tailed guidelines, information, and expertise likewise change. When these chronological phases of response actions are recognized in advance, it allows a greater degree of essential preparation of plans of action on the part of emergency response personnel, and particularly by their officers who will be called on to make immediate decisions on the scene.

REFERENCE

1. Transportation Emergency Action Guide for Hazardous Materials Incidents (Jody Chart 1) and Transportation Emergency Identification and Hazard Guide for Hazardous Materials (Jody Chart 2), Jody, Inc., Atlanta, Ga., 1983.

Automan: An Information System

Bruce Boguslav, Polly T. Strife, and Philip A. O'Connell

ABSTRACT

Hazardous materials regulations, domestic and international, are extensive, detailed, and subject to constant change. For any company, compliance with regulations is heavily dependent on the ability to acquire, compile, and disseminate accurate and timely information to all persons involved in hazardous materials-related functions. Digital Equipment Corporation has many U.S. and overseas manufacturing sites with chemical processes. Hazardous material specialists at Digital have developed AUTOMAN, an automated hazardous materials information system, to provide current regulatory information to all people involved--from purchasing to shipping and receiving personnel. AUTOMAN uses Digital's VAX/VTX (registered trademarks of Digital Equipment Corporation) Videotex software to provide on-line, real-time access to information about hazardous material transportation. Information for a particular product can be accessed through an easy-to-use menu. AUTOMAN will also provide generation of required package markings and shipping papers through a data base accessed by the Videotex software. The VAX/VTX software used in AUTOMAN allows easy and quick updating of large textual infobases and presents an economical, flexible, easy-to-maintain means of assembling and disseminating timely and accurate information vital to hazardous materials compliance.

Today's world is increasingly dependent on rapidly changing technologies to provide better communications, improved medical care, faster and more accurate information, and tools to make day-to-day tasks easier. However, today's technologies and those that are expected to be developed in the future are heavily dependent on materials and substances capable of posing some risk to any or all of the following: health, safety, property, and the environment. The ability to safely and legally transport such materials is vital.

Safety is a major concern for responsible shippers and transporters of hazardous materials. Hazardous materials that are carelessly or improperly prepared for shipment greatly increase the potential for an accident or incident that can cause injury to employees of the shipper and carrier, emergency personnel, and the general public. Improper or careless handling during transportation can have similar results.

Hazardous materials regulations are written to minimize the risks inherent in the transportation of hazardous materials. Domestic and international regulations are extensive, detailed, and subject to constant change. Public awareness of hazardous materials and fear of both the real and the perceived dangers involved with the transportation of such materials have greatly increased. It is probable that there will be continued growth and change as well as increased enforcement of the regulations and increased penalties for noncompliance.

Potential liability in this area is far-reaching. Liability for environmental damage can be particularly longlasting. Negligence can be expensive, time consuming, and difficult, if not impossible, to defend.

Corporations today are becoming increasingly aware of the need to be positive members of society. Few companies are satisfied to continue to be perceived as a necessary evil by their neighbors. Few communities are willing to quietly accept a corporate citizen who may in some way be endangering the welfare of the community's residents. Automatic issuance of required permits and zoning variances is a thing

of the past. Companies that have failed to establish themselves as responsible and responsive to a community's concerns and needs will find it increasingly difficult to do business in that community. Companies that engender adverse publicity by their health, safety, or environmental practices will find it difficult to do business in any community.

In addition to considerations of morality and good corporate citizenship, there are compelling business reasons for instituting and actively maintaining a hazardous materials transportation compliance program. The risks, which may include criminal penalties as well as the civil penalties discussed previously, involved in failing to have such a program are in excess of what would be acceptable to most astute managers and executives. The success of such a program will depend on the ability to assemble and rapidly disseminate accurate information and to institute and maintain controls to ensure both compliance with regulatory requirements and adherence to safety policies and procedures.

Digital Equipment Corporation, the second largest computer manufacturer in the world, stresses proactive regulatory compliance programs. Digital's need for the ability to more rapidly distribute the information required to ship and transport hazardous materials and to control purchases and shipments made from multiple locations led to the development of AUTOMAN, an automated hazardous materials control system. Digital's Corporate Hazardous Materials Group is responsible for ensuring corporate-wide compliance with domestic and international hazardous materials regulations. Digital is a company with more than 450 sites worldwide. Among these sites are more than 50 manufacturing sites, many with chemical processes. There are more than 200 field service sites where repair and maintenance materials are used, shipped, and transported by company personnel. Compliance responsibilities extend to the large corporate truck fleet that handles the transportation of vendor and interplant freight, including hazardous materials, in a six-state area. Hazardous materials are moved through the consolidation and throughput center where ocean and air charters are built. They are also found in the numerous distribution and logistics centers.

The Hazardous Materials Group has identified more than 1,000 potentially regulated materials in use at Digital. Purchase of these materials is done locally by literally hundreds of individual purchasing groups. The rapidly changing technologies in the electronic industry mean corresponding process changes and changes in chemicals and materials that the company uses. Under these circumstances, ensuring timely communication of information and the needed level of expertise and control at each site was nearly impossible.

In the past the Hazardous Materials Group attempted to satisfy information needs through the publication of a paper manual. The manual provided packaging, shipping, and regulatory information stated in easy-to-understand language for highway, air, and marine transportation (Figure 1). The clerical burden of maintaining the accuracy of the manual in the face of changing process technology and the dynamic nature of transportation regulations was cumbersome. The traditional method of updating the manual with change pages left much to be desired. Some of the more common problems associated with the revision process were

- Word processor system (WPS) was inefficient and required backup copies of floppy disks to be maintained.
- Cost factors made small changes prohibitive.
- Much time and many resources were required to produce complete revisions.
- There were constant changes and addition of new products as technological improvements were introduced.
- There were voluminous supplements and changes.
- Difficulty was encountered in maintaining accurate distribution lists because of personnel changing job functions.
- There was lack of control to ensure that the revisions were inserted in the manuals being used in the field.
- Expense and time lag were incurred in the printing and distribution process.
- Demands to provide additional manuals to newly trained personnel were increasing.

It became increasingly obvious that a more efficient means of providing the required information was needed. The initial task was to determine what the system capabilities should be to fulfill the needs and expectations of both the Hazardous Materials Group and the end user community. The following is a summary of the minimum requirements for the system:

- Automatic printing of the shipping papers after entering material names, quantities, and methods of transport, including determination of passenger versus cargo aircraft;
- Validation of transport method for the material and the quantity requested;
- Automatic printing of shipping labels (not hazard labels);
- Package specifications available for look up, update, and cross-indexing to the material requirements;
- Determination of size and number of packages needed to ship a given quantity;
- Automatic printing of detailed packing instructions;
- Multiple copies of the information available on the network to reduce the chances that it will be unavailable when needed;
- Ability for the Corporate Hazardous Materials Group to update and correct all information for automatic distribution to remote sites;
- Ability to print a hardcopy of any or all materials as an alternative to the current WPS/print shop manual;
- Cross-reference to Occupational Safety and Heath Act (OSHA) regulations for handling and storage of hazardous materials; and
- On-line glossary of terms and bibliography of regulations as a tool for verifying transport requirements.

When the draft of the minimum requirements had been completed it was decided that the most logical area in which to start development was creation of an electronic version of the paper manual. Using the VAX/VTX® software, a form of Videotex, this was accomplished within 6 months. The Videotex software allowed provision of all the transportation information required to prepare a shipment of hazardous materials in an on-line system. Implementation of the system was begun using two locations as test sites; those locations were chosen on the basis of the high volume of hazardous materials shipments that originated at them. Almost immediately the system began to show positive results: feedback from the users was constructive and as other locations became aware of the existence of the system they requested access to it. The most significant benefit was the capability to provide instant "updating" of any of the information stored in the infobase and to have it available immediately to the end user. By targeting the electronic manual as Phase 1 of the

HAZARDOUS MATERIAL Acetone
DEC NO.
VENDOR
TECHNICAL NAME Acetone

HIGHWAY

PROPER SHIPPING NAME	HAZARD CLASS	ID NO.	LABELS REQUIRED	PACKAGE MARKING	DOT AUTHORIZED PACKAGING
Acetone Flashpoint 0°F -18°C	Flammable Liquid	UN 1090	Flammable Liquid	Acetone UN 1090 This Side Up (If applicable)	17E steel drums. 12B box with inner: glass or earthenware not over 1 qt capacity each. Metal containers not over 1 gal.capacity each. 12A box with inner glass containers not over 1 gal. capacity each.
UPS PKG. 13, 17,		MAX NET QTY/PKG. See Pkg.		LTD QTY. Note 1	173.119

AIR

PROPER SHIPPING NAME	HAZARD CLASS	ID. NO.	LABELS REQUIRED	PACKAGE MARKING	AUTHORIZED PACKAGING NOTES AND LIMITATIONS	
Acetone Flashpoint 0°F -18°C	Flammable Liquid	UN 1090	Flammable Liquid Cargo Only and/or Direct. Arrows (If applicable)	Acetone UN 1090 This Side Up (If applicable)	P 4C1, 4C2, wooden or 4G fiberboard A box with inner: glass or earthen- S ware not over 1L capacity each. S Plastic or metal not over 5L E capacity each. N G E R	NOTE 305 MAX. NET QTY 5L GROUP II
					C 1A1 steel drums. 4C1, 4C2, A wooden or 4G fiberboard box R with inner: glass or earthenware G not over 2.5L capacity each. O Plastic not over 5L capacity each or metal not over 10L capacity each.	NOTE 307 MAX. NET QTY 60L
	CLASS/ DIVISION	SUBSIDIARY RISK	UN PACKING GROUP			GROUP
IATA	3	N/A	II			II
ICAO	3	N/A			ICAO SPECIAL PROVISION: N/A	

MARINE IMO

PROPER SHIPPING NAME	CLASS	ID. NO.	TECHNICAL NAME	PAGE NO.
Acetone	3.1	UN 1090	Acetone	3020

FIGURE 1 Example page from paper manual.

project, the needs of both the Hazardous Materials Group and the user community were met without hindering the current methods. It also allowed users to become familiar with the use of a video terminal to update and retrieve information.

Within 6 months of implementation the user community had grown to 16 manufacturing sites and numerous field service locations. During this time, on the basis of feedback from the users, some minor changes were made in the format displayed on the screen. This was considered an integral part of the development process to ensure that the system was "user friendly." User input was reviewed and used whenever possible.

As the user community continued to grow, development was started on Phase 2 of the system. Because of the standard shipping paper requirement for hazardous materials transported by air, it was decided that the next phase of the system would be the design of a data base capable of generating the "Shipper's Declaration for Dangerous Goods."

During the design phase it was determined that the data base should be structured so that information that is shared across materials (i.e., packaging specifications, quantity limitations) is stored independent of the individual materials. This simplifies updating and ensures consistency. The relationship between materials and this information is maintained through a series of "keyed links" invisible to the end user.

This module interconnects to the "look-up" module that allows for the entering of all information pertaining to a given shipping line item (i.e., material name, quantity, method of transport) and then generates, at the user's option, packaging instructions, shipping papers, and shipping labels. It verifies that the shipment is within quantity limitations for the mode of transport and flags shipments that violate standards.

When the system design portion had been completed the next step was to develop a prototype that used the International Civil Aviation Organization (ICAO) technical instructions. It was determined that these were the most appropriate standards to follow because compliance with them is required virtually worldwide when transporting hazardous materials by air. Addition of the U.S. Department of Transportation (DOT), International Maritime Organization (IMO), and other country and regional regulations was begun after completion of the prototype.

To ensure that any system development truly met the needs of its intended users, great care was taken with design. The combined skills and knowledge of hazardous materials consultants, business systems consultants, and senior software developers were used to develop a prototype system. The design and

prototype were presented to the intended users at regularly scheduled hazardous materials training sessions. Users were encouraged to give feedback, positive and negative, and to make suggestions for change.

Numerous comments and suggestions from users were incorporated before release of Phase 1 software. Release of the Phase 1 infobase was timed to coincide with scheduled hazardous materials training sessions. At the training sessions a video terminal was made available for students to use AUTOMAN to complete training exercises. An on-line instruction program for AUTOMAN was available to students but, in most cases, after a few minutes of verbal instruction and use, users were able to follow AUTOMAN's simple commands to get needed information. At the work site hazardous materials specialists are able to "register" on AUTOMAN and send questions or problems to the Hazardous Materials Group directly through an electronic mail feature. Registration for use of AUTOMAN is controlled by the Hazardous Materials Group to ensure that only properly trained individuals have access to the infobase. Only the Hazardous Materials Group can make changes to information contained in the infobase.

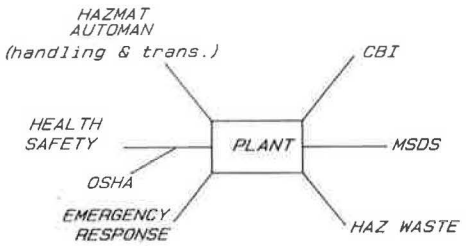

FIGURE 2 Linkage of infobases.

The Hazardous Materials Group was also concerned that any software developed have growth capabilities. The system provides users the opportunity to link to other hazardous materials-related infobases, such as "right-to-know," health and safety, environmental, and full material safety data sheet information (Figure 2). A totality of hazardous material information becomes accessible and affordable to a large number of users when Videotex software is used. Videotex-based software presents a flexible, easy-to-maintain means of assembling and disseminating the timely and accurate information vital to hazardous materials compliance.

```
                                                          VideoDEC Page: 104
      Hazardous Material:  Acetone
      DEC No.:
      Vendor:
      Technical Name:      Acetone
********************************************************************************
                                    HIGHWAY
Proper Shipping Name: Acetone
Hazard Class:         Flammable Liquid
ID No:                UN 1090
Flashpoint (deg.):    OF    -18C
Labels Required
  Flammable Liquid
Package Marking
  Acetone, UN 1090, This Side Up (if applicable)

DOT Authorized Packaging (173.119)
    17E steel drums. 6D with 2S poly liner. 12B carton with inner: glass or
    earthenware not over 1 quart capacity each or metal containers not over
    1 gal. capacity each. 12A box with inner glass containers not over 1 gal.
    capacity each.

UPS Pkg:          13, 17
Max. Net Qty/Pkg: See Pkg
Ltd Qty:          Note 1

********************************************************************************
                                     AIR
Proper Shipping Name:  Acetone
Hazard Class:       Flammable Liquid
ID No:              UN 1090
       Subsidiary Risk:     N/A
Passenger -  Packing Note:  305          Cargo -  Packing Note:  307
             Max. Net Qty:  5L                   Max. Net Qty:  60L
           Packing Group:  II              Flashpoint (deg.):  OF    -18C

Authorized Packaging Notes and Limitations
  Passenger:  4C1, 4C2 wooden or 4G fiberboard box with inner: glass or
              earthenware not over 1L capacity each. Plastic or metal not
              over 5L capacity each.

  Cargo:      1A1 steel drums. 4C1, 4C2 wooden or 4G fiberboard box with
              inner: glass or earthenware not over 2.5L capacity each.
              Plastic not over 5L capacity each, or metal not over 10L
              capacity each.

Labels Required:    Flammable Liquid, Cargo Only and/or
                    Directional Arrows (if applicable)
Package Marking:    Acetone, UN 1090, This Side Up (if applicable)

ICAO Special Provision:  N/A
********************************************************************************
                                    MARINE
Proper Shipping Name:  Acetone
   Class:  3.1                ID No.:  UN 1090          Page No.:  3020
```

FIGURE 3 Example of Videotex display.

Videotex software is used to manipulate large infobases of textual material subject to frequent updates and heavy usage. With Videotex, transportation information for a particular material can be accessed at a terminal through an easy-to-use menu. The desired product is chosen from an index; the mode of transportation (highway, air, or marine) and the page of information relating the appropriate regulatory information are then clearly displayed (Figure 3). The system is capable of generating necessary shipping papers, printouts of required markings, and detailed packaging instructions. Hard copies of the information "pages" can also be printed.

Current development includes the building of a relational data base of all regulatory and packaging information. This data base behind the Videotex "pages" allows for direct printing of shipping documents. A shipper can now look up a "page" of information and print the needed shipping documents simply by entering the consignee name and address, the quantity of the material being shipped, and the packaging that is available for use. The data base contains information on quantity and packaging requirements. When the entered packaging and quantity requirements have been verified, the shipping document will be generated. If the packing or the quantity entered do not meet requirements, the shipper, the shipper's supervisor, and the Hazardous Materials Group will be notified by the system. No shipping documents will be generated until this is checked and the proper packaging and quantity information is supplied. Only a supervisor or a member of the Hazardous Materials Group can enter the system to correct a mismatch. This development adds an additional level of control to the process, minimizes data entry, maximizes information integrity, and reduces overall risk of liability.

Another major area of future development is improving and expanding training for shippers and other employees who come in contact with hazardous materials. To this end, a computer-based instruction package (CBI) is being developed. CBI, in conjunction with classroom training, provides for increased learning experience and frequency of training. CBI allows individuals or groups to have the opportunity to review or learn new material in a multimodal, informal environment. Through the use of narrative, video, and questions and exercises, an individual can be walked through the process of shipping and receiving hazardous materials. All information needed to perform this function is provided and correct actions are reinforced. Learning can be better controlled by the individual who can stop, start, or review sections of the courses as needed. In addition, exposure to and use of AUTOMAN are included and linked to the CBI course. When a course is completed a certification examination can be taken immediately by using the CBI system. This examination is varied for each individual and is "graded" immediately. A record of the individual's "grade" is available to the individual and to the Hazardous Materials Group.

SUMMARY

Digital's Hazardous Materials Group through the use of Videotex, data-base, and video technology has developed an integrated approach to safety that effectively and efficiently handles hazardous materials and maintains compliance with all regulations. This has been accomplished in phases by identifying business areas and matching them to new technologies. Technology has been applied to solve business problems and to implement greater control over the process. Benefits have been derived in the form of greater efficiencies, productivity, and reduced risks.

ACKNOWLEDGMENT

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