 3000 Material Safety Data Sheets (MSDS) to serve over 18,000 staff members at five plant locations in Tennessee, Kentucky, and Ohio. The chemicals were selected by priority order based on exposure and hazard potential. For 1550 of the 3000 MSDS, information was primarily derived from data sources extant within the organization and supplemented by information from manufacturers' MSDS as appropriate. Concerns related to quality control and subsequent effective communication of the health hazard data led to the decision to develop the system and directed the selection of data resources, system format, and dissemination methods. The rationale for these decisions is discussed.

The database is processed on the IBM 3033 located at the Oak Ridge National Laboratory. The MSDS system at Energy Systems is dynamic, allowing continued addition of new chemicals, updating of existing data, and evaluation by a peer review committee.

Introduction

"What you don't know can't hurt you." This oft-repeated axiom has unfortunately been thoroughly disproven countless times throughout history. Even with our high-tech communications systems, the lack of reliable, complete, or effectively disseminated information continues to cause harm to people. A typical example is occupational exposure to 1,2-dibromo-3-chloropropane (DBCP). DBCP was recognized in 1961 as a testicular toxin in experimental animals [1]. Subsequently DBCP was also recognized as a bacterial mutagen [2]. Nevertheless, the chemical was produced and used widely in routine agricultural applications until 1977, when male agricultural workers in California and Israel were found to be sterile [3,4].

Such incidents, along with the generally increasing public concern about cancer and environmental pollution in the 1960s and 1970s, resulted in various

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special interest groups banding together to lobby for passage of "right-to-know laws" [5]. Continuing incidents of exposure of workers to hazardous materials, heightened public awareness, and burgeoning of laws at the state and local levels led the Occupational Safety and Health Administration (OSHA) to develop a uniform Hazard Communication Standard [6]. The law was published in the November 25, 1983, *Federal Register* and became effective on May 25, 1986. Under this standard, OSHA requires all employers included under Standard Industrial Classification codes 20–39 to assess and communicate to employees information concerning hazardous substances in the workplace. A part of this responsibility is to provide employee access to Material Safety Data Sheets (MSDS), which contain information on physical/chemical properties, potential health hazards, handling procedures, protective measures, and emergency response.

Some major issues encountered by one large organization, Martin Marietta Energy Systems, Inc. (Energy Systems), in attempting to comply with the law and some of the approaches and decision-making processes employed are presented. Energy Systems consists of five government-owned, contractor-operated (GOCO) facilities which it manages for the U.S. Department of Energy. About 18000 people are employed in a variety of scientific and highly technical missions. The three Energy Systems plants at Oak Ridge, Tennessee – the Oak Ridge National Laboratory, the Oak Ridge Gaseous Diffusion Plant, and a nuclear components production facility – carry out the missions of energy research and development, uranium enrichment, and weapons production, respectively. The other two plants in Paducah, Kentucky, and Portsmouth, Ohio, are also involved in uranium enrichment. To avoid duplicated efforts, the associated waste of funds, and potential employee confusion, it was determined that a consolidated MSDS system for all plants would be most efficient.

Communication factors

Hazard communication was the focal point of the entire effort. For the purpose of this paper, the term *communication* will include the interactions among the industrial hygiene personnel, the data managers/analysts, and the user community (Energy Systems employees).

With the diversity in technologies and locations, several problems were encountered in developing a consolidated MSDS system. The first organizational move, establishment of an MSDS project team consisting of industrial hygienists from the Oak Ridge plants, facilitated communication. The designation of one of the team members as the technical coordinator enhanced communication between the project team and other internal organizations.

The technical coordinator held meetings with the MSDS project team to resolve issues related to the chemical inventory and technical questions such as which resources should be used in preparing the MSDS, how to resolve conflicting information in a given data category, and the degree of technical detail necessary to comply with the law. Two major communication issues were: (1) the method and form of presentation of the information to the employees and (2) the degree of detail and the language level needed to inform the employees without confusing them. Each of these will be briefly discussed.

The method and form of communication of hazardous materials information to Energy Systems employees were affected by the diversity of the organization. Computerization has brought about tremendous changes in many parts of the Energy Systems operations. Some in-house organizations rely almost totally on electronic media for communication of technical and administrative information. Others use computer systems very little or not at all, and some are in intermediate or transition stages of computer use. Although a computerized MSDS system would appear to be the most efficient method of disseminating information on hazardous substances, the success of such a system is dependent on the extent of system access by employees, their individual computer capabilities, and their inclination to access computerized systems. A computer-assisted MSDS system offers the advantages of access across the organization to a uniform set of data in a timely fashion; furthermore, updating can be centrally controlled and can be done quickly whenever new or different information needs to be input.

From the foregoing considerations, it was decided to use an interactive computerized system as the primary communication tool and also to make subsets of the information available in paper form to those groups that either could not or did not desire to access the MSDS information electronically. Plans were outlined to make subsets of the system available on diskettes for employees with access to personal computers. Updating of the central file would result in a dated replacement diskette being distributed to those units.

The INQUIRE* database management system was chosen as the software package for management of the consolidated MSDS information. INQUIRE operates on the IBM 3033 mainframe system at the Oak Ridge National Laboratory and was selected as the result of a two-year study by the Computing and Telecommunications Division, as a database management system for long-term use by Energy Systems. INQUIRE is capable of operating in a time-sharing environment and can handle variable length and repeating data fields, so it is particularly attractive for an application such as the MSDS system. INQUIRE can also handle networking of subfiles, allowing easy incorporation of data from existing databases. When the MSDS project was initiated, the producers of the INQUIRE package indicated that a personal computer version would soon be available. This has not been accomplished, thus hampering the plans to make MSDS available on diskette. This option may be pursued further at a later data. At present, the MSDS information is accessible through distributed

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*INQUIRE is a registered trademark of INFODATA Systems, Inc.

paper copies of the computer information and direct access to the IBM mainframe system.

The data content and format of the MSDS were guided by the Hazard Communication Standard. Energy Systems also used the OSHA requirements and guidelines in planning and determined that the following factors should be considered in laying out the MSDS form:

- OSHA requirements must be met.
- Data presentation should be clear and logical.
- Specific data points must be easily identifiable.
- Efficient data compilation and input must be accommodated.

Initially the content of the data sheets was separated into three sections for operational efficiency: (1) physical/chemical properties, (2) health effects, and (3) handling and emergency response. The three sections improved work flow in preparing MSDS because staff and resources could be clustered logically. The staff could also specialize in a subject area with its associated resources, thus improving data extraction and compilation efficiency. The complete list of 70 data elements in 10 categories that are included in each MSDS record is shown in Table 1.

The second communication issue involved determining the extent of detail needed to completely inform the employees while avoiding the frustration that could result from a perceived unnecessary complexity. Energy Systems employees range from internationally reknowned scientists to persons with less than a high school education. The Hazard Communication Standard, however, is for the benefit of all, regardless of the degree of technical training. Because of these diverse backgrounds, serious consideration was given to creating two systems. One version would present extensive data and information on each chemical and be oriented to the technically trained members of the staff; the other would include less technical data and employ more lay terminology to accommodate those not so highly trained.

After many discussions and attempts at creating a few trial records, it was determined that this approach would be too costly and could not be accomplished within a reasonable time frame. The decision was made to produce MSDS containing a combination of technical and lay terminology. A single system was accepted with the provision that a glossary be prepared to permit ready access to definitions of technical terms (e.g., anhydrous, deliquescent, cyanosis, TLV) in language more easily understood by laymen. The glossary is a part of the computer retrieval system that can be read by requesting that option from the menu. Printed copies of the glossary are available with sets of printed MSDS.

Currently, the MSDS in the system include technical data and terminology for those who desire more detail and have the background to interpret the information. In addition, information is being presented in common terminology, particularly in the health effects section on symptoms and adverse effects,

TABLE 1

Catagories and data elements that are included in each MSDS record

1. Substance Identification
   - Record ID
   - Name
   - Synonyms
   - CAS Registry Number
   - Stores number
   - RTECS number
   - Formula
   - Health hazard rating
   - Fire hazard rating
   - Reactivity rating
   - General classification
   - Use
   - Additional remarks

2. Physical Data
   - Description
   - Boiling point
   - Specific gravity
   - Vapor density
   - Vapor pressure
   - Melting/freezing point
   - Volatility %
   - Solubility
   - Evaporation rate

3. Ingredients
   - Name
   - CAS Registry Number
   - RTECS Number
   - Percentage
   - Hazard evaluation data

4. Fire and Explosion Hazard Data
   - Flash point (method)
   - Autoignition temperature
   - Upper flammability limit
   - Lower flammability limit
   - Extinguishing media
   - Fire fighting procedures
   - Fire and explosion hazard

5. Reactivity Data
   - Stability
   - Conditions to avoid
   - Incompatibility
   - Hazardous polymerization

6. Health Hazard Data:
   - ACGIH, TLV
   - OSHA, PEL
   - NIOSH, PEL
   - Immediately Dangerous to Life or Health
   - Acute inhalation
   - Acute swallowing
   - Acute skin absorption
   - Acute skin contact
   - Acute eye contact
   - Chronic effects
   - Carcinogenicity, mutagenicity, and teratogenicity status
   - Target organs/systems
   - Treatment of inhalation emergency
   - Treatment of swallowing emergency
   - Treatment of skin contact emergency
   - Treatment of eye contact emergency
   - Physician's note
   - Aggravated conditions

7. Spill, Leak, and Disposal Information
   - Spill or leak emergency
   - Disposal procedure

8. Special Protection Information
   - Respirators
   - Ventilation
   - Gloves
   - Eye protection
   - Other protective equipment

9. Special Handling, Storing, and Packaging

10. Transportation Data
   - DOT name
   - DOT class
   - DOT label
   - DOT number
   - EPA number
   - Reportable quantity

so that the user should be able to obtain an understanding of the potential hazards posed by a given substance. Some members of the Peer Review Committee (PRC) feel that the technical portions of the MSDS records will result in confusion and frustration on the part of the average employee. Only time and actual experience in using the material will resolve the debate. Close attention will be given to this issue as updating and revisions continue.

Quality assurance factors

Quality assurance (i.e., the accuracy and usefulness of the data) was another major issue confronted by Energy Systems. Assurance of information quality greatly facilitates the process of proper planning, operating, and decision making. In the field of human health data analysis and communication, quality assurance takes on even more importance because the health and lives of people can be affected by the completeness and reliability of the information. A recent study by the National Research Council found that sufficient information exists to allow a complete health hazard assessment on less than 22% of 66000 chemicals used commercially [7]. This fact further emphasizes the importance of communicating limited available information effectively to ensure worker safety.

The Hazard Communication Law requires chemical manufacturers and importers to provide information on materials they produce or import. Therefore, it would appear that such companies would be the major source of information on the thousands of chemicals purchased by Energy Systems from commercial sources. Many chemical vendors, particularly some of the large corporations, have done a very credible job of preparing MSDS and responding to requests or sending MSDS along with the chemicals delivered. However, data quality and degree of responsiveness vary widely among companies. Some problems encountered with manufacturer data sheets include:

- Little or no information
- Slow or no response to requests for information
- Varying formats
- Different methods for handling ingredients
- Unverified or erroneous data

For these reasons Energy Systems determined to locate more accurate and complete data sources. The four-plant project team reviewed available information on MSDS from manufacturers and examined offerings of commercial vendors of MSDS. Not finding a readily available, high-quality product to meet Energy Systems' needs, the group approached the Information Research and Analysis (IR&A) Section at the Oak Ridge National Laboratory. IR&A has for many years developed chemical toxicology, health, and environmental effects information and other related data resources for the National Library of

Medicine, the National Toxicology Program, the Environmental Protection Agency, and several other federal agencies.

One of the most important tasks in developing the MSDS system was the setting of priorities for the processing of chemicals in the Energy Systems inventory. On the principle that the chemicals most widely used by the most people must be addressed first, the catalogs of chemicals available at each plant were reviewed. Chemicals such as the strong acids, bases, alcohols, and solvents and high-volume chemicals were given high priority because of their exposure and hazard potentials. A significant number of chemicals were subsequently added from the category of janitorial supplies.

Another extremely important task from a quality control perspective was the selection of data resources. Major health-related data resources that have been created and are readily available at ORNL include: the Hazardous Substances Data Bank (HSDB), formerly the Toxicology Data Bank; the U.S. EPA Gene-Tox Database; and the Environmental Mutagens, Carcinogens, and Teratogens (EMCT) Data Files. Both the HSDB and Gene-Tox data have undergone extensive peer review before being placed in the public file, and the data in both files continue to be scrutinized and updated. The comprehensiveness and high quality of the EMCT data files have been widely recognized by researchers in the field. For these reasons, Energy Systems made the decision to use, wherever possible, the resources available at ORNL for MSDS preparation. For trade name products, Energy Systems relied principally on the manufacturer's information.

The task of creating MSDS and developing a system to make the information available to the employees was undertaken by the in-house IR&A group that had created the above mentioned health effects data files. While some hazard information was available in quality, peer-reviewed, online databases, many areas had no such reliable sources of quality information. The most difficult area in which to find source material was in personal protective clothing such as glove material, eye protection, and respirator type. *Guidelines for the Selection of Chemical Protective Clothing* [8] was used as a general source for information concerning gloves and clothing; however, it became obvious that data gaps existed in this critical area. It is hoped that such information will become easier to acquire as research yields data that are more usable for the control of occupational exposure to chemicals.

After considerable debate, Energy Systems decided to provide "blanket" statements in all MSDS for two areas:

- Spill, Leak, and Disposal Information, and
- Special Protection Information

In the first area, the worker is instructed to contact his or her plant specialist in dealing with spill or leak emergencies or the specialists in disposal. The rationale is that a single call (local numbers are given on the MSDS) will immediately summon the level of expertise needed to deal with an emergency or to determine what needs to be done in subemergency situations. Spelling out proper detailed procedures can be very complex when the spill may vary from the contents of a test tube to that of a rapidly leaking tanker.

In the second case, special protection information, the specific requirements for respirators and ventilation are not defined for each chemical. The rationale is similar to that for spills, leaks, and disposal. Energy Systems has the expertise readily available to the workers at each facility, and precise recommendations require balancing numerous specific factors.

One of the most important quality assurance measures was the establishment of the PRC for evaluating information to be used in the Energy Systems MSDS information retrieval system. The PRC, with a total of 10 members, is composed of industrial hygienists, toxicologists, fire fighting specialists, and information specialists from the academic and industrial community outside Energy Systems and of similar experts in-house. Details of Energy Systems operations were provided to the committee members in order to establish the needs and maximize the utility of the MSDS information. The mechanism for conducting the review was similar to that used by the Hazardous Substances Data Bank Peer Review Committee [9]. Some useful recommendations presented by the PRC are summarized below:

- Information should be specific to the title compound, and close analog/derivative or general chemical class information should be avoided (e.g., use specific information to 2,4,5-trichlorophenol, not general class information for chlorinated phenols).
- Language used in the health effects section should be simple and straightforward (e.g., use *vomiting* instead of *emesis* or *tumor of the liver* instead of *hepatoma*).
- Emergency treatment should be concise and should refer only to those treatments that can be administered on site.
- The toxicity rating procedure should be re-evaluated to better communicate this important factor to the Energy Systems employee population. The revised rating scheme is based on numerical scales and the potential hazards involved as previously described [10].

The recommendations of the PRC have been addressed and have added to the value of the MSDS system. The PRC will be convened and consulted as work on the system continues. To date 1550 MSDS have been created using available data resources. Manufacturers' information for more than 1450 additional trade name products has been included in the MSDS system.

Conclusions

Virtually all employees within the American labor force occasionally come in contact with substances that could be considered hazardous if improperly used. For many workers, contact with hazardous chemicals is a daily requirement of the job. Furthermore, as technology advances, the list of potentially hazardous substances and the opportunities for worker exposure are increasing at a rapid rate. For these reasons, easy access to useful, accurate hazard information becomes increasingly important.

The intent of the OSHA Hazard Communication Law, to thoroughly inform all employees of chemical hazards, handling procedures, and protective measures, is certainly a goal that should be avidly pursued. However, the importance and complexity of the issue require that solutions to the problem be approached carefully with maximum attention to data quality.

The desire to comply with the intent of the law led Energy Systems health and environmental managers and industrial hygienists to seek a high quality, easily accessible system to disperse MSDS information to employees. The manufacturers' MSDS that had been used historically presented many deficiencies and the commercially available computerized databases essentially contained manufacturers' information in different formats and software packages.

As it now exists, the Energy Systems MSDS Database employs the most accurate and timely information available from the health effects databases that have been under development for up to 15 years at ORNL. Additional quality control procedures included the selection of a list of standard source books for obtaining types of information not available from the ORNL databases and establishment of a peer review committee to regularly evaluate the accuracy and effectiveness of the MSDS system. To date, more than half (all generic chemicals) of the 3000 chemical records in the database have been created by using these resources. For all remaining materials (trade names), manufacturers' information is relied upon as the best available.

Presentation of the data to employees is through both electronic and paper media, with the format designed specifically to meet OSHA guidelines and Energy Systems needs. The computerized system provides for easy updating of existing data and addition of new chemicals as they come into use. The use of both technical and common terminology with technical terms defined in an accompanying glossary is intended to provide for maximum understanding by the wide range of Energy Systems employees. Through these measures, it is hoped that a well-informed work force and an increasingly safe working environment can be maintained.

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