

Bar-Code Automated Waste Tracking System

Kansas City Division

T. E. Hull
Waste Management

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WASTE TRACKING SYSTEM**

T. E. Hull
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Bar-Code Automated Waste Tracking System

Abstract

The Bar-Code Automated Waste Tracking System was designed to be a site-specific program with a general purpose application for transportability to other facilities. The system is user-friendly, totally automated, and incorporates the use of a drive-up window that is close to the areas dealing in container preparation, delivery, pickup, and disposal. The system features "stop-and-go" operation rather than a long, tedious, error-prone manual entry. The system is designed for automation but allows operators to concentrate on proper handling of waste while maintaining manual entry of data as a backup. A large wall plaque filled with bar-code labels is used to input specific details about any movement of waste.

System Description

Introduction

In March 1992, the U.S. Department of Energy (DOE) directed all contractor facilities within the nuclear weapons complex to implement some method of waste tracking using bar-code technology. The Waste Management Department of AlliedSignal Inc., Kansas City Division* (KCD), was given the responsibility of designing and implementing the program for the KCD facility.

Existing tracking systems within the DOE weapons complex were visited to determine applicability for the Kansas City Plant. After evaluation, we chose to design a site-specific program with a general purpose application for transportability to other locations. The Bar-Code Automated Waste Tracking (BART) System was designed to do just that (Figure 1). In essence, we have a stand-alone point-of-generation to disposal (cradle-to-grave) tracking system.

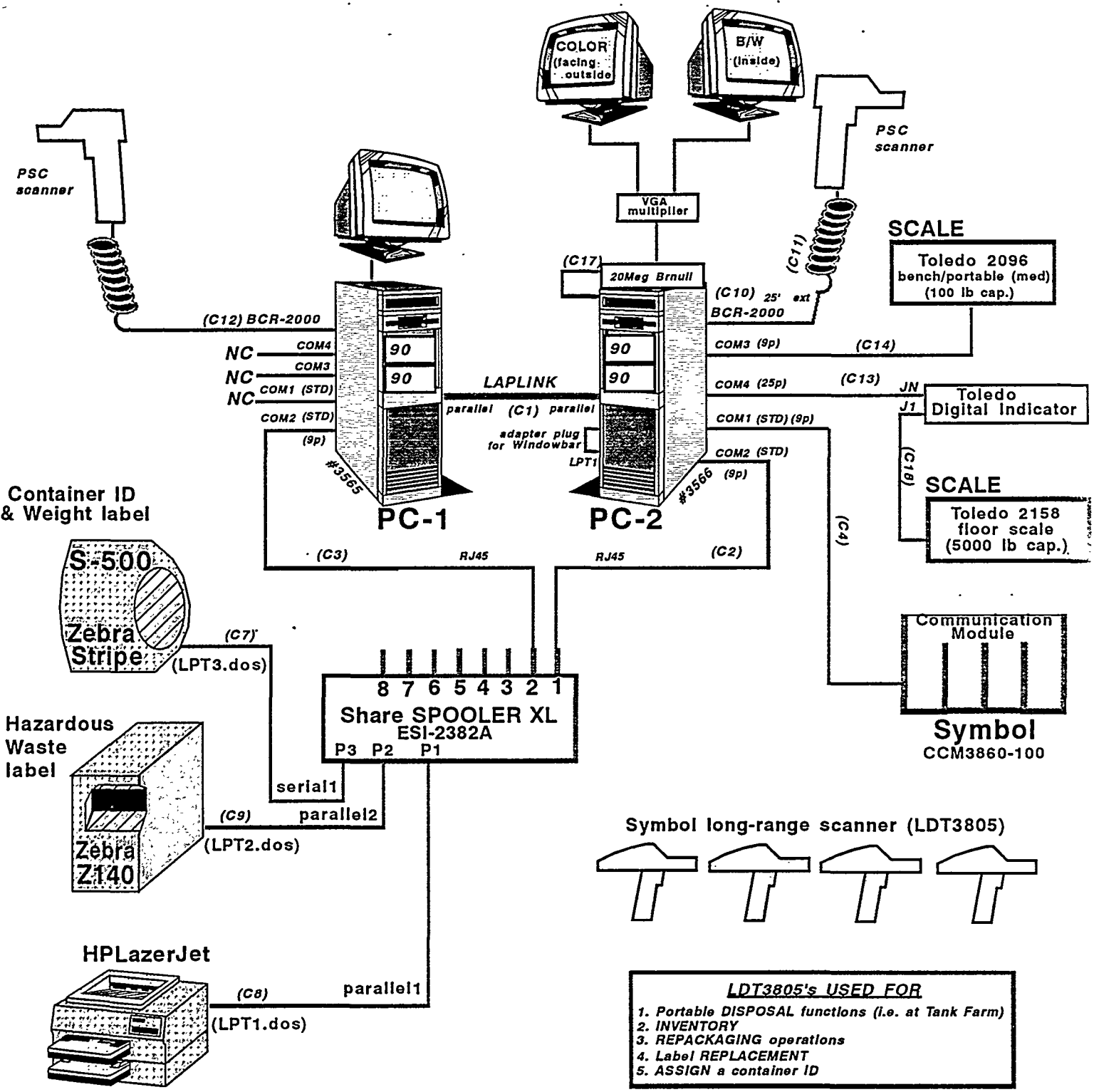
Because this program involved labeling our waste, we took the precautions necessary to include proper identification that would satisfy the federal and state regulations for proper handling of hazardous waste (in

accordance with RCRA, the Resource Conservation & Recovery Act). The method in place prior to this automated process was manual and resulted in potential improper labeling, confusion, and violation of time limit requirements for satellite accumulation (satellite storage) areas.

***We have a
cradle-to-grave
tracking system.***

System Overview

For the design phase of this project, we focused on three major goals. We wanted our system to be **user-friendly** (easy to learn and use), **totally automated**, and incorporate the use of a **drive-up window**. The concept we were aiming for was that the operators handling the waste should **NOT** be distracted from doing their jobs to input data into a system. We wanted the operators to perform a "stop-and-go" action. This necessarily dictated the location of our bar-code scanning operation to be physically close to all aspects of container preparation, delivery,



- LDT3805's USED FOR**
1. Portable DISPOSAL functions (i.e. at Tank Farm)
 2. INVENTORY
 3. REPACKAGING operations
 4. Label REPLACEMENT
 5. ASSIGN a container ID

Figure 1. Block Diagram of Hardware

pickup, and disposal. Because we designed the system for automation, that allowed our operators to concentrate on proper handling of waste while maintaining manual entry of data as a backup, should anything adverse happen to the bar-code scanners.

Our implementation of the drive-up window originated with observation of the everyday process of drive-up banking and drive-up fast food in our society. Again, we wanted to have a "stop-and-go" operation rather than a long, tedious, error-prone manual entry into the system.

Another major piece to our tracking system is a large wall plaque filled with bar-code labels (1 in. by 3.5 in.) that tell the computer specific details about any movement of waste. The wall plaque is approximately 4 feet tall by 6 feet wide and is located next to the drive-up window. See Figure 2, Bar-Coded Wall Plaque, for an example. The individual bar-coded labels are printed by a system designer and placed on the wall plaque for scanning by the operator.

The drive-up window is part of the exterior wall of the building. The wall plaque is attached to the outside wall next to the drive-up window and faces out. For operation, the user pushes a button on the drive-up window and the sliding window opens to give the user access to the bar-code scanner.

A computer screen is also visible from the outside through the sliding window. The sign-on screen for the system uses a security feature. Access to the system is done by scanning a bar-code on the back

of the personal ID badge of the operator. Access is controlled and regulated, and unauthorized use of the bar-code system is practically eliminated. Once access has been granted, the operator can scan any of the bar-codes on the wall plaque for input into the computer, and the input is handled as if the operator had keyboarded the information.

Summary of Features

The first impression of our bar-code automated waste tracking system is the security sign-on screen. Only those individuals with the proper access are allowed on the computer system. The special options access is regulated with the particular access level given in our security database. Current access levels range from 0 to 9. A password for each individual ensures a second level of security for our system.

When access is granted, the user will see the main screen which highlights the five choices available. The five choices are Container Delivery, Pickup, Disposal, Special Options, and Training. Once the user signs on to the system, there is a timeout feature which will automatically log the user out if there is no input within 60 seconds.

Container Delivery

The container delivery transaction initiates the waste tracking process. When a request is made for containers, the system attendant will retrieve the appropriate number of empty containers from the lot. These containers are already labeled with



The frog, green when portrayed in its natural color, demonstrates for us the environmentally conscious manner in which we handle our waste. We selected the frog as our "mascot" for the bar-code tracking system, and this image appears occasionally in our documentation and on-site identification. We gave our mascot the name BART (BAR-code Tracking). The frog image is copyrighted by New Vision Technologies Inc.

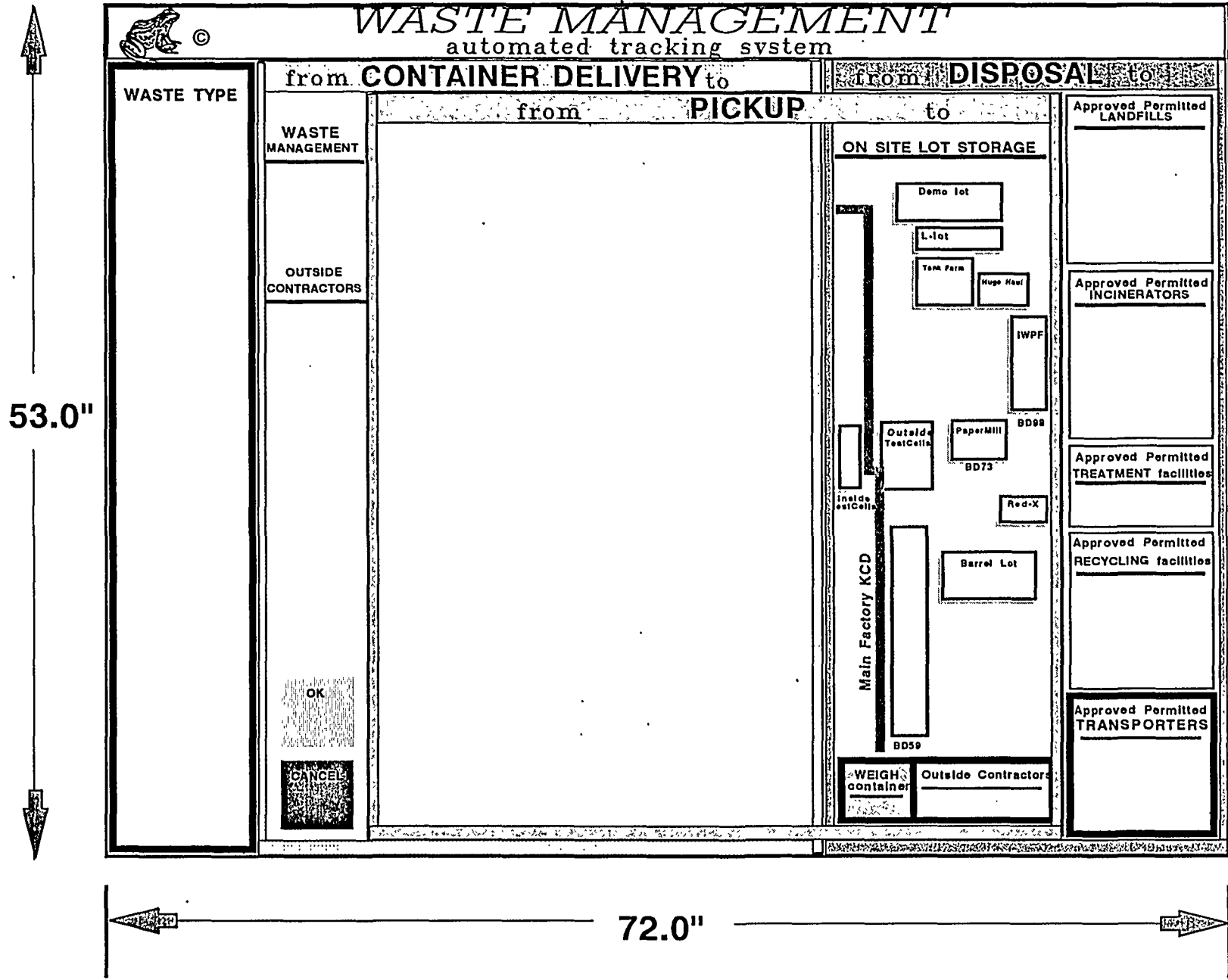


Figure 2. Bar-Coded Wall Plaque

a container ID. The user will log on to the system and scan the associated bar-codes for the container delivery sequence from the wall board. Each and every input requested from the system is either bar-coded on the wall plaque on the outside of the building or in a notebook.

The user will first scan through the steps necessary to create the new record for this waste activity; after that, the computer will automatically print out a bar-coded hazardous waste label (Figure 3).

We are now running version 2.1 of the software. The operator need only scan the bar-code once for where the container came from, where it is going, and the waste ID, even for multiple containers sent to the same location. For two or more containers sent to the same location, the operator simply scans each of the container IDs (one for each container) and the system will automatically print the correct number of hazardous waste labels.

Pickup

The pickup transaction accumulates additional information about the waste when the generating department or location is finished using the container. The using department will contact Waste Management for container pickup. Waste Management will retrieve the containers and bring them back by the bar-coding station for scanning. An associate with computer access will scan the appropriate bar-codes to log the containers in for pickup. Weighing-in each container is a part of the pickup function.

After scanning in the information for a pickup, we now know the date we picked up the waste, the individual weight of the waste for each container, and what storage lot we put the waste on.

Disposal

At disposal, the operator can either use the scanner attached to the bar-code station or use one of the portable bar-code scanners. The disposal transaction is done on the day of disposal.

When a hauler comes for a waste shipment, an operator will verify that the labels are accurate and then scan the document ID's of all of the containers going on this shipment.

When the disposal transaction is done, the record for this particular waste is completed. The following information is gathered in this transaction:

1. The storage lot this waste came from,
2. The disposal facility the waste is going to,
3. The transporter (hauler) that will deliver the waste to the disposal facility,
4. The manifest ID number associated with this shipment, and
5. The date of shipment.

Special Options

The special options category is for unique data handling situations. The choices available on the special options screen are Special Container Delivery, Manifest ID's, Print Label(s), and Data Handling. This topic is covered in detail later in the Special Options section.

Training

In order to allow the users or potential users a training tool to practice using the system and to facilitate an active

Waste Tracking
Document ID

N9301234T



Contr-ID
C930793
Code39

HAZARDOUS WASTE

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL

If found, contact the nearest police or public safety authority or the U.S. Environmental Protection Agency.

Weight

PLACE BARCODED WEIGHT LABEL HERE

EPA ID # /Manifest Document #: MO9890010524 / _____

EPA WASTE #: D001,D002,D006,D007,D008

W
A
S
T
E

Waste Corrosive Liquids, n.o.s., (Contains Sulfuric and Phosphoric Acid), 8, UN1760, II, RQ(D002)

(WASTE ACID LIQUID, CORROSIVE)
Use for TRAINING/DEMONSTRATION purposes only

Generator: U.S. Department of Energy - Kansas City Plant AlliedSignal Inc. - Kansas City Division

Address: P.O. Box 419159, Waste Management Department D/161, BD59

City: Kansas City State: MO Zip: 64141-6159 Phone: (816) 589-8350, (816) 997-3600

Internal Waste Identification

Originator (call x7700 for pickup)

Accumulation

Department: DEPT# Post Location: LOCATION

Beginning Fill Date End Fill Date

10/1/93

PLACE BARCODED MANIFEST LABEL HERE

LOT STORAGE DATE:

In the event of a spill or release of this hazardous waste, contact the U.S. Coast Guard National Response Center at 800-424-8802 for information and assistance.

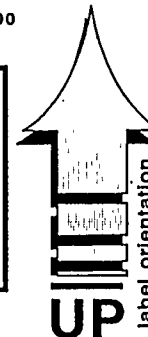


Figure 3. Bar-Coded Hazardous Waste Label

demonstration of the system for visitors, the training option was installed. Anyone with access to the system can put the system in the training mode and practice scanning.

A bar-code on the wall plaque is used to initiate the training demonstration. Once the bar-code is scanned, the screen highlights to the user that he/she is in the training mode. The system will allow the user to scan all of the bar-codes and act as it would if a real transaction were occurring, except the computer will not increment the pointers used to ensure unique document ID's for containers. The letter "T" is appended to the latest existing document ID to set this record apart from legitimate records.

This training option has proven to be a tremendous asset. Not only does it allow for an active demonstration of the system, but it facilitates smooth verification that the system is working properly after a modification is done.

Internal Lot-to-Lot Transactions

Also needed in our waste handling was the ability to pick up waste from the generating department and put it on a temporary storage lot. Pending sampling or a decision to handle the waste in an alternate manner, the waste container will be moved from that initial storage lot to another storage lot. This is called an internal lot-to-lot movement of waste.

Anyone with access to the system can execute an internal lot-to-lot move. This is handled under the pickup transaction. After initiating the pickup routine, the user would scan a pre-existing bar-code that is located on the wall plaque for internal lot-to-lot moves. This is the first bar-code that is scanned when the computer is in the pickup mode. This will put the computer in the internal lot-to-lot operation, and the

specific questions that the user needs to answer are displayed on the screen. Basically, the operator needs to tell the system what storage lot this container came FROM and what storage lot it is going TO.

Portable Scanning Functions

The functions available on the portable bar-code laser scanners are Disposal (used for remote scanning of containers not at the bar-code station), Inventory, Repackaging, Label Replacement, and Assign a Container ID. For a detailed description of each category, refer to the section entitled Portable Bar-Code Laser Scanners.

Repackaging

For our operations, the need to repackage waste is necessary and inevitable. Many times containers arrive in Waste Management with only a small amount of waste inside. It is imperative that we consolidate these wastes into fewer containers. To accommodate this, the portable scanners were programmed with a repackaging option. This will allow us to consolidate waste and condense it in order to facilitate containers for maximum storage and enhanced shipment of waste. The specific steps involved in repackaging are described later under Portable Bar-Code Laser Scanners.

General System Transactions

System Accuracy

A software routine that checks for inaccurate information is much more reliable than relying on correct manual input into a system. Our program automatically checks for proper input after scanned-in bar-code data (or manually entered data for that matter) and notifies

the operator of a Good Entry or Invalid Entry.

A Good Entry screen will show a solid bright green blank screen with the words "Good Entry" displayed for approximately 1 second.

An Invalid Entry screen will flash (alternating ON/OFF three times) a bright red section on the screen with the words "Invalid Entry" displayed. After the screen flashes the invalid entry note, a one-line error message is displayed on the screen directly underneath the requested input.

If the data was invalid, the operator must re-enter it before continuing on to the next input. Alternatively, there are two utility bar-coded functions that the operator may scan at any time. They are Backup One Step and Cancel. These two functions perform as their name indicates and are self explanatory.

The operator may, at any time in the sequence, perform a Backup One Step function and re-enter the data.

When the operator has scanned all appropriate bar-codes to record the necessary details about this movement of waste, there is a confirmation screen which displays all of the selected information and asks the operator to Accept or Cancel this input.

If incorrect information has been entered into the system (like scanning D/111 when you wanted to scan D/112, for example), the operator can scan one of two utility bar-

codes to either Backup One Step or Cancel this input.

Of course, if everything is correct, the operator will scan OK/Accept as the third option; the information is saved and appropriate labels are printed out on the bar-code printers. However, the operator may—at any time in the sequence—perform a Backup One Step function and re-enter the data by scanning another appropriate bar-code for that entry. These are some of the user-friendly options built into our tracking system.

System Capabilities

The system we designed has the capability of making the following identifications:

- The initial generator of the waste (i.e., a specific department),
- The beginning fill date for each container,
- The type of waste placed into the container,
- The day that the waste was picked up,
- Which temporary lot (if any) and/or long-term storage lot it was put on,
- The day it was put on the lot,
- The individual weight of the waste inside each container (net weight),
- The day we shipped the containers off-site for disposal,
- Which disposal site it was sent to,
- What transporter took it there for us, and
- The associated manifest number assigned to that shipment.

This information is collected through three sessions that we call "transactions." They are Container Delivery, Pickup, and Disposal. A complete record in the database will contain data in all three sections. Each of the three transactions is date stamped. See Figures 4 and 5 for diagrams of the data-handling system.

Container Delivery Transaction (color code YELLOW)

To initiate the container delivery sequence, the operator must already have signed on through the security screen as mentioned previously. The main screen shows these options, each color coded for its specific purpose: Container Delivery (yellow), Pickup (blue), Disposal (red), Special Options (white), and Training (gray).

The operator will scan the bar-code on the wall plaque to begin the container delivery process. The computer screen (viewed through the drive-up window from the outside) will display a yellow border to indicate the container delivery mode. At this point, several questions will be prompted on the computer screen, each of which will allow the operator to scan the appropriate bar-coded information from the wall plaque. The sequence of information for the container delivery input is:

1. Waste Type
2. Where did empty container come FROM
3. Where is it going TO
4. Container ID
5. Verify choices

The waste type bar-code is located in a list on the wall plaque. The operator would scan the appropriate bar-code pertaining to the waste that will be put in the container.

The database structure is set up such that the bar-code waste type acts as a license plate pointer to retrieve more detailed information about the waste that could not be encoded in the bar-code. For example, a general description of the waste along with proper shipping name information (if applicable), would be accessed and saved in the database as extra information about this waste.

Next, the operator would scan the appropriate bar-code identifying where this empty container came from. This is almost always from our barrel lot, but in some cases it may be from another lot. Accordingly, if we are issuing a container from an outside contractor, this container does not belong to us and would be handled appropriately by scanning the bar-code associated with that contractor. In this way, we are able to handle special wastes like asbestos and TPH-contaminated soil/rubble which are currently not regulated by RCRA.

Container Delivery input gathers the data needed when sending a container to a requesting department.

After that, the operator must scan the bar-code that identifies where this container is going. On the wall plaque, there is a list of departments and plant locations that are frequent generators of waste.

Next, the user must scan the container ID bar-code attached to the container. This bar-code again acts like a license plate pointer to tell us exactly what type of

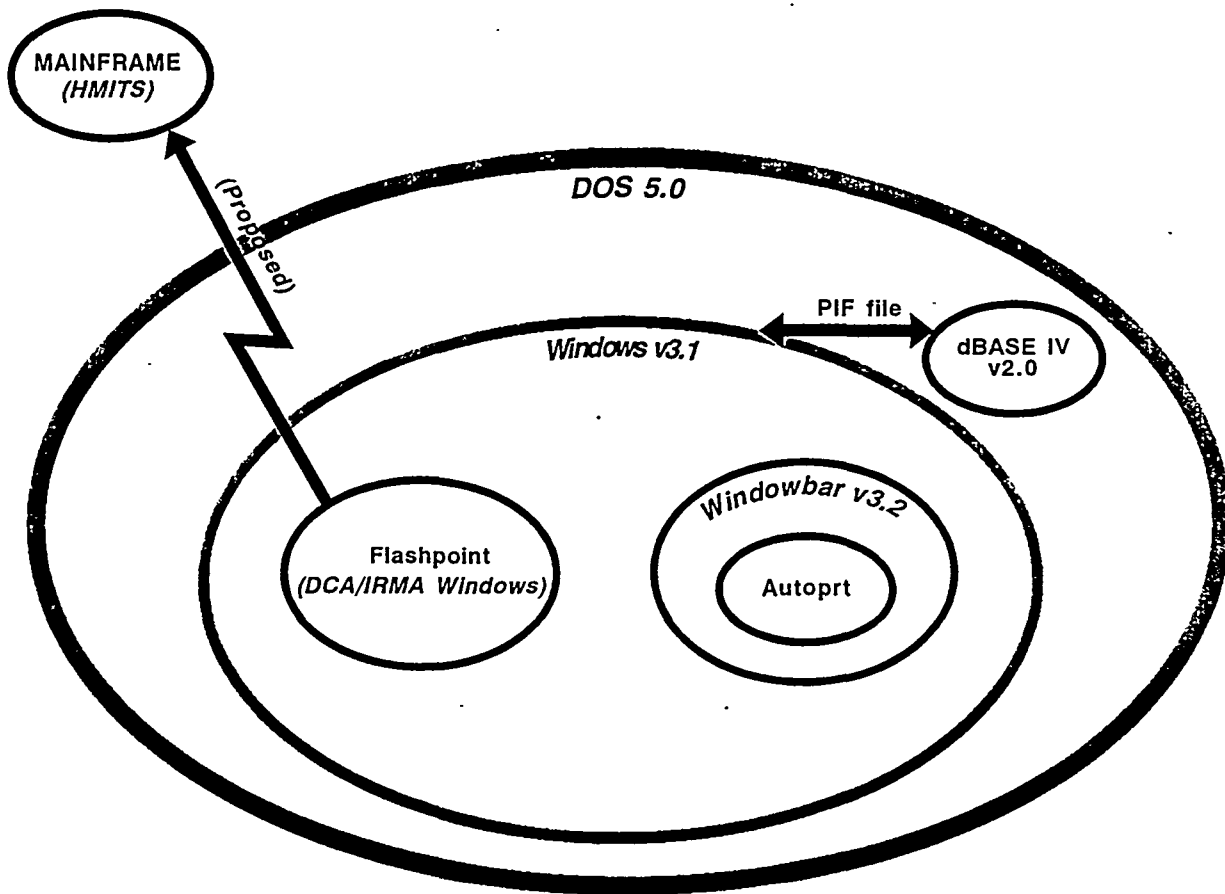


Figure 4. Software System Structure

container this is and its associated empty tare weight. In order to issue a container into the plant for use, it must have a container ID bar-code attached. (Refer to the "Assign a Container ID" section under the "Portable Bar-Code Laser Scanners" heading later in this report.)

The program allows the operator to scan multiple container IDs. This greatly reduces the flowtime necessary to send several containers to the same location for the same waste type. The operator would either scan another container ID or "OK/Accept" to complete the list.

The final screen prompt asks the operator if everything that was entered is correct. If not, the user would scan either Cancel to start all over from the beginning, or Backup One Step to back up and re-enter the

information necessary. The Backup One Step feature can be used successively to back up two or more entries and allow the operator to proceed from that point forward.

When everything is acceptable, the operator scans the OK/Accept bar-code and the screen displays a message that it is printing the hazardous waste label. At this point, the user is finished with the input and may hang up the scanner and close the door to the drive-up window. Of course, if additional labels are required, the operator would move on to do another container delivery.

Each container delivery is handled separately. The computer system will automatically update and increment the document ID for each hazardous waste

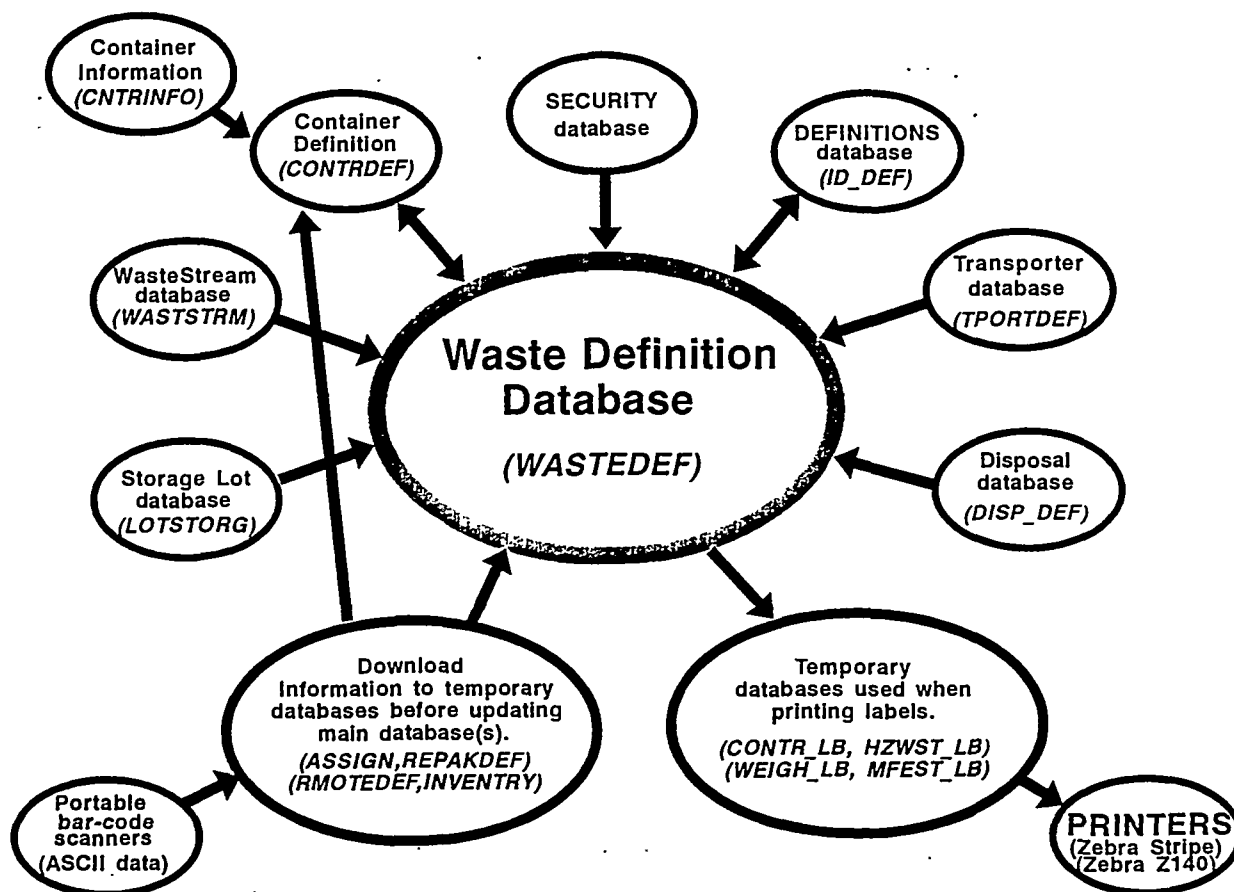


Figure 5. dBASE IV Database Files and Interaction

label. This is the bar-code that uniquely identifies each container of waste. This label is 5.5 in. X 10 in. and is attached with prepasted adhesive to the container. The container is now ready for delivery to the generating department/location.

Pickup Transaction (color code BLUE)

To initiate the pickup sequence, the operator must already have signed on through the security screen as mentioned above. The main screen shows the options, each color coded for its specific purpose, with Pickup in blue. The operator will scan the bar-code on the wall plaque to begin the pickup process. The computer screen (viewed through the drive-up window from the outside), will display a blue border to indicate the pickup mode. At this point, several questions will be

prompted on the computer screen, each of which will allow the operator to scan the appropriate bar-coded information from the wall plaque. The sequence of information for the pickup input is:

1. Where did the waste come FROM
2. What storage lot is it going TO
3. Weigh the container
4. Document ID
5. Verify choices

The first question that the operator must answer is, where is this container of waste coming from? The user can scan the bar-code off of the wall plaque. Then the user must tell the system which storage lot this

The Pickup function will accumulate additional information about the waste.

waste will be stored on. Again, this can be scanned off of the wall plaque.

Next, the operator would ensure that the waste container is placed on the scale and then scan a bar-code off of the wall plaque to initiate an automatic weighing of the container. The screen will display the weight.

The last piece of information is the document ID that the user would scan into the system. This unique bar-code is already on the container from when it was issued in the Container Delivery process.

The last option for the user to address is to verify that the choices that were entered are correct. As with the Container Delivery process, the operator has the option to either accept the choices (scan the OK/Accept bar-code), Backup, or Cancel the operation by scanning the appropriate bar-code label off of the wall plaque for that action.

When the OK/Accept bar-code is scanned, the program will update the necessary record and automatically print out a bar-coded weight label (Figure 6) to be attached to the waste identification label already on the container.

Disposal Transaction (color code RED)

To initiate the disposal sequence, the operator must already have signed on through the security screen as mentioned

earlier. The main screen shows the color-coded options, with Disposal in red. The operator will scan the bar-code on the wall plaque to begin the disposal process.

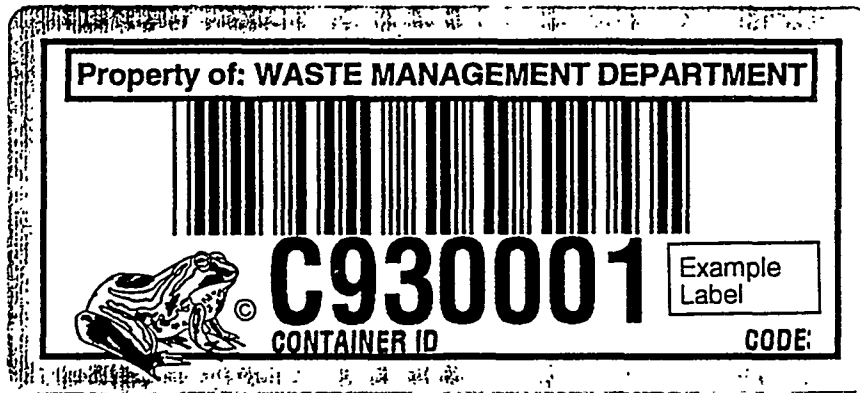
As an alternative to using the main bar-code station for the disposal transaction, one of the portable handheld bar-code scanners may be used to accumulate the data associated with this shipment. Accordingly, that information must then be downloaded to the host PC. Detailed operation of the portable handheld bar-code scanners and the available options are outlined in a later section, Portable Bar-Code Laser Scanners.

The computer screen (viewed through the drive-up window from the outside), will display a red border to indicate the disposal mode. At this point, several questions will be prompted on the computer screen, each of which will allow the operator to scan the appropriate bar-coded information from the wall plaque. The sequence of information for the disposal input is:

1. What storage lot is waste coming FROM?
2. What disposal facility is waste going TO?
3. What transporter is taking the waste?
4. Manifest ID
5. Document ID
6. Verify choices

Even though we know what storage lot the container is in, we still want the operator to scan where this container came from. There are two reasons for this. First, this keeps the scanning process in the same order. The transactions are always in the FROM, TO order. Second, this gives us

example Container ID label



example Weight label



example Manifest label



Figure 6. Bar-Coded Container ID, Weight, and Manifest Labels

another check that the waste is actually on that lot and not somewhere else.

After the bar-code is scanned for the storage lot it was taken off of, the operator will scan the bar-code off of the wall plaque that pertains to the particular disposal site we will use for this shipment. Then he/she will scan the appropriate bar-code for the transport company that will haul this waste for us. NOTE: Each disposal site (incinerator, landfill, treatment facility, recycling, etc.) and every transporter has an approval status as to whether or not they are legitimate and approved for that

waste. In each case, the contracts are reviewed. They are approved or NOT approved based upon anticipated waste generation and/or a previous history of good/poor service.

If the contract is NOT approved, a simple entry (manual) into the database for that transporter or disposal site will not allow the user to scan that particular bar-code for use. The program will treat that input as an Invalid Entry and will not continue until the operator scans a valid bar-code of an approved disposal site or transporter.

At this point, the record contains information about the generation, pickup, and disposal of waste. There are other options available where the user, for example, may want to transfer waste from one lot to another. We call this type of transaction an internal lot-to-lot transfer, and it was discussed earlier in Summary of Features, along with all other options that are unique and don't apply to the three main areas of transaction.

Until the disposal transaction occurs, data for that particular record will be incomplete. However, it does contain valuable information about the history of the waste as of that point in time. For example, we might want to know what storage lot this waste was stored on and how long it has been there, even though we have not shipped it off-site yet for disposal.

The Disposal process will complete the record by gathering information about where and when this waste was shipped off-site.

Special Options

You must have the appropriate access level and a password in order to use the special options of the bar-code system. The appropriate access level is granted by the system administrator, and an associated bar-coded password is provided to log on to the computer.

Instead of the normal entry into the system, as explained under System Overview, the

user with the approved access will scan his/her personal ID badge as normal, then the computer will ask that individual to also scan (or enter) his/her password. From this point on, the system will work as has already been described; however, that person will have access to the special options category, whereas the average user will not.

Once inside the special options, the user will see another menu. This screen is also color coded, and a display in a purple box on the screen indicates to the observer that someone is in the special options window. Currently, there are four options available. They are Special Container Delivery, Manifest ID's, Print Labels, and Data Handling.

Special Container Delivery

Special container delivery operates in the same manner as the normal, standard container delivery except that additional information may apply to this waste that is not ordinary or for whatever reason may need to be identified separately. The waste tracking system is designed to track a category of waste called "special waste" which is handled differently than regulated hazardous waste under RCRA. In order for the majority of waste container deliveries to remain automated, the special container delivery option was created for these cases. The only way to get this information is to manually enter this data. Ultimately, the bar-code automated waste tracking system will track ALL waste, including hazardous, nonhazardous, radioactive, mixed waste, special waste, and scrap.

The special container delivery uses the same format and asks the same questions as the normal container delivery option described earlier in the Container Delivery portion of the System Description section, except two additional questions are asked that require the manual entry. This extra

information may include a special waste authorization number that would apply ONLY to that container of waste and—even if we generated that waste again at another time—would have another authorization number assigned to it. We might also want to track waste from a specific project number. Either one of these would be manually entered into the computer at the appropriate point of reference.

Manifest ID's

Associated with each shipment of waste sent off-site for disposal is a manifest ID that uniquely identifies that load of waste. In addition, the Kansas City facility has a 12 digit pre-assigned generator code that never changes and precedes this unique ID.

A user with access to the special options category can select this option, and the computer screen will instruct that user through the steps necessary to print as many manifest ID labels as required for a particular shipment. For example, if we were shipping 150 containers to landfill X on April 7, 1994, the user would access this option to print manifest labels and then type in the appropriate manifest associated with this shipment. Then the user would answer the question, how many labels do you need? with 150. When the user hits <ENTER>, the computer system is automatically set up to look for this label and print out as many as were requested—in this case, 150 of them. One hazardous waste label goes on each container, and one manifest ID label (Figure 6) goes with each waste label.

Print Labels

This option was created to allow a system administrator to check the proper connections to the printer. Also, in the event that something jammed up on the printer, it would allow the user to repair the

printer and quickly reprint an otherwise good label.

Also added to this option is a Replace a Label option. This feature is used for two reasons:

1. First, a user occasionally will incorrectly scan a bar-code of the waste type that a certain container is used for. As an extreme example, let's say Department 1 asked for a 5 gallon container for waste acid liquid and the operator scanned the bar-code for the alkaline liquid waste type. The system would allow this label to be printed and, theoretically, it could be placed on the acid liquid waste container. When the discrepancy is noticed, someone with the special options access can issue a replacement label to redefine the waste ID associated with that container. The re-issued label is placed over the existing label on the container.
2. Second, this function is used for replacing labels when the containers are readied for off-site shipment. This is necessary because of the DOT requirements for proper labeling and identification before this waste is transported over the road. For each waste container that doesn't have all of the necessary information for the proper shipping description, a replacement bar-coded hazardous waste label must be issued.

The system's tracking integrity is unchanged by maintaining the unique document ID on the new label that is printed.

Data Handling

There are three choices that appear in a submenu when this option is selected from

the special options window. They are (1) download data from the portable scanner, (2) backup the data disk, and (3) archive data. Alternatively, as noted on the screen, the operator can still scan <BACKUP>, <CANCEL>, or type "b" or "c" to quit this submenu and return to the previous screen.

1. **Downloading data from a portable scanner** to the host PC will transfer the accumulated data that was gathered in the scanner and update the waste tracking database with the latest information.

When the Downloading Data From The Portable Scanner option is chosen, the screen will show the selections available. They are Disposal Download, Inventory Download, Repackaging Download, Label Replacement Download, and Assign Container ID Download.

The method of download is the same regardless of which choice is selected; the only differences are the particular filename that is transferred and the handling of this data when it is received in the host PC. For this reason, a single description of the download process will be sufficient to define the activity. In accordance with our user-friendly guidelines that we started out with (described in System Overview), the user is walked through each step of the downloading process.

2. **Backing up data** is of paramount importance. At the end of each day, the operator will run this procedure to backup the entire disk (90 meg Bernoulli). The process takes approximately 90 seconds. In addition, the system administrator makes a weekly backup of the entire

data disk, which is kept in a secure, separate position.

3. **The archiving function** is currently in development (August 1994). This process will allow us to off-load portions of the database that are complete (i.e., when all portions of the record have been input) AND it is no longer necessary to keep this information in immediate access. As our database continues to grow, this function will become mandatory to ensure a manageable size to the database and reduce the time necessary for updating our records in the Pickup or Disposal transactions. A separate 90 megabyte Bernoulli disk will be used initially for this archived data.

Portable Bar-Code Laser Scanners

Introduction

The portable laser scanners we have are Symbol units (model number LDT3805). We have four units. These are data collection terminals with a full alphanumeric keypad (literally a "PC on a stick"), each with its own AUTOEXEC and CONFIG.SYS files, drives, etc. RF scanners were investigated, but because of the security nature of the work with the DOE, approval for RF communication devices requires extensive review and approval. We did not have the luxury to wait for this approval and complete our design and implementation by October 1, 1993. RF portable scanners are the ideal choice and would facilitate immediate real time data acquisition. The portable data collection devices that we have must be downloaded by the operator. The programming for the portable scanner was done in Microsoft C/C++ v6.0.

An executable file (also created in Microsoft C/C++ v6.0) must be downloaded and the nonvolatile RAM (NVM RAM) must be initialized before the portable scanners may be used. Once the LDT3805 units are programmed, the operator or system administrator will type "WMTS" at the DOS prompt. This runs the Waste Management Tracking System executable program and displays the options available for the user at the main menu. There are five operations that the LDT3805 is designed to handle. They are Disposal, Inventory, Repackaging, Label Replacement, and Assigning a Container ID. When any of these options is run, then a convenient, visible indicator (an asterisk) appears on the main menu screen next to that option. This tells the operator that there is information on the portable scanner that needs to be downloaded to the host PC.

Disposal

This disposal routine is similar to the disposal function using the bar-code scanner attached to the computer. The main difference and major advantage for this option is that when we prepare containers for shipment, the operator can take a portable scanner to the location used for staging the waste and, prior to loading a vehicle, run the disposal program that will allow for scanning multiple containers one after another. This eliminates the need to bring every container back to the bar-code station for scanning.

Before the disposal function can be executed, the portable scanner must already be running the Waste Management Tracking System executable file, as mentioned in the introduction above. The operator selects the disposal option on the portable scanner by pressing the "d" key on the keypad of the scanner. The operator will refer to the screen of the

portable unit for step-by-step directions on what information to input (either a bar-code scan or manual entry).

Every input that is requested has a bar-code label that may be scanned. These bar-codes are located in two places. They are located on the giant wall plaque and also in either one of two notebooks that can be physically taken to the actual location of container staging. This disposal routine allows the use of bar-code scanning at a remote location without requiring that each container be physically brought back to the bar-code computer scanning station.

Portable Scanner

The disposal function will allow us to scan waste containers at a remote location.

The following sequence is prompted on the screen of the portable unit:

1. Enter the storage lot ID where the container(s) came FROM.
2. Enter the disposal ID of the disposal facility that this waste is going TO.
3. Enter the transporter company that will physically move this waste to the destination.
4. Enter the manifest number associated with this shipment of waste.
5. Enter the operator ID of the person who is making this transaction.

6. Enter the document ID(s) of the container(s) that are going out on this shipment.

The last question will allow the operator to scan continuously for document ID's until the "OK" bar-code is scanned to signal the end of the list. This closes the file and saves the information on the hard drive of the scanner. The accumulated information is stored in an ASCII text file on the portable device. The next step is to download the disposal data from the handheld unit to the computer. The download routine was described earlier in the section on Special Options.

Inventory

The inventory routine allows the operator to take a physical inventory of the containers on our storage lots. Before the inventory function can be executed, the portable scanner must already be running the Waste Management Tracking System executable file, as mentioned in the introduction to this section. The operator initiates the inventory sequence by pressing "I" on the keypad of the portable scanner. The input requested by the scanner is all bar-coded and may be scanned into the unit or, if needed, manually entered using the keypad.

The following sequence is prompted on the screen of the portable unit:

1. Enter the storage lot ID where you are taking inventory
2. Enter the container ID(s)

This inventory function is more of a double check effort to verify that the containers that the system shows are on storage lots are actually there. This is a confirmation option.

Entering the container ID (prompt No. 2 above) will allow the operator to scan continuously for container ID's until the "OK" bar-code is scanned to signal the end of the list. This closes the file and saves the information on the hard drive of the scanner. The accumulated information is stored in an ASCII text file on the portable device. The next step is to download the disposal data from the handheld unit to the computer. The download routine was described in the section on special options.

Portable Scanner

The inventory function will speed up locating and accountability of containers.

Repackaging

The repackaging function allows the operator to take waste from one container and place it into another container for consolidation purposes. Before the repackaging function can be executed, the portable scanner must already be running the Waste Management Tracking System executable file, as mentioned in the introduction to this section. The operator initiates the repackaging sequence by pressing "R" on the keypad of the portable scanner. The input requested by the scanner is all bar-coded and may be scanned into the unit or, if needed, manually entered using the keypad.

The following sequence of input is prompted on the screen of the portable unit:

1. Enter the document ID of the RECEIVING container
2. Enter the document ID(s) of the containers going into the receiving container

The last question will allow the operator to scan continuously for document ID's until the "OK" bar-code is scanned to signal the end of the list. This closes the file and saves the information on the hard drive of the scanner. The accumulated information is stored in an ASCII text file on the portable device. The next step is to download the disposal data from the handheld unit to the computer. The download routine was described in the section on special options.

Portable Scanner

The repackaging function allows moving waste from one container to another for consolidation.

Label Replacement

The Label Replacement function currently in development (September 1994) is already available at the computer scanning location. To give us this capability on the portable scanner greatly decreases the amount of time on the main computer for re-issuing labels and increases our efficiency to prepare waste for off-site shipments. Also, this inevitably increases the overall efficiency of the tracking system as the normal day-to-day activity of the operation is not interrupted.

Before the Label Replacement function can be executed, the portable scanner must already be running the Waste Management Tracking System executable file, as mentioned in the introduction to this section. The operator initiates the Label Replacement sequence by pressing "L" on the keypad of the portable scanner. The input requested by the scanner is all bar-coded and may be scanned into the unit or, if needed, manually entered using the keypad.

The following sequence is prompted on the screen of the portable unit:

1. Enter the waste type for this container.
2. Enter the manifest ID.
3. Enter the document ID(s) of the container(s) that needs labels replaced.

This last question allows the operator to scan continuously for document ID's until the "OK" bar-code is scanned to signal the end of the list. This closes the file and saves the information on the hard drive of the scanner. The accumulated information is stored in an ASCII text file on the portable device. The next step is to download the Label Replacement data from the handheld unit to the computer. The download routine was described earlier in the section on special options.

Assign a Container ID

The Assign a Container ID function is used to attach a bar-coded container ID label to a container that we use for collecting waste on-site. Assigning a container ID to a waste container is the first step necessary for our bar-code waste tracking system. When a shipment of new, unused containers is delivered to our plant, Waste Management personnel will apply a preprinted bar-code label in the form

C930000 (refer to Figure 6, Container ID). The letter C stands for container; the number (930000—the number begins with the current year) identifies only that container. A container type (in the form ZAA where AA is a two-character pre-assigned code for that type) is used for each different style of container used for waste collection at our facility. A notebook of possible container types is available with a pictorial ID and a predefined bar-code for each container type.

Before the container ID assignment function can be executed, the portable scanner must already be running the Waste Management Tracking System executable file, as mentioned in the introduction to this section. The operator initiates the Assign Container ID sequence by pressing "A" on the keypad of the portable scanner. The input requested by the scanner is all bar-coded and may be scanned into the unit or, if needed, may be entered manually using the keypad.

The following sequence of input is prompted on the screen of the portable unit:

1. Enter the container type for this container
2. Enter the container ID(s)

The last question will allow the operator to scan continuously for container ID's until the "OK" bar-code is scanned to signal the end of the list. This closes the file and saves the information on the hard drive of the scanner. The accumulated information is stored in an ASCII text file on the portable device. The next step is to download the disposal data from the handheld unit to the computer. The download routine was described in the section on special options. See Figure 7 for an example of a data printout.

This completes the list of functions that the portable scanners are programmed to do. On the initial screen of the portable scanner, next to the function and menu pick that is available, the screen will display a set of two asterisks (**) to indicate that data is currently in the handheld unit and needs to be downloaded. Once the data is downloaded, the portable scanner will no longer display the asterisks.

Future Applications

The timeframe involved with the design of the system, procurement of materials, assembly, prove-in, troubleshooting, and implementation was November 1992 to October 1, 1993 (see Figure 8, Timeline of Development).

At the time of this initial writing, some of our future applications and improvements are already identified. They are

1. Program upgrade to allow multiple container deliveries,
2. Enhanced shipment preparation for off-site shipments,
3. Two-dimensional (2-D) bar-code symbology for material safety data sheets, and
4. Integration of the waste acceptance criteria (WAC) program into the bar-code waste tracking system. This will ensure that only approved generators of each waste type will get the waste container. If a department requests a container for a waste they are not approved to generate or if the system operator scans a bar-code for a waste that is not appropriate, the system will notify the operator of an INVALID WASTE SELECTION. The department must fill out a request for approval to generate the waste.

Of these four, the first two have been incorporated and are running under version 2.1 of the software. The third application requires further investigation and may require additional software purchase, although the current hardware should allow 2-D applications.

Also on the horizon is the adaptability for this package to be used at another site (either an AlliedSignal facility or commercial treatment, storage, and disposal facilities). Potential technology transfer and additional business opportunities are being pursued. The compact nature of our waste tracking system (a PC based stand-alone unit) and its user-friendliness make this system attractive.

SHIPMENT for MANIFEST ID #94043

Waste ID	DocumentID	ContrID-siz	Begin Fill Date	Department	Pickup Date	StorageLot	gross Weight	Disposal	Manifest	Ship Date	COMMENTS
ACIDCH-S	N9303482	C931539- 55	12/22/93	D/0061-FX46	01/06/94	ACID-PAD	178.0	ENSCO-AR	94043	04/12/94	Remote disposal
ACIDCH-S	N930510	C932260- 55	09/27/93	D/0061-FX46	10/14/93	ACID-PAD	163.0	ENSCO-AR	94043	04/12/94	Remote disposal
ACIDCH-S	N930928	C932526- 55	10/14/93	D/0061-FX46	11/11/93	ACID-PAD	105.0	ENSCO-AR	94043	04/12/94	Remote disposal
ACIDCH-S	N931259	C932746- 30	10/23/93	D/0097-SJ-8	10/23/93	ACID-PAD	271.0	ENSCO-AR	94043	04/12/94	Remote disposal
ACIDCH-S	N931260	C930953- 55	10/23/93	D/0161-BD59	10/23/93	ACID-PAD	22.0	ENSCO-AR	94043	04/12/94	Remote disposal
ACIDCH-S	N931966	C931314- 30	11/09/93	D/0061-FX46	12/08/93	ACID-PAD	37.0	ENSCO-AR	94043	04/12/94	Remote disposal
ACIDCH-S	N932009	C930960- 30	11/11/93	D/0061-FX46	04/07/94	ACID-PAD	97.0	ENSCO-AR	94043	04/12/94	Remote disposal
ACIDCH-S	N932755	C933193- 30	12/02/93	D/0061-FX46	12/22/93	ACID-PAD	61.0	ENSCO-AR	94043	04/12/94	Remote disposal
ACIDCH-S	N9400637	C934064- 30	01/06/94	D/0061-FX46	02/02/94	ACID-PAD	75.0	ENSCO-AR	94043	04/12/94	Remote disposal
ACIDCH-S	N9400645	C934065- 30	01/06/94	D/0154-J8	01/28/94	ACID-PAD	46.0	ENSCO-AR	94043	04/12/94	Remote disposal
ACIDCH-S	N9400646	C933638- 30	01/06/94	D/0154-J8	01/28/94	ACID-PAD	54.0	ENSCO-AR	94043	04/12/94	Remote disposal
ACIDCH-S	N9400734	C941063- 30	01/10/94	D/0965-BD98	03/14/94	ACID-PAD	84.0	ENSCO-AR	94043	04/12/94	Remote disposal
ACIDCH-S	N9400735	C941045- 30	01/10/94	D/0965-BD98	02/25/94	ACID-PAD	59.0	ENSCO-AR	94043	04/12/94	Remote disposal
ACIDCH-S	N9401510	C941081- 30	02/01/94	D/0061-FX46	02/21/94	ACID-PAD	38.0	ENSCO-AR	94043	04/12/94	Remote disposal
ACIDCH-S	N9402028	C941040- 30	02/15/94	D/0061-FX46	03/08/94	ACID-PAD	47.0	ENSCO-AR	94043	04/12/94	Remote disposal
ACIDCH-S	N9402177	C941482- 30	02/18/94	D/0061-FX46	03/23/94	ACID-PAD	43.0	ENSCO-AR	94043	04/12/94	Remote disposal
ACIDCH-S	N9403377	C942492- 30	03/23/94	D/0061-FX46	04/07/94	ACID-PAD	35.0	ENSCO-AR	94043	04/12/94	Remote disposal

Total number of bar-coded containers shipped: 17 # of 55 gallon containers: 4 # of 30 gallon containers: 13
 Total net weight of waste: 1099.0 lbs Gross wt of payload: 1415.0 lbs # of wood skids for shipment: 4, @ 40 lbs ea: 160.0 lbs

TOTAL PAYLOAD (includes weight of skids): 1575.0 lbs	Waste/Payload ratio: 69.78%
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Figure 7. Example of Data Printout

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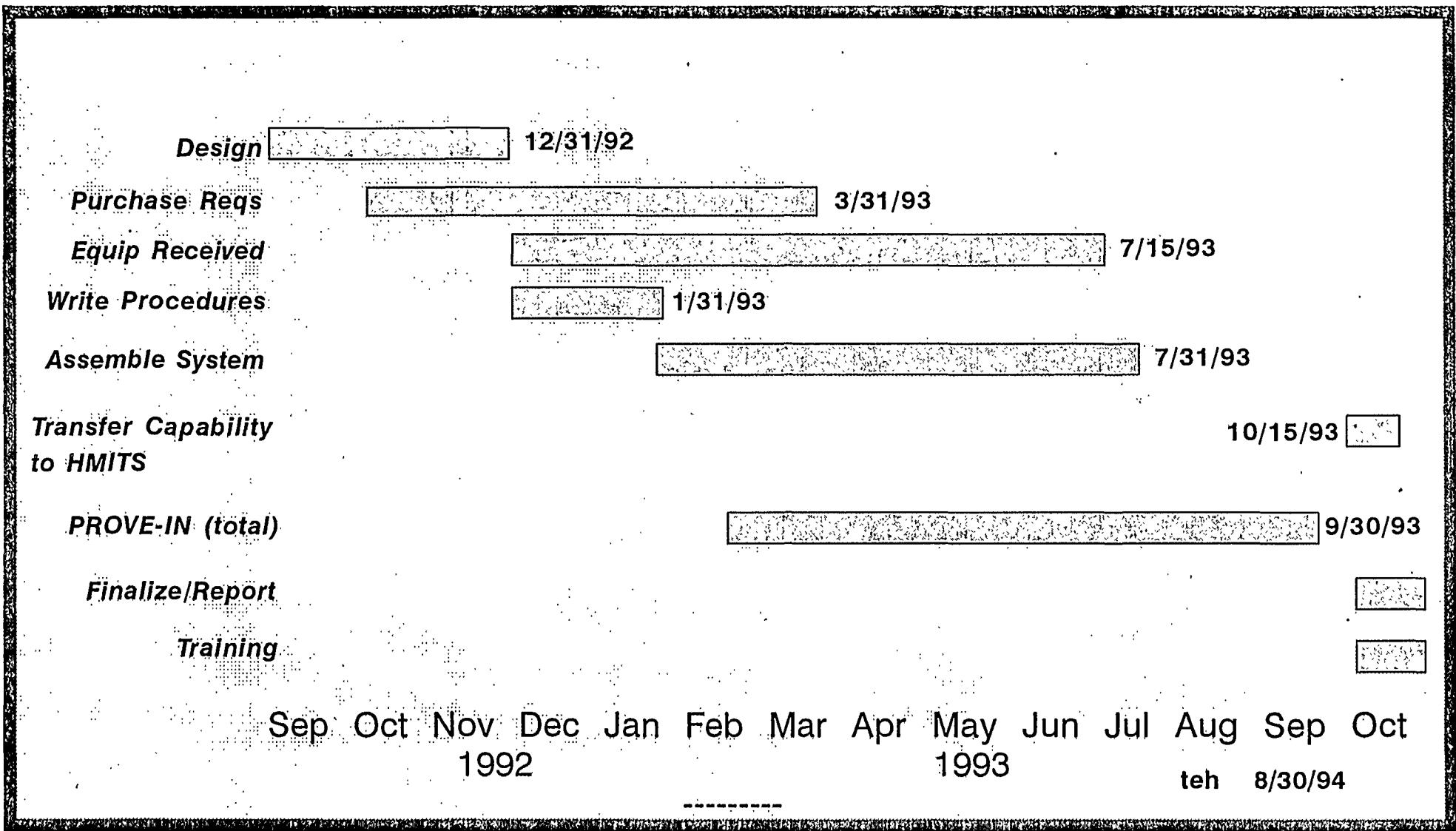


Figure 8. Timeline of Development

List of Hardware

(asrq = as required)

<u>Quantity</u>	<u>Description</u>
2	PC Computer equipment/peripherals (IBM Valuepoint 433DX with 210M hard drive, dual 90M Bernoulli internal removable drives, 1 external dual 20M Bernoulli drive, color VGA monitor, mouse, keyboard) *
asrq	Furniture -- Anthro workstation modular carts with shelving options *
1	Sliding window - protruded from building with internal shelf
1	Large Wall Plaque - dimensions = 4.0 ft X 6.0 ft to hang on the outside of building
1	Sharespooler (model XL ESI-2382A) - for printer sharing *
1	Zebra Stripe (model S500) thermal transfer bar-code printer *
1	Zebra with parallel option (model Z140) thermal transfer bar-code printer *
1	HP Laserjet III laser printer *
4	Symbol (model LDT3805) portable laser scanner *
1	Symbol (model 3860-100) portable communication/charging dock (for LDT3805's) *
2	Seagull Scientific (model BCR2000) PC plug-in module with PSC laser scanner and cable *
1	Seagull Scientific (model BCR2000 number: GUNSCNRI) PC plug-in module w/ PSC industrial scanner *
1	Barcode Systems (model BCS3000 bar-code analyzer) *
1	Hamil Scale (Toledo model 2096) benchtop scale 1000 lb cap. at 0.1 lb increments *
1	Hamil Scale (Toledo model 8530) digital indicator for model 2096 scale *
1	Hamil Scale (Toledo model 2158) Vertex floor scale 5000 lb cap. at 1.0 lb increments *
1	Hamil Scale (Toledo model 8142) digital indicator for model 2158 scale *
2	High Speed multi-I/O card (9p, 25p serial, 25p parallel) *
1	VGA Multiplier -- to drive more than one monitor with the VGA output of one PC *
2	Holster - for use with LDT3805 portable scanners *
1	Extra battery pack(s)
1	VGA monitor (monochrome) *
asrq	Supplies (printer labels -- Container ID, Weight, Manifest, Hazardous Waste Labels) (printer ribbons -- Sony (model 4050) 4.33 in. and 5.12 in. widths) *
asrq	Miscellaneous (cabling, connectors, etc.) RJ45 flat cables various lengths, parallel and serial cables various lengths, connectors -- RJ45 to RS232 9p and 25p convertors, gender convertors, etc.

* Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof.

List of Software

<u>Quantity</u>	<u>Description</u>
2	Microsoft Windows v3.1 *
1	Mayer Automation Windowbar (bar-code printing software) *
2	Procomm Plus for Windows (communication software) *
2	Hijaak software (data conversion) *
2	dBASE IV v2.0 (database management) *
2	dBASE IV v2.0 (runtime stand-alone software) *
1	Bar-Code Waste Tracking System software version 2.1 (dBASE application)
1	Laplink (serial/parallel connection between PC's) *
2	Microsoft C/C + + v6.0 *
1	LDT3805 programming kit (ADK Libraries) *
2	Norton Desktop *
2	Presentation Task Force *

* Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof.