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Urban Mass Transportation Administration

Development of an Automated Emergency Response System (AERS) for Rail Transit Systems

Transportation Systems Center
Cambridge MA 02142

October 1984
Interim Report

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Joseph F. Petrie, William T. Hathaway

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16. Abstract

This report describes the efforts of the Urban Mass Transportation Administation's (UMTA) Office of Technical Assistance, Safety and Security Staff, to evaluate the Bay Area Rapid Transit District's (BART) microprocessor-based Automated Emergency Response System (AERS) in central control rooms of other rail rapid transit systems. The report discusses the deployment of demonstration AERS systems at the Washington Metropolitan Area Transit Authority (WMATA) and at the Port Authority Transit Corporation (PATCO) of Pennsylvania and New Jersey. Also discussed are the subsequent efforts by the central control supervisory staffs through September 1983 to extend the demonstration systems into operating systems that meet not only the emergency action requirements of the respective transit systems, but other unique requirements as well.

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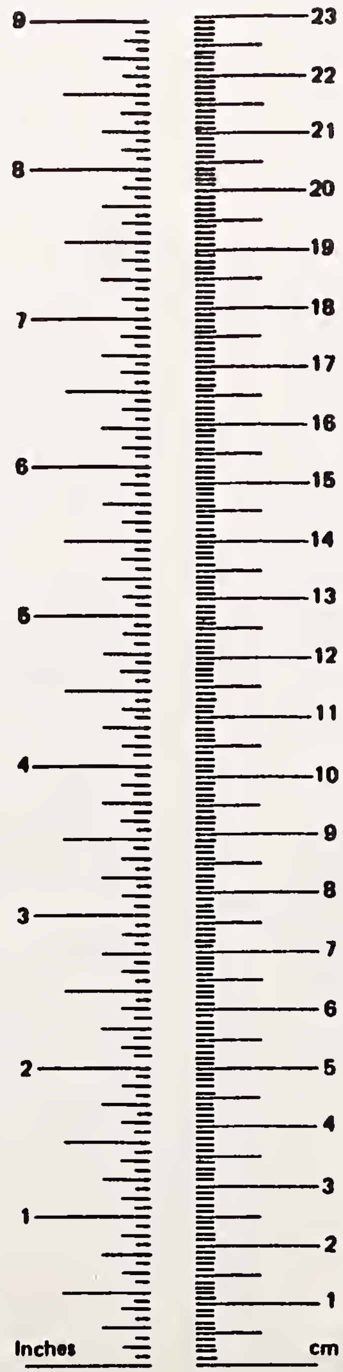
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

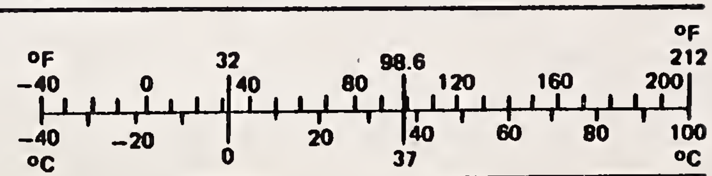
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in. = 2.54 cm (exactly). For other exact conversions and more detail tables see NBS Misc. Publ. 286. Units of Weight and Measures. Price $2.25 SD Catalog No. C13 10 286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	36	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

In 1979, the Bay Area Rapid Transit District (BART) had a serious fire in their Transbay Tube running under San Francisco Bay between Oakland and San Francisco. As a result of the fire, BART developed a microprocessor-based information retrieval system to aid in the emergency decision-making process. This system was proposed, designed and programmed by Richard Blake, a supervisory controller at BART.

In 1982, the Urban Mass Transportation Administration (UMTA) Office of Technical Assistance initiated an effort to encourage the installation of similar systems, referred to as Automated Emergency Response Systems (AERS), at other transit sites. The Transportation Systems Center (TSC), in support of the UMTA Safety and Security Staff, demonstrated the system to transit officials at workshops and on-site at several transit systems. Interest was generated, and two deployment sites - the Washington Metropolitan Area Transit Authority (WMATA) and the Port Authority Transit Corporation (PATCO) of Pennsylvania and New Jersey - were selected. Demonstration software was prepared for the two transit systems.

This report describes the status of the AERS and highlights the changes made by WMATA and PATCO train controllers, who have since incorporated and expanded the AERS into the operating systems of their respective central controls. It is especially significant to note that at both demonstration sites the programs were modified by central control supervisory staff who had never been trained to program in the BASIC programming language.

Among those people who have made contributions to the demonstration effort, special thanks must go to Lloyd Murphy of UMTA's Office of Safety and Security for overall guidance and the necessary funding, without which the sharing of BART's AERS with other transit systems would have been extremely difficult. Richard Blake of BART deserves special thanks for his willingness to share his original program and his time by adapting the software for WMATA and PATCO. Credit must also be given to central control superintendents Joseph Taylor, Joseph Amado and P.T. Hobgood of WMATA, and Bart Kane and William Thorpe of PATCO, for their help in deploying and expanding the AERS at their respective transit systems. Ralph Weule and William Fleisher of BART, Richard Labonski of

WMATA, David Andrus of PATCO and Donald Dzinski of APTA deserve recognization for their support and encouragement all through the deployment efforts. Special thanks also go to David Heimann of TSC and Thomas Lindsley of Dynatrend Inc. for their assistance in support of the WMATA and PATCO staffs. Mr. Heimann and Robert Dorer, also of TSC, were instrumental in preparing portions of section 7.

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1. INTRODUCTION

This report presents the results of an effort to deploy and evaluate automated emergency response systems (AERS). Developed initially by a train controller at the Bay Area Rapid Transit District (BART), the AERS is a computerized data bank containing equipment and facilities location information and predetermined response actions. Its purpose is to provide controllers, dispatchers and supervisors with a quick and accurate information retrieval system. In the development of UMTA's Recommended Emergency Preparedness Guidelines for rail transit systems, the AERS was identified as a decision-making aid that would be of value to the transit industry. The UMTA Office of Technical Assistance Safety and Security Staff, supported by the Transportation Systems Center (TSC), acquired this initial AERS from BART and demonstrated it at several transit meetings and transit systems.

The basic features of the BART AERS are as follows:

1. The software had been under development since 1979 and is now fairly complete as a tool for controller/dispatchers.
2. The software was designed by a controller for controller/dispatchers.
3. The software was developed for an Apple II Plus^{TM} microprocessor - a relatively inexpensive, 8-bit, portable personal computer.
4. The software is written in the (Applesoft) BASIC computer language, which is a relatively simple programming language.
5. The Apple II Plus computer is relatively easy to transport (the computer, printer, and video monitor travel in three suitcases and the programs, or software, are on two 5-1/4 inch floppy diskettes).
6. Cost and space requirements of the Apple computer allow multiple units in a control room to provide a highly reliable, accessible AERS capability.

The deployment and evaluation of the AERS was conducted at the Washington Metropolitan Area Transit Authority (WMATA) and the Port Authority Transit Corporation (PATCO) of Pennsylvania and New Jersey. Each transit system was provided with software similar to the BART AERS microprocessor and other hardware, data sets tailored to represent a portion of their respective systems, and training in the operational AERS and the programming behind the software. BART assisted TSC in providing both the software and training.

The following sections provide a more detailed description of this effort and of plans for the next generation AERS. Section 2 gives a brief overall description of the AERS. Section 3 describes the BART AERS, the parent AERS which has been under development since the Transbay Tube Fire in 1979. Sections 4 and 5 describe the WMATA and PATCO demonstration efforts, and section 6 describes the present status of the AERS. Finally, section 7 contains a brief description of the effort to develop a generalized, generic AERS software capable of being easily modified and installed at virtually any transit system.

2. DEFINITION OF AERS

The current AERS, depicted graphically in Figure 2-1, is an Apple II Plus microprocessor-based set of BASIC programs that: (1) retrieves data on a location; (2) displays data base entries; (3) updates data base entries; and (4) displays site-specific data to meet the unique requirements of the transit systems.

The AERS data base may be visualized as a two-dimensional array or matrix in which the rows refer to locations and the columns refer to data attributes (fans, dampers, fire departments, etc.). Thus, AERS can be described as a specialized computer-based information retrieval system that is designed to display data on a location (across a row) or on a data element (down a column). AERS also contains the following characteristics:

1. Quickly displays track and track-related data items that are contained in the files.
2. Features computer video displays and printed output organized to provide meaningful data for use by the supervisors and controller/dispatchers during any normal or abnormal situation.
3. Is on-line during all periods of operation, whether the system is in service for revenue or for track maintenance.
4. Operates independently of the transit system's mainframe computer.
5. Consists of multiple units providing a highly reliable uninterrupted supply of data during all operating periods.
6. Has a data base which can be verified by the transit system.
7. Has utility programs to maintain the data base, etc.

The two unique elements of the AERS are the data base and hardware. The following two sections define these AERS elements.

2.1 DATA BASE

As noted above, the AERS data base element may be visualized as a two-dimensional array or matrix of data. The columns of the array (i.e., the AERS

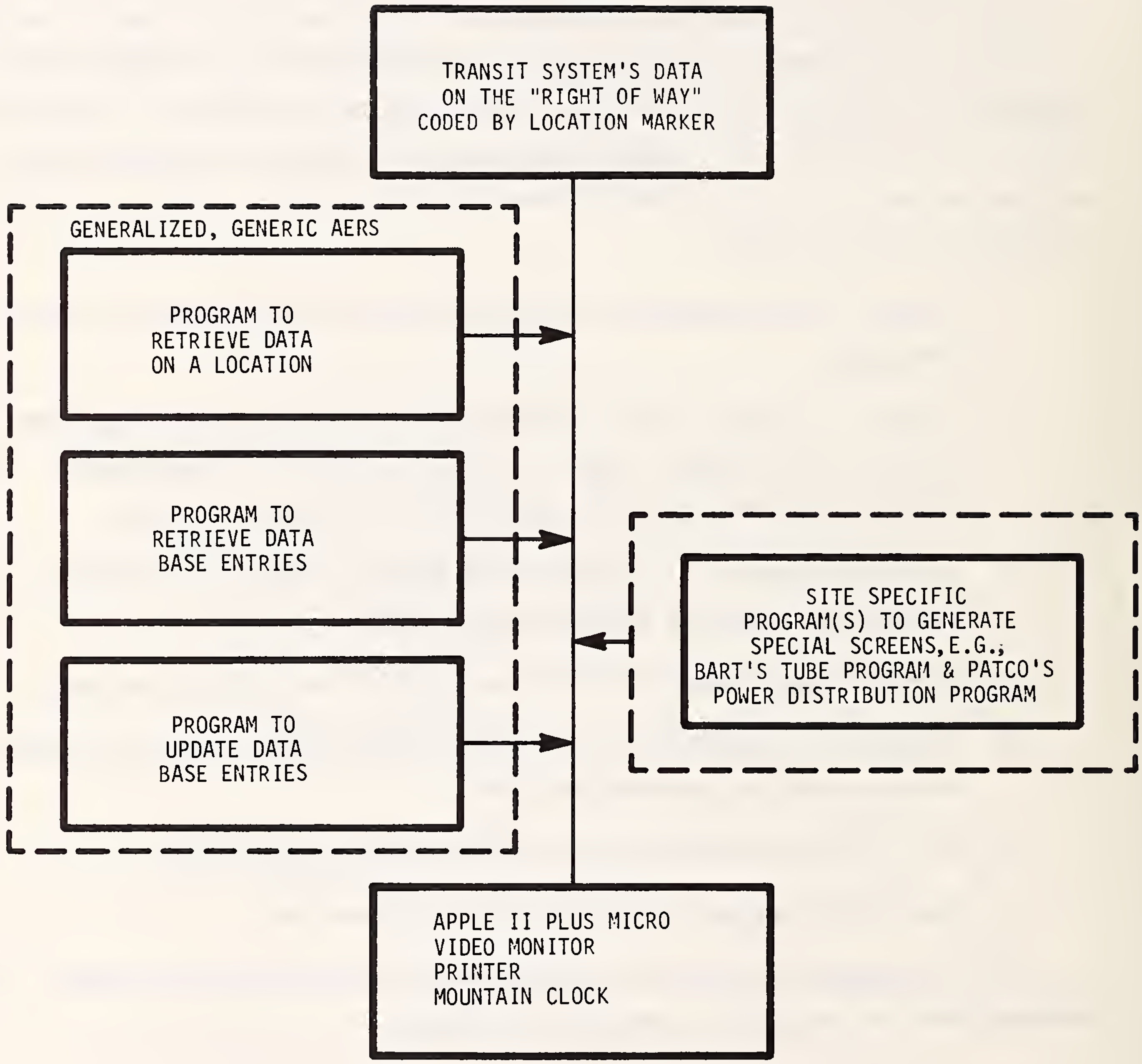

FIGURE 2-1. AERS SCHEMA

data files, data sets, etc.) represent a set of files containing track and track-related data arranged by location marker - i.e., line and mileage markers or line and chain markers. For the purposes of this report, line and mileage markers or line and chain markers are called location markers.

Data elements in the files include reference and operations data such as: (1) third rail switches; (2) interlockings; (3) access points; (4) station names; (5) cross-passages in subways, tunnels, and tubes; (6) station phones; (7) maintenance of way access points; (8) emergency phones; (9) fire and/or police department jurisdiction and emergency phones; and (10) intersecting streets.

For the purposes of this report, it is assumed that the AERS files contain only track and track-related data for practical application, especially during abnormal periods. Operating information such as schedules, daily passenger loads, etc., though stored and reported using the same equipment, is not covered in this report.

2.2 HARDWARE

The current AERS hardware deployed at WMATA and PATCO consists of an Apple II Plus microprocessor (48K), an Epson™ printer, a GE video monitor, a 5 1/4 inch floppy diskette disk drive, and a Mountain clock. BART has four sets of similar equipment.

The video monitor (CRT screen) and printer provide at present the only means of output from the AERS. The video monitor displays may be categorized as follows:

1. Main menu displays, which identify the principal options (functions) and accept the user-defined selections as input to the programs.
2. Subordinate menu displays, which are accessible through the main menu or other subordinate menus.
3. Video output displays for emergency actions, showing the information retrieved as a result of user input on a subordinate menu. In the BART AERS, this consists of ventilation and evacuation information for the Transbay Tube and the Berkeley Hills Tunnel.

4. Other video monitor displays, including such displays as the agency's logo, and listings of items being revised.

There are currently two options for generating printed output: (1) print what is on the screen simultaneously, or (2) print what is on the screen optionally before the next video display is outputted by the microprocessor.

3. BART AERS

A fire on a train in any section of a transit system can be extremely hazardous. The degree of hazard varies from section to section, depending on whether the section is underground or aerial, has special ventilation requirements, is not easily accessible, and so on. One such section at BART is the Transbay Tube, a three and one-half mile segment under the San Francisco Bay between Oakland and San Francisco. BART AERS was developed in response to the 1979 Transbay Tube fire.

One of the critical elements of fire emergency response in the Transbay Tube is establishing proper ventilation so that passengers are exposed to minimal quantities of smoke. This requires the ability to remotely open one of the many dampers (which are normally closed) to the exhaust duct, which then carries the smoke to the ends of the tube for venting. After the appropriate damper is opened, the supply and exhaust fans are activated and the smoke is carried away to both the Oakland and San Francisco ends of the tube. This procedure is more complicated than would appear at first glance. Establishing ventilation in the tube requires an integration of a number of variables, including: (1) train length; (2) location in the tube; (3) fire location; and (4) ventilation regime for the specific location so as to ventilate the smoke over the fewest number of cars and passengers.

When, in 1979, a fire did occur, central controllers had to quickly and accurately determine proper ventilation and evacuation schemes under critical conditions. The operation was enormously complex due to the volume of hard copy data (maps, engineering drawings, etc.) required to evaluate and choose among a variety of strategies for evacuation, removal, and rescue, with each strategy involving different mixes of electrification and de-electrification. The situation was further complicated because the control room staff did not know the exact location of the train or extent of the fire. Because of the volume of data, the differing alternative response requirements, and the complication of not knowing the location of the train or the extent of the fire, the customary manual method of response proved inadequate.

3.1 MICROPROCESSOR SELECTION

At the time of the fire in 1979, BART management had been considering using one of its mainframe computers for an emergency action support system. Various means to provide full-time, on-line, real-time access for central control staff, using a computer that was periodically off-line for maintenance, were under consideration. Some approaches, such as procuring a back-up computer, or linking dissimilar computers to back up one another when one is off-line for maintenance, would have been expensive and time-consuming.

The management study showed that the transit system needed a moderately priced computational and retrieval capability that would be available 100 percent of the time. Redundant Apple II Plus microprocessors met these requirements.

Central control was provided with the resources to purchase equipment and to develop the AERS. The initial development of the AERS concentrated on the emergency action module designed specifically for the Transbay Tube. Later, the system was expanded to include the Berkeley Hills Tunnel, and eventually all locations. The AERS currently contains a number of modules designed to meet the information needs of the control room staff and higher management. There are at present four Apple II Plus computers in central control. It should be remembered that the software was designed to be an aid to the controllers and not to replace the officially approved standard operating procedures manuals used in central control.

3.2 BART AERS SOFTWARE INTRODUCTORY NOTES

For the purposes of this document, two common BASIC computer terms - function and menu - will be used. A function is a programmed interactive query, and a menu is a list of functions. An abbreviated main menu for the BART AERS is shown in Figure 3-1. (This abbreviation is explained in Section 3.3.) The next four sections discuss the three functions identified in Figure 3-1 in the following order: (1) obtaining data on a location; (2) displaying data base entries; (3) determining emergency actions for a location in the Berkeley Hills Tunnel; and (4) determining emergency actions for a location in the Transbay Tube. Note that the corresponding figures are presented on page 17-22.

3.3 SOFTWARE TO RETRIEVE DATA ON A LOCATION (FUNCTION 2)

BART's main menu, as shown in Figure 3-1, displays only three of the six functions that the user can currently select: emergency action software; displaying data on a location, and displaying all of the data base entries. (The other three functions pertain to central control responsibilities and so will not be covered in this document). The main menu (generated using a program named INPUT) prompts the user to enter a numeric value to identify the specific routine that the program is to follow.

Assume that the user selects the second function, i.e., displaying data on a location. Figure 3-2 shows that after selecting the function, the user is then prompted for the input required for that specific routine. In this instance, the user is prompted to enter the location in one of four acceptable formats. Mileage marker and line are self-explanatory. The others, called zone codes, are codes for stations, interlockings, maintenance of way access points, maintenance yards, etc.

At BART, these zones are usually coded with a three- or four-digit alphanumeric designation as follows:

1. A-line stations from Lake Merritt to Fremont, A10 to A90 ascending by 10.
2. M-line stations from Oakland West to Daly City, M10 to M90 ascending by 10 (except for Embarcadero, which is M16).
3. C-line stations from Rockridge to Concord, C10 to C60 ascending by 10.
4. R-line stations from Ashby to Richmond, R10 to R60 ascending by 10.
5. K-line stations from 12th Street Oakland to MacArthur, K10 to K30 ascending by 10.
6. Maintenance of way access points, such as MW02 on the M-line at Milepost 13.12.
7. Others, such as A05 Oakland WYE and A15 Oakland Shop.

Figure 3-3 shows the retrieval of location data for location 5.5 C - that is, mileage marker 5.5 on BART's C-line. Note that this area is in the Berkeley Hills Tunnel and is also covered in the emergency action option. Table 3-1 identifies generically, by type of area, the data that the software displays when retrieving data on a location.

3.4 SOFTWARE TO DISPLAY DATA BASE ENTRIES (FUNCTION 3)

The data base entries display is the last of three functions shown on the main menu (see Figure 3-1). If the user, by entering the number 3, selects this function, the screen then prompts to enter the "attribute" of data to be displayed, such as access points, cross streets, or fire department jurisdictions (Figure 3-4). Assume, for example, that the user wants to display the data on the type of area (transitions). Once the appropriate number has been entered (in this instance, "8"), the user is prompted to enter the letter designating a specific line (Figure 3-5). After the line has been entered, the screen displays the data on that attribute for each reference mileage marker (C-line transitions are shown in Figures 3-6 and 3-7).

Note that at the bottom of the screen in Figure 3-6, three prompts are given: (SPACE), (RETURN), and 1-6. In order to view additional "pages" of data (when they exist) for that attribute, the user should enter a space; up to 25 lines of data will be displayed on each screen. To return to the main menu, the user should enter a carriage return. Finally, by entering a number between 1 and 6, the user can return directly to whichever function he or she desires.

Figures 3-8 through 3-14 present the displays for the remaining attributes on the C-line. (Note that only one "page" of data is given for each attribute.)

3.5 BART AERS - EMERGENCY ACTION SOFTWARE FOR THE BERKELEY HILLS TUNNEL (FUNCTION 1)

The first function on the main menu is "determine emergency actions." The emergency action module consists of two major programs: (1) BHT for the Berkeley Hills Tunnel and (2) TUBE for the Transbay Tube. The latter is described in Section 3.6.

TABLE 3-1. SUMMARY OF DATA DISPLAYED WHEN RETRIEVING DATA ON A LOCATION

	Type of Area			
	Station Interlock Maint. of Way	Subway (Between Stations)	Aerial	Grade
Input Data Entered	Approp. Zone Code	Milepost Line	Milepost Line	Milepost Line
Data Displayed				
• Area	X	X	X	X
• MUX (Train Control Area)	X	X	X	X
• Interfaces (Both Directions)	X	X	X	X
• Rail Number (Both Directions)	X	X	X	X
• Fire Department	X	X	X	X
• Station Phones	X			
• Access Points		X	X	X
• Cross Street (within ½ mile)			X	X
• Ventilation Facilities		X		
• Distance to Next Zone (Station) (Both Directions)		X	X	X
• Western Pacific Milepost & Controller Phone Number (when applicable on the A line)			X	X

The unique physical characteristics of the 3-1/2 mile Berkeley Hills Tunnel are: (1) portal doors at the Orinda side of the tunnel that are normally (but not always) closed as part of the ventilation scheme; (2) ventilating fans that, if run, can be run either in supply or exhaust; (3) cross-passage doors at 1000-foot intervals; (4) a metal grate walkway with a railing along the side of the tunnel; and (5) a high tension line running along the top of the tunnel.

The BHT program is used to assess any abnormal situation that could require ventilating the tunnel, because the software indicates (1) whether or not to close the portal doors and (2) whether to run the ventilation fans in supply or exhaust.

Figures 3-15 through 3-19 show screens generated by the emergency action function. Figure 3-15 gives the first emergency action screen. This display is used to prompt the user to input the data which will determine whether the area is covered by the BHT or Tube software. (In this case, the user entry of 5.5 C designates the BHT.) Note that the user input for the first prompt conforms to one of six acceptable formats:

1. mileage marker, line and track
2. mileage marker, line, track and reverse running
3. zone and track
4. zone, track and reverse running
5. two adjacent zones
6. two adjacent zones, track and reverse running

The user is then prompted to enter the length of the train, which is a key variable in BART's ventilation scheme (Figure 3-16). In response to this prompt, 6 has been entered for a 6-car train. The next prompt requests information about the location of the fire (Figure 3-17). There are five acceptable fire location entries:

1. the exact car number
2. front of the train
3. middle of the train
4. rear of the train
5. unknown

"Unknown" has been entered, and Figure 3-18 shows the resulting screen prior to program execution.

Figure 3-19 shows the screen for the same location and train length in the Berkeley Hills Tunnel, but now the fire is isolated on a front car. Note that this screen shows some of the information contained in Function 2, retrieve data on a location. It also includes: (1) the instruction to run the ventilation fan in exhaust; (2) the location of the nearest cross-passage doors; (3) the identifying numbers of emergency phones; (4) the switch for the 34.5 KV cable; and (5) the distance to the portal.

The BART AERS programs were written to edit or check the user input. For example, Figure 3-20 shows the screen display for a section of the system for which no emergency action software has been written. Note that the user can either input a new location or make a carriage return to go to another menu.

3.6 BART AERS - EMERGENCY ACTION SOFTWARE FOR THE TRANSBAY TUBE (FUNCTION 1)

Before the Transbay Tube program is discussed, an explanatory note on the structure of the tube would be useful. Figure 3-21 gives some of the emergency instructions currently contained in each transit vehicle. As shown in the top two graphics, the tube's two outer sections contain the tracks and walkways. The walkways, which run along the inside of each track, are principally at the door level of the vehicle, except when the walkways descend to the track level at the cross-passage doors. The rectangular space in the middle is the gallery, which contains assorted equipment, including rescue and fire fighting equipment. If evacuation is required, the current plan is to evacuate through the gallery to the other track.

The software for the Tube program is similar to that described in section 3.5 for the Berkeley Hills Tunnel. When the train location has been entered according to format, the input program checks the value of the location to determine whether this corresponds to the values for sections in either the Berkeley Hills Tunnel or the Transbay Tube. (Since there is no special ventilation scheme for the remainder of the system, input on smoke location and length of the train is required only for the tunnel and tube.) If the location entered is within the appropriate mileage markers on the M-line, the user is then prompted to enter a train length of between 3 and 10. As mentioned previously, an inaccurate entry will not be accepted. The user is then prompted to enter a value for the location of the fire. Only five options are permitted: (1) an exact value between 1 and 10 to identify the specific car; (2) "F" for front of the train; (3) "R" for rear of the train; (4) "M" for middle of the train; and (5) "U" for unknown.

Figure 3-22 shows the output for an emergency action inquiry involving a Transbay Tube value, 4.6M2 (mileage marker 4.6 on the M-line's Track No. 2), for the location of the train; 5 as the length of the train; and F as the location of the fire. The M-line and Transbay Tube codes shown in Figure 3-22 are as follows: (1) BV = exhaust fans; (2) MV = supply fans; (3) DR = cross-passage door; (4) BD = damper; (5) M = emergency phone; and (6) MR = third rail section.

A number of items on Figure 3-22 should be noted. First, the display shows in outline format many of the items in BART's standard operating procedure. Some procedural items are not shown, such as a prompt for notifying the San Francisco and Oakland fire departments via the hot line. Second, the user input can be revised simply by entering the appropriate number in the "Revise #" prompt. Using the "Revise #" prompt does not always affect the program-generated values shown on the display. Obviously, the values will change if the location of the train is changed. Also, by changing the length (the numbers of cars), other values, such as "Rear A" values and the number of the car located at a cross-passage door, will change. The damper to be opened might change if the fire location (number 3) changes, because the algorithm is programmed to vent the smoke over the fewest cars.

Finally, virtually all the values displayed are calculated in the Transbay Tube program and are not taken from the AERS files. Speed and accuracy are two principal reasons for this. It is faster to calculate these values than to search the files, obtain the values, and display them. Also, because there is no data to be entered into the files, there is no chance of input errors or of displaying erroneous data from damaged data sets. This ability to calculate the values of the items is a result of the uniformity in the design and construction of the Transbay Tube, in which 300-foot uniform, pre-cast sections were towed to the site, maneuvered into position, flooded, sunk, joined together, and eventually pumped out.

As a result of using uniform 300-foot sections, all values can be calculated using 300 feet as the baseline. Track features, therefore, maintain a numerically constant relationship. For example, the cross-passage doors (DR) are numbered sequentially, and the emergency phones (M) are numbered sequentially odd or even depending on the track (odd on the even numbered track and even on the odd-numbered track). Dampers (BD) are numbered with even numbers on the even track.

The major difficulty in the Transbay Tube is that the uniformity can cause train operator disorientation, resulting in an inability to determine the exact location of the train in the tube. In fact, in the Transbay Tube fire of 1979, the operator experienced difficulty in pinpointing the train location for the controllers. As a result, some additional, easily read identification markers have been added: mileage markers (eventually placed every 50 feet); large numbers painted on the yellow cross-passage doors; numbers to identify the emergency phones, etc.

3.7 PROGRAMS TO MAINTAIN THE FILES

Figure 3-23 shows the BART file maintenance functions and Figure 3-24 shows some of the files maintained. Two control features have been incorporated in the BART file maintenance update process. First, only one supervisor is allowed to update the files. This ensures supervisory accountability for any errors contained in the various files. Second, the software requires the user to review the updated information before it is written onto the file.

3.8 OTHER FEATURES IN THE BART SOFTWARE

Additional software has been added to the BART AERS installation to handle special control room functions, such as controlling access to the AERS data base; displaying schedules and expected departure times over a brief period of time; updating train schedules; collecting and displaying daily performance statistics; and displaying messages at an appropriate time, including special maintenance work being performed. These functions are itemized as functions 4 through 6 on the main menu. Because the functions are not applicable to AERS, they are not documented or discussed in this report.

3.9 SUMMARY

BART originally purchased its microprocessors to implement an "Emergency Actions" program, but soon realized that the computers could perform additional emergency and operational data retrieval tasks. The ability of the computer to maintain and operate a data base led to the implementation of an additional function: the display of relevant information that a central controller may need for any location in the transit system. This eliminated the problem of accessing information recorded in different places by making all necessary information easily obtainable from a single source.

In summary, prior to AERS, it was necessary in the event of an emergency to:

1. Consult procedures and, if applicable, the Emergency Plan.
2. Consult Decision Trees (as required).
3. Consult Track Maps.
4. Consult emergency ventilation regimes (as required).
5. Determine fire jurisdictions, if applicable.
6. Double-check information.
7. Disseminate information.

The microprocessor has achieved the following objectives:

1. Provides rapid access to information.
2. Ensures accuracy of information.
3. Reduces error potential.
4. Ensures consistency of results.
5. Concentrates all required emergency information in a single location.

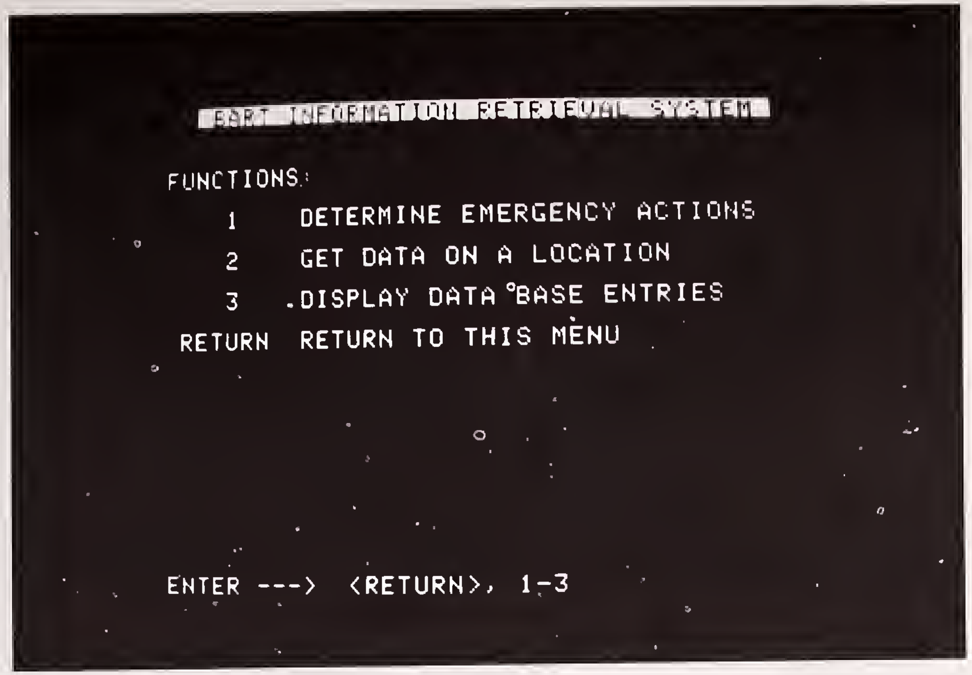

FIGURE 3-1. BART MAIN MENU

FIGURE 3-2. DATA RETRIEVAL ON A LOCATION (FUNCTION 2)

FIGURE 3-3. DATA RETRIEVAL ON A LOCATION (FUNCTION 2); RETRIEVAL FOR 5.5 MILEPOST ON THE C-LINE

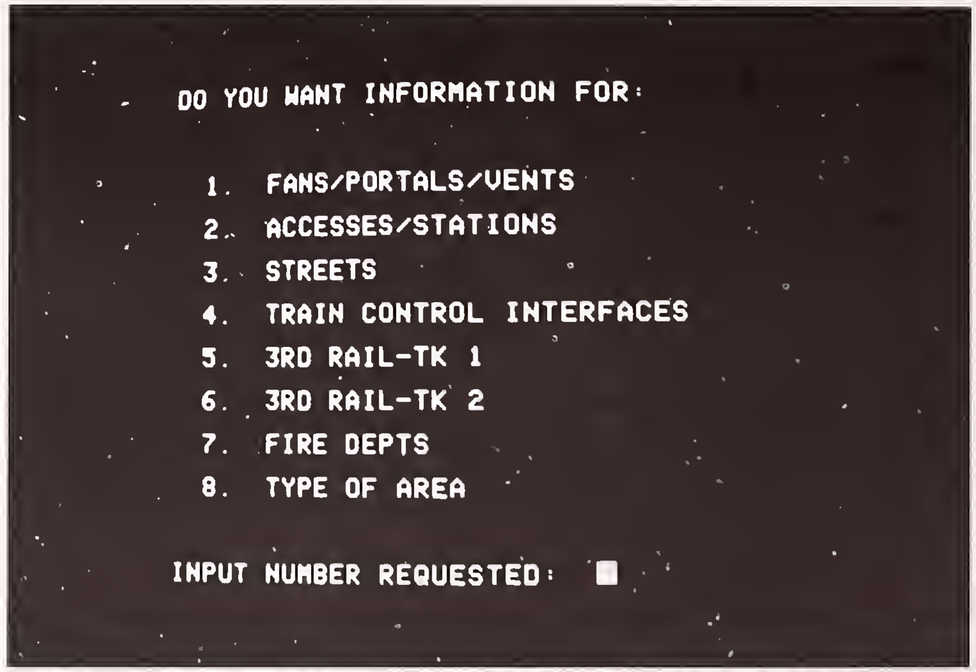

FIGURE 3-4. RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3)

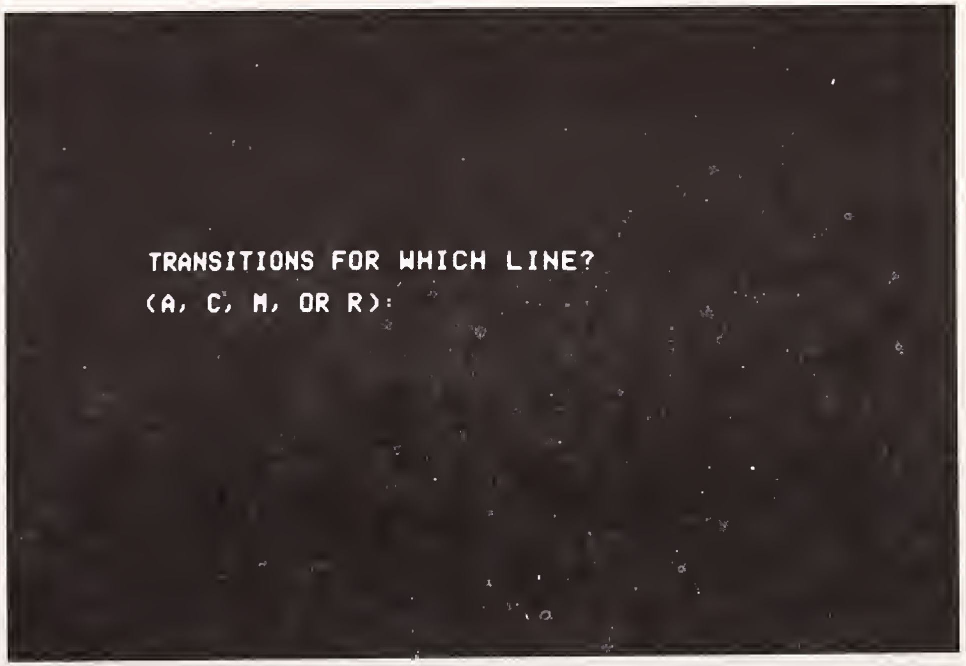

FIGURE 3-5. SUBORDINATE MENU FOR RETRIEVING DATA BASE ENTRIES (FUNCTION 3)

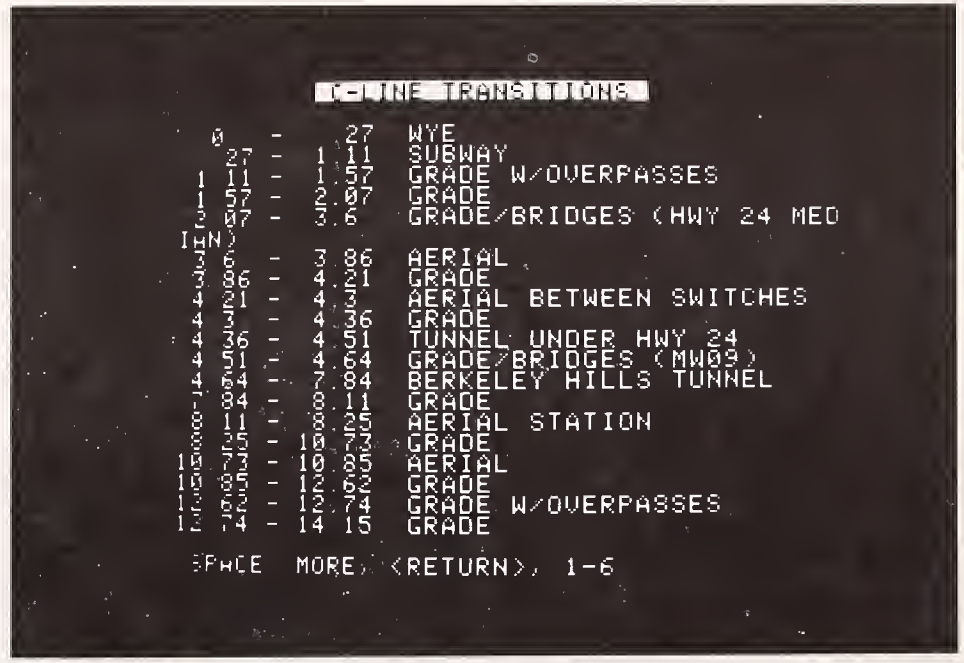

FIGURE 3-6. RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE TRANSITIONS

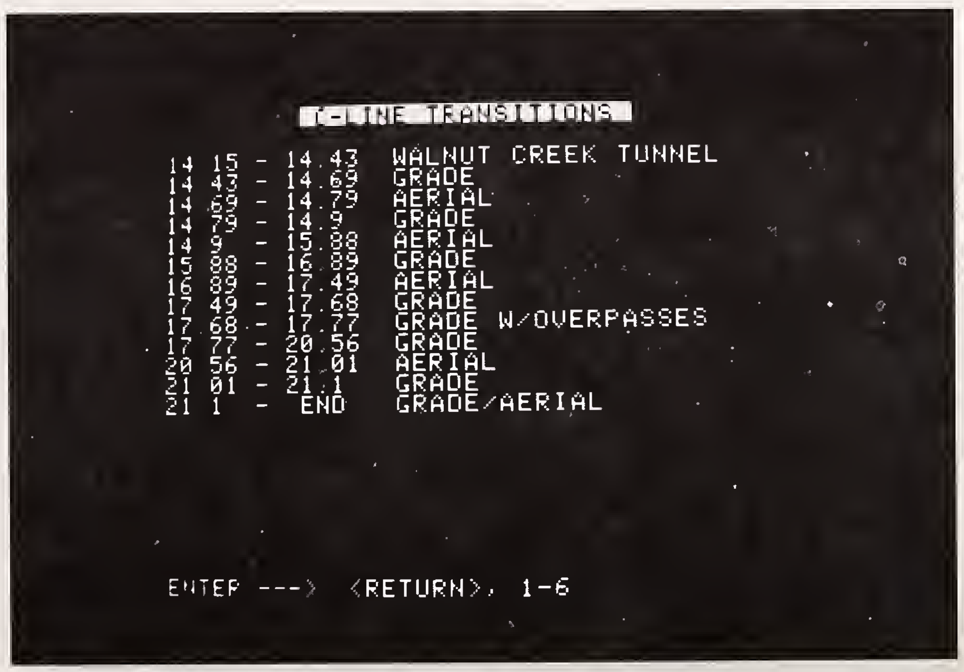

FIGURE 3-7. RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), SCREEN 2 OF C-LINE TRANSITIONS

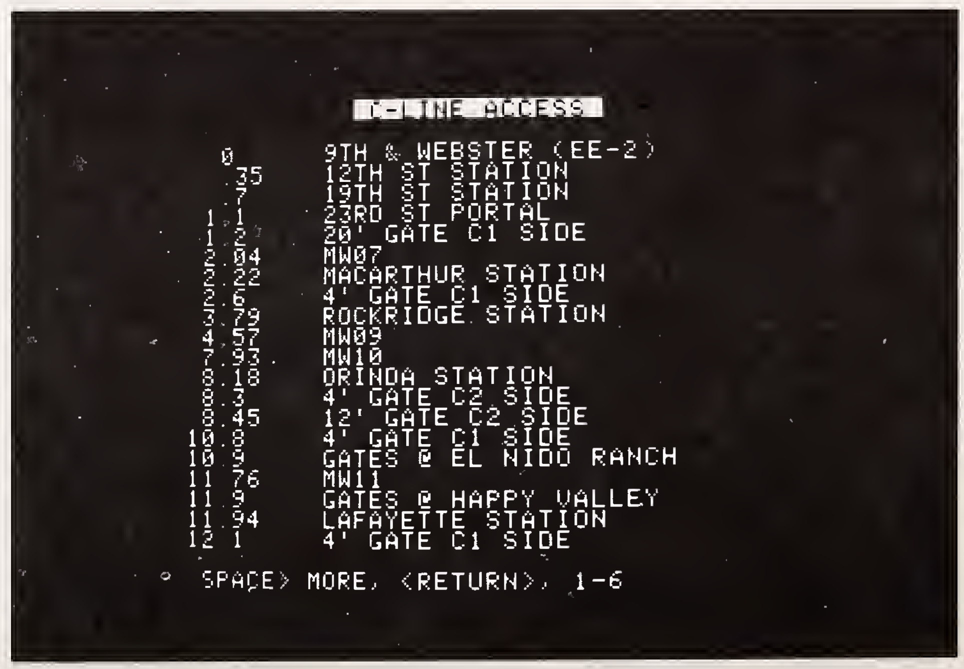

FIGURE 3-8. RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE ACCESS POINTS

FIGURE 3-9. RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE FIRE DEPARTMENTS

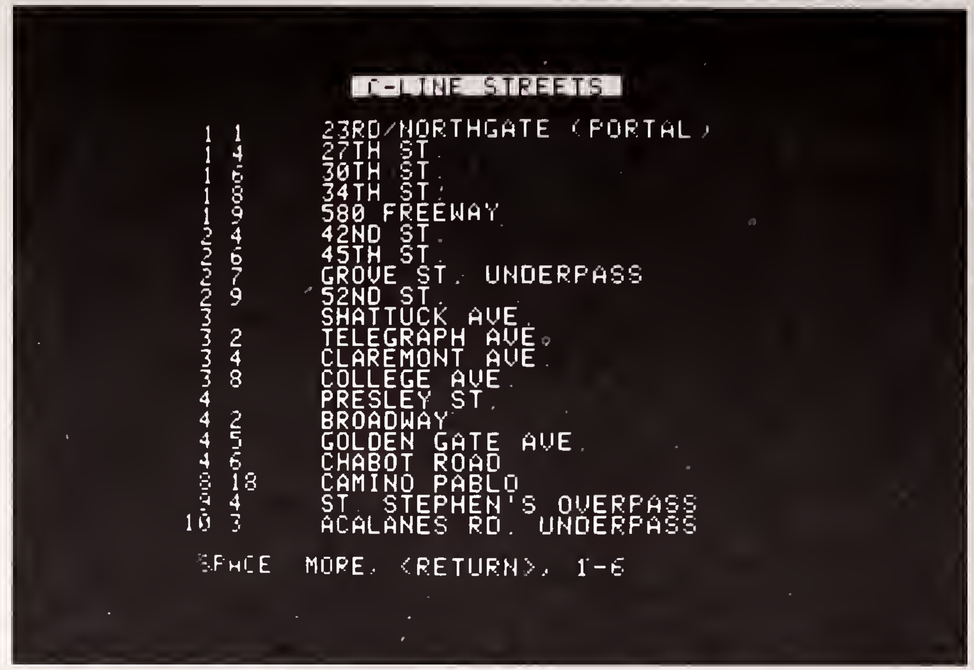

FIGURE 3-10. RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE STREETS

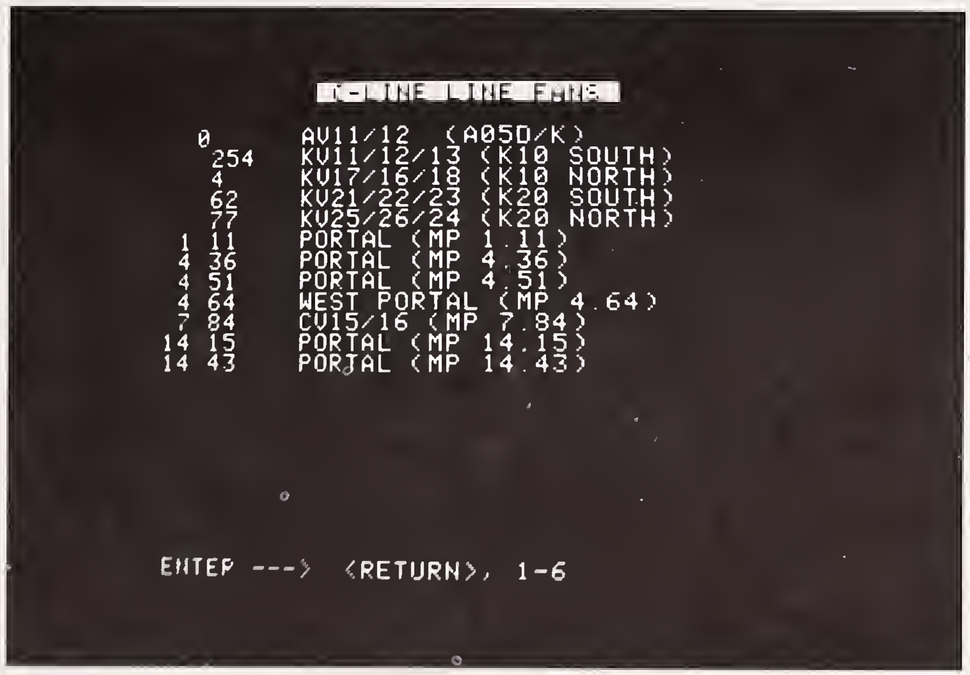

FIGURE 3-11. RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE FANS

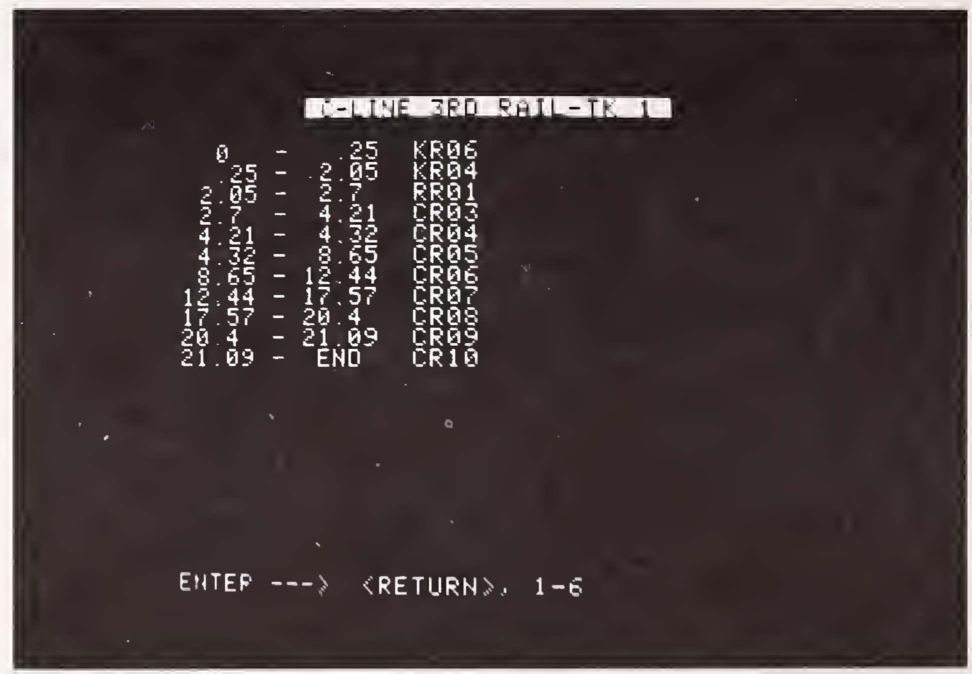

FIGURE 3-12. RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE THIRD RAILS - TRACK 1

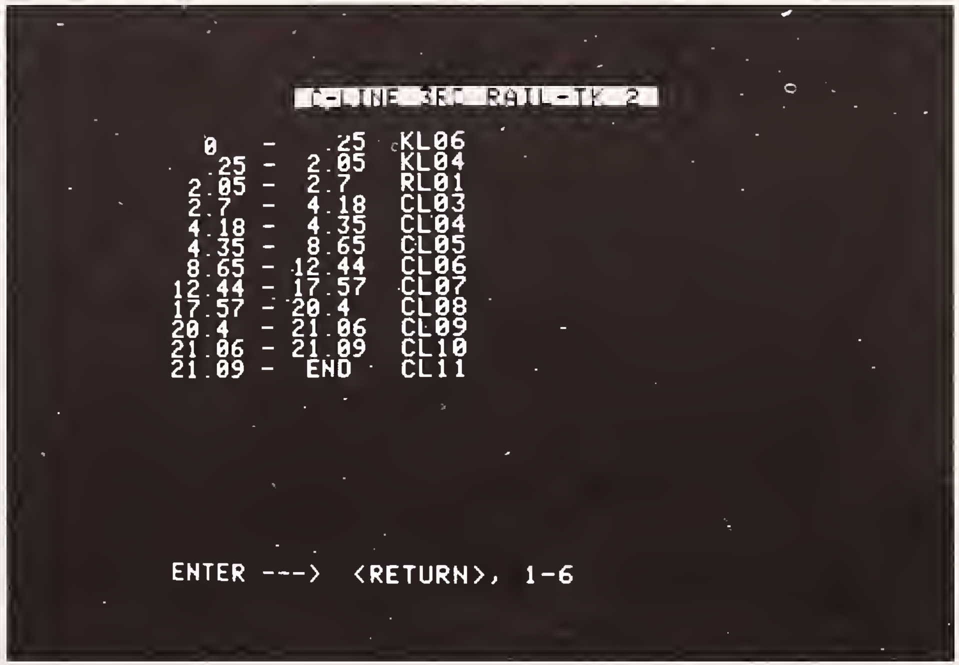

FIGURE 3-13. RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE THIRD RAILS - TRACK 2

FIGURE 3-14. RETRIEVAL OF DATA BASE ENTRIES (FUNCTION 3), C-LINE INTERFACES

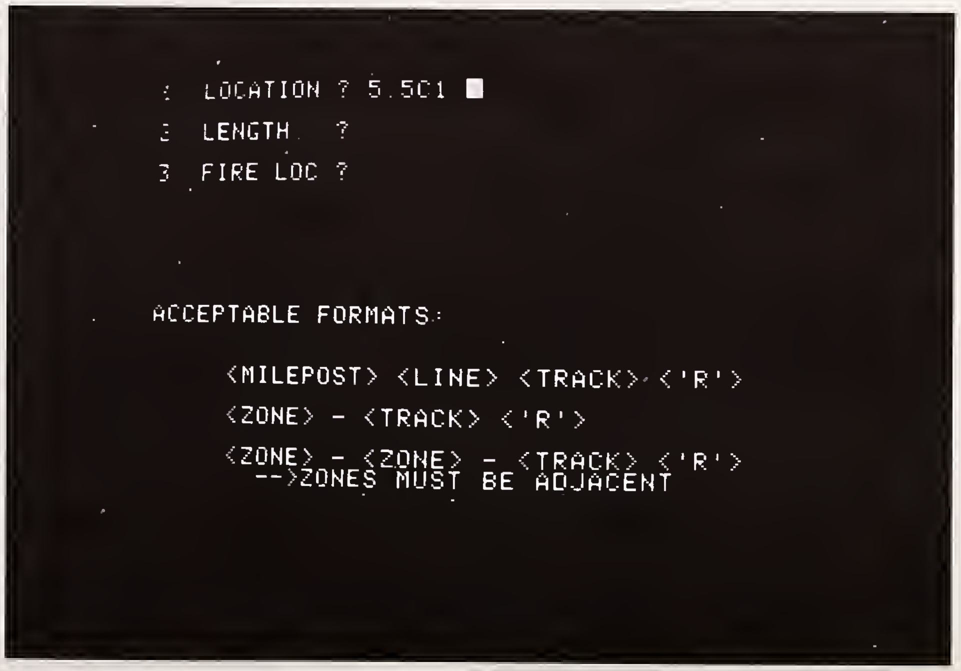

FIGURE 3-15. ENERGENCY ACTION SOFTWARE (FUNCTION 1), FIRST USER ENTRY

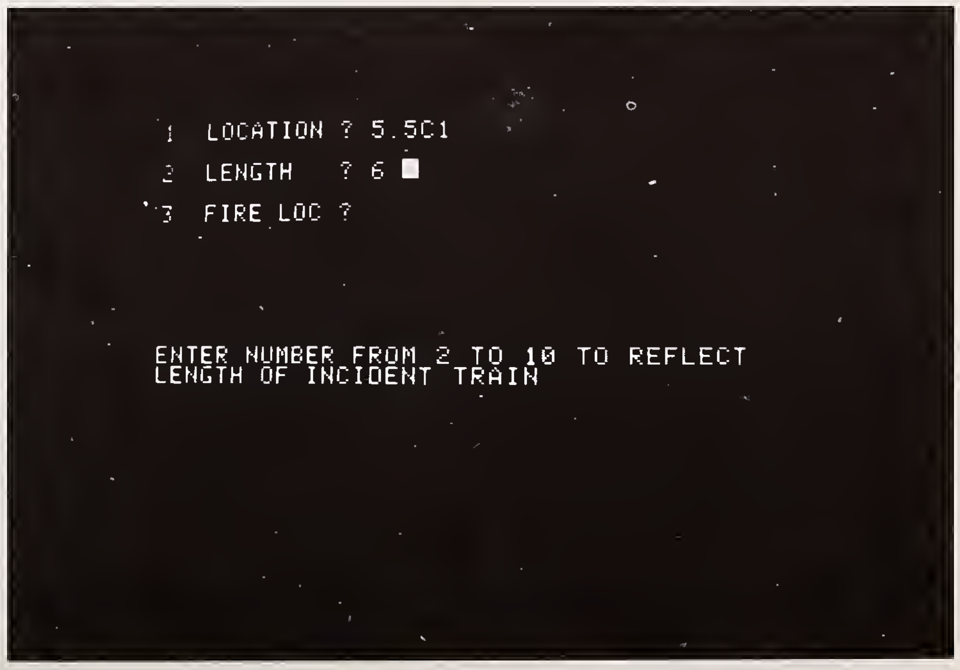

FIGURE 3-16. EMERGENCY ACTION SOFTWARE FOR THE BERKELEY HILLS TUNNEL, SECOND USER ENTRY

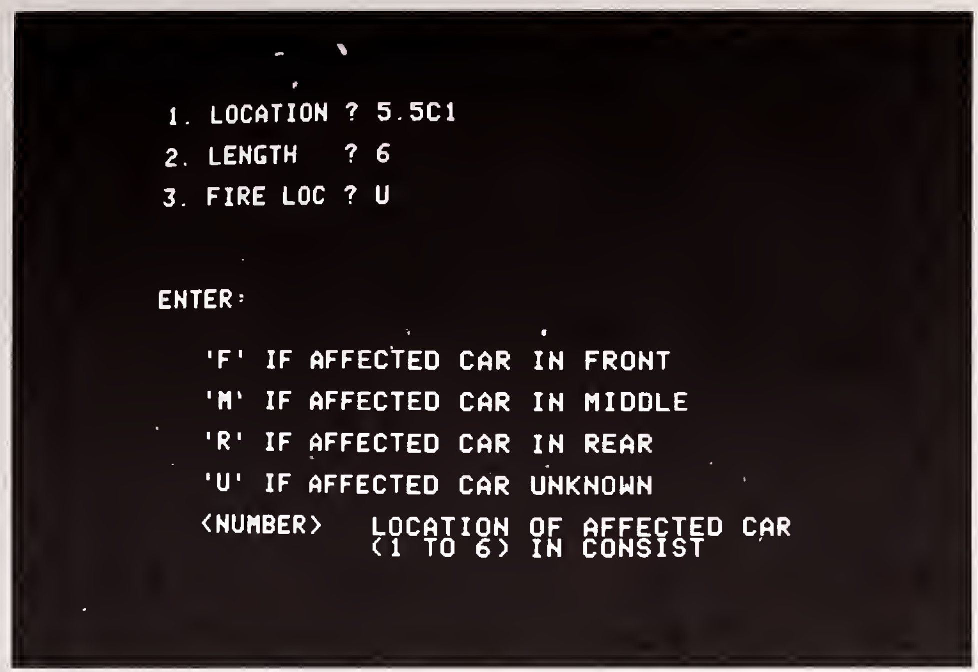

FIGURE 3-17. EMERGENCY ACTION SOFTWARE FOR THE BERKELEY HILLS TUNNEL, THIRD USER ENTRY

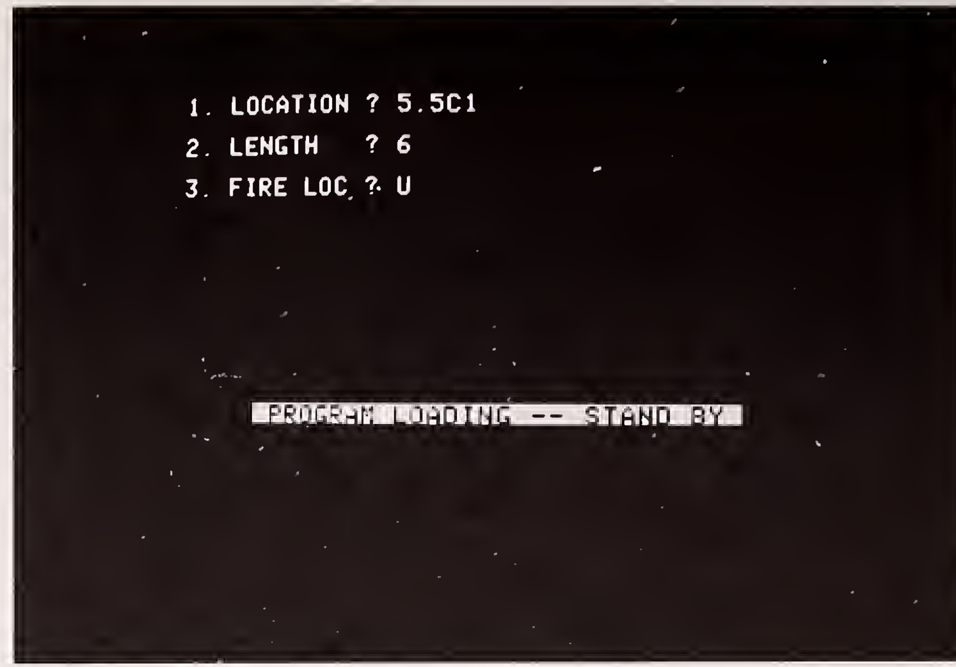

FIGURE 3-18. EMERGENCY ACTION SOFTWARE FOR THE BERKELEY HILLS TUNNEL, PROGRAM EXECUTION DISPLAY

FIGURE 3-19. EMERGENCY ACTION SOFTWARE FOR THE BERKELEY HILLS TUNNEL, RESULTING DISPLAY

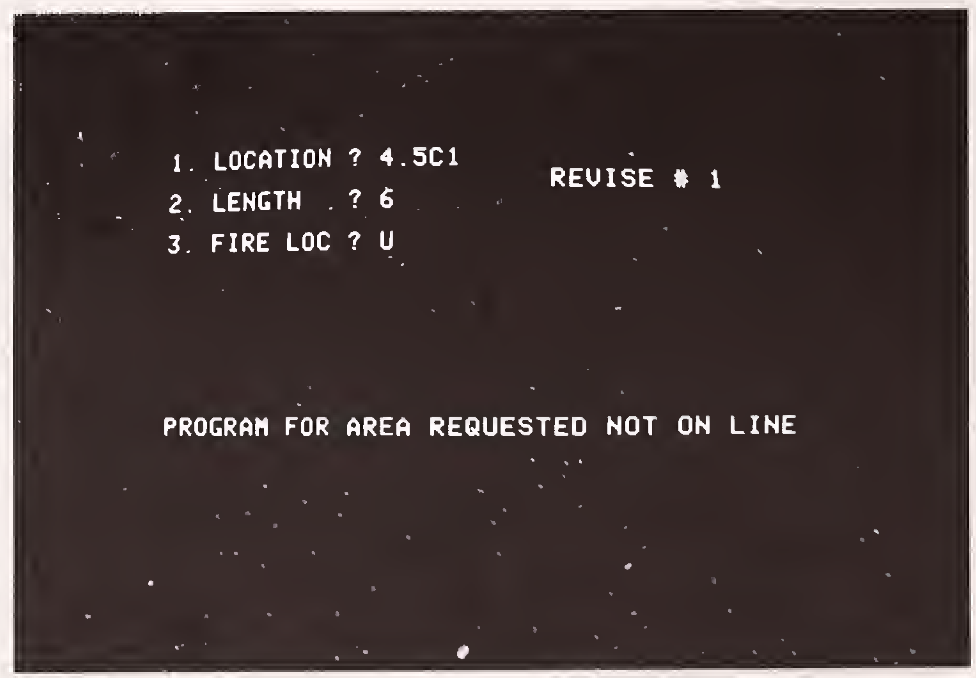

FIGURE 3-20. EMERGENCY ACTION SOFTWARE, C-LINE LOCATION NOT COVERED BY BHT PROGRAM

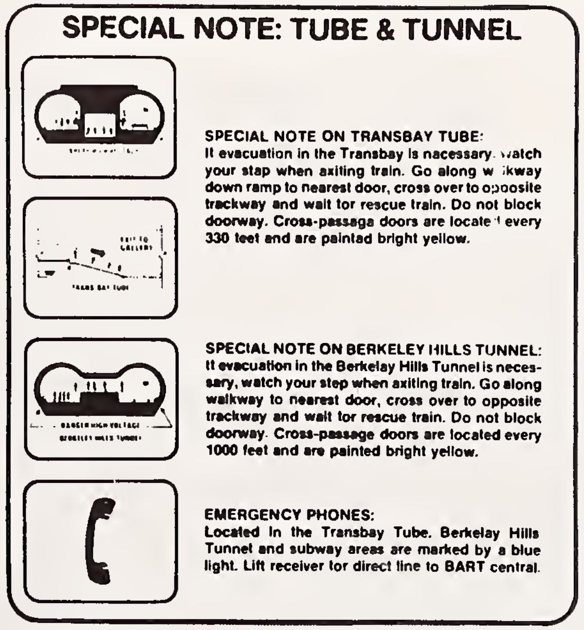

FIGURE 3-21. TUBE AND TUNNEL EMERGENCY INSTRUCTIONS

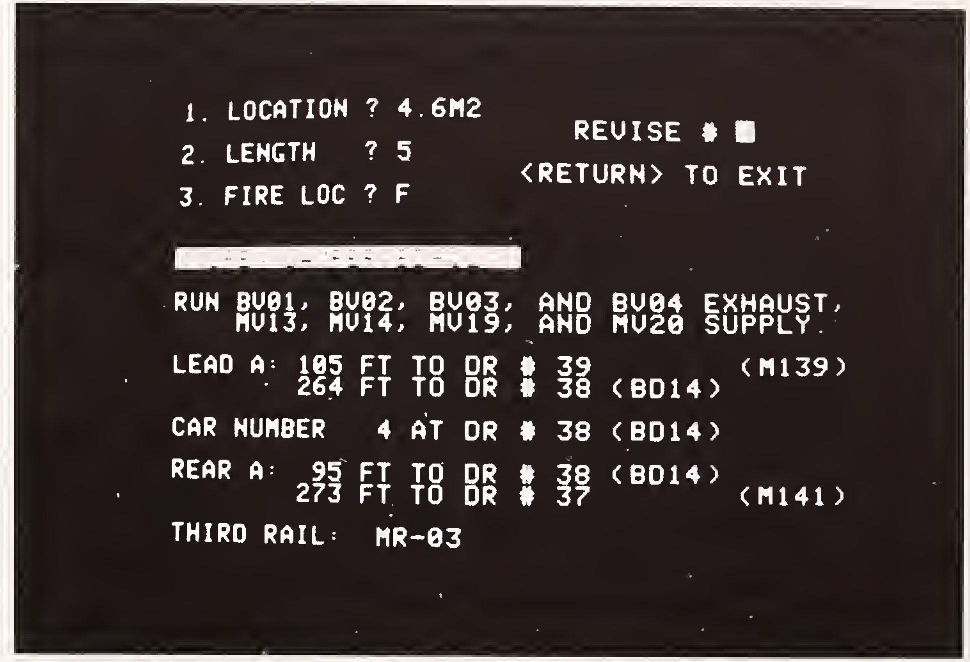

FIGURE 3-22. EMERGENCY ACTION SOFTWARE, TRANSBAY TUBE

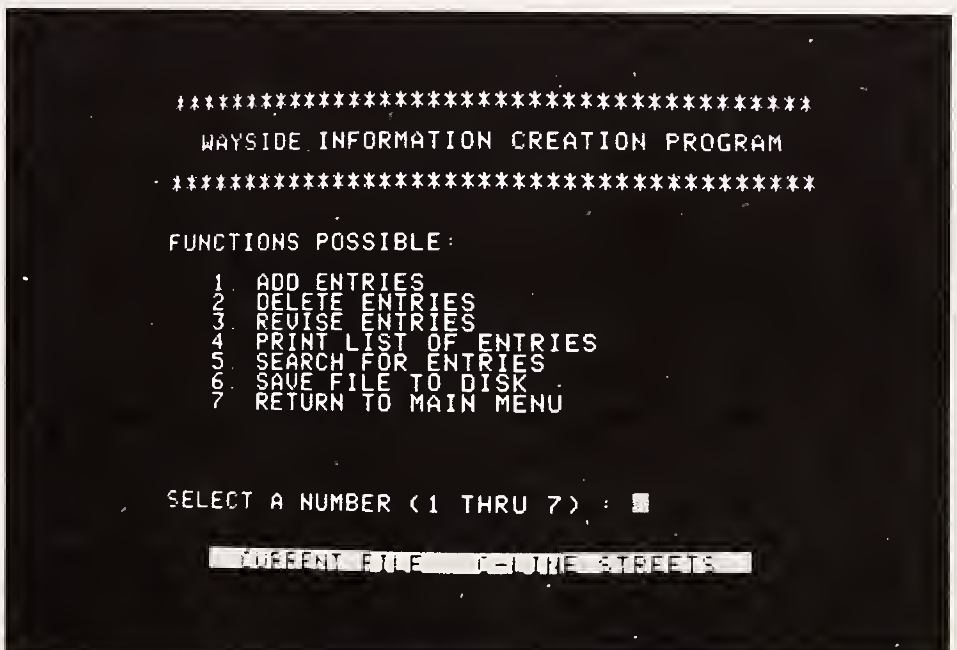

FIGURE 3-23. BART FILE MAINTENANCE MENU

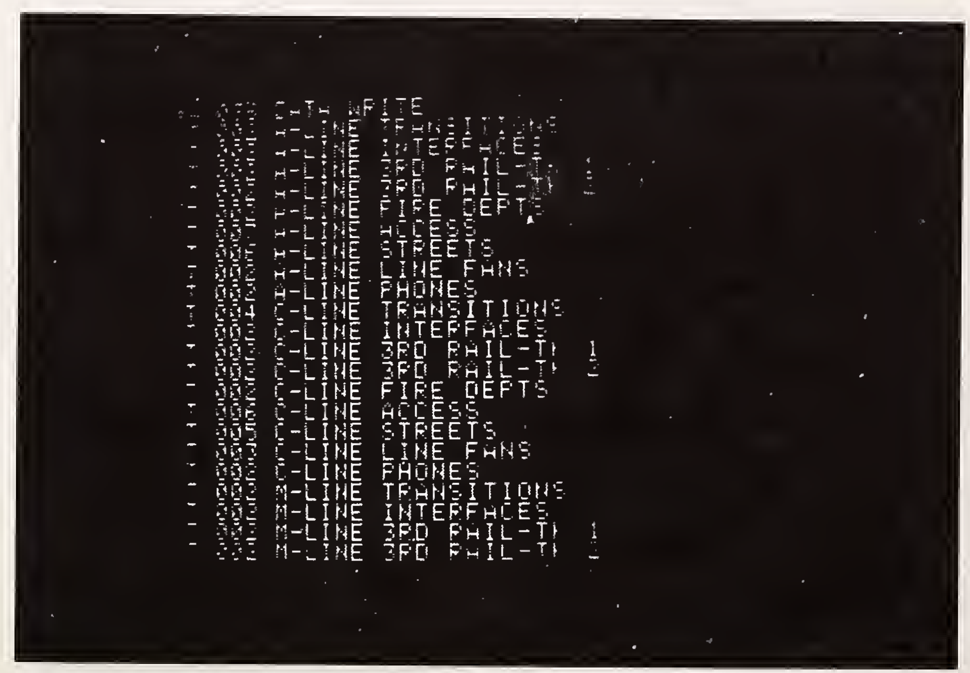

FIGURE 3-24. LISTING OF SELECTED FILES MAINTAINED USING UPDATE PROGRAM FOR BART

4. DEVELOPMENT AND DEPLOYMENT OF THE WMATA AERS DEMONSTRATION SYSTEM

4.1 DEPLOYMENT ACTIVITIES

In response to a request from the Washington Metropolitan Area Transit Authority (WMATA), UMTA, BART and TSC established a deployment team to deploy a version of AERS at WMATA. The demonstration software used at WMATA was patterned after the BART AERS software. Files were established for the C-line (Metro Station to the Washington National Airport Station).

The BART software was converted to fit the WMATA environment. For example, because WMATA uses engineering chain markers instead of the mileage markers used by BART, an appropriate location marker conversion was made. The BART software was also rewritten to:

1. Provide emergency action data showing the WMATA ventilation scheme for the C-line, which employs station fans to vent smoke from the tunnel environment.
2. Retrieve data using station codes similar to the existing 3 digit BART codes. The WMATA station codes were truncated to 3 digits - for example C01 to C10 in place of the C001 to C010 codes used on engineering drawings.
3. Use location indicators consisting of line letters and chain markers to retrieve and update data.

The demonstration system was installed over a three-day period in December 1982. During this time, training sessions were conducted for selected train controller/dispatchers. Separate workshops were conducted for the train control room supervisory staff, the programming staff, management staff and transportation department managers.

Although not all controllers were trained, each of the selected members of the control room staff received at least 10 hours of hands-on training over the three-day period. Specifically, a group of first shift controllers and one supervisor (assistant superintendent) met daily between 9:30 am and 2:00 pm and a similar group of second and third shift controllers and an assistant superintendent met daily between 6:30 pm and 10:00 pm. A major portion of these sessions was devoted to identifying and discussing specific requirements of the WMATA train control room that were not contained in the demonstration software and data bases.

Managers, supervisors, and management staff in the transportation department, along with staff from other departments, such as the safety staff, attended workshops which were conducted as required.

The WMATA AERS programs were similar to the BART programs. A few of the major changes in input have already been noted. The following sections itemize some of the more noticeable changes. (All of the figures appear at the end of this section, on pages 30-34.) Figure 4-1 shows the main menu, which, though essentially the same as the one at BART, was revised to include utility (data base update) programs and a function to print out data.

4.2 WMATA AERS DEMONSTRATION SOFTWARE - INFORMATION ON A LOCATION (FUNCTION 2)

Screens shown in Figures 4-2 through 4-5 are essentially the same as those on the parent BART AERS. Figure 4-2 shows the first screen generated when the user opts to retrieve data on a location. As in BART AERS software, the acceptable formats are itemized on the bottom of the screen. Figures 4-3 through 4-5 show the screens that result when the location (line, chain marker or station code) is entered in one of the acceptable formats.

4.3 WMATA AERS DEMONSTRATION SOFTWARE - DISPLAYING DATA BASE ENTRIES (FUNCTION 3)

Figure 4-6 gives the attributes available under the display data base entries function. Figures 4-7 through 4-11 show the displays for attributes 3, 5, 6 and 7 respectively. The C-line screens shown here contain the data originally entered for the workshops. While WMATA's menu and attributes for this function essentially duplicate those of the BART AERS, the WMATA data in fact lack the precise detail that characterizes the BART data sets.

4.4 WMATA AERS DEMONSTRATION SYSTEM - PROGRAMS TO UPDATE A FILE (FUNCTION 4)

The WMATA AERS contains a utility program function that allows supervisory personnel to update files. Figures 4-12 through 4-15 show the various prompts involved in the update process. Because nonsupervisory employees at

WMATA do not have access to the microcomputer and AERS software, control of file maintenance updates is of less concern. Thus the update process, which, as at BART, is the responsibility of the supervisors, can be included as a function on the main menu.

4.5 WMATA AERS DEMONSTRATION SYSTEM - EMERGENCY ACTION DATA (FUNCTION 1)

The demonstration emergency action data display contains a rough outline of the ventilation and rescue plan for the transit system's C-line as it existed in December 1982. The plan was provided by the WMATA safety department and covered two situations: (1) fire in a subway tunnel and (2) fire in a station. Because the strategy of the emergency plan is to ventilate the tunnels using the station fans, evacuation of the station(s) through which smoke is being vented will sometimes be required. The emergency action procedures display is designed to indicate such things as when to evacuate a station. Figures 4-16 through 4-18 show sample screens for a fire occurring on the C-line at chain marker 3500 (location marker C 3500) for the WMATA demonstration system.

Figure 4-19 shows the screen for a fire incident occurring at a station, and Figure 4-20 shows the screen for an incident occurring outside of a tunnel. Note that at the time of the demonstration and deployment, WMATA had not identified any areas comparable to BART's Transbay Tube and the Berkeley Hills Tunnel, for which special programs would be necessary. After deployment, however, a number of such areas were identified: Benning Road Station and Tunnel, Capitol Heights Station; and the Addison Road Station and Tunnel. Because they were not part of the C-line, none of these segments was included in the demonstration software and data sets.

4.6 ADDITIONAL REQUIREMENTS IDENTIFIED DURING THE INSTALLATION OF THE DEMONSTRATION AERS

Additional requirements identified by controller/dispatchers and assistant superintendents are presented in this section. The process of identifying the requirements, which proved especially effective, is discussed in section 4.7.

The requirements for central control microprocessors recommended by central control supervisors, and revalidated in a survey of the supervisors conducted in September 1983, are listed below (some of these requirements were not supported by all controllers):

1. Include "+" in chain markers for the AERS software to correlate them with the chain markers shown on engineering drawings, etc.

2. Include the origin for the following alarm points:

   (a) flammable vapor detectors (FVD alarms)

   (b) trainway zones

   (c) speed restrictions

   (d) fire alarm locations

   (e) subway drainage pump stations (DPSs)

   (f) aerial structures

   (g) gaps in third rail

3. Include other railroad markers parallel to WMATA trainway, e.g., B&O, Conrail, AMTRAK, et al.

4. Add a power map by chain markers.

5. Add the tunnel cross-passages and crossovers which can be used to evacuate a track.

6. Add the closest usable exits (since some exits, ladders in fan shafts for example, are not usable).

7. Highlight switches that are automatically restored.

8. Show a checklist of emergency procedures and information - a print-out of "bullets" outlining the steps. (Note: this has already been done.)

9. Print a checklist for emergencies on which the controllers can insert additional information, such as the name of the fire department official in charge.

10. Add Metro system phone numbers, e.g., train control rooms, maintenance phones, and emergency phones by chain markers.

11. Add chain markers related to vital points, e.g., stations and interlockings.

12. Add station platform graphics for above-ground and underground stations with street address, fire hydrant, normal and emergency exits.

13. Add bus terminal and emergency shuttle stop locations as they relate to train stations.

14. Print a checklist for train troubleshooting, such as for proper closure of doors.

15. Print the general orders affecting train operations.

16. Print a daily operations summary, including statistics on train control activity.

17. Show statistics, such as the monthly operation summary report (graphs and charts).

18. Add train schedules (a low priority item for management).

19. Show the station fans, shaft fans, vent locations and their control points.

20. Add data for additional lines.

21. Show maximum speed limits for all areas of the railroad.

22. Show a graphic layout of the system, including:

    (a) grade level

    (b) tunnel, surface, or aerial

    (c) fan shafts, vent shafts

    (d) emergency exits

The controllers in the workshops also suggested: (1) implementing a controller exchange program with other mass transit systems; (2) training in APPLESOFT BASIC for controllers; (3) honoring the Rail Transportation Directorate request that chain markers be added to the system in 100-foot intervals; (4) acquisition of additional microprocessors.

As expected, some of the additional requirements were due to the system characteristics and features of WMATA, which are quite different from the BART system. For example, WMATA has an extensive supplemental bus service which can be pressed into service when appropriate. Coordinating service to get the patrons to leave the stations at the proper exits can be a time-consuming process for the staff of central control. Similarly, any activity that requires the controller/dispatchers to get in-house or outside personnel to a specific location at any station or station exit requires extensive coordination and communications skills. There have been a few instances where buses, firemen and emergency staff arrived at the incorrect station, station platform, station exit, etc.

Due to time constraints and prior commitments, the only requirement addressed during the workshops was the extension of the software to incorporate other lines. Controller/dispatchers and assistant superintendents did in fact add data in their workshops for the K-line (Ballston to Rosslyn stations).

4.7 IDENTIFICATION OF ADDITIONAL REQUIREMENTS AND PRIORITY SETTING

This section discusses the unique process used at WMATA to collect the requirements covered in the preceding section, and shows how the workshop sessions were used to establish the priorities for these requirements. Since no new requirements were initially envisioned, the process of identifying the requirements is briefly described below.

The process began during the first evening's workshop for second and third shift controller/dispatchers. Because the session had proceeded more quickly than expected, the collection of additional AERS requirements was approached a day earlier than originally planned. At first, the controller/dispatchers were surprisingly reluctant to recommend additions. After much prodding, and after assurances that these recommendations would not be taken as criticism of the demonstration system, and that the requirements would be discussed with WMATA management, the compilation of a list began in earnest. Nearly a dozen unique requirements were identified that evening. The next day, the first shift controller/dispatchers followed their lead, and in an almost competitive spirit identified an additional half-dozen requirements.

In summary, conventional techniques for identifying requirements were not used. Instead, the informal brainstorming sessions conducted among the controller/dispatchers and assistant superintendents who actually work in the system produced the requirements listing.

Priority setting was less difficult. A series of management overview workshops was begun in which additional requirements were briefly reviewed and priorities set. The only differences of opinion came in matters relating to schedules, which are low priority items for the safety staff.

4.8 SUMMARY

The demonstration software was successfully deployed and enthusiastically received by the controller staff. (Some controllers, in fact, took programming courses at local educational institutions - on their own time and at their own expense - in order to reprogram and extend the AERS.) Users were trained, management and staff were briefed, and computer support staff provided with details required to extend the demonstration software to other lines. Also, additional requirements unique to WMATA were enumerated.

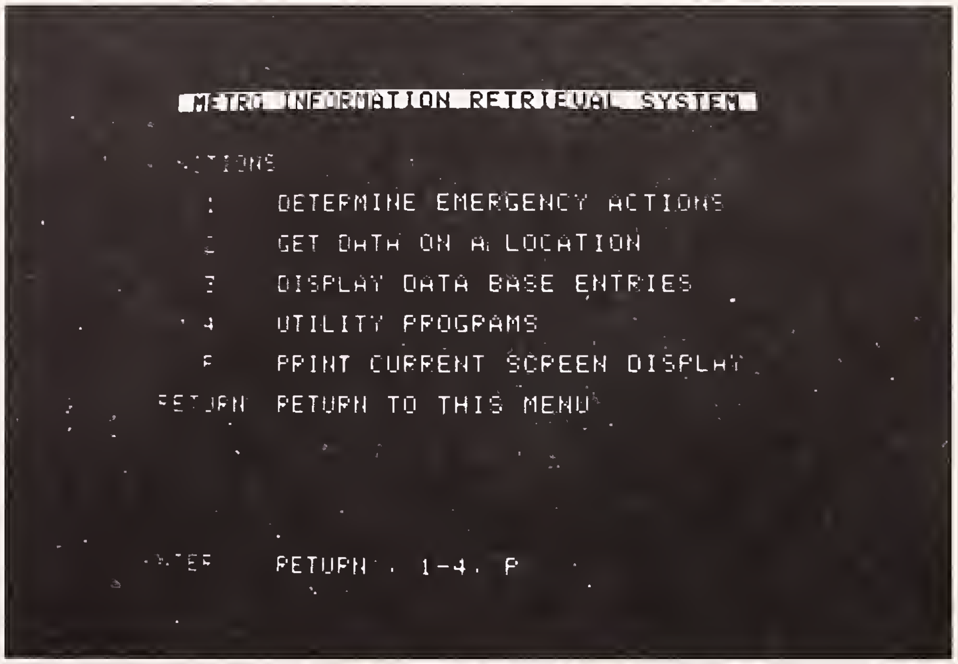

FIGURE 4-1. WMATA MAIN MENU

FIGURE 4-2. WMATA DEMONSTRATION AERS, DISPLAY INFORMATION ON A LOCATION (FUNCTION 2), FIRST SCREEN

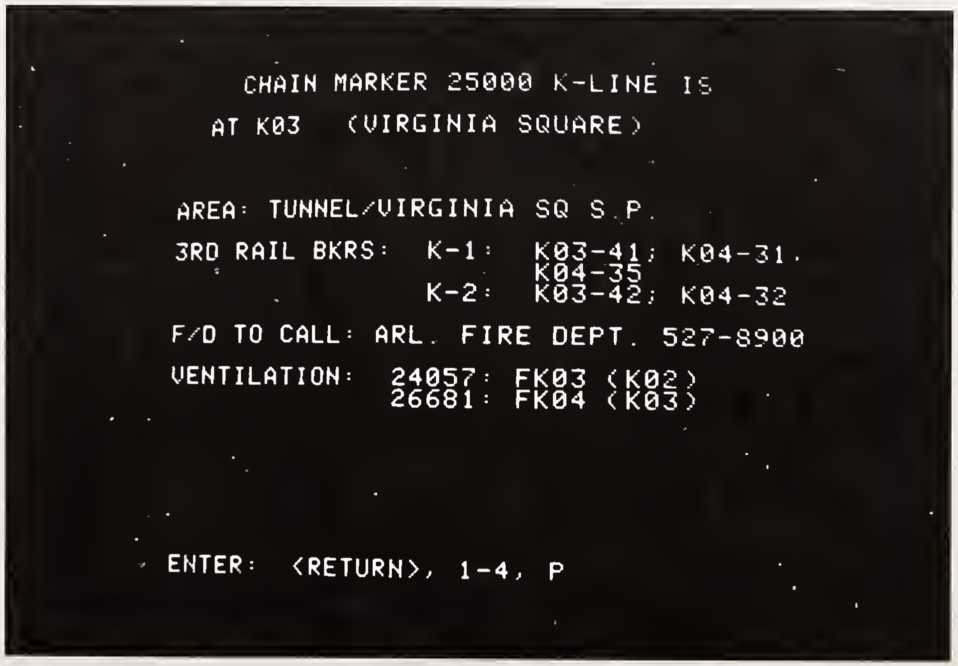

FIGURE 4-3. DATA RETRIEVAL ON LOCATION (FUNCTION 2) INPUT FOR K-LINE CHAIN MARKER 25000

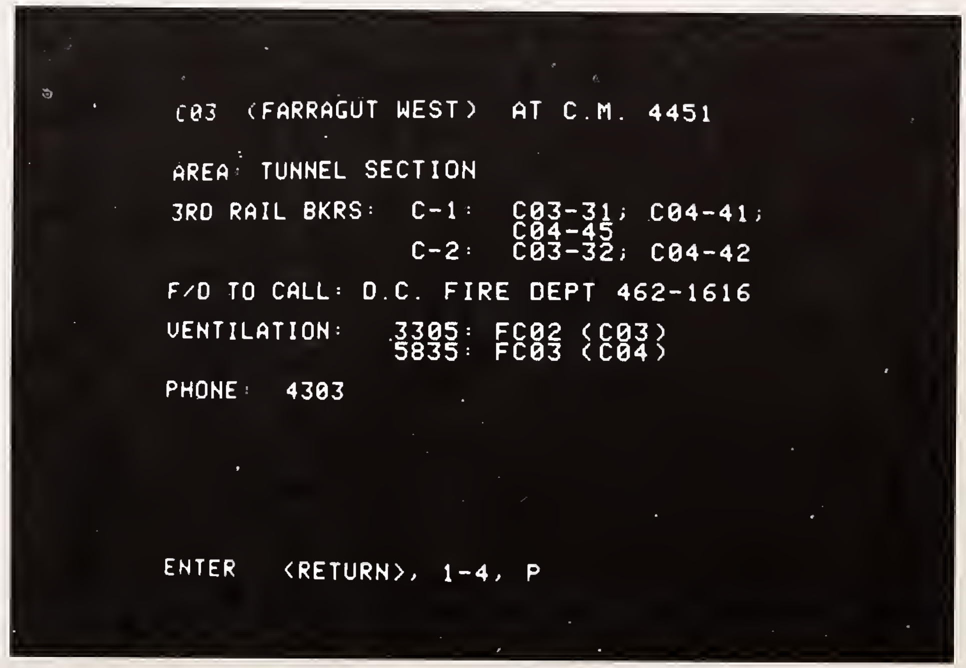

FIGURE 4-4. DATA RETRIEVAL ON A LOCATION (FUNCTION 2) INPUT, STATION CODE

FIGURE 4-5. DATA RETRIEVAL ON A LOCATION (FUNCTION 2) INPUT, STATION CODE

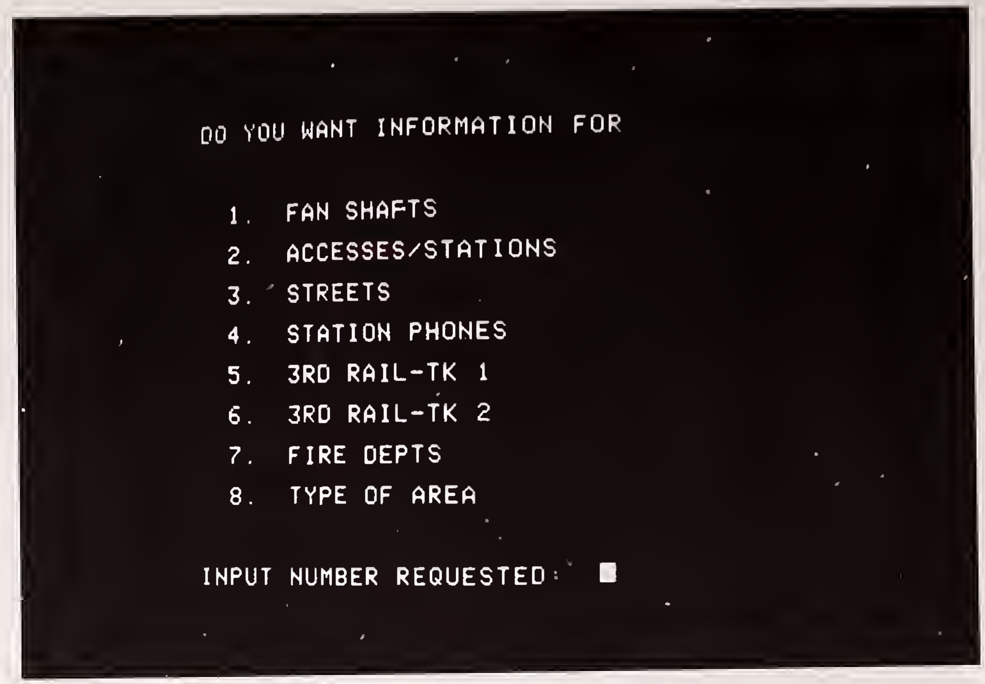

FIGURE 4-6. DISPLAY DATA BASE ENTRIES (FUNCTION 3), FIRST SCREEN

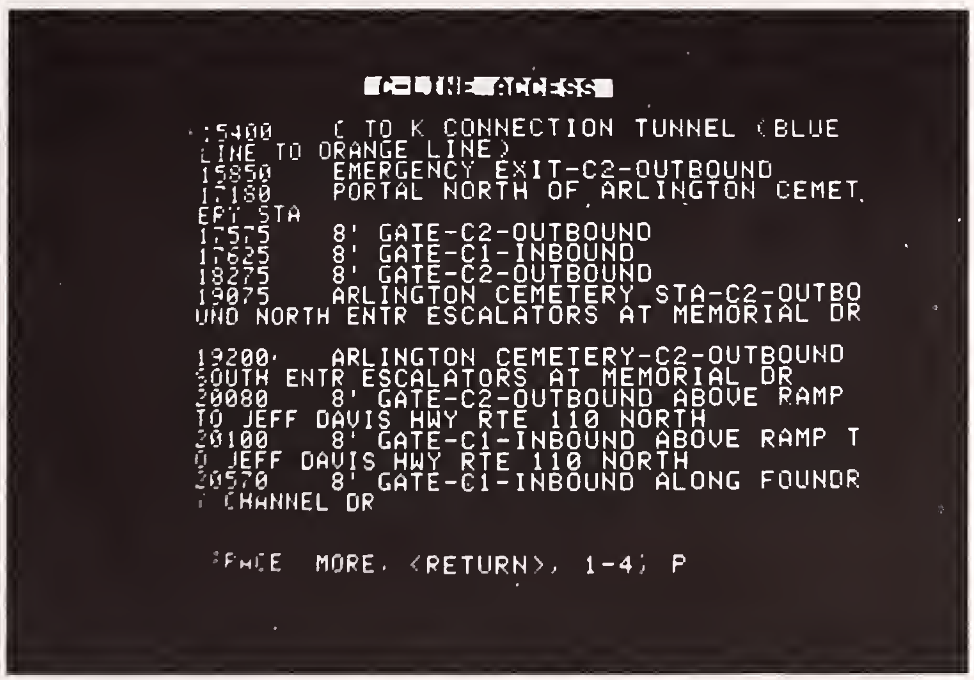

FIGURE 4-7. DISPLAY DATA BASE ENTRIES (FUNCTION 3), C-LINE ACCESS POINTS

FIGURE 4-8. DISPLAY DATA BASE ENTRIES (FUNCTION 3), C-LINE STREETS

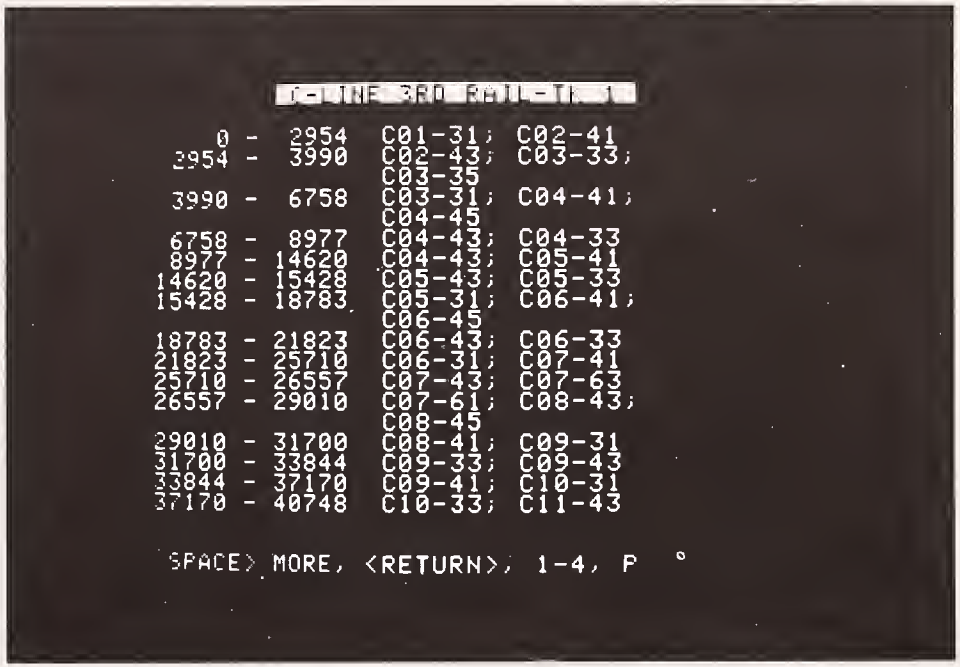

FIGURE 4-9. DISPLAY DATA BASE ENTRIES (FUNCTION 3), C-LINE THIRD RAIL TRACK NO. 1

FIGURE 4-10. DISPLAY DATA BASE ENTRIES (FUNCTION 3), C-LINE THIRD RAIL TRACK NO. 2

FIGURE 4-11. DISPLAY DATA BASE ENTRIES (FUNCTION 3), C-LINE FIRE DEPARTMENTS

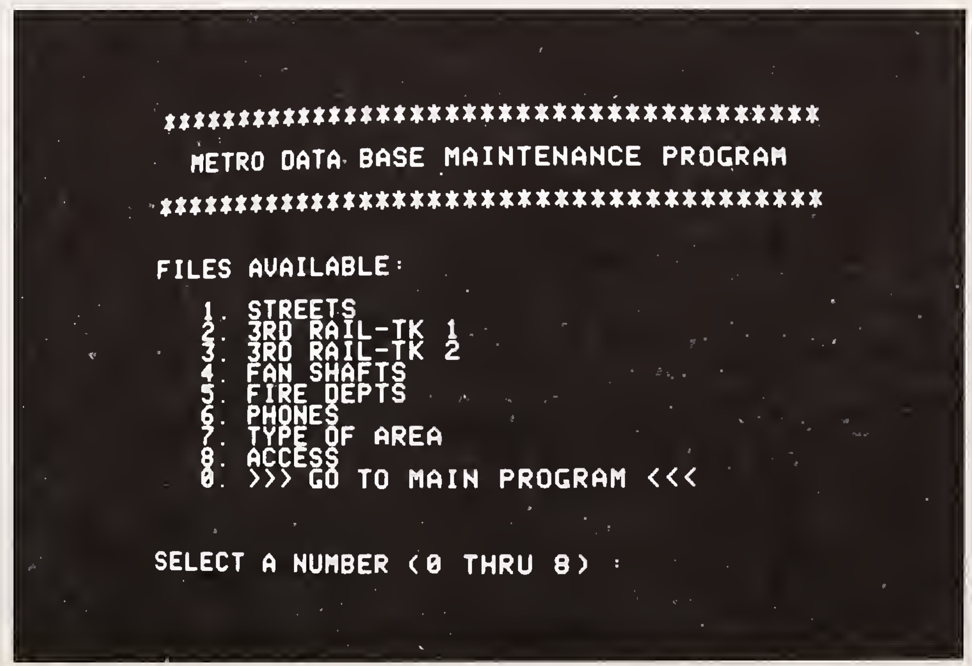

FIGURE 4-12. FILE MAINTENANCE SOFTWARE (FUNCTION 4), FIRST SCREEN

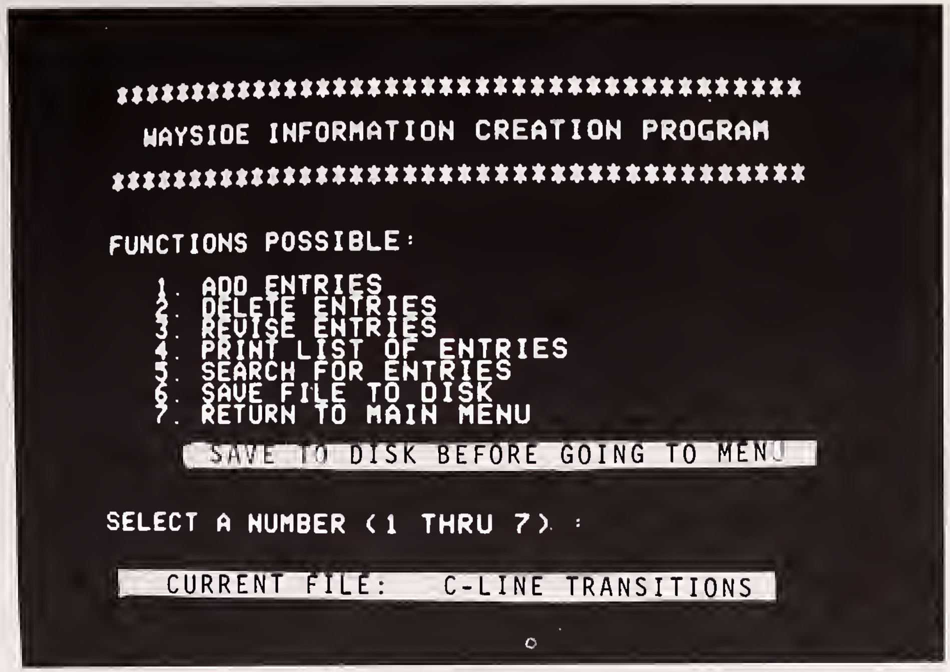

FIGURE 4-13. FILE MAINTENANCE SOFTWARE (FUNCTION 4), SECOND SCREEN

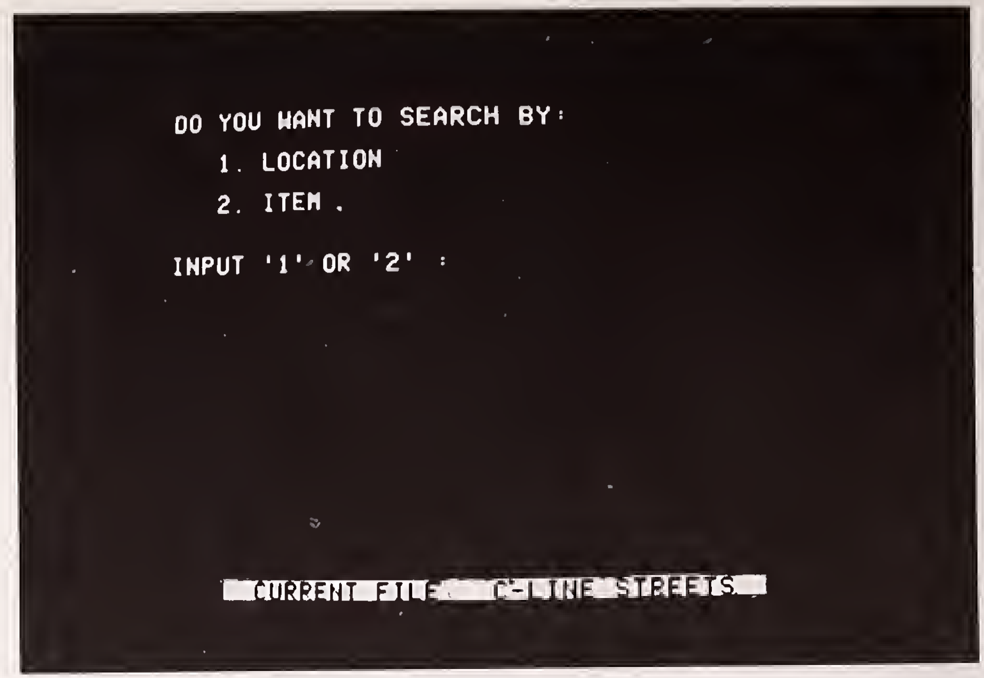

FIGURE 4-14. FILE MAINTENANCE SOFTWARE (FUNCTION 4), SEARCHING A FILE

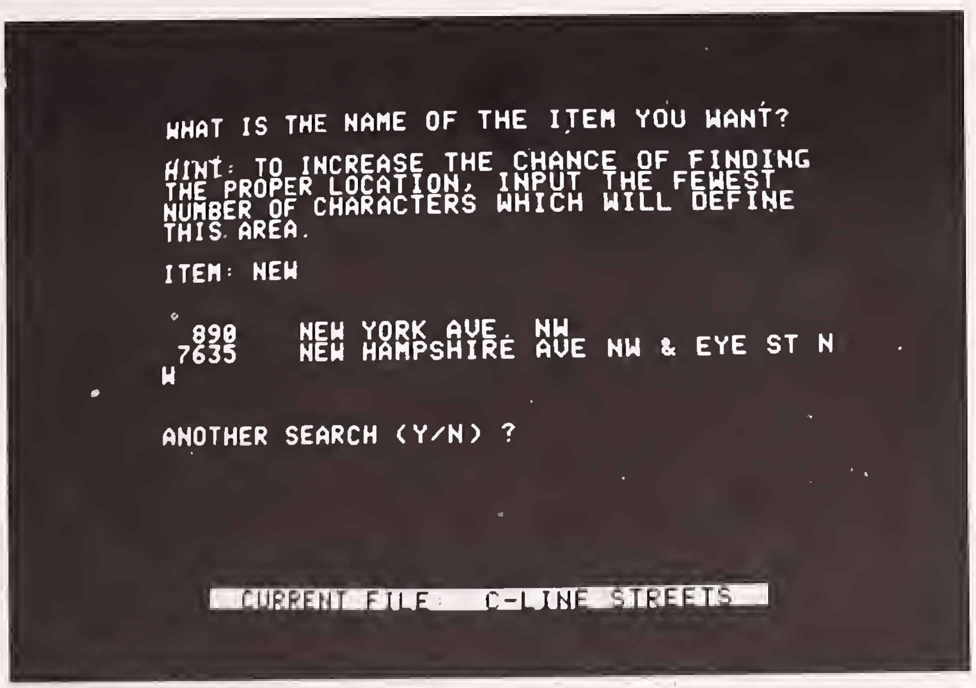

FIGURE 4-15. FILE MAINTENANCE SOFTWARE (FUNCTION 4), SEARCHING A FILE BY RETRIEVING AN ITEM

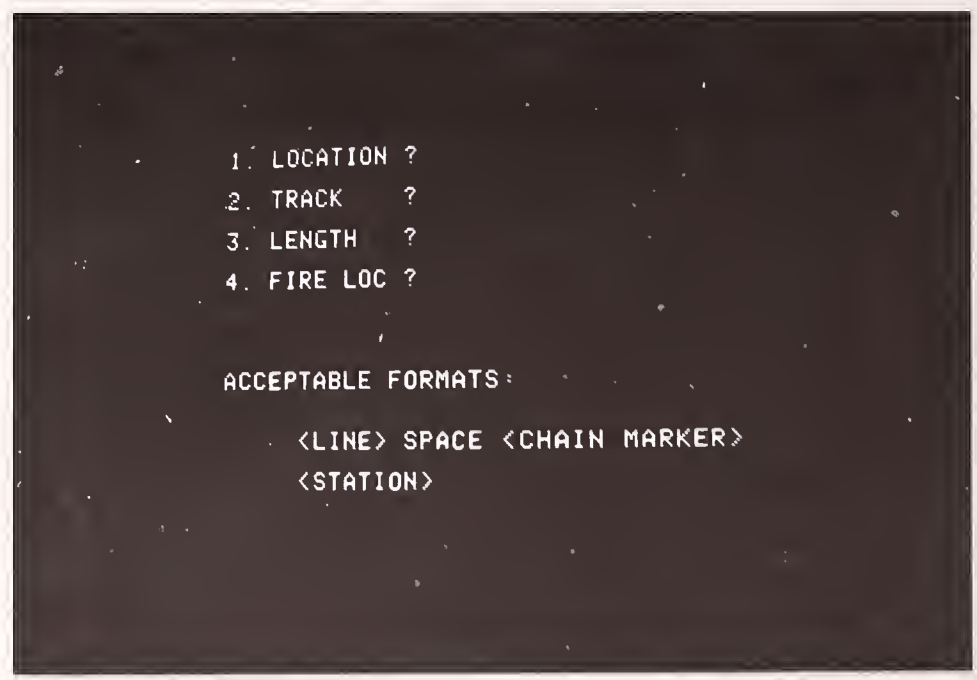

FIGURE 4-16. EMERGENCY ACTION DATA (FUNCTION 1), FIRST SCREEN

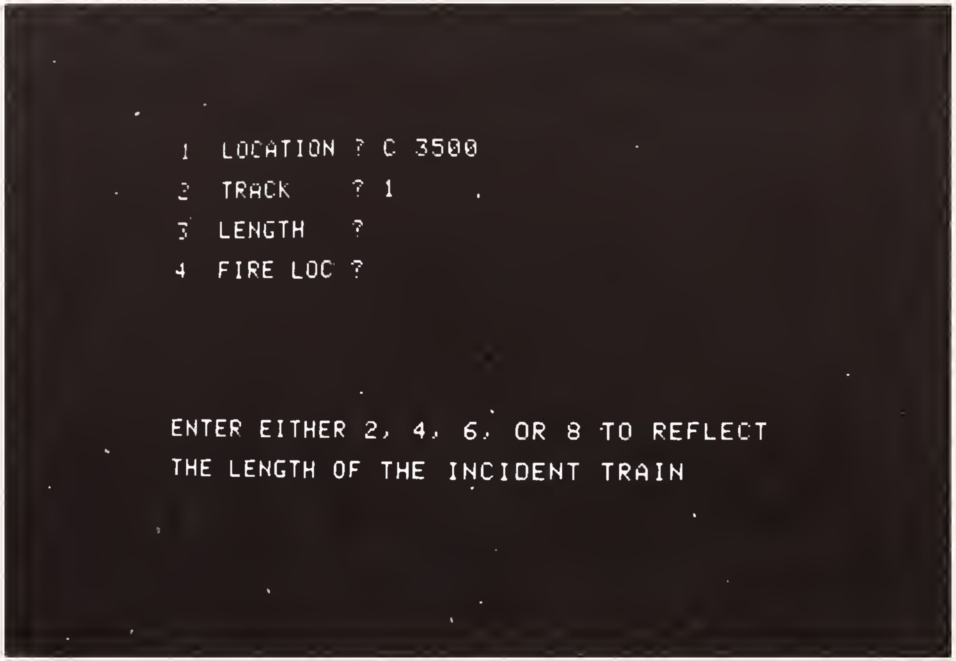

FIGURE 4-17. EMERGENCY ACTION DATA (FUNCTION 1), SECOND SCREEN

FIGURE 4-18. EMERGENCY ACTION DATA (FUNCTION 1): C-LINE, CHAIN MARKER 3500, 6-CAR TRAIN, FIRE LOCATION IN FRONT

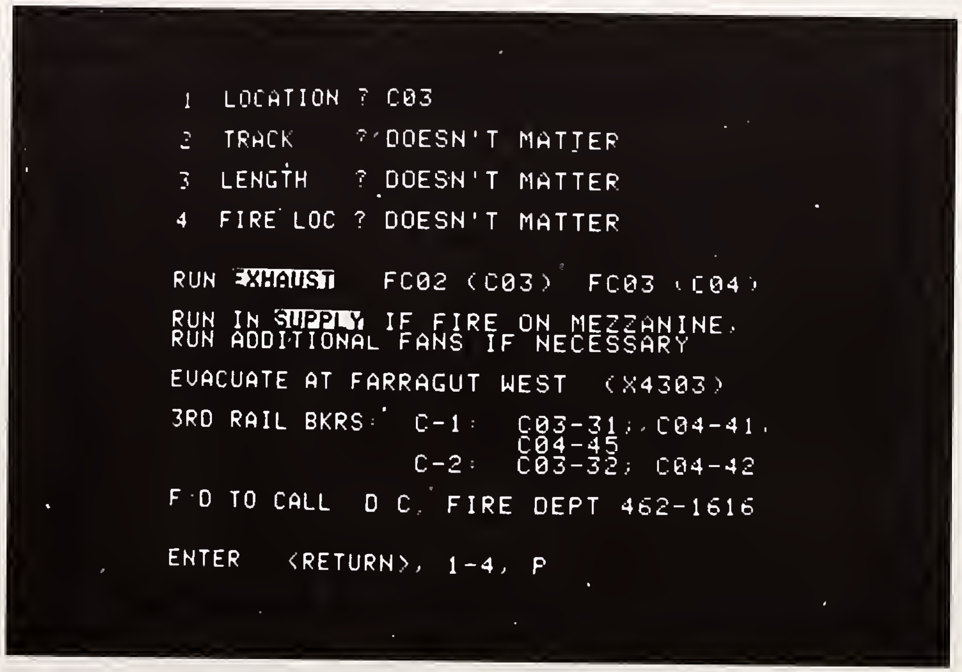

FIGURE 4-19. RETRIEVAL OF EMERGENCY ACTION DATA (FUNCTION 1) BY STATION CODE

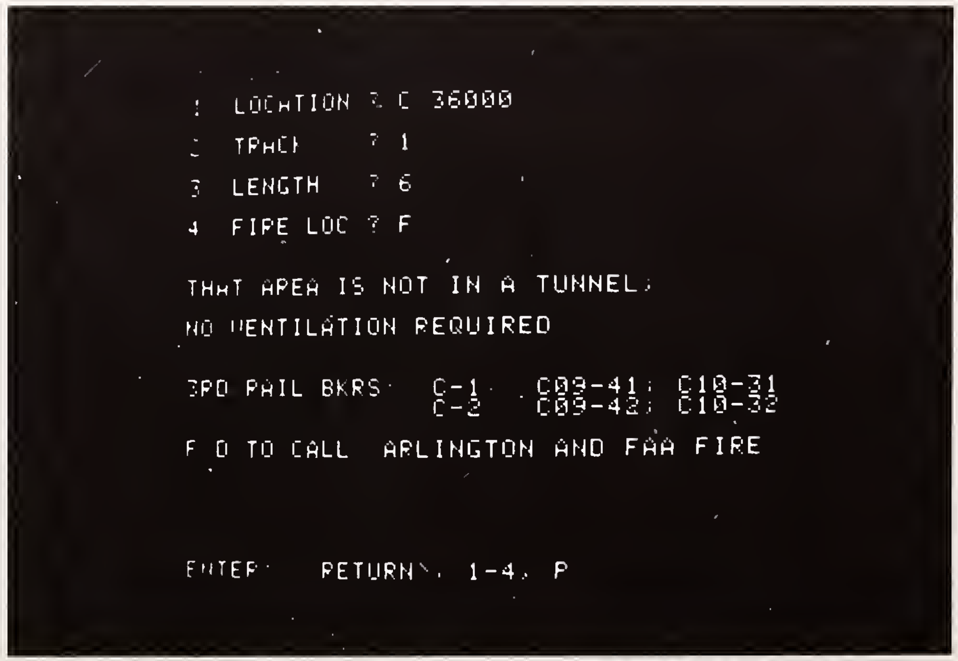

FIGURE 4-20. RETRIEVAL OF EMERGENCY ACTION DATA (FUNCTION 1) BY LINE AND CHAIN MARKER

5. DEVELOPMENT AND DEPLOYMENT OF THE PATCO AERS DEMONSTRATION SYSTEM

While the WMATA AERS Demonstration software was being programmed and deployed, UMTA, TSC, BART and PATCO were making arrangements for the PATCO AERS demonstration to be deployed in February 1983. This was part of an effort by PATCO to introduce additional automation into the Center Tower Building where central control dispatching, fare collection and related functions are performed.

The TSC and BART AERS deployment team was reassembled. Programming was simplified because there were no special ventilation requirements for any point on the transit system, and therefore no emergency action software was needed. The major modification was to expand the "retrieve data on a location" function to a two page CRT display.

5.1 DEPLOYMENT ACTIVITIES

In February 1983, the demonstration software was installed in Center Tower, Camden, New Jersey. Because there was no emergency action software, the training sessions were abbreviated and each controller/dispatcher received approximately five hours of training.

The two-day PATCO training sessions were similar to the three-day WMATA sessions. Two sets of controller/dispatcher training sessions were held each day in Center Tower. A major portion of the training sessions was devoted to identifying PATCO-specific requirements.

Programming staff were included in the first shift session of the first day. Managers and staff were provided with overview workshops in the afternoon of the second day. Also, each of the three supervisors in Center Tower attended at least one session, while covering the normal operations for their staff who attended the training sessions. The first training session was videotaped to assist in future training of additional staff. Finally, on the second day, two management briefing sessions, which included the top management and staff of PATCO and invited guests from the Southeastern Pennsylvania Transit Authority (SEPTA), were held.

At the conclusion of the training sessions, the equipment was installed at one of the controller/dispatcher consoles. As at WMATA, PATCO was loaned an

APPLE II Plus microprocessor with one disk drive, an Epson printer, a GE video monitor, and assorted software and supplies were also provided.

5.2 PATCO AERS DEMONSTRATION SOFTWARE - MAIN MENU

All figures appear at the end of this section, pages 39-40. Figure 5-1 shows the main menu. Note that Functions 3 and 4 have been deleted, since they deal with setting the time on a clock and leaving messages, which are not covered in this document.

5.3 PATCO AERS DEMONSTRATION SOFTWARE - DATA ON A LOCATION (FUNCTION 1)

Unlike the BART and WMATA programs, the data retrieval software was programmed to display the location data on two screens. A sample ouput is shown in Figures 5-2 and 5-3. Note that the data points are exactly as the transit system provided them on the various documents furnished to TSC for coding. The data points are in civil engineering terms, such as Center Line (C/L), etc.

As will be shown in a later section, these TSC-coded data points have almost all been transformed by central control supervisors into the day-to-day vernacular of PATCO's Center Tower.

5.4 PATCO AERS DEMONSTRATION SOFTWARE - DISPLAY DATA BASE ENTRIES (FUNCTION 2)

The display data base entries function, the second major way to retrieve data, is similar to the BART and WMATA versions of the software. Sample outputs are shown in Figures 5-4 and 5-5. Only a few of the screens are given here, since they are generally the same as the formats shown in previous selections. The present samples were selected deliberately to show the changes made by PATCO staff between February and December 1983. These changes are discussed in more detail in the next section.

5.5 DATA BASE UPDATE PROCESS (FUNCTION 5)

As shown in Figures 5-6 through 5-8, the PATCO data base update process is similar to the process used with the WMATA programs. Like the WMATA process, control of the data sets is shared by the supervisors. Nonsupervisory staff who have access to the data sets have been instructed not to update the data.

5.6 ADDITIONAL REQUIREMENTS

Because of the experience at WMATA in getting controller/dispatchers to identify additional requirements, these requirements were solicited from the very start of training at PATCO, using as examples the items that the WMATA controller/dispatchers had identified three months earlier. The list of PATCO-specific requirements and the results of a September 1983 supervisory review are given below (some of the suggested requirements were not supported by all controllers).

1. Emergency checklist procedures, i.e., derailment, bomb scare, third rail trippings, suicides.
2. Car equipment troubleshooting procedures checklist.
3. Car equipment modification and breakdown history.
4. Conrail-shared corridor - milepost and phone number.
5. Philadelphia station lighting cables; New Jersey station lighting.
6. Pertinent station information (CFA system, fare collection).
7. PAX line phone numbers in stations (note: this has already been done).
8. List of all company PAX phones and locations.
9. Emergency call up list similar to the one in the procedure book.
10. Emergency schedule headway optimization under emergency conditions.
11. Key employee telephone numbers for emergencies, or telephone numbers of all employees.
12. Fire extinguisher location and type for all facilities.
13. Complete dispatcher's procedure book entered on computer data base.
14. Station identification by number similar to fare collection identification - referenced by milepost (possibly in fare collection system).
15. Run time in reverse operation between interlockings to establish best headway pattern (including departure times resulting in the best "meets" during emergency situations where a section of track is out of service).

16. Emergency ladder locations.

17. Third rail - which side of the track?

18. Wayside equipment out of service - interlockings, switches, power controls.

19. Location of third rail heaters.

20. Dispatchers' capability to control yard power.

21. Location of hospitals in proximity to stations.

22. Track circuits by milepost (and length of track circuit in feet).

In the September 1983 supervisory review of the requirements, one reviewer provided the following outline:

I. Emergencies (Items 1, 4, 6, 7, 8, 9, 11, 12, 16, 17, 18, 21)

   A. Procedural Checklist

   B. Station Information (Graphics) including exits, stairways, and escalators

   C. Call List

II. Restoration of Services (Items 2,3,10,15)

III. Housekeeping (Word Processing Capability) such as maintenance log (carry over), so dispatcher is not burdened with redundant functions

5.7 SUMMARY

The PATCO AERS demonstration system is closer to an operational system than the WMATA version. In fact, it required only a few additional programs and data points to become an extremely useful tool for the controller/dispatchers.

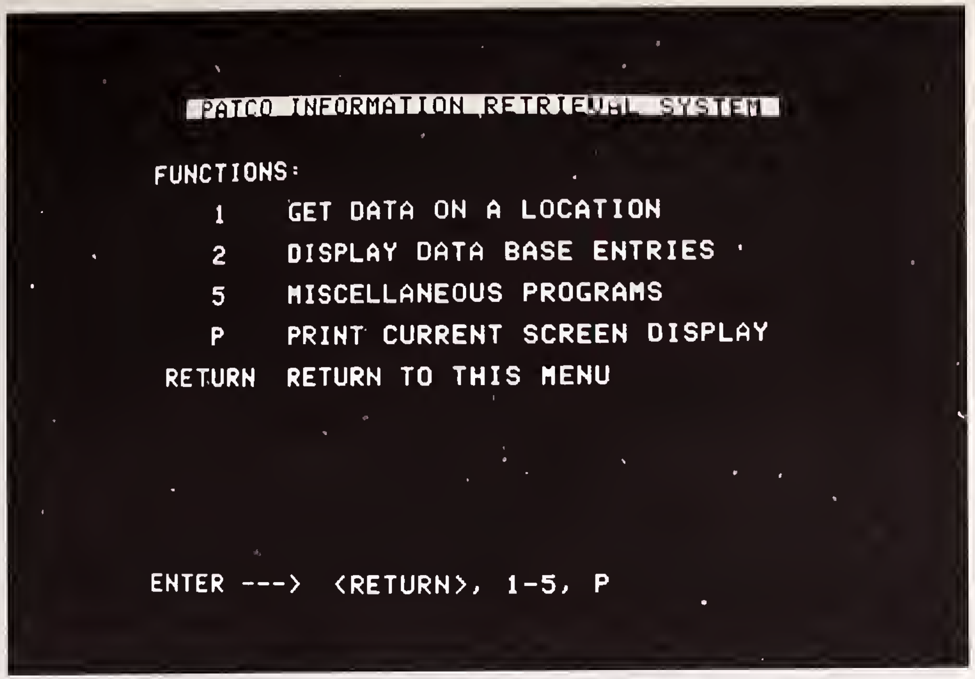

FIGURE 5-1. PATCO DEMONSTRATION AERS, MAIN MENU

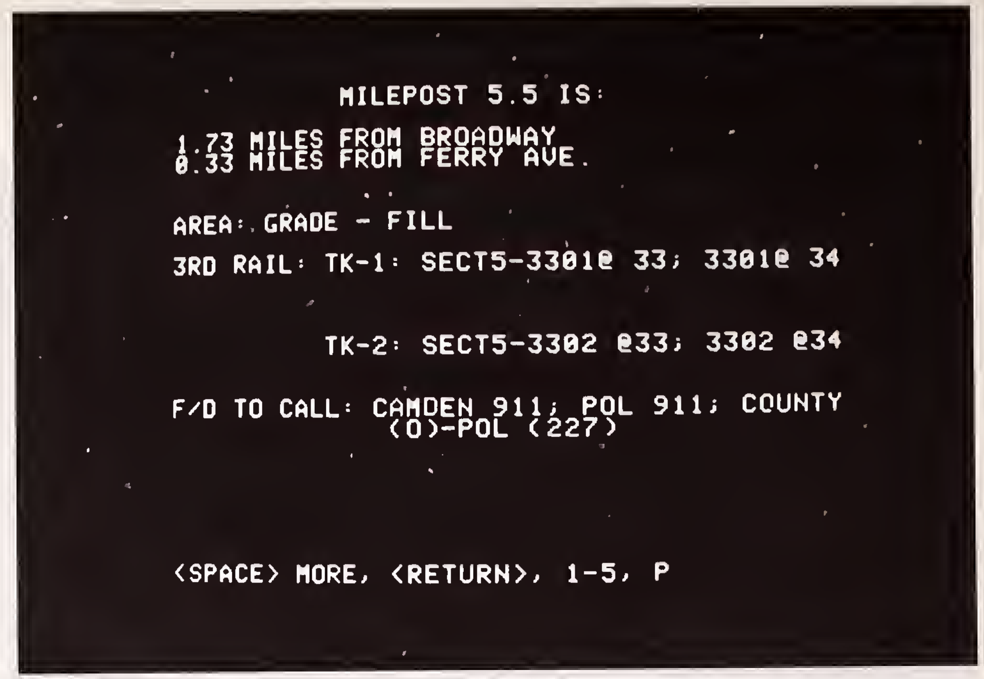

FIGURE 5-2. DISPLAY DATA ON A LOCATION (FUNCTION 1), FIRST SCREEN

FIGURE 5-3. DISPLAY DATA ON A LOCATION (FUNCTION 1), SECOND SCREEN

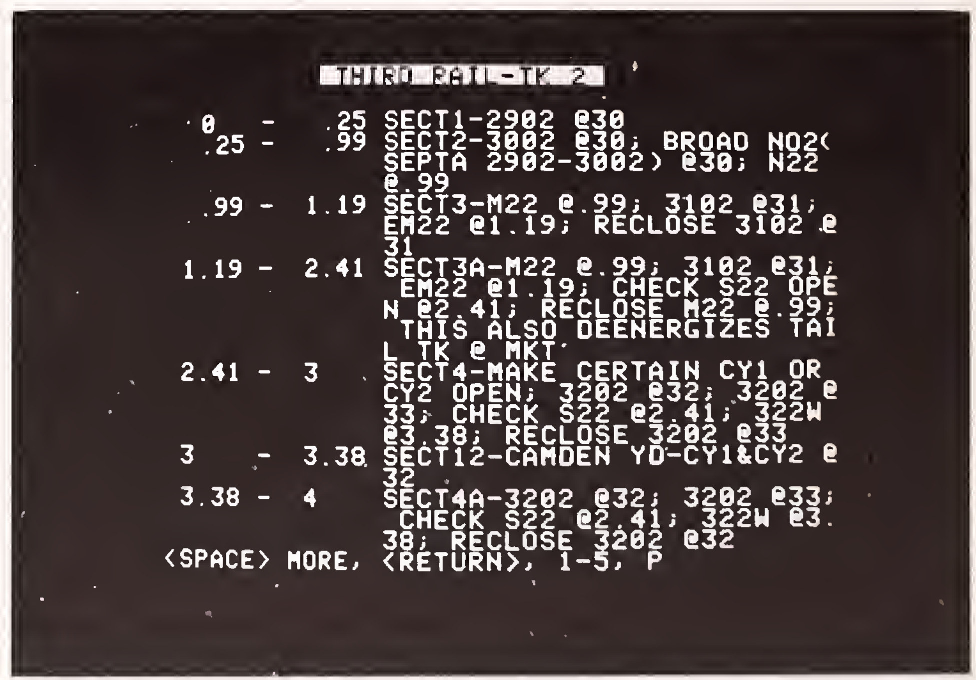

FIGURE 5-4. PATCO DEMONSTRATION AERS, DISPLAY DATA BASE ENTRIES (FUNCTION 2) FOR THIRD RAIL, TRACK NO. 2

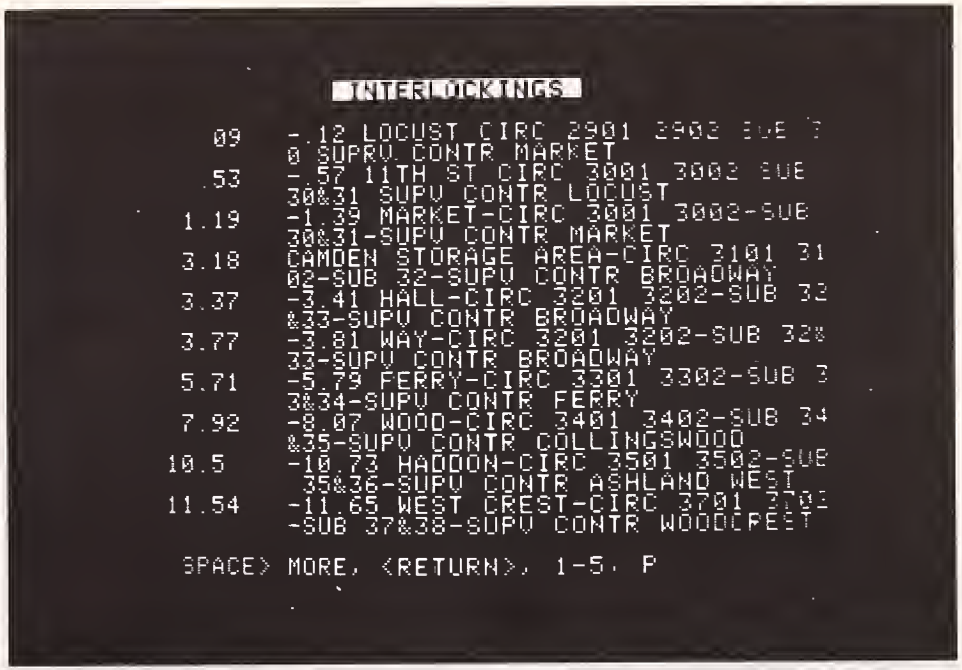

FIGURE 5-5. PATCO DEMONSTRATION AERS, DISPLAY DATA BASE ENTRIES (FUNCTION 2) FOR INTERLOCKINGS

FIGURE 5-6. PATCO DATA BASE UPDATE PROGRAM (FUNCTION 5), FIRST SCREEN

FIGURE 5-7. PATCO DATA BASE UPDATE (FUNCTION 5) SEARCH ROUTINE

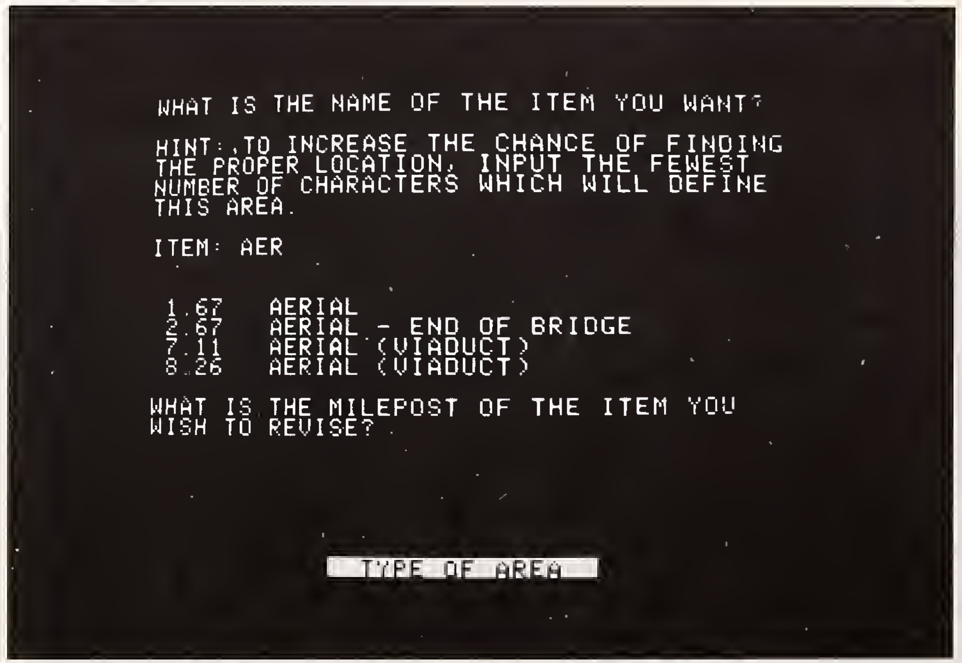

FIGURE 5-8. PATCO DATA BASE UPDATE (FUNCTION 5) SEARCH ROUTINE FOR AN ITEM:TEST RETRIEVAL

6. CURRENT STATUS OF THE DEMONSTRATION AERS

The challenge for WMATA and PATCO control room staff was to expand their respective AERS data bases with a minimum of TSC, BART and UMTA support. Their equipment base was not extensive. Each transit system was supplied with one microprocessor, disk drive, video monitor, printer, etc., and no backup or developmental equipment. Their programming and programming support bases were also minimal. Each transit system was provided with limited training in the AERS software but no training in Applesoft BASIC, the fundamental programming language of the APPLE II Plus microprocessor.

The transit systems were given Apple manuals and advice on how to program. The only additional programming support was limited software support with which to troubleshoot problems. Neither transit system was provided with professional programming support.

This section describes the activities of the central control staff, since the installation of the demonstration, to extend the software to meet their organizations' requirements. In general, each system's software was extended far beyond what members of the installation team had initially thought possible. Given that the demonstration software was not well documented and used advanced programming techniques for cursor control, the achievements of both the WMATA and PATCO central control staff were especially noteworthy.

6.1 WMATA

When the deployment team left in December 1982, WMATA AERS had data for only one line, the C-line from Metro to National Airport, and the staff was adding data for the K-line from Rosslyn to Ballston. Since then, data has been added for the A-line (Metro to Van Ness); B-line (Metro to Silver Spring); D-line (Metro to New Carrollton); and G-line (Metro to Addison Road). In addition, more detailed descriptions have been added to a number of the data points. As of September 1983, the only line in service without data in the data files is the L-line (L'Enfant Plaza to Pentagon).

At the time of the deployment team's departure, no member of the central control staff had been trained in BASIC. Since then, one of the assistant superintendents has obtained formal training at his own expense for programming in BASIC, and another assistant superintendent has essentially trained himself to program in BASIC by using Apple manuals and other published sources.

WMATA has also added a checklist and a system map to its software. The latter is important because it is a first step towards a graphics capability, a function which supervisors and controller/dispatchers have sought. (See Figure 6-1 on page 44 for the screen of the system map. All of the figures appear at the end of this section, on pages 44-49.)

The checklist added by WMATA central control (Figure 6-2) is another item of importance to WMATA supervisors and controller/dispatchers, for two reasons. First, it formalizes the incident reporting process by providing printed formatted output for supervisor and controller/dispatcher notes. Second, it provides a readily available reference document that summarizes the system's formal standard operating procedures. Figures 6-3 through 6-6 show different operating procedures which have been programmed to date.

The WMATA staff has begun to add elements of the power distribution system to the AERS system and track graphics (see Figures 6-7 and 6-8). The transit system has also begun to extensively revise the ventilation schema that was incorporated in the original demonstration software. For the first time, the actual program design and coding is being performed by personnel other than the central control staff (in this instance, by the safety staff).

6.2 PATCO

Because PATCO operates only one line, and because its data base was fairly complete when the installation team left in February 1983, PATCO began to: (1) provide formal and informal training for the staff; (2) revise data terminology to reflect the way Center Tower contoller/dispatchers actually communicate with other PATCO personnel; and (3) add further capabilities.

The data base revisions and added capacities are especially interesting because PATCO extended the software and data bases seemingly with "other-than-prime-time" shifts in mind. Some of these shifts are covered by only one employee (backed up by PATCO supervisory staff on an "on call" basis), who may often be a "part-timer" working a second job. PATCO central control supervisors have had to report in for those shifts to assist during abnormal operations. It appears that these software and data base revisions and additions were specifically designed to reduce the number of times that the supervisory staff has to report to work during these weekend periods.

PATCO has added more descriptions to the data sets for safety department (fire and police) jurisdictions. Two backup phone numbers have been coded for the police and fire departments to expedite communications in an emergency, as shown in Figure 6-9. PATCO has also enlarged descriptions in the data sets for third rails, interlockings, and single tracking (see Figure 6-10). In changing these descriptions, PATCO has expanded the display for retrieving data on a location to four screens (see Figures 6-11 through 6-14). PATCO has also added a module for high voltage circuits, and the main menu has been revised accordingly, as shown in Figures 6-15 through 6-17.

PATCO management has taken a visible role in encouraging its system's AERS development - for example, by encouraging both formal and informal training. At PATCO's expense, two controller/dispatchers have taken introductory and BASIC programming language courses at local colleges.

6.3 FUTURE DIRECTIONS

The WMATA control room staff has been identifying the location of gaps in the third rails and entering this data into the program. As mentioned before, a new ventilation schema to replace the ventilation programs installed in December 1982 is being programmed. PATCO has been specifying the programming needed for a scheduling module to assist in the train-scheduling function of central control.

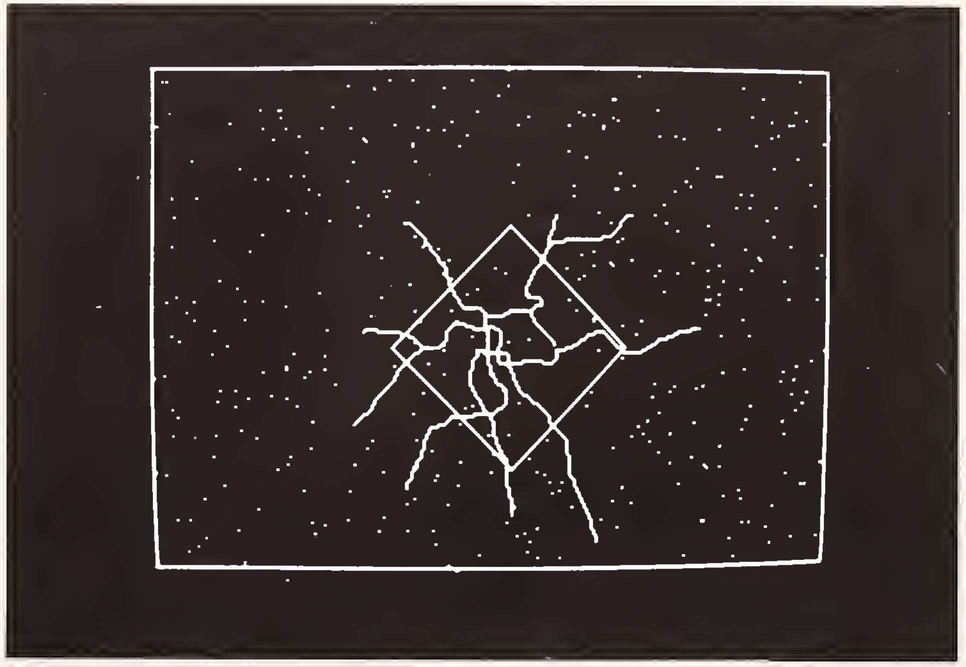

FIGURE 6-1. WMATA SYSTEM MAP

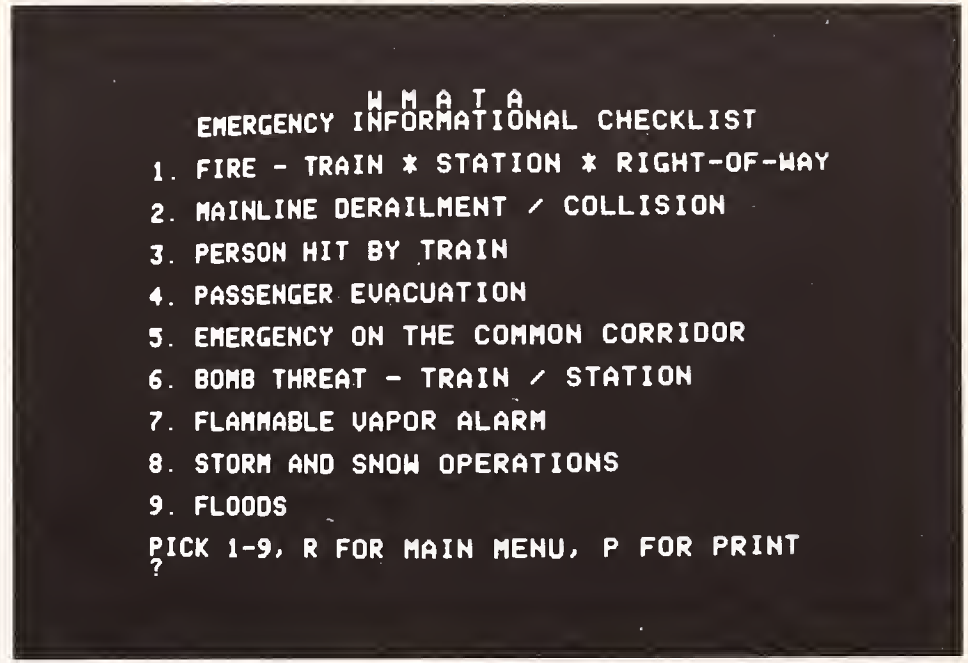

FIGURE 6-2. WMATA EMERGENCY PROCEDURES CHECKLIST, MAIN MENU

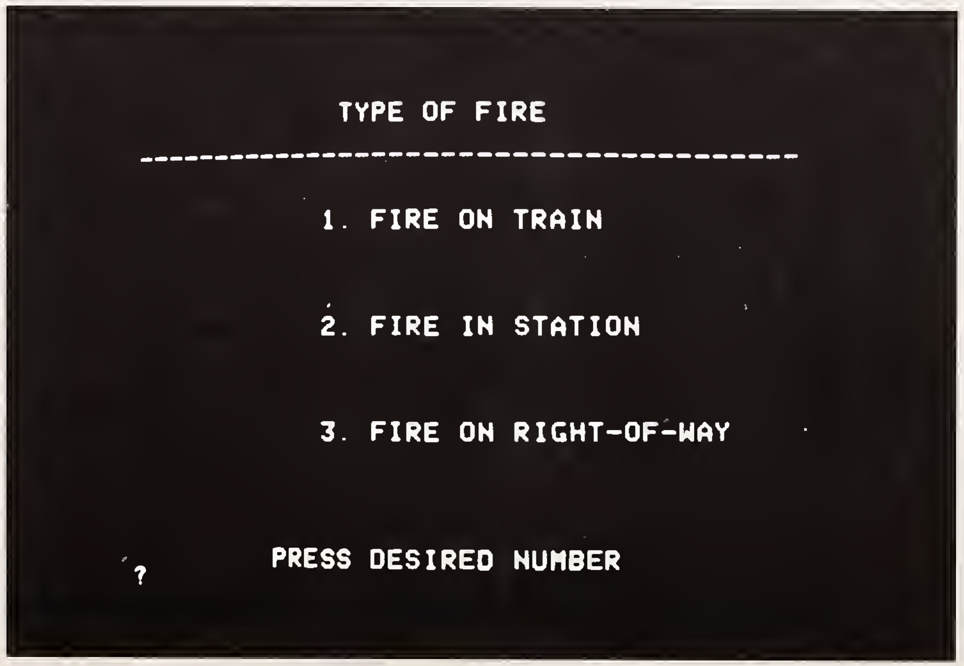

FIGURE 6-3. WMATA EMERGENCY PROCEDURES CHECKLIST, FIRST OPTION

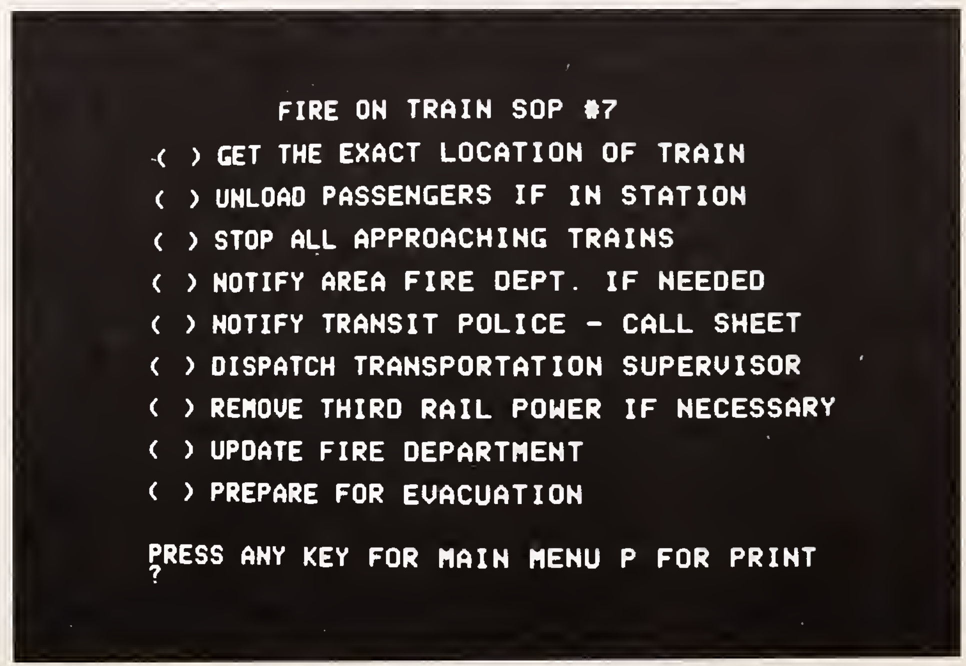

FIGURE 6-4. WMATA EMERGENCY PROCEDURES CHECKLIST, TRAIN FIRE OPTION

FIGURE 6-5. WMATA EMERGENCY PROCEDURES CHECKLIST, STATION FIRE OPTION

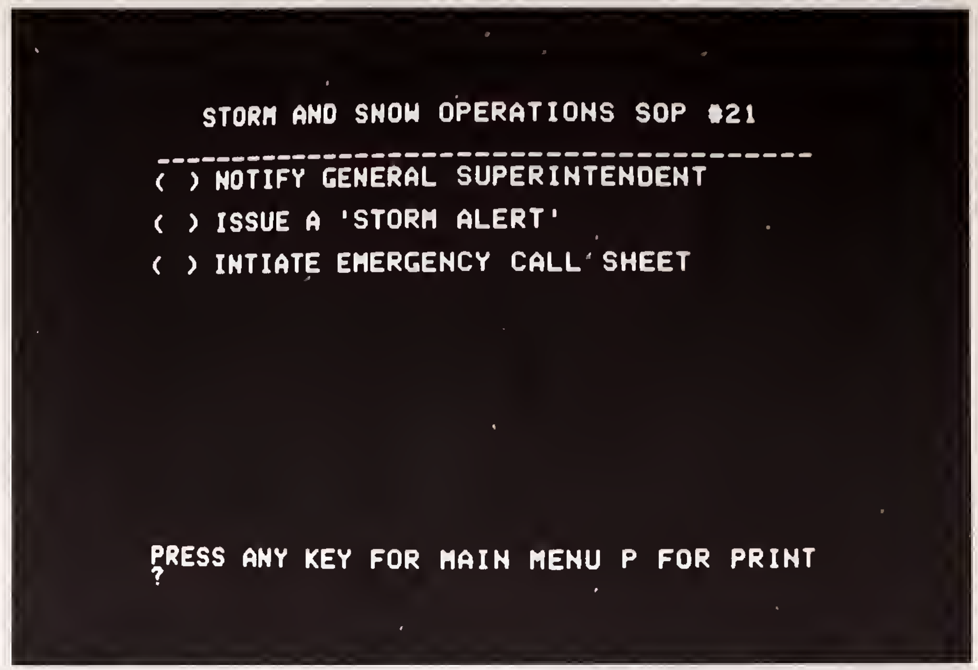

FIGURE 6-6. WMATA EMERGENCY PROCEDURES CHECKLIST, STORM AND SNOW OPTION

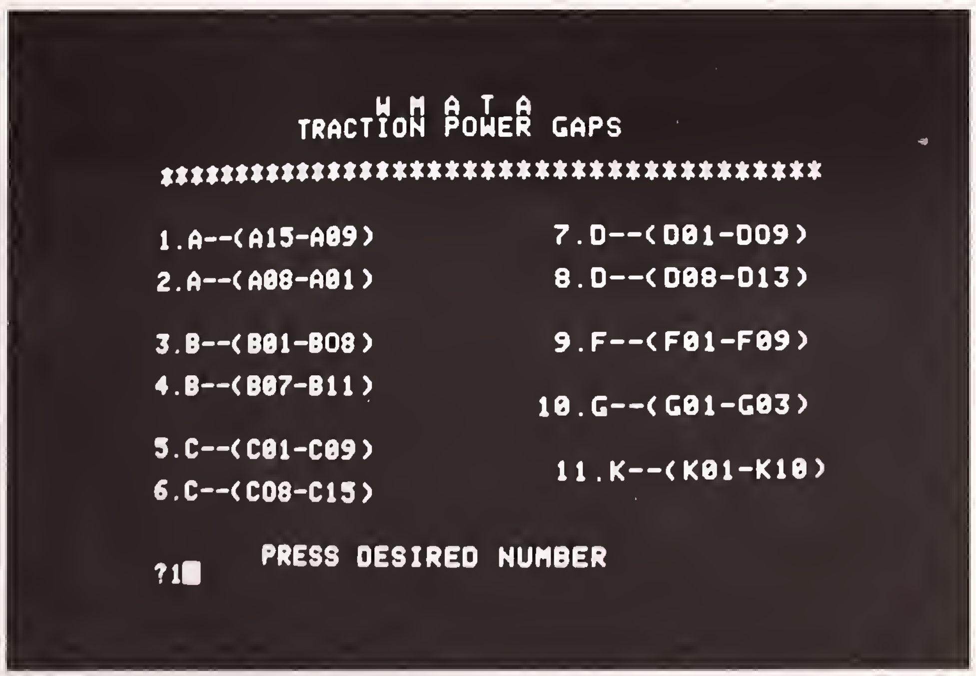

FIGURE 6-7. WMATA TRACTION POWER GAPS MENU

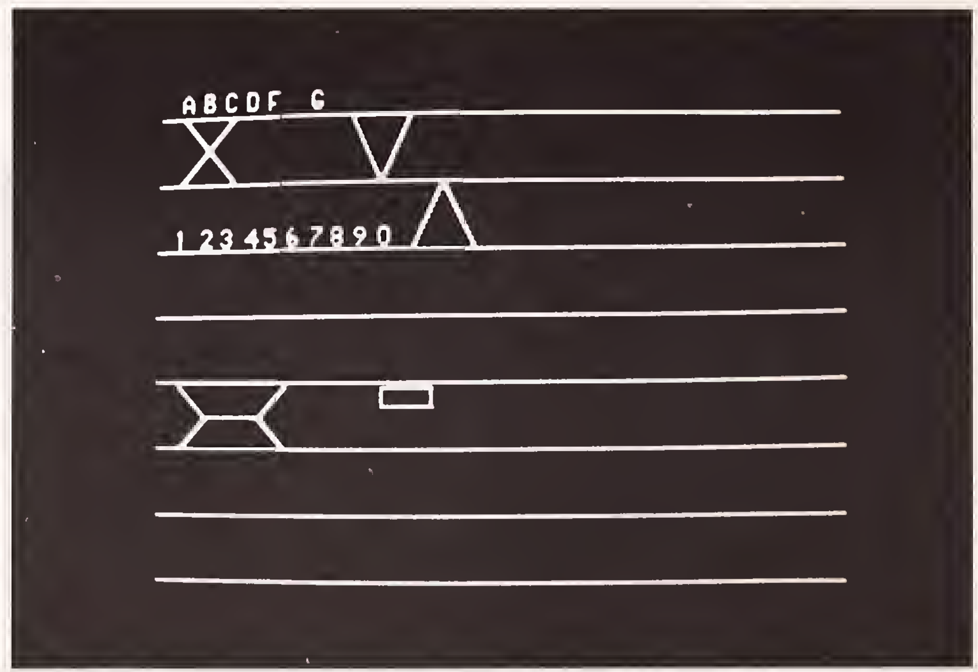

FIGURE 6-8. WMATA INTERLOCKINGS GRAPHICS

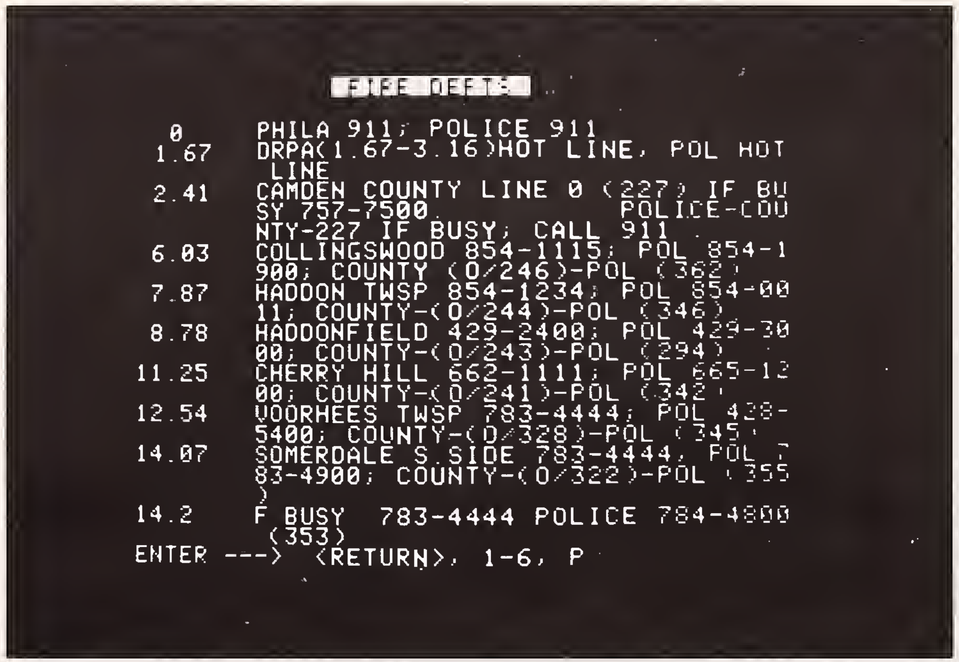

FIGURE 6-9. PATCO FIRE EMERGENCY DATA SET

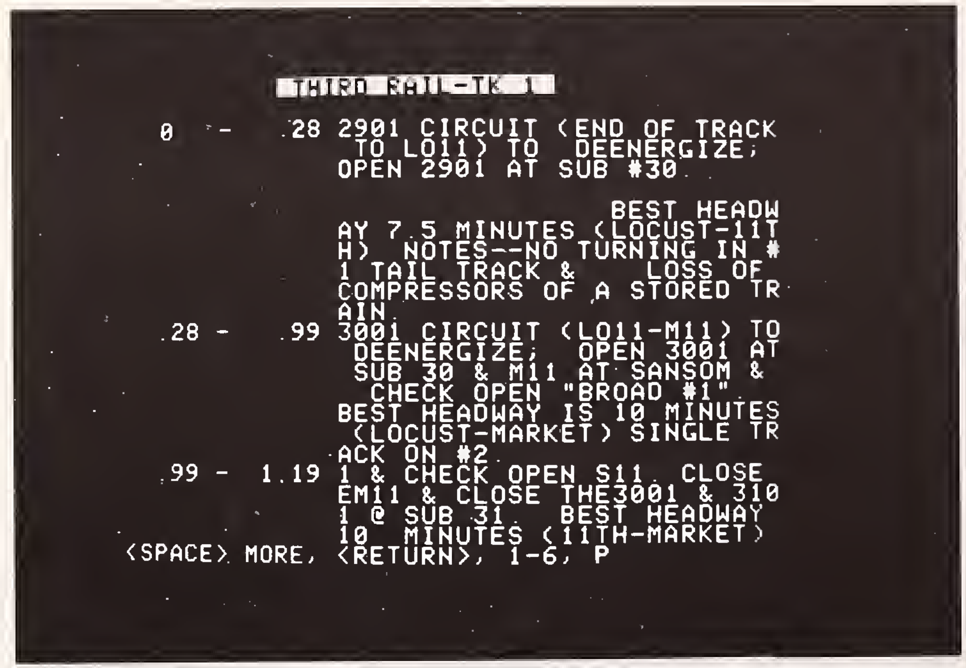

FIGURE 6-10. PATCO THIRD RAIL DATA, CODING AS OF SEPTEMBER 1983

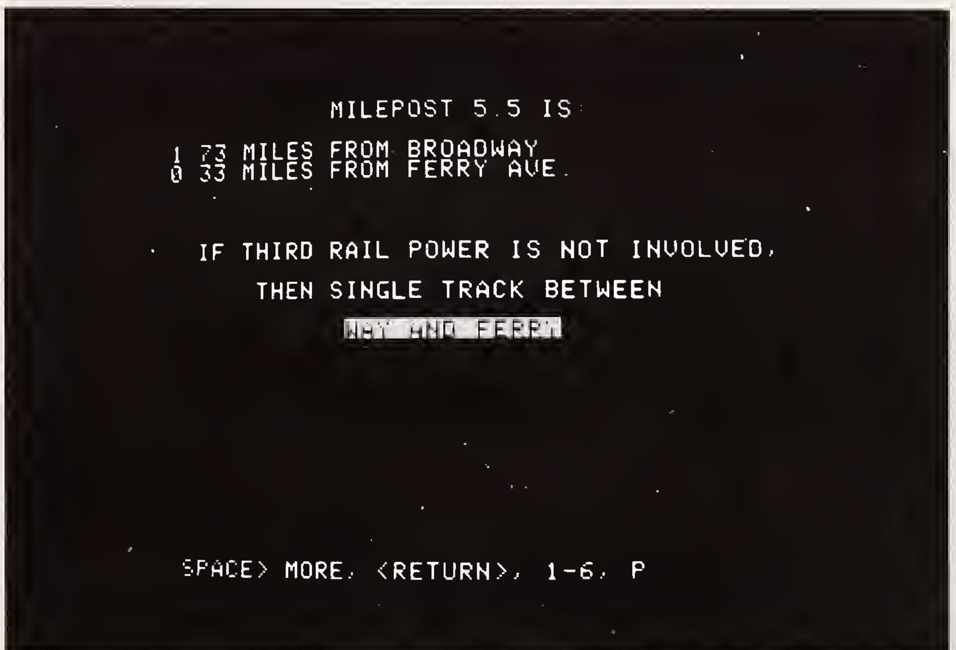

FIGURE 6-11. RETRIEVAL OF PATCO DATA ON LOCATION, FIRST OF FOUR SCREENS

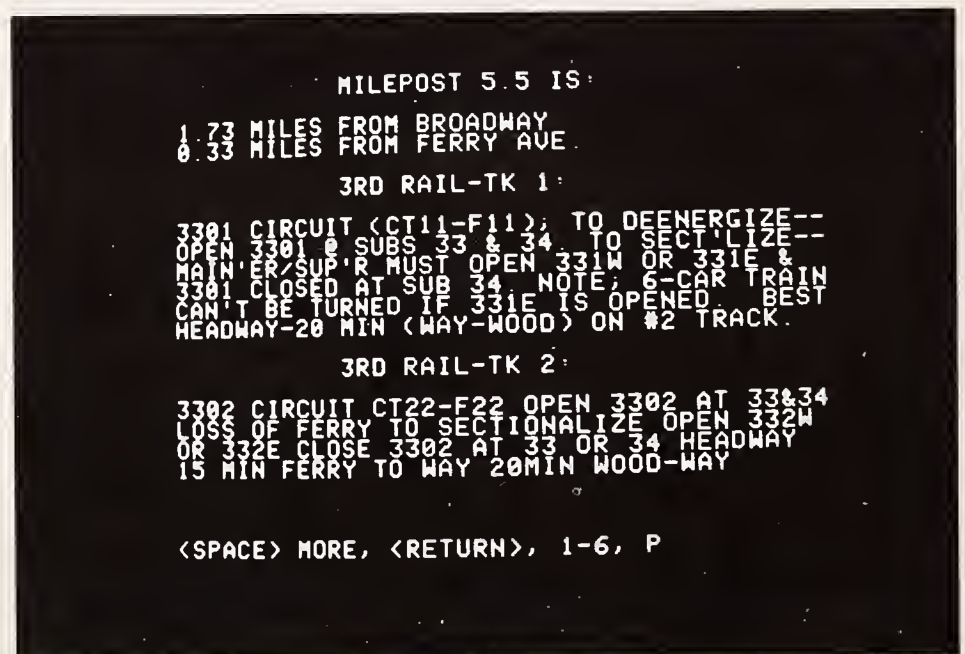

FIGURE 6-12. RETRIEVAL OF PATCO DATA ON LOCATION, SECOND OF FOUR SCREENS

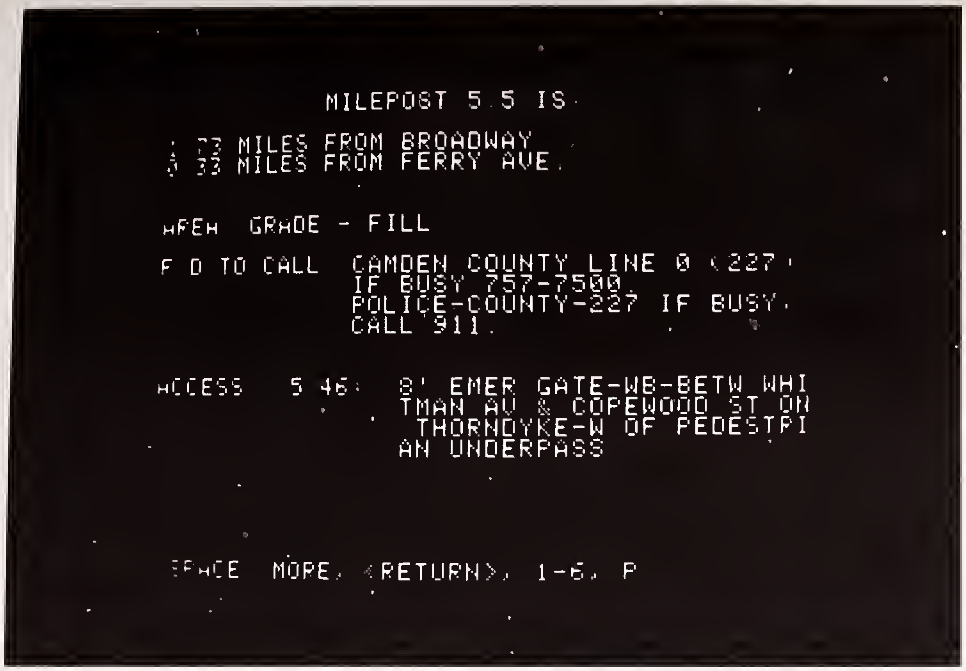

FIGURE 6-13. RETRIEVAL OF PATCO DATA ON LOCATION, THIRD OF FOUR SCREENS

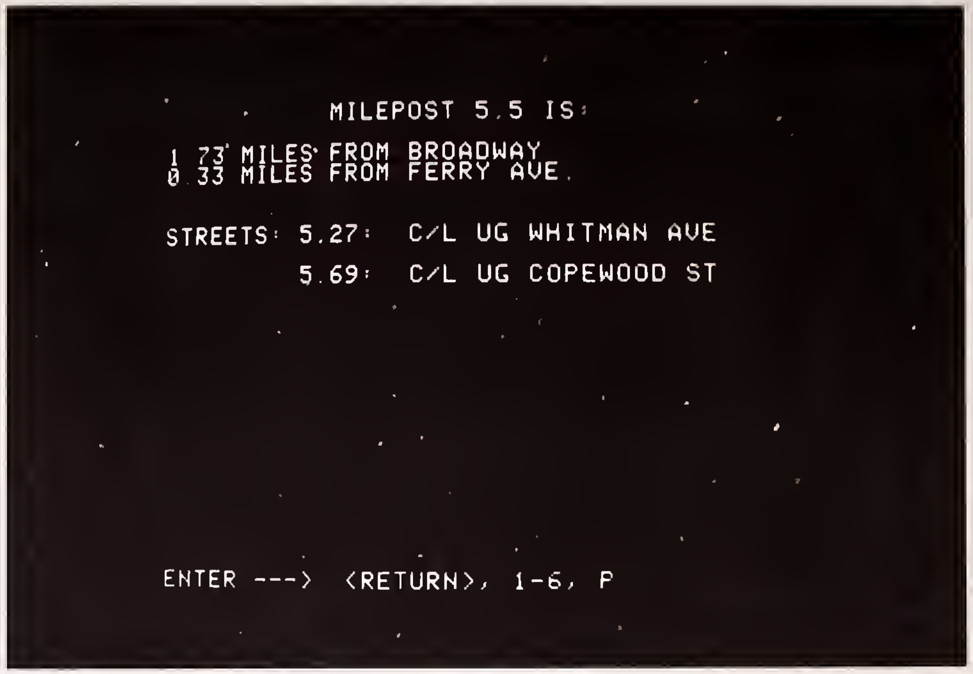

FIGURE 6-14. RETRIEVAL OF PATCO DATA ON LOCATION, LAST OF FOUR SCREENS

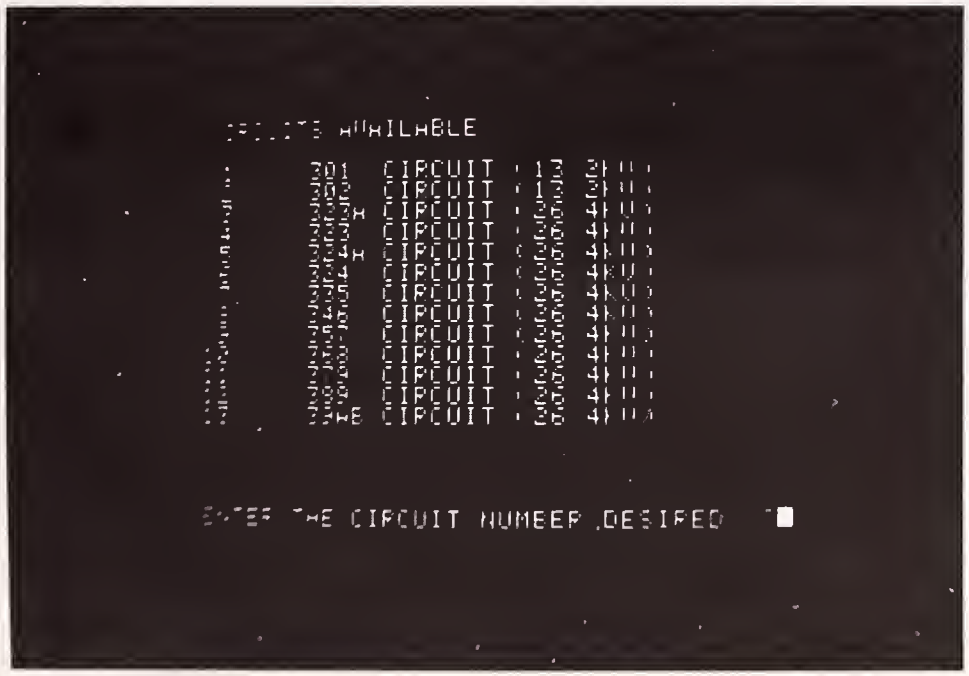

FIGURE 6-15. PATCO HIGH-VOLTAGE CIRCUIT-RETRIEVAL MENU

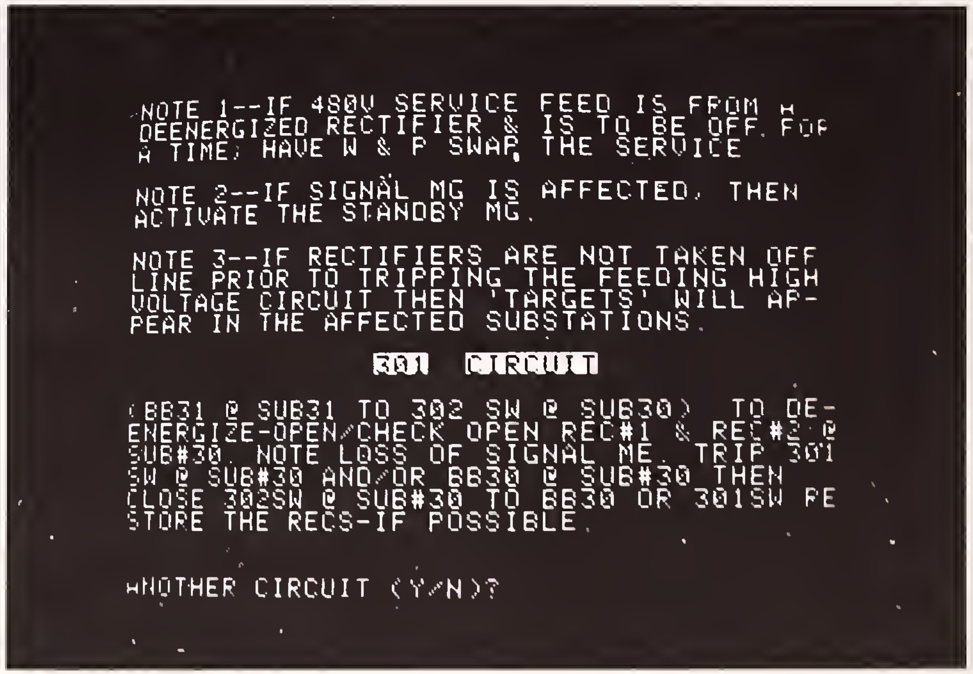

FIGURE 6-16. PATCO HIGH-VOLTAGE CIRCUIT-RETRIEVAL MENU, CIRCUIT 301 (13.2 Kv)

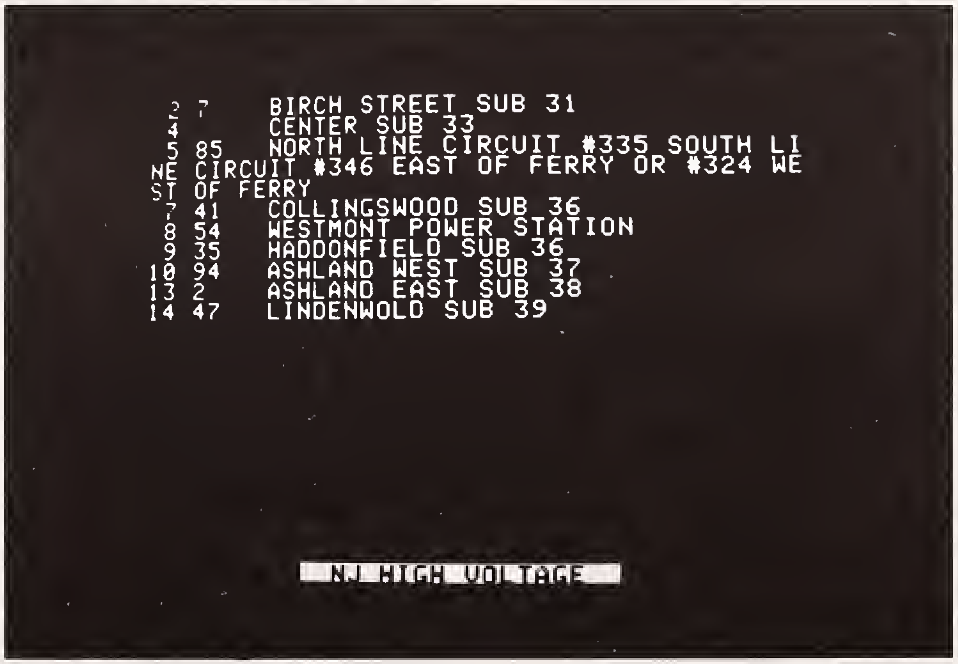

FIGURE 6-17. PATCO NEW JERSEY HIGH-VOLTAGE CIRCUIT GRID

7. DEVELOPMENT OF A GENERALIZED, GENERIC SYSTEM

The initial BART AERS and the WMATA and PATCO deployment efforts have demonstrated that an AERS can considerably enhance a transit system's ability to respond to an emergency situation in a timely and effective manner. Additional site demonstrations at other transit systems have generated considerable interest in the transit community, and several transit systems have requested UMTA assistance in obtaining their own AERS. In answer to these requests, UMTA has asked that TSC undertake the development of a generic AERS (AERS II). In identifying desirable system attributes, it was determined that the generic AERS should:

1. Be fast and accurate.
2. Have sufficient storage capability to accommodate data sets for the largest system.
3. Be easy to transport to and install at a new transit system.
4. Be easy to modify to meet a system's unique requirements by the addition of video monitor screens, the alteration of existing screens, etc.
5. Be easy for central control staff who are not computer professionals to program.
6. Allow the required data sets to be built with a minimum of effort, either by entering data or downloading data from the transit system's main-frames.
7. Be virtually self-documenting.
8. Be modular, so that when new modules are developed by specific transit systems, they can be easily transported and added to another system's AERS.

To develop a generic system meeting these requirements, TSC proposed the project implementation plan shown in Figure 7-1. This plan consists of the following ten tasks:

Task 1 AERS II system design description

Task 2 AERS II data, emergency response and related specifications

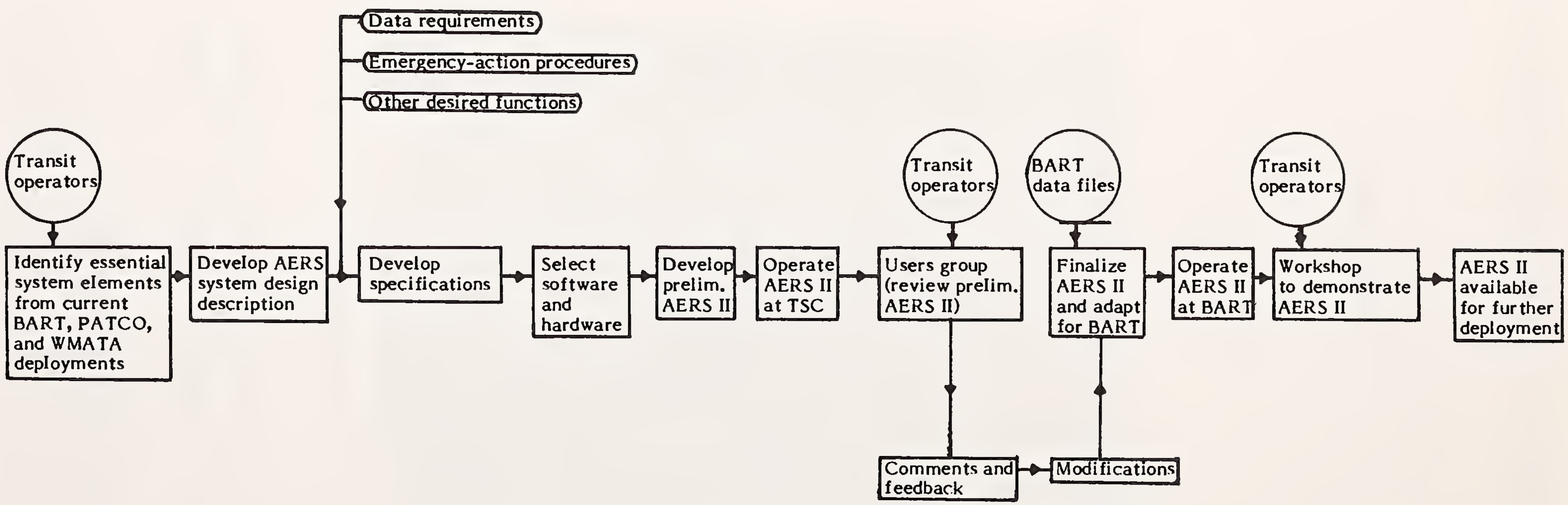

FIGURE 7-1. AERS II DEVELOPMENT PLAN

Task 3 Formation of a user group

Task 4 Enlistment of BART technical support

Task 5 Development and refinement of AERS II program(s)

Task 6 User group meeting

Task 7 Application of AERS II to BART

Task 8 AERS II documentation

Task 9 AERS II demonstration/workshop

Task 10 AERS II distribution and support

These tasks make use of the expertise of the transit community and the experience gained in the original BART AERS and subsequent WMATA and PATCO AERS deployment efforts.

The functional goals and objectives outlined in Table 7-1, the system-oriented goals and objectives outlined in Table 7-2, and the schema for AERS II (an 8, 16 or 32-bit microprocessor-based system) shown in Figure 7-2 are the results of Task 1. The results of Task 2 are shown in the Data Specification List presented in Tables 7-3 and 7-4. The specific emergency procedures requirements identified by WMATA and PATCO (discussed in sections 4.6 and 5.6 of this report) supplement the material in Table 7-4. The next task to be performed is the formation of a user group to assist in formulating the final AERS program design, and to help in its development.

The AERS effort has been a joint government and industry venture. As can be seen by the inclusion of BART technical support and an industry user group in the implementation plan, this policy of government-industry cooperation will continue to play a major role in the design and development of the generic AERS II. This new, highly adaptable AERS, to be based on the experiences described in this report, will have a significant impact on the emergency response capability of user transit systems, with the potential for wider transit applications as well.

TABLE 7-1. FUNCTIONAL GOALS AND OBJECTIVES

- o CONTAIN ALL NECESSARY EMERGENCY INFORMATION
- o BE EASILY TRANSPORTABLE FROM ONE TRANSIT SYSTEM TO ANOTHER, PRINCIPALLY BY ADDING THE DATA FOR THE NEW SYSTEM
- o MAKE IT SIMPLE FOR THE TRANSIT SYSTEM TO IMPLEMENT CHANGES IN SCREEN FORMAT AND INFORMATION
- o BE IMMEDIATELY USABLE BY A TRANSIT SYSTEM (i.e., TURNKEY DELIVERY)
- o BE EASILY LEARNED BY PEOPLE WITHOUT COMPUTER BACKGROUND
- o ALLOW FOR IMPROVEMENT BY PEOPLE WITHOUT COMPUTER BACKGROUND
- o BE USER FRIENDLY AND PROVIDE AID TO USERS IN CORRECTING SYNTAX AND OTHER USAGE ERRORS
- o HAVE SELF-DOCUMENTING PROGRAMS, WITH MINIMAL NEED FOR A MANUAL
- o RESPOND RAPIDLY, ESPECIALLY IN EMERGENCY MODE
- o ALLOW FOR EASY UPDATING OF INPUT FILES
- o STAND ALONE, WITH NO RELIANCE ON OTHER COMPUTERS
- o BE ALWAYS AVAILABLE (AND THEREFORE BE EXTREMELY RELIABLE)
- o ALLOW USERS TO MAKE SIMPLE MODIFICATIONS OF EMERGENCY AND OTHER PROCEDURES
- o PROVIDE FOR SECURITY OF SOFTWARE AND DATA FILES FROM UNAUTHORIZED CHANGES

TABLE 7-2. SYSTEM-ORIENTED GOALS AND OBJECTIVES

o SYSTEM

-STAND ALONE MICROCOMPUTER SYSTEM
-RAPID RESPONSE TIME
-NOT HARDWARE SPECIFIC
-EASY OPERATOR INTERFACE
-EASILY LEARNED OPERATING SOFTWARE

o HARDWARE

-NOT RESTRICTED TO ONE BRAND
-SMALL SIZE (MINIMIZE SPACE REQUIREMENTS)
-WIDE RANGE OF MASS STORAGE DEVICES TO ALLOW MATCHING NEEDS OF INDIVIDUAL TRANSIT PROPERTIES
-NO SPECIAL ENVIRONMENT REQUIREMENTS
-NO SPECIAL POWER REQUIREMENTS

o SOFTWARE

-MODULAR CONCEPT
-PORTABLE PROGRAMMING LANGUAGE
-EASILY PROGRAMMED INPUT AND OUTPUT VIDEO MONITOR SCREENS
-MAIN MENU SCREENS WITH SELF CHECKING ENTRIES TO MINIMIZE ERRORS
-BOTH GRAPHICAL AND TABULAR DATA ENTRY
-COMPLETE USER DOCUMENTATION FOR OPERATION AND DATA MAINTENANCE

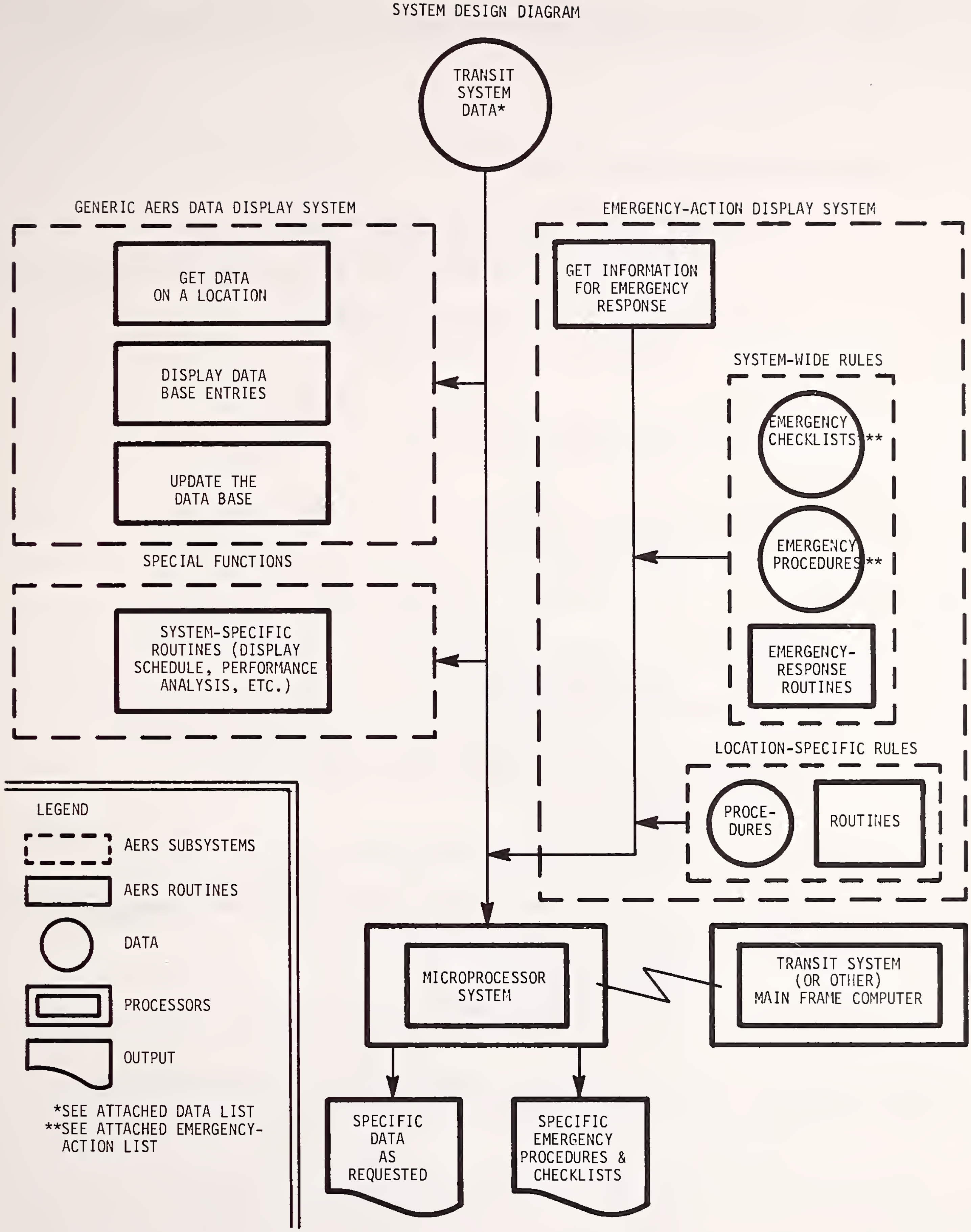

FIGURE 7-2. GENERALIZED AERS II

TABLE 7-3. DATA SPECIFICATION LIST (BASED ON FILES IN BART, PATCO AND WMATA AERS)

I. Emergency facilities and procedures

A. Ventilation procedures (where appropriate)
- Location of fans, vent shafts
- Procedure to determine which fans to set and proper direction

B. Evacuation procedures (where appropriate)
- Direction in which to evacuate
- Exit point

C. Rescue procedures
- Designation of rescue train
- Exit point

D. Fire departments to call
- Name of department
- Phone number
- Portion of system covered by each fire department

E. Police departments to call
- Name of department
- Phone number
- Portion of system covered by each police department

F. Hospitals and other medical units to call
- Name of unit
- Phone number
- Portion of system covered by each unit

G. Key transit personnel to call (security, operations, management,etc.)
- Names
- Positions
- Phone numbers
- Events for which they should be called

II. Physical system description (all items include location, shown by line, mileage marker, chain marker, or other descriptor)

A. Type of area
- Subway
- At grade
- Aerial

B. Stations
- Location of platform egresses
- Location of mezzanine egresses

TABLE 7-3. DATA SPECIFICATION LIST (CONTINUED)

C. Access points to system, such as
    - Stairway
    - Shaft
    - Gate
    - Grade crossing
    - Maintenance of way
    - Bridge
    - Walkway

D. Streets
    - Name of cross street(s)

E. People (passenger or personnel) crossovers

F. Rail crossovers (interlockings)

G. Third rail sections
    - Section descriptions

H. Shared rail corridors
    - Name of co-occupant
    - Location identifiers of co-occupants
    - Controller phone number for co-occupant

J. Other entities (such as high-voltage circuits)

III. Communications

A. Station phones
    - Station
    - Phone number (primary)
    - Phone number (alternate)

B. Emergency phones on right-of-way
    - Location
    - Phone number

IV. Anomalies (temporary changes from usual situation)

- Equipment out of order
- Equipment down for maintenance
- Special temporary rules
- New equipment

Note: The transit system should provide as complete a set of data as possible, correlated to their location code (i.e., line-and-mileage marker, line-and-chain marker, line-and-station, etc.)

TABLE 7-4. EMERGENCY ACTION SPECIFICATION LIST

Procedure/checklist specification is by one or both of the following:

By type of response:

- Ventilation
- Evacuation
- Rescue
- Provision of alternative transit service

By type of emergency:

- Fire in tunnel
- Fire at grade or aerial
- Derailment
- Collision
- Disabled train
- Disabled operator
- Loss of power
- Critically-ill passenger
- Crime
- Bomb threat
- Toxic fumes
- Flood
- Structural or track defect found
- Suicide or other person hit
- Object on track
- Storm/snow

Note: (1) The transit system should provide as complete a set of procedures as possible, correlated to their location code, i.e., line-and-mileage marker, line-and-chain marker, line-and-station, etc.

(2) Special output screens will be programmed to outline the procedures or checklists.

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