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# The Internal Revenue Service Post-Of-Duty Location Modeling System - User's Manual

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Paul D. Domich, Richard H. F. Jackson, Marjorie A. McClain

U.S. DEPARTMENT OF COMMERCE  
National Bureau of Standards  
National Engineering Laboratory  
Center for Applied Mathematics  
Gaithersburg, MD 20899

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SYSTEM - USER'S MANUAL**

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**U.S. DEPARTMENT OF COMMERCE, Malcolm Baldrige, *Secretary***  
**NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director***



## ABSTRACT

This report is a user's guide for a microcomputer package which was designed by the National Bureau of Standards to assist the Internal Revenue Service in choosing locations for its posts-of-duty which will minimize costs to the IRS and to the taxpayer. The user may select the types of costs to be considered and may specify potential locations for new posts-of-duty. The system displays maps showing workload for a district, current post-of-duty locations and new post-of-duty locations. This manual provides hardware and software requirements for the system, installation procedures, data file formats, and detailed operating instructions.

Keywords: facility location, interactive graphics, greedy heuristic, interchange heuristic, personal computer, microcomputer, Graphical Kernel System, zip code map



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## Section I: Introduction

### A. Description of Reports

This paper is one of a series of reports documenting the Internal Revenue Service Post-of-Duty Location Modeling System, which was developed for the IRS Research Division by the Center for Applied Mathematics of the National Bureau of Standards. The reports in the series are as follows.

#### 1) The Internal Revenue Service Post-of-Duty Location Modeling System: Final Report

This report describes the post-of-duty location problem and its mathematical model. It discusses the types of data which are considered in calculating costs, describes the methods used to solve the location problem, and gives a brief introduction to the computer implementation of the model. (NBS Contact: Richard H. F. Jackson)

#### 2) The Internal Revenue Service Post-of-Duty Location Modeling System: User's Manual

This report is a user's guide for the post-of-duty location computer system. It gives hardware and software requirements, instructions for installing the system, descriptions of data files, and detailed instructions for operating the system. (NBS Contact: Marjorie A. McClain)

#### 3) The Internal Revenue Service Post-of-Duty Location Modeling System: Programmer's Manual for FORTRAN Driver

The post-of-duty location program is written in two sections of code, one in FORTRAN and the other in PASCAL. This report describes the FORTRAN driver which handles graphics displays and controls input and output for the solution procedure. The report includes an alphabetical list of the FORTRAN routines, describing the purpose, the calling sequence and the variables of each routine. (NBS Contact: Marjorie A. McClain)

#### 4) The Internal Revenue Service Post-of-Duty Location Modeling System: Programmer's Manual for PASCAL Solver

This report describes the second part of the post-of-duty location program, the PASCAL solver. It discusses the algorithms and data structures used to solve a location problem. (NBS Contact: Paul D. Domich)

## B. Introduction to the System

The Internal Revenue Service Post-of-Duty Location System is a microcomputer package designed to assist IRS district planners in choosing locations for posts-of-duty (POD's) which will minimize costs to the IRS and to the taxpayer. The package uses color graphics in performing the following functions.

### 1) Displaying Workload

The user may choose the type of workload to be displayed, such as the number of returns examined or the number of criminal investigation cases. Then a state zip code map is drawn, with each zip code shaded according to the workload it generates.

### 2) Displaying Initial POD Sites

A state zip code map is drawn showing where POD's are currently located and also where new POD's could potentially be located. The user may make modifications to this information to specify POD's which may not be or must be in the set of POD's determined by the solution procedure.

### 3) Solving for Optimal POD Locations

Using the initial POD information specified by the user, the solution procedure calculates the cost of assigning each zip code to each current or potential POD. The cost includes travel costs associated with the workload of each zip code, office rental costs, and costs of opening new POD's or closing old POD's. The user may set parameters indicating what types of workload (such as taxpayer service or criminal investigation) should be included in the travel cost calculations. Also, weights may be assigned to pairs of zip codes and POD sites to scale travel costs. The user must specify the number of POD's desired in the solution. The solution procedure then determines the set of POD's which will result in the least total cost for the district.

### 4) Displaying Optimal POD Locations

A state zip code map is drawn showing where the new POD's determined by the solution procedure are located. Also, a report file is generated which summarizes the problem specification and the solution. The report includes a list of which zip codes are to be assigned to which POD's.

### 5) Controlling Display of Maps

On any of the state zip code maps mentioned above, the user may zoom in on a small region, back up to a larger region, or find the five-digit zip code number of an area on the map.

This manual describes how to set up and use the POD location system. Section II contains the computer hardware and software requirements. Section III explains the procedure for installing the system and describes the format of required data files. Section IV contains detailed instructions on how to operate the system.

Note: Reference to a tradename or product in this report does not imply endorsement by the National Bureau of Standards.

## Section II: Computer Requirements

### A. Hardware

The POD location system has been designed to run on an IBM-PC XT or AT equipped with a math coprocessor and with one of the following types of displays.

#### 1) IBM Enhanced Graphics Adapter with Enhanced Color Display

This display has a screen size of 640x350 pixels and uses 16 colors. Text, lines and marker symbols are drawn in high resolution, and shaded regions of maps are filled using solid colors. The system requires at least 128KB of graphics memory, rather than the standard 64KB. This extra graphics memory is necessary in order to display 16 distinct colors; without enough memory, colors which are different in the graphics program may look the same on the screen (so, for example, a shaded map may appear to be all one color).

#### 2) IBM Color Graphics Monitor Adapter

This display, used in medium resolution mode, has a screen size of 320x200 pixels and uses four colors. Text characters are larger than on the enhanced display, so menus take up a greater proportion of the display screen. Shaded regions of maps are filled using cross-hatching.

A printer is desirable, but not necessary.

The system may also run on IBM-compatible machines, but due to the use of graphics device drivers (see Section III Part A) for the specific displays listed above, unpredictable results may occur if other displays are used. The system has been successfully tested on a Compaq Deskpro with a Princeton Graphics Quadchrome monitor and on a Compaq portable. It may be possible to use a PC with no fixed disk, but the package was not designed for this.

### B. Software

To run the POD location system, the following software is required.

- 1) IBM-PC DOS (Version 2.1 or later)
- 2) IBM Virtual Device Interface (VDI) and device drivers
- 3) Executable code for the POD location system

A programmer who wants to be able to make changes in the system will need additional software, such as source code, IBM Professional FORTRAN, Turbo PASCAL, and the IBM Graphical Kernel System. See "The Internal Revenue Service Post-of-Duty Location Modeling System: Programmer's Manual for FORTRAN Driver" and "The Internal Revenue Service Post-of-Duty Location Modeling System: Programmer's Manual for PASCAL Solver" for further information.

### Section III: Setting Up the System

This section describes how to install the system for the first time or when updates need to be made to data files. It is assumed that the user who initially sets up the system is thoroughly familiar with IBM-PC DOS and, in particular, can work with subdirectories and create and make changes in data files using a text editor. However, once the system has been properly installed, detailed knowledge of DOS is not necessary to use it.

#### A. Graphics Device Drivers, AUTOEXEC.BAT and CONFIG.SYS Files

The graphics portion of the POD location program was written using a subroutine library called the Graphical Kernel System (GKS). Running a program which uses GKS requires the presence of the Virtual Device Interface (VDI), which links the program to the type of graphics display device being used. The VDI files INIT\_VDI.EXE, VDI.SYS and either VDIDY010.SYS (for an enhanced color display) or VDIDY004.SYS (for a regular color display) must be copied into the root directory or a subdirectory.

Next, the VDI must be initialized in the CONFIG.SYS file and optionally in the AUTOEXEC.BAT file. These files contain commands which are executed by the computer as soon as it is turned on. They must be in the root directory and may be created or modified using a text editor. The files should contain the following statements.

##### AUTOEXEC.BAT

```
\path\INIT_VDI
```

##### CONFIG.SYS

```
FILES=10  
BUFFERS=10  
DEVICE=\path\ANSI.SYS  
DEVICE=\path\VDIDY010.SYS (for an enhanced color display)  
DEVICE=\path\VDIDY004.SYS (for a regular color display)  
DEVICE=\path\VDI.SYS
```

##### Notes:

- 1) \path\ indicates the full DOS path name giving the location of the file. It is needed only if the file is not in the root directory.
- 2) After making any changes to the AUTOEXEC.BAT or CONFIG.SYS files, the computer must be restarted for the changes to take effect.
- 3) ANSI.SYS is a file provided with DOS; INIT\_VDI.EXE, VDIDY010.SYS, VDIDY004.SYS and VDI.SYS come with the VDI.

- 4) VDI.SYS must be the last device listed in the CONFIG.SYS file.
- 5) An enhanced color display can be made to appear like a regular color display by using the VDIDY004.SYS device driver. Both device drivers can be listed in the CONFIG.SYS file; the last one listed will be the default display mode used by an application program. To switch to the other device driver, type "SET DISPLAY=\path\VDIDYXXX.SYS" (where "XXX" is either "004" or "010") before running the program.
- 6) The DOS "shift-printscreens" command for making printed copies of a display screen will only work with the VDIDY004 device driver. It does not copy enhanced graphics screens. (Type GRAPHICS before running a program in which printed copies of graphics screens are desired; see the DOS manual for more information.)
- 7) FILES=10 and BUFFERS=10 are values suggested by the Professional FORTRAN manual for use with Professional FORTRAN programs.
- 8) If the device driver has not been properly initialized, the message "CANNOT OPEN WORKSTATION" will appear when trying to run an application program.
- 9) It is not actually necessary to include INIT\_VDI in the AUTOEXEC.BAT file. It may be executed any time before running an application program.

## B. Program Files

A directory should be created on the fixed disk to contain the POD location system programs and data files. Copy the following program files from the floppy disk provided to the new directory.

- 1) TEMPZIP.BAS
- 2) UNFORM.EXE
- 3) SAVGEN.EXE
- 4) TEMPSTE.BAS
- 5) BINST.EXE
- 6) LOCATE.BAT
- 7) DRIVER.EXE
- 8) SOLVER.COM

The first five programs listed are used only once, for initializing data files (see Part C). The last three are used to run the POD location system, where the batch file LOCATE controls the execution of DRIVER and SOLVER. (For more information on these programs, see Section IV.)

## C. Data Files

The data files required by the POD location system can be divided into two categories: (1) geographic data files used to draw maps and (2) IRS data files used to initialize and solve a location problem. The data files contain information on a state-wide basis, even if the IRS district of interest is only part of a state. For a given state, each data file is

named using the state code number followed by a three-letter extension indicating the type of data in the file. The state code number may be determined by looking at the name of the provided zip code boundary file. For example, STATE12.ZIP is the name of the file containing zip code boundary coordinates for Florida. In the following description, "XX" is substituted for the state code number.

#### 1) Geographic Data Files

The system is currently designed using zip code boundary data from Ganesa's Statmap package. This data must be processed before it can be used by the POD location system. (The initialization process only needs to be done once, when the system is first installed. After that, it is done only when updates are made to the zip code files.)

##### Procedure:

- a) Switch to the POD location system directory and type BASICA TEMPZIP. Enter the state code number when the program prompts for it, and also the number of floppy disks containing the Ganesa zip code boundary file STATEXX.ZIP. Then the program will give instructions to insert each floppy disk in the A: drive. The terminal will beep after each disk is read, which may take several minutes apiece. After all the disks have been read, the message "ZIP CODE FILE LOADED" will appear on the screen. Type SYSTEM to exit from BASIC. A new file called STATEXX.TMP will exist on the fixed disk, which contains the zip code boundary file with end-of-record marks added.
- b) Type UNFORM and enter the state code number when prompted. This program will run for several minutes to create a new file called STATEXX.ZIP, which is an unformatted direct access version of STATEXX.TMP. This is done to increase the speed of file accessing. STATEXX.TMP should be deleted after UNFORM has been run to save disk space, since the system uses only the unformatted version.
- c) Type SAVCEN and enter the state code number when prompted. This program calculates the centroid of each zip code in STATEXX.ZIP. It creates a new file called STATEXX.CEN, which is an unformatted direct access file containing five-digit zip codes, centroids, and pointers to the boundary file.
- d) Type BASICA TEMPSTE and enter the state code number when prompted. Insert the floppy disk containing the Ganesa state boundary file STATEXX.ST into the A: drive. The program will create a new file called STATEXX.TM on the fixed disk, which contains the state boundary file with end-of-record marks added. Exit from BASIC by typing SYSTEM.
- e) Type BINSTE and enter the state code number when prompted. This program creates a new file called STATEXX.STE which is an unformatted direct access version of STATEXX.TM. STATEXX.TM should be deleted after BINSTE has been run, since the system uses only the unformatted version.

Note: The Ganesa coordinate files will eventually be replaced by GDT files, so the above procedure will be changed and probably simplified. There will be an additional procedure for setting up a zip code adjacency file to be used with the map-coloring algorithm. Also, provision will be made for districts which are not entire states.

## 2) IRS Data Files

Two files of IRS data are required which contain current POD information and workload data for a given state. The names of these files are STATEXX.POD and STATEXX.WRK. If these files are provided by the National Office on a floppy disk, they should be copied into the POD location system directory. (Another file, STATEXX.GDF, may also be provided. If so, copy it too.) Otherwise, the files must be created using a text editor. The format of the files is as follows.

### a) STATEXX.POD:

The purpose of this file is to maintain a list of the zip codes and associated costs of all POD sites which currently exist in the state and also of potential new POD sites. The first line of the file should contain the total number of possible POD sites (current and potential) for the state, followed by the office space requirement (given as square feet per IMF return). Each remaining line (one line per POD site) should contain the five-digit zip code of the site, the opening or closing cost for a POD at the site (\$), and the rental cost for office space at the site (\$ per square foot per month). Current POD sites should have minus signs in front of their zip codes. (This determines whether the second number is an opening or closing cost; current POD sites have closing costs and potential POD sites have opening costs.) Numbers in the file should be separated by spaces, and the zip codes should be listed in sequential order.

Example:

```
9 .062
-20001 1.0 3.0
-20003 .5 .5
 20004 2.0 1.5
 20007 1.5 1.0
-20010 2.0 2.0
-20013 2.0 1.0
 20014 1.5 .5
-20015 2.0 2.5
-20018 1.0 2.0
```

This example shows nine POD sites, six of which are current POD sites.

### b) STATEXX.WRK:

The first line of this file should contain the travel cost (\$ per mile) and the travel distance limit (miles) for the state. (The travel distance limit is the maximum distance that a person would be expected to travel to reach a POD site.) The second line should



contain the 16 IRS trip factors, one for each category of workload (see below). (An IRS trip factor is the average number of trips an IRS employee must make for each case in a particular category.) Similarly, the third line contains the 16 taxpayer trip factors (the average number of trips a taxpayer must make per case). Each remaining line of the file (one line per zip code, listed in sequential order) should contain a five-digit zip code followed by 16 numbers giving the workload for that zip code in each of the following categories.

- 1) Examination - Class 1
- 2) Examination - Class 2
- 3) Examination - Class 3
- 4) Examination - Class 4
- 5) Examination - Class 5
- 6) Examination - Class 6
- 7) Examination - Class 7
- 8) Examination - Class 8
- 9) Examination - Class 9
- 10) Examination - Class 10
- 11) Examination - Class 11
- 12) Examination - Class 12
- 13) Collection - TDI's
- 14) Collection - TDA's
- 15) Taxpayer Service
- 16) Criminal Investigation

Example:

```
.205 800.
1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
20001 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20002 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20003 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20004 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20005 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20006 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20007 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20008 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20009 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20010 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20011 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20012 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20013 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20014 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20015 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20016 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20017 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20018 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

This example shows a state with eighteen zip codes, with nonzero workload in only the first category. (The numbers are given only to

show the format of the workload file and are not intended to represent realistic data.)

To summarize, the following data files must exist to run the POD location system.

- 1) STATEXX.ZIP (zip code boundary file)
- 2) STATEXX.CEN (centroid file)
- 3) STATEXX.STE (state boundary file)
- 4) STATEXX.POD (POD file)
- 5) STATEXX.WRK (workload file)

These files are set up when the system is first installed and only need to be changed when updates are made to the data.

## Section IV: Using the System

### A. Overview

This introduction gives a general overview of the steps a user should go through to solve a location problem. Detailed instructions for each step are provided in later parts of this section. The overview also describes how maps are used in the system and explains how to use the cursor to locate zip codes and to zoom in on maps.

### Steps in Solving a Location Problem

(Before the system is used for the first time, several data files must be set up. See Section III for information on how to do this.)

#### 1) **Enter the system.**

Type LOCATE to enter the system, and identify the state to work on. Wait for the top-level menu to appear. (See Part B for more information on entering the system.)

#### 2) **Display workload.**

This step may be repeated at any time, or it may be skipped. Select the function for displaying workload from the top menu. Choose the category of workload to be displayed. A state map will appear which can be zoomed in on to show zip codes shaded according to their workloads. (See Part D for more information on displaying workload.)

#### 3) **Display and initialize POD information.**

Return to the top menu and select the function for displaying and modifying initial POD sites. A state map will appear with asterisks showing where POD's are currently located. Zoom in on the map to an area of interest, and then color in zip codes to indicate whether they are to be considered as currently existing POD sites, potential new POD sites, or fixed POD sites which cannot be moved. Zip codes which are not colored cannot be POD sites. (See Part E for more information on displaying POD information.)

#### 4) **Initialize cost information and solve for best POD locations.**

Return to the top menu and select the function for solving for optimal POD locations. Set options as requested to select categories of workload to be considered in the cost calculation and to choose weights for IRS and taxpayer costs. Travel difficulty factors may be entered for pairs of zip codes and POD sites which are separated by geographic barriers. Choose the number of POD's desired in the solution. The solution procedure will then begin, and a summary of the stages of the process will appear on the screen. (See Part F for more information on initializing and solving a location problem.)

## 5) **Display solution.**

Select the function for displaying optimal POD locations from the top menu. A state map will appear with asterisks showing where POD's have been placed by the solution procedure. Zoom in on the map to areas of interest. (See Part G for more information on displaying a solution.)

## 6) **Exit from the system.**

Return to the top menu and select the function for exiting from the system. Examine the report file, which summarizes the location problem and its solution. (See Part C for more information on exiting from the system.)

## Use of Maps

In several of the steps listed above, maps are drawn to display information. Although the type of information is different at each step, the procedure for manipulating the maps is the same. The user may zoom in on a small region, back up to a previous map, or find the five-digit zip code number of an area on the map.

The first map drawn always shows the outline of the state and centroids of certain zip codes, but no zip code boundaries. (The reason for not including zip code boundaries at this level is that many of them are too small to be distinguished and it would take a very long time to draw them for the whole state.) A menu appears to the left of the map giving the user several choices on how to proceed.

### 1) **Exit**

This option returns the user to the top menu.

### 2) **Zoom**

This option allows the user to zoom in on the map to display zip code boundaries in a small region. When this option is chosen, instructions appear in the menu area telling how to use the cursor to draw a box around the area to be enlarged. First a crosshair (+) cursor appears in the center of the screen, which can be moved using the arrow keys and the "home", "end", "page up" and "page down" keys on the right side of the keyboard. Move the cursor to one corner of the area to be enlarged; then press return (↵) to enter the coordinates of this point into the computer. (The cursor normally moves in large increments. To make it move in smaller increments, first press the "insert" key.) Next, move the cursor to locate the opposite corner of the box. This time the box is actually drawn on the screen. Then press return to enter this point.

The old map will be erased from the screen, and a new map showing zip codes in the boxed area will be drawn. A new menu will appear on the left side (see below). If a mistake was made in entering the box corners (for example, if both corners were the same point), the message "TRY AGAIN" will appear; start over, again entering both corners of the

box. The user may take advantage of this feature to cancel an undesired box, by entering an intentional mistake for the second corner.

### 3) Full Display

This option causes the full state map to be drawn with zip code boundaries included. It is expected that this option will normally not be used. A new menu will appear on the left side of the screen (see below).

After either of the last two options above is chosen, a new menu appears on the left side of the screen with the following options.

#### 1) Exit

This option returns the user to the top menu.

#### 2) Zoom

This option allows the user to zoom in on a specified area of the current map. The procedure for drawing a box around the area is the same as given above. After the new map has been drawn, the same menu of options appears. The user may zoom as many times as desired.

#### 3) Back Up

This option redraws the previous map and its display menu. Only one level of backing up is allowed. For example, if five zooms had been done, only the fourth map could be redisplayed. However, it is always possible to return to the full state map and then zoom in again.

#### 4) Full State

This option redraws the full state map showing the state boundary and zip code centroids.

#### 5) Map Key

This option displays a key which defines what the colors on the map mean. Two further options are available at this level. First, the user may exit from the map key and return to the menu of display options. Second, the user may move the cursor to locate a zip code on the map and have its five-digit number displayed in the lower left corner of the screen.

The cursor is moved with the arrow keys and the "home", "end", "page up" and "page down" keys on the right side of the keyboard. Pressing the "insert" key makes the cursor move in small increments. To locate a zip code, move the cursor near the centroid of the zip code and press return (↵). The five-digit zip code number will be written at the bottom of the menu area. If the cursor is too far away from a centroid, the message "ZIP NOT FOUND" will be written instead.

It is important that the cursor be positioned close to the centroid of the zip code region of interest. The program that prints the five-digit zip code does not recognize the boundaries on the map, so it is not necessarily enough merely to have the cursor in the correct region. The zip code printed is that of the nearest centroid to the cursor, whether it is in the same region as the cursor or not.

In addition to the two options discussed above, other options are available on the POD initialization map for changing the colors of zip codes. See Part E for information on how to do this.

The remainder of this report provides descriptions of menus and detailed instructions for each step used in solving a POD location problem.

## B. Entering the System

To enter the POD location system, switch to the directory containing the system files (using the DOS "Change Directory" command) and type LOCATE. Enter the state code number when prompted. (This number is provided with the system data files when the package is installed.)

If a report file exists from a previous session, the system will then ask whether the report is to be overwritten. (See Part C for information on the report file.) If the user answers "yes", the old report file will be replaced by a new report on the current session. If the user answers "no", the new report will be appended to the old report file.

The message "SORTING CENTROIDS" will then appear, followed by a brief pause. (If the pause lasts for more than a minute or if the message "CANNOT OPEN WORKSTATION" appears, check for device driver errors in the AUTOEXEC.BAT or CONFIG.SYS files. See Section III Part A.) Then the top-level menu will appear on the screen, as shown in Figure 1.

IRS POST-OF-DUTY LOCATION SYSTEM	
<b>F1</b>	- Exit.
<b>F2</b>	- Display workload.
<b>F3</b>	- Display or modify initial POD sites.
<b>F4</b>	- Solve for optimal POD locations.
<b>F5</b>	- Display optimal POD locations.

Figure 1. Top-level menu.

This menu lists the steps used to solve a POD location problem, along with a function key number for each step. To make a selection from the menu, just push the corresponding function key (no return  $\leftarrow$  is necessary). The following is a brief description of each of the choices in the top menu. For a more complete description, see the subsection listed in parentheses.

**F1 - Exit (Part C)**

Exits from the POD location system.

**F2 - Display workload (Part D)**

Draws a map showing workload for each zip code.

**F3 - Display or modify initial POD sites (Part E)**

Draws a map showing where POD's are currently located and also where new POD's are allowed to go. The user may alter this information by coloring the map, and the data is saved for use by the solution algorithm (see F4).

**F4 - Solve for optimal POD locations (Part F)**

Solves the location problem initialized using F3.

**F5 - Display optimal POD locations (Part G)**

Draws a map showing the new POD locations determined using F4.



### C. Exiting from the System

To exit from the POD location system, choose F1 from the top menu. The system will automatically delete several work files which were created during the session. For reference, the names of these files are NAMES, ERRORS.GKS, STATEXX.DBL and STATEXX.SOL.

After exiting from the system, the user should examine the report file STATEXX.REP, either by scanning it with a text editor or by listing it on a printer. This file contains a summary of all parameters used to set up a location problem and a list of POD's and zip code assignments in the solution, if these steps were performed during the session. (Reports of previous sessions may also be contained in the same file.)

#### D. Displaying Workload

The F2 function in the top menu is used to display a map showing workload for each zip code. Before drawing the map, the system will ask the user to choose the category of workload to be displayed from the following list.

- 1) Examination (Number of returns in classes 1-12)
- 2) Collection (Number of TDI's and TDA's)
- 3) Taxpayer Service (Number of notices)
- 4) Criminal Investigation (Number of cases)
- 5) Single Column of Workload File

Type the number of the desired category. If category 5 is selected, the user will be prompted to type in the number of the column to be displayed (a number from 1 to 16). (See Section III Part C for a description of the workload columns.) The workloads are then read in from the file STATEXX.WRK and are divided into six equally spaced ranges. A color is assigned to each zip code based on which range its workload lies in. This information is not displayed immediately, but is stored for later use.

While the file is being read, the system compares the zip codes in the workload file with the zip codes in the boundary file which will be used to draw the map. If any zip codes appear in the workload file but not in the boundary file, they will be ignored. If any zip codes appear in the boundary file but not in the workload file, they will be drawn as blank areas on the workload map. In either case, a message will appear on the screen indicating which zip codes were mismatches so that the user may check if the workload file is accurate.

After the workload file has been read and colors have been calculated, a map showing only the state boundary and small boxes for zip code centroids is drawn. No zip code boundaries are drawn at this level. On an enhanced graphics display, the centroids are drawn in six different colors, with brighter colors indicating higher workloads. On a regular color display, all the centroids are drawn in yellow; the user must zoom in on the map in order to see the workload. To the left of the state map, a menu of display options appears on the screen (see Figure 2).



Figure 2. Full state map display menu.

The menu choices are discussed below.

**F1 - Exit**

Exits from the workload display mode and returns to the top menu.

**F2 - Zoom**

Zooms in on a specified area of the map to display workload there. See Part A for a complete description of how to use the cursor to draw a box around the area. A new map showing zip code boundaries in the boxed area will be drawn, and a new menu will appear (see below).

**F3 - Full Display**

Draws a map of the full state showing zip code boundaries and workloads. It is expected that this option will normally not be used, since the zip codes will be too small and the map will take a long time to draw. A new menu will appear on the left side of the screen.

After choosing F2 or F3 from the full state display menu, the menu of display options shown in Figure 3 will appear.

DISPLAY OPTIONS
F1- EXIT
F2- ZOOM
F3- BACK UP
F4-FULL STATE
F5- MAP KEY

Figure 3. Zip code map display menu.

The options are described below.

**F1 - Exit**

Exits from the workload display mode and returns to the top menu.

**F2 - Zoom**

Zooms in on a specified area of the current map. See Part A for a complete description of how to use the cursor to draw a box around the area. After the new map has been drawn, the same menu of display options appears. The user may zoom as many times as desired.

**F3 - Back Up**

Redraws the previous map and its display menu. Only one level of backing up is allowed.

**F4 - Full State**

Redraws the full state map showing the state boundary and zip code centroids. The full state display menu also reappears.

**F5 - Map Key**

Displays the map key shown in Figure 4 defining what the zip code colors mean.



Figure 4. Workload key.

There is a color for each of the six possible workload ranges, listed in order from the lowest workload to the highest workload. Two menu options exist.

**F1** - Exits from the workload key and returns to the menu of display options.

**F2** - Allows the user to locate a zip code on the map using the cursor and have its five-digit number displayed in the lower left corner of the screen. (The procedure for using the cursor to locate a zip code is described in Part A.)

### E. Displaying or Modifying Initial POD Sites

The F3 function in the top menu is used to display a map showing current POD sites and other potential POD sites. This information is read from the file STATEXX.POD. The user is allowed to make modifications by changing the colors on the map. The modified POD information is saved for use later by the solution algorithm.

Before the map is drawn, the system checks to see that all POD zip codes appear in the master list of zip codes obtained from the boundary file. If any mismatches occur, a message will appear on the screen and the POD will be ignored by the system. The user should check on the accuracy of the file STATEXX.POD.

After the zip codes have been checked, a map showing only the state boundary and centroids of certain zip codes is drawn. On an enhanced graphics display, centroids of current POD sites are drawn as red asterisks and centroids of other potential POD sites are drawn as small blue boxes; other zip code centroids are not drawn. On a regular color display, centroids of current POD sites are drawn as red asterisks; centroids of all other zip codes are drawn as yellow boxes. A menu of display options appears on the left side of the screen (see Figure 5).

DISPLAY OPTIONS
F1- EXIT
F2- ZOOM
F3-FULL DISPLAY

Figure 5. Full state map display menu.

The menu choices are discussed below.

**F1 - Exit**

Exits from the POD initialization mode and returns to the top menu. The current POD set-up is saved to be used later by the solution algorithm. If F3 is entered again from the top menu, the previous set-up is erased and a new initialization is begun.

**F2 - Zoom**

Zooms in on a specified area of the map to display POD information there. See Part A for a complete description of how to use the cursor to draw a box around the area. A new map showing zip code boundaries in the boxed area will be drawn, and a new menu will appear (see below).

**F3 - Full Display**

Draws a map of the full state showing zip code boundaries and POD information. It is expected that this option will normally not be used, since the zip codes will be too small and the map will take a long time to draw. A new menu will appear on the left side of the screen.

After choosing F2 or F3 from the full state display menu, the menu of display options shown in Figure 6 will appear.

DISPLAY OPTIONS
F1- EXIT
F2- ZOOM
F3- BACK UP
F4-FULL STATE
F5- MAP KEY

Figure 6. Zip code map display menu.

The options are described below.

**F1 - Exit**

Exits from the POD initialization mode and returns to the top menu. The current POD set-up is saved to be used later by the solution algorithm. If F3 is entered again from the top menu, the previous set-up is erased and a new initialization is begun.

**F2 - Zoom**

Zooms in on a specified area of the current map. See Part A for a complete description of how to use the cursor to draw a box around the area. The same menu will appear after the new map is drawn, and the user may zoom as many times as desired.

**F3 - Back Up**

Redraws the previous map and its display menu. Only one level of backing up is allowed.

**F4 - Full State**

Redraws the full state map showing the state boundary and zip code centroids. The full state display menu also reappears.

**F5 - Map Key**

Displays the map key shown in Figure 7 defining what the zip code colors mean.



POD TYPES	
F1-EXIT	
F2-FIND ZIPCODE	
F3-SET COLOR	
F4-	
CANT BE	
F5-	
MAY BE	
F6-	
IS NOW	
F7-	
MUST BE	
<b>USE F1-F2</b>	

Figure 7. POD map key.

A function key is associated with each color to allow colors to be changed on the map. The functions are as follows.

- F1 - Exits from the map key and returns to the menu of display options.
- F2 - Allows the user to locate a zip code on the map using the cursor and have its five-digit number displayed in the lower left corner of the screen. (The procedure for using the cursor to locate a zip code is described in Part A.)
- F3 - Enters the mode for changing the color of a zip code on the map. The zip code must have been located already using F2.
- F4 - Sets a zip code to be a site which is not allowed to have a POD. The coloring mode must have been entered using F3.
- F5 - Sets a zip code to be a site which is allowed to have a POD but does not currently have one. The coloring mode must have been entered using F3.
- F6 - Sets a zip code to be a site which currently has a POD. The coloring mode must have been entered using F3. Current POD sites are allowed to be removed by the solution algorithm.
- F7 - Sets a zip code to be a site which must have a POD. The coloring mode must have been entered using F3. Sites which must have a POD are fixed and will not be removed by the solution algorithm.

To summarize, the map originally shows current POD sites and other potential POD sites as read from the file STATEXX.POD. The user may

fix a POD site or make other changes by first locating the zip code (F2), entering the coloring mode (F3), and then choosing the correct color (F4, F5, F6 or F7). A message is always given at the bottom of the menu area telling which functions keys can currently be used; if any other key is pushed it will be ignored.

## F. Solving for Optimal POD Locations

The F4 function in the top menu is used to solve a POD location problem given an initial configuration of current, potential and fixed POD sites, as set up using the F3 function. F3 creates data structures which must be used by F4, so F3 must always be done first even if no modifications are to be made to the configuration read from the input file.

After F4 is pushed, the system will allow the user to set various parameters to be used in calculating costs. The following list of default parameter settings will appear on the screen.

#	ITEM	POSSIBLE	ACTUAL
1	IMF EXAMINATION	0,1	1
2	IMF COLLECTION	0,1	1
3	IMF TAXPAYER SERVICE	0,1	1
4	IMF CRIMINAL INVESTIGATION	0,1	1
5	BMF EXAMINATION	0,1	0
6	BMF COLLECTION	0,1	0
7	BMF TAXPAYER SERVICE	0,1	0
8	BMF CRIMINAL INVESTIGATION	0,1	0
9	TAXPAYER TRAVEL COST WEIGHT [0.0-1.0]		1.00000000
10	IRS TRAVEL COST WEIGHT [0.0-1.0]		1.00000000
11	MAXIMUM TRAVEL DISTANCE IN MILES		80.00000000

The first eight items indicate which categories of workload should be included in the cost calculation; a value of 1 means the category is included and a value of 0 means it is not included. (In the current version of the system, Business Master File (BMF) data cannot be included.) The next two items are weights to be assigned to IRS employee travel costs and taxpayer travel costs. For example, setting the IRS weight to 0 and the taxpayer weight to 1 would cause the solution procedure to consider only costs to the taxpayer. The weights can have any decimal value from 0 to 1, and they need not add up to one. The final item on the parameter list is the maximum distance that a person would be expected to travel between a zip code and a POD. The value listed (in this example, 80 miles) is read from the file STATEXX.WRK. The distance limit is used to cut down on storage space and on the running time of the solution procedure, since zip codes separated by too large a distance can be eliminated from consideration.

The system then asks whether the user wishes to change any of the default parameter settings. If the answer is "yes", the user is asked to enter the number of the item to be changed and its new value. These should be typed on one line, separated by a space. The new value will then appear in the parameter list, and the user may proceed to make further changes.

Next, the system will ask if the user wants to change any travel difficulty factors. These are weights which are assigned to pairs of zip codes and POD's to scale their travel costs. This is especially useful in cases where, for example, a zip code and a POD site are close together but are separated by some geographic barrier which makes travel between them difficult. By assigning a high weight to the pair, the user makes it unlikely that the solution procedure will try to assign the zip code and POD to each other. It should be kept in mind that the solution procedure

automatically takes distances between zip codes and POD's into account when making assignments, so distance should not be considered when setting difficulty factors.

Default settings for travel difficulty factors are read from the file STATEXX.GDF if it exists; otherwise all factors are assumed to be equal to one. If the user responds "yes" to the question on changing travel difficulty factors, new values may be entered into the file. Type a zip code, a POD zip code and the new factor on one line separated by spaces. The factor may be any positive number. A factor greater than one implies that travel is of more than average difficulty; a factor less than one implies easier travel.

After all options have been set, there will be a pause for several minutes while the workload file STATEXX.WRK is read and all possible zip code pairs and their costs are computed. (For a complete mathematical description of the cost calculation, see "The Internal Revenue Service Post-of-Duty Location Modeling System: Final Report".) The zip codes in the workload file are compared with the master list of zip codes obtained from the boundary file. If any zip codes appear in one file but not the other, they are eliminated from consideration by the solution procedure. A message will be printed on the screen whenever a skip occurs, but the solution will proceed normally based on the subset of zip codes which appear in both files. The user may wish to modify the workload file to correct the skips (see Section III Part C).

It is possible that for some zip code there may be no POD site within the required distance limit. In this case, the message "INITIAL POD SITES NOT FEASIBLE" will appear on the screen. The user should then either increase the distance limit or set more potential POD sites.

After costs for each zip code pair have been calculated, a summary is printed giving the total number of zip codes, the total number of possible POD sites (current and potential), and the number of currently existing POD's. Then the user is prompted to enter the number of POD's desired in the solution. This can be any number from one to the total number of possible POD sites.

The solution algorithm then begins and passes through four phases.

1) Initial Assignment

Zip codes are assigned to the currently existing POD's, and the total cost of the assignment is printed on the screen.

2) Initial Interchange

Each current POD is examined to see if it can be switched with another potential site to give a lower allocation cost. A message is printed on the screen whenever a switch is made. The result at the end of this phase is a better arrangement of the initial set of POD's. The cost of the new arrangement is printed on the screen.

### 3) Greedy Heuristic

In this phase, POD's are added to (or deleted from) the initial set until the specified number of POD's has been reached. One POD is added (or deleted) at a time, and it is chosen as the site which, when taken with the initial set, will give the lowest possible allocation cost. Messages are printed on the screen telling which POD's have been added (or deleted) and what the allocation cost is at each step.

At some stage of the solution algorithm, a message may appear saying that a solution is infeasible. This means that for some zip code it was impossible to find a POD site within the specified maximum distance limit. The algorithm will proceed using the last known feasible number of POD's for the final interchange.

### 4) Final Interchange

In the last phase, the set of POD's determined by the greedy heuristic is examined to see if any POD in the set should be switched with one not in the set. The switches are listed on the screen along with the final allocation cost.

The solution is stored for later display, and the top menu reappears on the screen.

### G. Displaying Optimal POD Locations

The F5 function in the top menu is used to display a map showing the solution to the POD location problem determined using the F4 function. Also, information on the solution, including assignments of zip codes to POD's, is written in the report file STATEXX.REP (see Part C). First a map of the state boundary is drawn, with asterisks indicating the centroids of POD's in the solution. The menu of display options shown in Figure 8 appears on the left side of the screen.

DISPLAY OPTIONS
F1- EXIT
F2- ZOOM
F3-FULL DISPLAY

Figure 8. Full state map display menu.

The menu choices are discussed below.

**F1 - Exit**

Exits from the solution display mode and returns to the top menu.

**F2 - Zoom**

Zooms in on a specified area of the map to display the solution there. See Part A for a complete description of how to use the cursor to draw a box around the area. A new map showing zip code boundaries in the boxed area will be drawn, and a new menu will appear (see below).

**F3 - Full Display**

Draws a map of the full state showing zip code boundaries and POD locations. It is expected that this option will probably never be used, since the zip codes are too small and the map will take a long time to draw. A new menu will appear on the left side of the screen.

After choosing F2 or F3 from the full state display menu, the menu of display options shown in Figure 9 will appear.

DISPLAY OPTIONS
F1- EXIT
F2- ZOOM
F3- BACK UP
F4-FULL STATE
F5- MAP KEY

Figure 9. Zip code map display menu.

The options are described below.

**F1 - Exit**

Exits from the solution display mode and returns to the top menu.

**F2 - Zoom**

Zooms in on a specified area of the current map. See Part A for a complete description of how to use the cursor to draw a box around the area. The same menu will appear after the new map is drawn, and the user may zoom as many times as desired.

**F3 - Back Up**

Redraws the previous map and its display menu. Only one level of backing up is allowed.

**F4 - Full State**

Redraws the full state map showing the state boundary and zip code centroids. The full state display menu also reappears.

**F5 - Map Key**

Displays the map key shown in Figure 10.



<b>NEW PODS</b>
<b>F1-EXIT F2-FIND ZIPCODE</b>
<b>* = POD</b>
<b>USE F1-F2</b>

Figure 10. Solution map key.

Only the zip codes which the solution algorithm determined should be POD sites are colored on the map and their centroids are shown as asterisks. The following options exist on the menu.

- F1** - Exits from the solution key and returns to the menu of display options.
- F2** - Allows the user to locate a zip code on the map using the cursor and have its five-digit number printed in the lower left corner of the screen. (The procedure for using the cursor to locate a zip code is described in Part A.)

Note: It is planned that, in a future revision of the POD location system, the solution map will be able to show assignments of zip codes to POD's, rather than just showing POD sites. A POD and all its assigned zip codes will be drawn in the same color.

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