USING BAR CODES TO MANAGE RADWASTE IN A NUCLEAR POWER FACILITY

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ABSTRACT

Maintaining accountability, and tracking the location of radioactive waste, has been simplified through the use of bar codes at the Peach Bottom and Limerick Nuclear Power Plants. A system has been developed which utilizes portable, programmable bar code readers and a microcomputer to collect and report pertinent data on the generation and location of radwaste in the plant. The system, which was customized for each plant, was designed to collect data at the work place through the use of the portable bar code readers and menu cards. The program was designed in a modular format for easy modification and expansion and the system has been adapted for the tracking of equipment, tools, instruments, and respirators.

The benefit from this inventory management system is more timely and accurate information for the control of radwaste generation, handling, storage, and shipping. The improved control has resulted in more efficient, cost effective radwaste operations, reduced radiation exposure to personnel, and a cleaner, more orderly plant.

INTRODUCTION

The use of bar codes is quickly becoming an accepted part of our lives. From the checkout counter at the local food store, to programming our VCRs, their use for entering data into a data base or a computer is becoming more widespread. Now bar codes are being used in the nuclear power industry by the Philadelphia Electric Company and Bechtel to quickly and accurately track the radwaste generated at the Peach Bottom and Limerick Nuclear Generating Stations.

For those of you who are unfamiliar with bar codes, a short explanation will help to acquaint you with their technology.

A bar code is an optically recognizable series of bars and spaces, with unique combinations of wide and narrow bars and spaces making up the numbers 0 - 9, the letters of the alphabet, some punctuation marks, and other characters. It is sort of a morse code in which the spaces also have meaning. A combination of letters and numbers is simply a string of these unique bar code symbols. Many different code symbologies exist, but the most widely used are the UPC (Universal Product Code) and 3 of 9 symbology, also called Code 39. The bar code reader optically reads the code and converts it to a normal ASCII stream for the computer.

Some history on bar codes demonstrates the maturity and growing widespread acceptance of this technology.

1932 -Bar codes developed in a Harvard Business School Masters Thesis

1960 -Railroad car identification system adopted

1970 -Universal Product Code (UPC) symbology proposed and adopted for use in identifying consumable products made and sold throughout the world. This now includes EAN (European Article Number) and JAN (Japanese Article Number) which are based on UPC

1974 -Code 39 developed

1982 -Code 39 symbology adopted by U.S. Military

1984 -Code 39 adopted by Health Care Industry

PROBLEM

Maintaining accountability for and tracking the current location of radioactive waste in a nuclear facility has always proven difficult. Whether it be low-level trash; drums containing oils, sludge, or solids; or High Integrity Containers (HICs) containing higher-level waste, facility personnel have typically had difficulty maintaining accurate records on the waste. The information required typically includes where and when it was generated, the type and volume generated, and its current location in the plant.

Compounding these problems is the ever increasing cost of processing and disposal of radwaste. Any instances of excessive generation or inefficient handling and packaging of radwaste will result in higher operating costs for the plant. Furthermore, management attention to problem areas cannot be focused without timely and accurate information.

Data collection systems based on paper forms and manual data collation or manual data entry into a computer have generally been found to be unwieldy and difficult to use well as being error prone.

SOLUTION

At the Peach Bottom and Limerick Nuclear Power Plants, the solution to this tracking and accountability problem was a bar code based inventory management system. Since 1985, bar codes have been used to identify and track containers of radwaste as well as to identify and track tools and eqiupment. The system in use collects data at designated points in the radwaste cycle, from origin to disposal, in order to provide management with up-to-date and accurate information on the status of the radwaste situation. The use of bar codes provides a unique combination of state-of-the-art technology and a high degree of data input accuracy to the system. The bar code reader equipment available today uses solid state circuity and compact size which allows portable operation. The accuracy in the reading of the bar codes is virtually 100 percent. If the reader has any question as to the accuracy in the scanning of the label, it simply will not indicate a positive read.

The system is designed to be used at the work place. This is done by maintaining our data base on a microcomputer and collecting the data with portable readers. This allows for data collection which is virtually paperless and which improves the accuracy of the data collection. The system was developed to be "user friendly" to allow the data collection to be done in a cost effective manner.

Finally, the system is customized to the site where is being used. The data collected is specified by the needs of the site and the system uses terms and locations which are a normal part of the everyday plant operation.

APPROACH

The approach used to solve the problem was to design a data collection program which was user friendly (i.e. Menu driven) and modular in design to facilitate future modifications and expansion. The program was designed to identify important information on the waste itself as well as to track its location. The program also provides the means to manipulate the data effectively.

The resulting system consists of the following components:

Master Program

This master program is mounted on the microcomputer and is the designated program caretaker. It performs all of the data base maintenance and housekeeping functions, as well as providing the interactive capability between the various data bases. It contains all of the reference tables used by the program to identify actions performed, location identities, labels, menu cards, etc.

The master program also contains the reporting function which allows the user to sort and manipulate the data collected by the data collection modules. The sort function has the capability to report the data in almost any form and thus is a powerful tool to be used in identifying problems and providing information.

Custom Application Modules

The custom application modules contain the methodology to collect the specific data required by the site. The program portion of the modules is split between the microcomputer and the programmable bar code reader. This allows the data to be collected with the portable bar code readers and then recognized when it is loaded into the microcomputer's data bases. The data fields are placed on menu cards which sequence the data collection as well as provide a choice of appropriate answers to the questions.

The menu cards are designed to identify to the user the type of data which must be entered. This helps to prevent the wrong kind of data from being erroneously entered into the data base. The menu cards use bar codes whenever possible to input the answers to provide accuracy and consistency.

Data collected by the radwaste tracking modules are site specific but typically includes information such as:

Waste Type or Description

- Origin
- Volume or Size
- Generation Date
- Classification
- Responsible Individual or Group
- Location
- Processes
- Status (Clean vs. Contaminated)
- Weight
- Dose Rate
- Bar Code Labels

The bar code labels used by the program are simple sequentially numbered labels which are keyed to a specific site and to a specific module by an alphabetic code (via reference tables):

PCD = Peach Bottom-Container Drums

LCD = Limerick-Container Drums

The labels are purchased preprinted to avoid having to print labels on the site. This also gives a higher percentage

of acceptable scans with the bar code reader on the first pass and avoids duplication of numbers. The program uses the label number as the identifier and assigns a string of data to it to define the container and the radwaste it contains or the operations performed on the radwaste.

EQUIPMENT

The equipment required by the system to collect and process the data is standard off-the-shelf hardware. The items and their functions are:

Microcomputer

An IBM PC/AT or compatible machine is recommended with a 40 MB hard disk/card to handle the data which the program will generate. This provides fast, efficient operation with plenty of storage space and room for expansion of the program. The function of the PC and its associated printer is to house the master program and the data collection modules and to provide the means to process, edit, and print out the data.

Portable, Programmable Bar Code Readers

The bar code readers which are in use are MSI Data Corporation PDT-III's. These readers are lightweight, portable, and work with a variety of scanners (contact wand, fixed and moving beam laser scanners) and provide 16 - 64 kilobytes of EPROM (programmable memory) capability in the form of a removable chip.

The programmable memory chip contains a portion of the program from each custom application module, as described earlier. It is designed to recognize the unique identification code from each menu card and to then prompt the user to enter the correct data. The program follows the format of each menu card and checks to ensure that data of the proper format has been scanned before accepting it. This provides the consistency and accuracy in data collection which the entire system requires to function efficiently.

These readers contain an internal clock which is used to stamp each data entry with the date and time. The readers also contain sufficient memory capacity, to store the data collected, to allow for efficient operation before requiring data unloading.

The portability and light weight of the readers allows the user to collect data at the work place without writing anything down on paper. This is an important part of the system design, in that the data is entered to the data base directly, rather than being manually recorded and then manually entered at a later time. This eliminates a statistically large source of error and the time delay between data generation and use.

Location Labels

Bar code labels are also used in the system as equipment to identify plant locations and to provide speed, accuracy, and consistency to the entry of the work location data. These labels are installed throughout the plant and are keyed to specific room or equipment names and the numbering scheme used on the site. They provide familiar points of reference and allow the users to identify the work location with one quick scan.

DATA COLLECTION

The majority of the data in the programs can only be entered via the bar code reader. An example is that a drum cannot be "issued" at the PC, but only via the reader and the menu cards. This encourages the use of the readers at the work place where the information can be obtained accurately.

To collect data, the user first inputs his employee ID number to "badge-on" to the system. Then, as each radwaste container is generated, the container (drum, HIC, LSA box, etc.) is labeled with a unique bar code label. The user then uses the portable bar code reader to scan the appropriate menu cards and actual bar code label on the container to define the relevant data for each container of radwaste. The program in the reader, in conjunction with the menu cards, prompts the user to enter the data required in the correct sequence. The date and time are automatically recorded by the reader for each data entry in order to sequence all of the data collected. The users ID number and the date/time information are useful for determining who the user was when data which is in error was collected or when questions are raised.

Data on existing containers can be updated as conditions change, particularly their locations, or as the radwaste undergoes processing. This is accomplished via additional menu cards which again define the proper types of data to be entered. A similar process is followed for identifying and tracking of equipment.

After the data collection has been completed, the information in the portable bar code reader is uploaded into the PC and reviewed for correctness. The data is then transferred into the master data base and new data files are created or existing data files are updated. Records which have been updated or edited are not deleted but are transferred to the historical data base. This allows the user to track the radwaste from its point of origin to its final disposal by providing a complete record of all transactions performed on any particular container.

RESULTS

The master program generates a wide variety of reports which are used for operational and management information. The reports function allows the user to sort by any of

the data fields used to collect the data and by the range of the responses. This allows the user to formulate any number of reports directed at a specific group, type of radwaste, specific location or other desired variable . The reports function works on either the master data base or the historial data base in order to provide as much information as is required.

The reports function is also capable of customizing the printed output to simplify data analysis. This is accomplished by the elimination of unwanted data fields and by specifying spacing or page breaks. In addition, the reports function can compile some of the data and report totals.

Custom reports can also be generated in the form of sub-programs which manipulate the data and perform calculations. This is useful in calculating year-to-date type totals or calculating totals of all types of radwaste. The custom reports are accessed via a simple menu screen and are cataloged for repeated report generation.

The reports which the master program produces are useful for the data which they contain, but they are also useful in manipulating the data to identify:

- Problem areas in radwaste generation or handling,
- Scheduling activities,
- Individual or group responsibilities,
- Radwaste volume in storage or volume changes, and
- Cradle-to-grave sequences for various types of radwaste

BENEFITS

The use of the bar code based management information system has already resulted in improved efficiency in general radwaste operations. The benefits which have been realized from the system to date include:

- Reduced generation of radwaste, especially from identified repairable sources (i.e. leaky valves),
- Reduced man-hours used to accurately track the radwaste and equipment,
- Improved reports on items being tracked,
- Improved control over radwaste packages,
- Improved traceability of tools and equipment, and
- A cleaner and more orderly plant (due to equipment being returned to its designated location.

Benefits which are beginning to be realized and which will be more apparent in the future include:

- Reduced inventory of radwaste and equipment (fewer duplicates).
- More efficient consolidation of radwaste and use of containers.
- Lower personnel exposures from the handling of radwaste.

OTHER APPLICATIONS

Other applications for the use of bar codes currently under development include:

Shipping Manifest Generation

Feeding data directly to a program to calculate isotopic inventories and print shipping manifests.

Respirator Tracking

Use/Recycle/Inspection

Calibrated Equipment and Instrument Tracking
Use/Recalibration

- HP Instruments
- I&C Instruments
- Calibrated Tools

Clean & Contaminated Tool and Equipment Issue & Tracking

Fire Extinguisher Tracking - Location/Testing

Shielding Tracking - Location/Type/Removal

Furniture Tracking - Location/Condition

Sample Tracking - Custody/Origin/Analysis

The new applications will collect data in much the same manner as was described for radwaste and will provide similar benefits. Because the system is modular, system expansion is achieved by simply plugging in a new module, without disturbing current uses. Also, because the system is integrated, the data can be shared between all modules thus allowing the tracking of items within items (i.e. equipment stored in boxes, etc.).

SUMMARY

Once in operation, this bar code system can provide nuclear facilities with more timely and accurate information for the control of radwaste generation, handling, storage, and shipping. Also, the required data collection is streamlined and more accurate. As a result, a bar code based inventory management system can significantly improve the ability of the management of a nuclear power plant to control its radioactive waste and to do so in an efficient, cost-effective manner.