

Flight Procedures Handbook

Shuttle Portable Computer (SPoC)

Mission Operations Directorate

Basic
July 1988

NASA

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

SHUTTLE PORTABLE COMPUTER (SPoC)
HANDBOOK

MISSION OPERATIONS DIRECTORATE

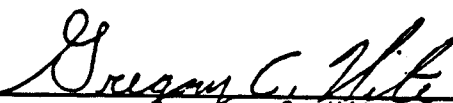
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SECTION 1.0 INTRODUCTION

The concept of an independent computational capability aboard the Shuttle has been operational since STS-1. Originally the HP41 hand-held calculator was employed for this purpose, but it has significant limitations. The SPoC greatly augments HP41 capabilities. STS-9 was the first Shuttle mission manifested with a SPoC, and it proved to be such an asset for the crew that a SPoC has been manifested on every subsequent Shuttle mission. In its original role it was used as a situational awareness aid, depicting the Orbiter and its ground track over the earth's surface. The SPoC has evolved to provide a backup alternative means of obtaining landing opportunities, deorbit targets, and center of gravity management procedures. These targets and procedures are only utilized in the event of a total loss of communications with the ground or a time critical systems failure during a loss of communication period requiring an emergency deorbit before ground assistance can be provided. Nominally, the SPoC is unstowed and set up during the post insertion time frame and remains active until entry interface minus 20 minutes.

The SPoC saves Mission Control Center (MCC) personnel time and resources by eliminating need to routinely transmit such data as Acquisition of Signal/Loss of Signal (AOS/LOS) times via voice or teleprinter. During the mission, the Flight Dynamics Officer (FDO) will take SPoC system questions in the MCC Mission Operations Control Room (MOCR) and pass them to the SPoC Team if necessary.

1.1 SPoC Mission Definition

The SPoC is a portable "lap top" microcomputer providing the crew and mission operations personnel with an independent computational and display facility, enhancing productivity and reliability. This microcomputer is mandatory for flight because of the crew support it provides. The SPoC was designated as noncritical hardware by Configuration Control Board Directive 1253 in 1983. This classification was reaffirmed in 1987 by On-Orbit Flight Techniques Panel Meeting #82 [ref. NASA memo DAB-88-04 (FT)]. Currently, there are four major roles for the SPoC.

- a) Provide automated cues for such events as upcoming ground communication times, earth observation site availability, sunrise and sunset times, nodal crossings, orbiter ground track, and location over the earth's surface.
- b) Provide a backup alternative means of obtaining landing opportunities, deorbit targets, and center of gravity management procedures in the event of a total loss of communications with the ground or a time-critical systems failure during a loss of communication period requiring an emergency deorbit before ground assistance can be provided.
- c) Provide computational and display support for special purpose applications on a flight-specific basis (e.g. the Orbit Refueling System (ORS) and the Gravity Gradient Free Drift programs).
- d) Provide mission status and contingency deorbit support in the Emergency Mission Control Center (EMCC).

1.2 How To Use This Handbook

This handbook relates procedures and concepts associated with SPoC operation. Acronyms and other terms pertinent to this discussion, but whose definitions may not be apparent from context, are defined in APPENDIX F (GLOSSARY). As a convention, the names of SPoC applications will be in capitals. A brief history of the SPoC is presented in Appendix E. If you are interested in operating SPoC immediately, proceed to Appendix A, INITIALIZING THE SPoC, for your first SPoC session. Appendices A through D are designed to provide an introductory overview without exercising all SPoC capabilities. For the location of complete and detailed information, consult the Table of Contents.

SECTION 2.0 HARDWARE

The SPoC has 384k bytes of nonvolatile bubble memory for use in storing programs and data. Four Erasable Programmable Read Only Memory (EPROM) slots, located above the keyboard, are user-accessible. Each SPoC EPROM has a 64k byte capacity, providing 256k bytes of Read Only Memory (ROM). The SPoC directly accesses 512k bytes of Random Access Memory (RAM). The foldup display is a high resolution electroluminescent flat panel which measures 7-and-9/16 by 3-and-3/4 inches (512 pixels by 256 scanlines).

There are four types of keys on the SPoC: alphabetic/numeric keys, modifier keys for issuing commands, arrow keys for positioning the cursor, and a return key for selection box control. The memory, display, and 57-character keyboard are in a magnesium case, which together weighs approximately 10 pounds. The unit will fit into one-half of a standard size briefcase.

SPoC is hosted on a GRiD Compass computer purchased off-the-shelf and modified for flight. A standard lithium battery circuit that provides power for the internal clock is replaced by a silver oxide battery and equipped with diodes and a fuse to ensure fail-safe operation. The internal modem is removed. Flight displays are fitted with electromagnetic interference filters. This prevents electromagnetic interference generated by the electroluminescent display from harming the General Purpose Computers (GPCs) or other equipment onboard. When used onboard the Shuttle, SPoC runs on phase A ac power and uses a power cable which is compatible with the Orbiter's power outlets. Finally, the foot of a flight SPoC is milled to permit fan exhaust flow when folded up for flight operation.

2.1 Operation

There are two different setup procedures for the SPoC: Setup For Ground Operation (Section 2.2), and Setup For Flight Operation (Section 2.3). In either case, the SPoC can be turned on with a rocker switch on the back panel. Also on the back panel are the power connector and fuse assembly.

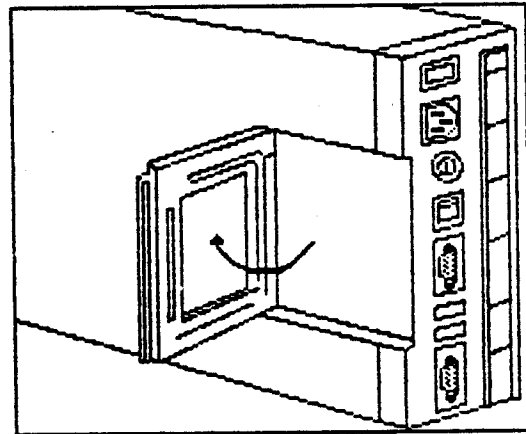
2.1.1 Bubble Memory Access

WARNING: DO NOT CYCLE SPoC POWER DURING BUBBLE MEMORY ACTIVITY. Data files can be damaged if power is turned off while bubble memory is being accessed. Damaged files will prevent proper SPoC operation until ground support equipment can be utilized.

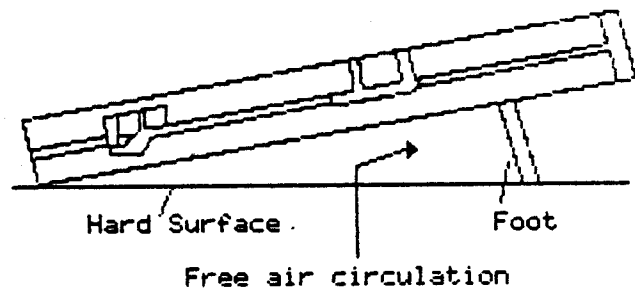
Bubble memory access is indicated by the flickering squares located in the lower right hand corner of the screen. This indicator is flickering only when bubble memory is being accessed. Nominally the flickering squares disappear when bubble memory access is terminated. Due to an oversight of the GRiD operating system, it is possible the flickering squares may become static when bubble memory access is terminated. The display of the static squares most often occurs at the SPoC Main Menu but can occur whenever bubble memory access is terminated. In either case, if the flickering squares disappear or become static, bubble memory access has terminated.

2.2 Setup For Ground Operation

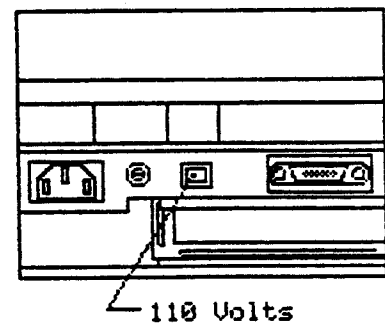
Step 1: Pull down the foot at the back of the computer until it clicks into place. This will provide a good viewing angle and permit ventilation underneath the SPoC. Exhaust flow from the SPoC fan is free to exit nonflight units with the foot in this position.



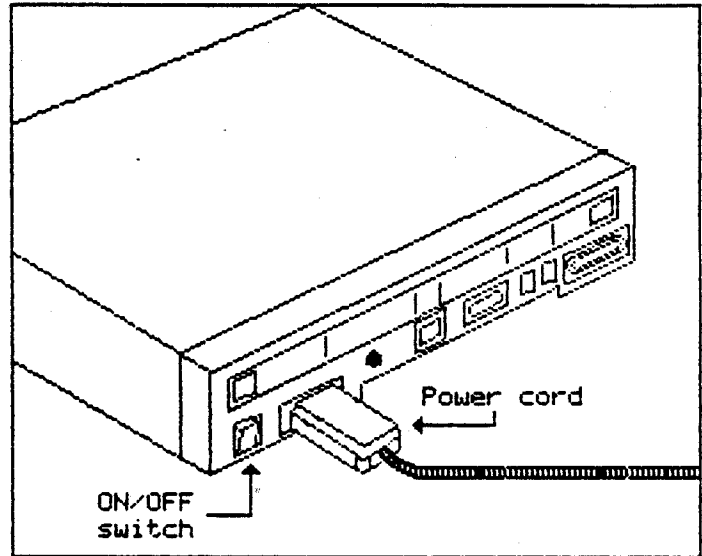
Step 2: Place the SPoC on a flat work surface.



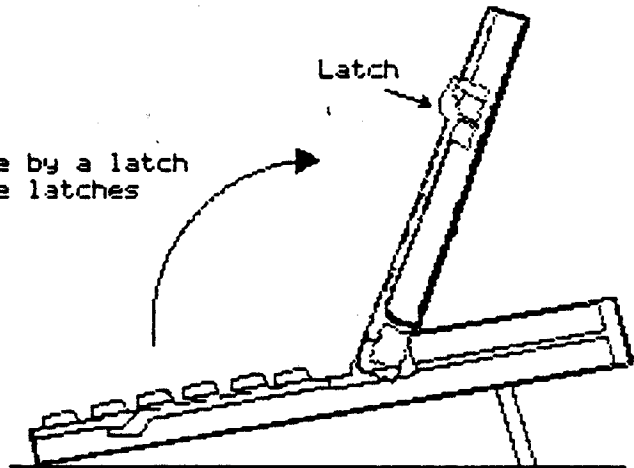
Step 3: Verify the voltage switch is set for 110 volts.



Step 4: When you are facing the rear of the SPoC, the ON/OFF switch is on the far left side. Verify the power switch on the back panel is OFF. Connect power cord to a 110-volt 60hz outlet.



Step 5: The screen is locked in the frame by a latch on each side of the computer. Pull these latches forward and lift the screen.



Step 6: Turn power ON. In addition to enabling power, this also loads initialization programs into RAM.

CAUTION: WHEN CYCLING POWER, LEAVE THE SWITCH OFF FOR AT LEAST 5 SECONDS BEFORE TURNING IT BACK ON. Ignoring this precaution may cause improper loading of system software.

2.3 Setup For Flight Operation

SPoCs are stowed in a middeck locker during ascent and entry. The Post Insertion Checklist calls for SPoC activation a few minutes before payload bay door opening. Panel F3 is configured so the SPoC can be attached to it using velcro and bungee cords. For this setup, the power cord plugs into the ac utility outlet on panel F1. However, SPoC location depends on crew preference. It may be attached to any panel as long as SPoC's six foot power cord can reach an ac utility outlet. Outlets from ac 1 are located on panels F1 and M052J, while ac 3 outlets are on panels A15 and M013Q. SPoC remains in operation until entry interface minus 20 minutes.

To activate the SPoC:

Step 1: Verify the voltage switch is set for 110 volts.

Step 2: Verify power switch is in the OFF position.

Step 3: Connect power cord, first to the SPoC and then to an ac outlet.

Step 4: Unlatch and pull up screen.

Step 5: Turn the power switch to ON.

Due to the zero-g environment, there is no need to pull down SPoC's foot. An operations/malfunctions cue card is used on orbit and can be attached with velcro just below the SPoC screen.

2.4 EPROM Installation/Removal

SPoC applications may be stored on EPROM chips. If the EPROM chips are not installed, an appropriate message and instructions will be displayed.

WARNING: CARE MUST BE TAKEN TO HANDLE THE EPROM CHIP ONLY BY ITS PLASTIC ENDS, AND TO TURN OFF SPoC POWER BEFORE INSTALLATION. Otherwise, you may damage both the computer and the EPROM chip.

CAUTION: NEVER BRING A CHIP IN CONTACT WITH THE SPoC WITHOUT FIRST TOUCHING THE COMPUTER'S METALLIC CASE. THE EPROM CHIP MUST BE KEPT OUT OF DIRECT SUNLIGHT OR OTHER ULTRAVIOLET RADIATION.

2.4.1 Installing An EPROM Chip

The EPROM chip slots are located above the keyboard on the left hand side, protected by a removable cover. Follow the instructions below. Failure to follow these instructions may damage the EPROM chip.

- 1) Make sure that the SPoC is plugged in. Plugging the power cord into both the computer and the ac outlet allows static electricity to discharge through the power cord.
- 2) Verify the SPoC power switch is in the OFF position.
WARNING: THE POWER SWITCH MUST BE TURNED OFF. This will prevent shock hazard and damage to both the computer and the EPROM chip.
- 3) Clear your workspace of any objects that might accidentally fall into the EPROM area while the cover is removed. Remove the EPROM slots' protective cover.
- 4) Remove the EPROM chip from its storage case. **WARNING: HANDLE THE CHIP BY ITS PLASTIC ENDS ONLY.** EPROMs are extremely sensitive to static electricity and may be damaged by handling. Before bringing the chip into contact with the SPoC, first touch the computer's metallic case to discharge static electricity.
- 5) Align the chip with the socket. **NOTE:** One end of the socket has two notches and the other end has only one. The EPROM chip can be installed in any empty socket.
- 6) Press firmly on the EPROM chip until it snaps into the socket.
- 7) Replace the protective cover.

WARNING: NEVER USE THE COMPUTER WITHOUT THE EPROM SLOTS' PROTECTIVE COVER IN PLACE. An object that accidentally falls into the EPROM area may damage EPROMs or SPoC.

- 8) Turn the power switch to the ON position. SPoC software will be activated.

2.4.2 Removing An EPROM Chip

Store EPROM chips in the carrying case when they are not installed in the SPoC.

WARNING: WHEN REPLACING AN EPROM CHIP, HANDLE IT BY ITS PLASTIC ENDS ONLY. EPROMs are extremely sensitive to static electricity and may be damaged by handling.

No special tool is needed to remove an EPROM chip. The most convenient item to use is the EPROM slots' protective cover.

To remove an EPROM chip:

- 1) Make sure that the SPoC is plugged in.
- 2) Verify the power switch is in the OFF position.

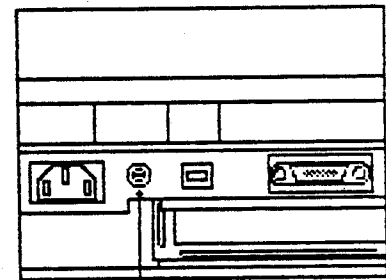
- 3) Clear your workspace of any objects that might accidentally fall into the EPROM area while the cover is removed. Remove the EPROM slots' protective cover.
- 4) Remove the EPROM chip with the edge of the protective cover. Slip an edge of the protective cover between the plastic end of the chip and the center ridge in the EPROM area. Pry the chip loose. Carefully remove the chip from the socket, making sure to handle it by the plastic ends only.
- 5) Store the EPROM chip in its carrying case.
- 6) Replace the protective cover.

2.5 Fuse Installation/Removal

The fuse assembly is located on the back panel between the power cord receptacle and the voltage switch. The fuse may be replaced on the ground or in flight. Spare fuses are stored in the EPROM stowage kit. To replace a fuse:

- 1) Verify the power cord is unplugged.
- 2) Unscrew fuse assembly and remove old fuse.
- 3) Install a new fuse in the fuse assembly.
- 4) Replace fuse assembly.

Follow the ground or flight setup procedures defined in Section 2.2 or 2.3.



FUSE ASSEMBLY

SECTION 3.0
SPoC USER INTERFACE

SPoC applications have been designed for similarity in appearance and operation. Utilization of menus and forms allows the user to select, input, edit, and execute without unnecessary typing. Menus permit the user to select a single item for execution, while forms permit the user to input several data values on one display. Prompts appear at the bottom of the screen, as an aid to the user. When appropriate, error messages also appear at the bottom of the screen instructing the user how to correct erroneous inputs. FIGURE 3.1 illustrates a typical menu, and FIGURE 3.2 illustrates a typical form. The components of each diagram are labeled, and will be discussed in detail.

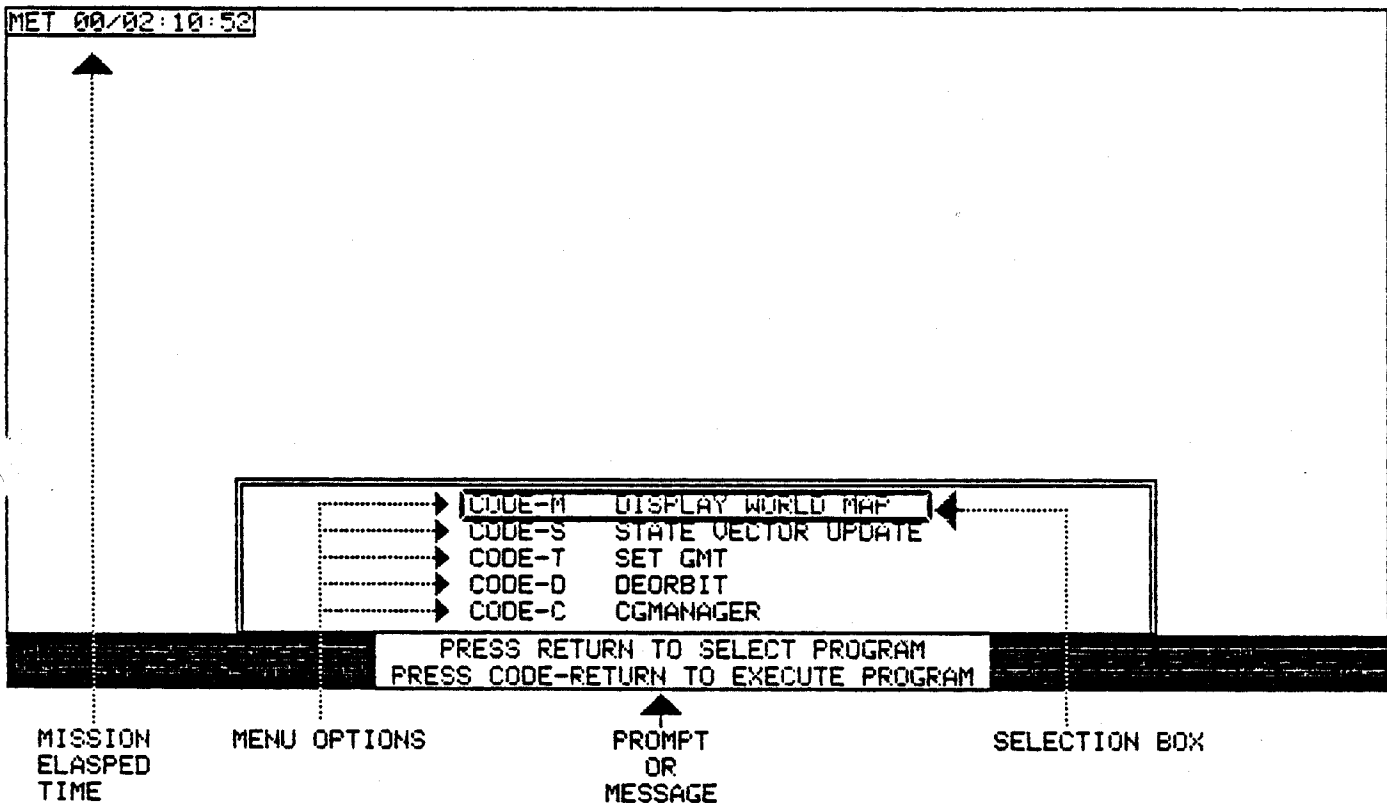


FIGURE 3.1 Typical SPoC Menu

NOTE: Messages are displayed on the screen in inverse video. In this document, messages displayed on screen images will appear as black characters against a white background. This is done for readability.

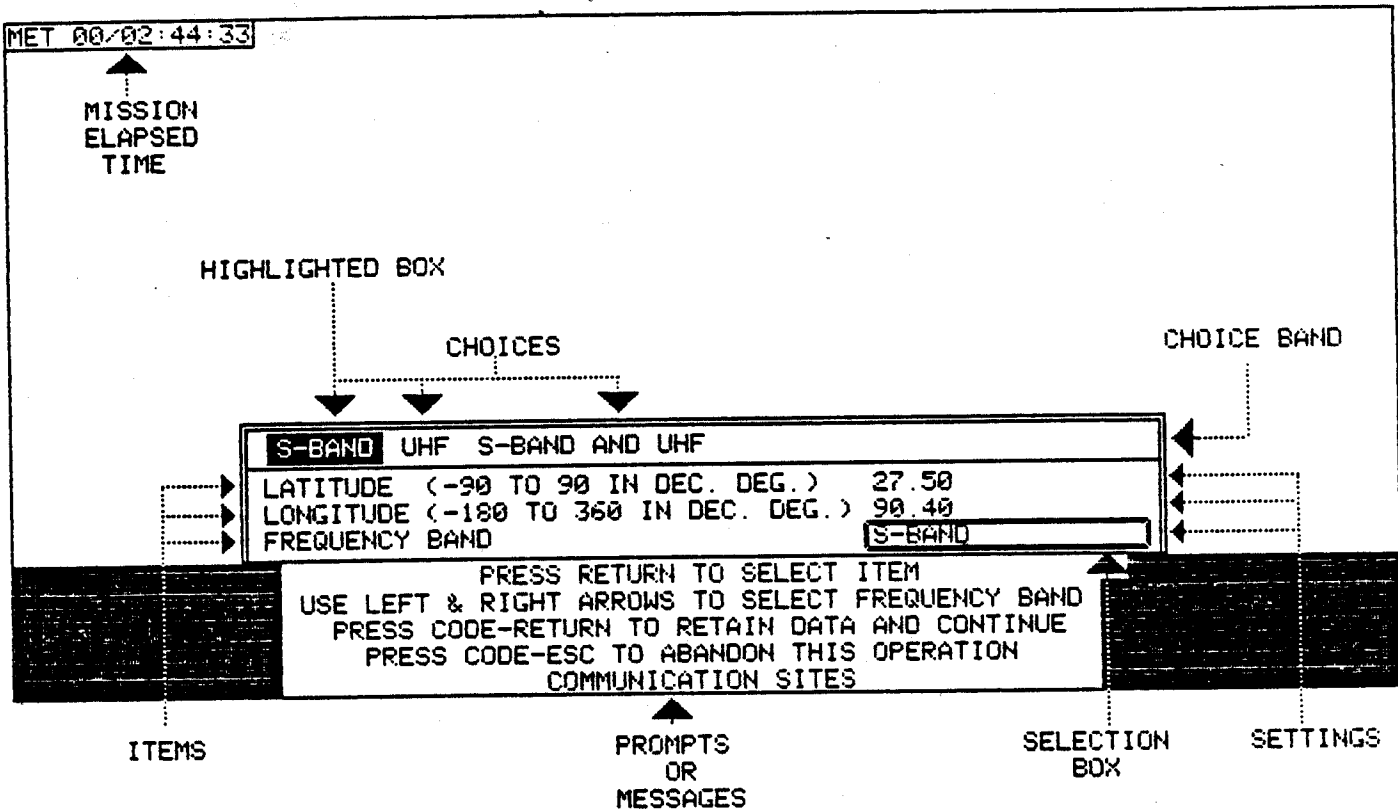


FIGURE 3.2 Typical SPoC Form

3.1 Modifier and Command Keys



FIGURE 3.3 SPoC Keyboard

Modifier keys include the CODE keys, SHIFT keys, and the CONTROL key. The CODE keys and SHIFT keys are located at the lower left and lower right of the keyboard. The CONTROL key is located at the lower left corner of the keyboard. The RETURN key, ESCAPE key, and any other keys that invoke a menu option are command keys. The most often used modifier keys are the CODE keys. To execute any menu option or to accept the settings in a form, the user must hold down a modifier key(s) and then press the

appropriate command key.

CAUTION: SPoC EXPECTS THE COMMAND KEY "PRESS" ACTION TO BE BRIEF (NO MORE THAN 0.2 SECONDS). Pressing a command key for finite intervals may issue multiple instructions with unpredictable results.

3.2 Special Key Combinations

Throughout the remainder of this handbook, the following convention will be followed. CODE-[key] will indicate that the CODE key is held down until the [key] is pressed. As an example, CODE-RETURN indicates that the user holds down the CODE key until the RETURN key is pressed. CODE-ESCAPE indicates that the CODE key is held down until the ESCAPE key is pressed. CODE-M indicates that the CODE key is held down until "M" is pressed. CODE-CTRL-N indicates that the CODE key and the CTRL key are held down until "N" is pressed. A menu item will be executed or form settings will be accepted only if a CODE-[key] combination is pressed. The CODE-RETURN combination executes the menu option selected or accepts the form settings selected. The CODE-ESCAPE combination has a special function. To exit a menu without executing any of the displayed options or to exit a form without modifying the form settings, press CODE-ESCAPE. If the user presses CODE-ESCAPE, program control returns to the previously displayed screen. If CODE-ESCAPE is pressed at the main menu of a program, the program is exited and control returns to the SPoC Main Menu, which displays the available applications. A CODE-ESC from the SPoC Main Menu is ignored.

3.3 The Selection Box

The selection box is a moving rectangular outline that encloses the current option or setting. In a menu, the selection box identifies the option that will be executed when the user presses CODE-RETURN. In a form, the selection box identifies data currently being modified. Movement of the selection box is controlled by the RETURN key. Each time the RETURN key is pressed, the selection box advances to the next option. If the RETURN key is pressed while the selection box is located on the last option of the menu, the selection box will advance to the first option on the menu. The SPoC Main Menu is displayed in FIGURE 3.1 with each part of the menu labeled. All SPoC menus have similar parts.

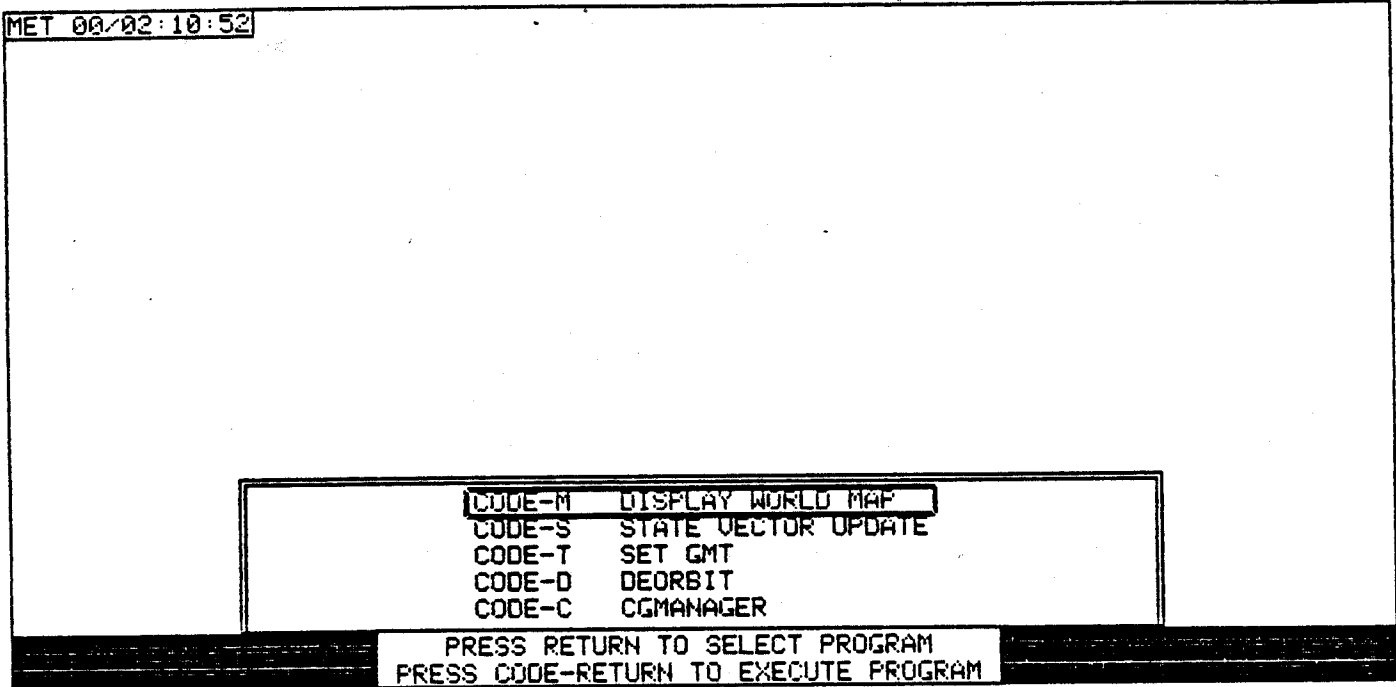


FIGURE 3.4 SPoC Main Menu

If the menu in FIGURE 3.4 receives a CODE-RETURN with the selection box located on the first option, the WORLD MAP application will be executed. Press the RETURN key once, and the selection box advances to the next option, as shown in FIGURE 3.5.

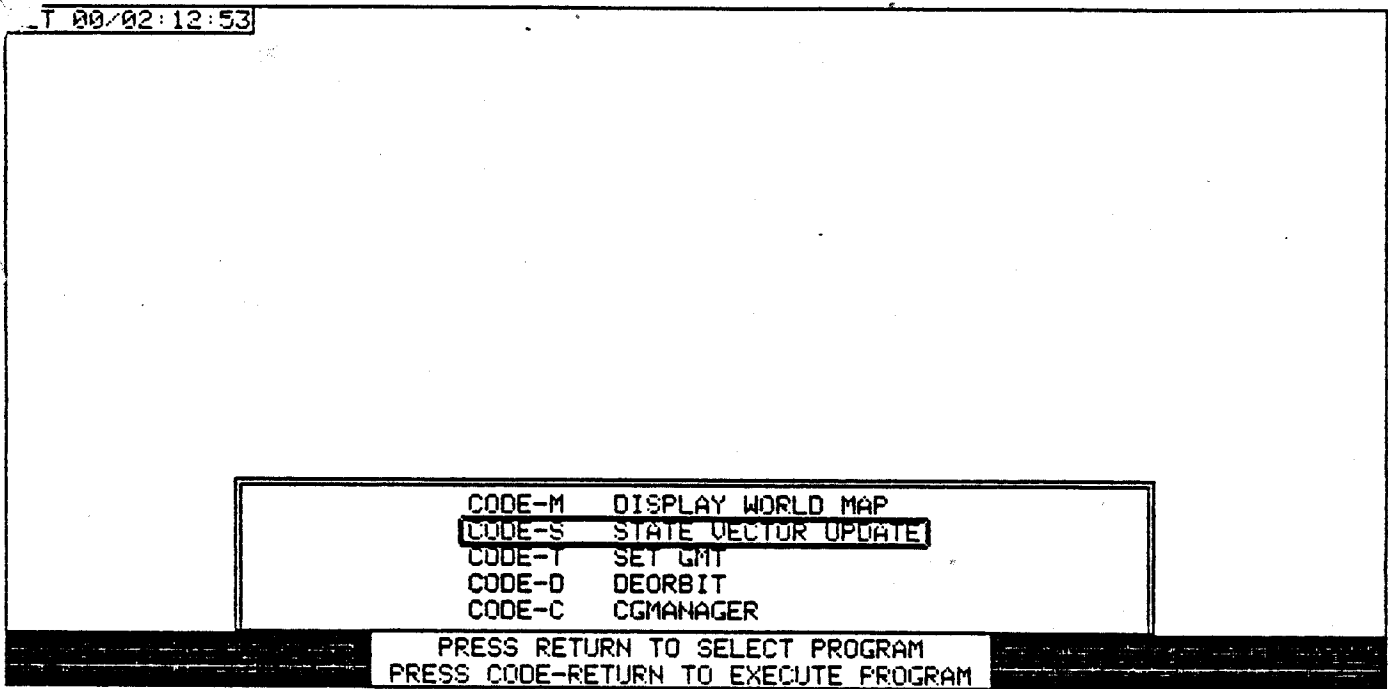


FIGURE 3.5

If the menu in FIGURE 3.5 receives a CODE-RETURN with the selection box located on the second option, STATE VECTOR UPDATE will be executed.

3.4 SPoC Menus

SPoC menus permit the user to select one option to be executed with a minimum of keystrokes. To select an option, press the RETURN key repeatedly until the selection box is located on the option to be executed. Press CODE-RETURN to execute the option. There is an alternate method of selecting and executing an option from a menu. Press CODE-[key], where [key] is the designated letter for the option to be executed. Using the SPoC Main Menu as an example, DEORBIT can be selected by pressing the RETURN key three times to locate the selection box on the menu option DEORBIT (as shown in FIGURE 3.6). DEORBIT is then executed by pressing CODE-RETURN. Using the alternate method, DEORBIT can be selected and executed by pressing CODE-D regardless of where the selection box is currently located.

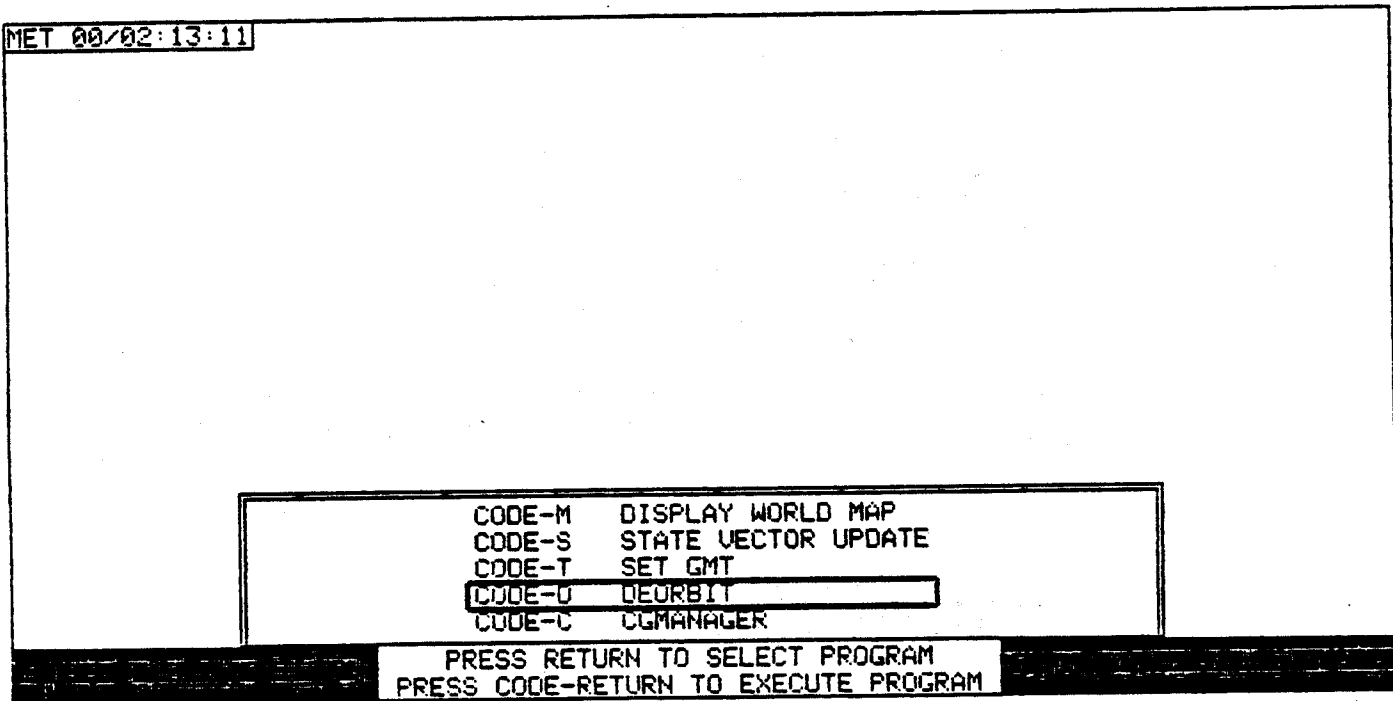


FIGURE 3.6

3.5 SPoC Forms

SPoC forms permit the user to enter or edit data for one or more items. Forms are different from menus for these reasons:

- a) Forms let users change the settings of several items. Menus let users select only one option.
- b) Users may input their own settings to forms. Many forms do not limit users to predefined choices.
- c) When users press CODE-RETURN, they accept the settings of all form items, not just the outlined setting.

FIGURE 3.2 displays a typical SPoC form with the components labeled.

A form consists of the following components.

Items: labels which identify data to be modified. Each item has a setting associated with it.

Settings: actual values the user has typed, chosen from the choice band, or received by default. These settings are either choice or editable fields, depending on the application.

Selection box: moving indicator that surrounds the setting currently being modified. RETURN moves it down and SHIFT-UPARROW moves it up.

Choice band: located at the top of the form, it may be configured in one of three ways. If there are choices for the current item, the choices are displayed there (see FIGURE 3.8). If the item is an editable item, the choice band may be blank (see FIGURE 6.1) or contain pertinent information with the edit prompt (see FIGURE 3.7).

Choices: predefined values for a setting, which appear in the choice band. The highlighted choice appears within the selection box automatically.

Highlighted box: indicates the choice that appears in the selection box, when choices are available. Pressing the arrow keys moves the highlighted box among choices. Horizontally grouped choices utilize the LEFTARROW and RIGHTARROW keys for movement, while vertically grouped choices are selected with the UPARROW and DOWNARROW keys. If the item is an editable item, the highlighted box, if displayed, will contain pertinent information and the edit prompt.

A setting is editable if there are no choices listed in the choice band. In this case, the edit prompt appears in the selection box as a small flashing triangular field. A setting is a choice setting if there are choices listed in the choice band. FIGURE 3.7 displays a form with the selection box located on an editable setting. Notice there are no choices available in the choice band, only pertinent information and the static edit prompt.

MET 00/01:39:00

STATIC EDIT PROMPT.....	EDITING ABC DATA	FLASHING EDIT PROMPT
	LATITUDE (-90 TO 90 IN DEC. DEG.) 27.50	
	LONGITUDE (-180 TO 360 IN DEC. DEG.) 90.40	
	FREQUENCY BAND S-BAND	

PRESS RETURN TO SELECT ITEM
 USE LEFT & RIGHT ARROWS TO SELECT FREQUENCY BAND
 PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
 PRESS CODE-ESC TO ABANDON THIS OPERATION
 COMMUNICATION SITES

FIGURE 3.7

To change data for an editable setting, use the LEFTARROW and RIGHTARROW keys to locate the flashing edit prompt. The following actions are possible on all data left of the prompt.

- 1) Press the BACK SPACE key to erase the rightmost character of data.
- 2) Press CODE-BACK SPACE to erase the rightmost word of data.
- 3) Press CODE-SHIFT-BACK SPACE to erase all data.

Data may be inserted right of the flashing prompt by pressing the appropriate keys. Once satisfied with the settings, press CODE-RETURN to incorporate all settings and proceed to the next form or menu. To exit a form without accepting any new settings, press CODE-ESC. Upon pressing CODE-ESC, the former item settings are restored and the previous form or menu will be displayed.

In FIGURE 3.8, the same form is displayed as in FIGURE 3.7, but the selection box has been located on a different setting. Notice the choices for this setting are listed in the choice band. Also notice the choice appearing in the highlighted box appears in the selection box too. Use the LEFTARROW or RIGHTARROW keys to move the highlighted box.

MET 00/02:44:33

S-BAND	UHF	S-BAND AND UHF
LATITUDE (-90 TO 90 IN DEC. DEG.)	27.50	
LONGITUDE (-180 TO 360 IN DEC. DEG.)	90.40	
FREQUENCY BAND	S-BAND	

PRESS RETURN TO SELECT ITEM
USE LEFT & RIGHT ARROWS TO SELECT FREQUENCY BAND
PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
PRESS CODE-ESC TO ABANDON THIS OPERATION
COMMUNICATION SITES

FIGURE 3.8

In FIGURE 3.9, a different choice has been selected by moving the highlighted box. The user has pressed the RIGHTARROW key twice to move the highlighted box two choices to the right. Notice again the selection box contains the same choice as the highlighted box.

MET 00/03:12:47

S-BAND UHF	S-BAND AND UHF
LATITUDE (-90 TO 90 IN DEC. DEG.)	27.50
LONGITUDE (-180 TO 360 IN DEC. DEG.)	90.40
FREQUENCY BAND	S-BAND AND UHF

PRESS RETURN TO SELECT ITEM
USE LEFT & RIGHT ARROWS TO SELECT FREQUENCY BAND
PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
PRESS CODE-ESC TO ABANDON THIS OPERATION
COMMUNICATION SITES

FIGURE 3.9

3.6 Messages

There are three types of SPoC messages.

- 1) Prompts
- 2) Error messages
- 3) Informative messages

As an aid to the user, each SPoC menu or form has prompts displayed at the bottom of the screen. Information provided by prompts will inform the user what action should be taken next. FIGURE 3.10 is a typical SPoC form with prompts displayed at the bottom of the screen.

NET 00/02:10:52

ENTERING AAA DATA

LATITUDE (-90 TO 90 IN DEC. DEG.)

LONGITUDE (-180 TO 360 IN DEC. DEG.)

FREQUENCY BAND

PRESS RETURN TO SELECT ITEM
USE LEFT & RIGHT ARROWS TO SELECT FREQUENCY BAND
PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
PRESS CODE-ESC TO ABANDON THIS OPERATION
COMMUNICATION SITES

FIGURE 3.10

Error messages provide information for correcting erroneous user inputs. FIGURE 3.11 displays an error message indicating that the user has input an improper latitude.

MET 00:02:10:52

ENTERING AAA DATA	
LATITUDE (-90 TO 90 IN DEC. DEG.)	91
LONGITUDE (-180 TO 360 IN DEC. DEG.)	45
FREQUENCY BAND	S-BAND

IMPROPER LATITUDE < REENTER LATITUDE >
PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
PRESS CODE-ESC TO ABANDON THIS OPERATION
COMMUNICATION SITES

FIGURE 3.11

Informative messages provide status on what action is currently being taken. Informative messages require no user action. The message in FIGURE 3.12 informs users the state vector is being propagated.

MET 00/03:12:55

PROPAGATING STATEVECTOR

FIGURE 3.12

SECTION 4.0 OVERVIEW OF SPoC PROGRAMS

In this section, a high level overview of SPoC software will be presented. FIGURE 4.1 shows the High-Level Functional Flow of SPoC software. There are five operating modes for SPoC software: InFlight, Debug, Development, SmartDemo, and DummyDemo. This document pertains only to the InFlight mode. If remote users have questions about SPoC software modes, contact the SPoC Team at the Johnson Space Center.

LAUNCH TIME UPDATE

During SPoC initialization, the actual launch Greenwich Mean Time (GMT) can be input to update the launch time expected premission. The launch time is stored in bubble memory and used to compute Mission Elapsed Time (MET).

GMT UPDATE

Current GMT can be updated in SPoC's internal clock. The internal clock is maintained by an internal battery during periods when SPoC power is OFF.

STATE VECTOR UPDATE

This program allows the user to input position and velocity vectors in the True of Date Rotating (TDR) coordinate system. These vectors are obtained from the GPC Memory Page and are written to bubble memory for access by other programs.

SPoC EXECUTIVE

The SPoC EXECUTIVE program displays the SPoC Main Menu from which the user may select the application desired. Upon exiting any program selected from the SPoC Main Menu, program control returns to the SPoC Main Menu.

WORLD MAP

The SPoC presently runs WORLD MAP as its primary program. A graphics display of a world map is overlaid by the Orbiter's current trajectory status. The following information/functions are available.

Current MET

Fixed coastline and Spaceflight Tracking and Data Network (STDN)/

Tracking and Data Relay Satellite (TDRS) coverage graphics

Day and night areas on the earth's surface

AOS/LOS and identification of next/current ground communication site

AOS/LOS and identification of next/current TDRS coverage

Current and two predicted ground tracks

Current position of the Orbiter on the world map
AOS of the next earth observation site
AOS of future earth observation sites
Current F-stop
F-stop for the selected earth observation site
Predicted Site Acquisition Table (PSAT) Display
Table of TDRSS AOS/LOS
Communication/Earth Observation site reconfiguration
Latitude and longitude of the Orbiter
Time to Orbiter sunrise, noon, or sunset
Sun glint position on the world map
Sun glint look angles
Longitude and MET of the next/previous ascending node
Time until/from the next/previous ascending node

DEORBIT

This program supplies deorbit burn opportunities and maneuver targets for crew use in the event of a total loss of communications with the ground, or a time-critical systems failure during a loss of communication period requiring an emergency deorbit before ground assistance can be provided. SPoC DEORBIT has superseded a previously used HP-41 deorbit program.

CGMANAGER

SPoC CGMANAGER is a program which allows the Orbiter's Center-of-Gravity (CG) and weight to be computed onboard using current propellant quantities, cargo status, and non-propellant consumable quantities. The program also accepts DEORBIT in-plane-change-in-velocity and optional target CG data. It then computes CG and weight information for pertinent entry check points. CGMANAGER communicates with the SPoC DEORBIT program by sending the current Orbiter weight and by receiving desired delta velocity maneuver values. The program uses the same computational method as the MCC's Mission Operations Computer (MOC) Mass Properties Processor.

SPoC High-Level Functional Flow

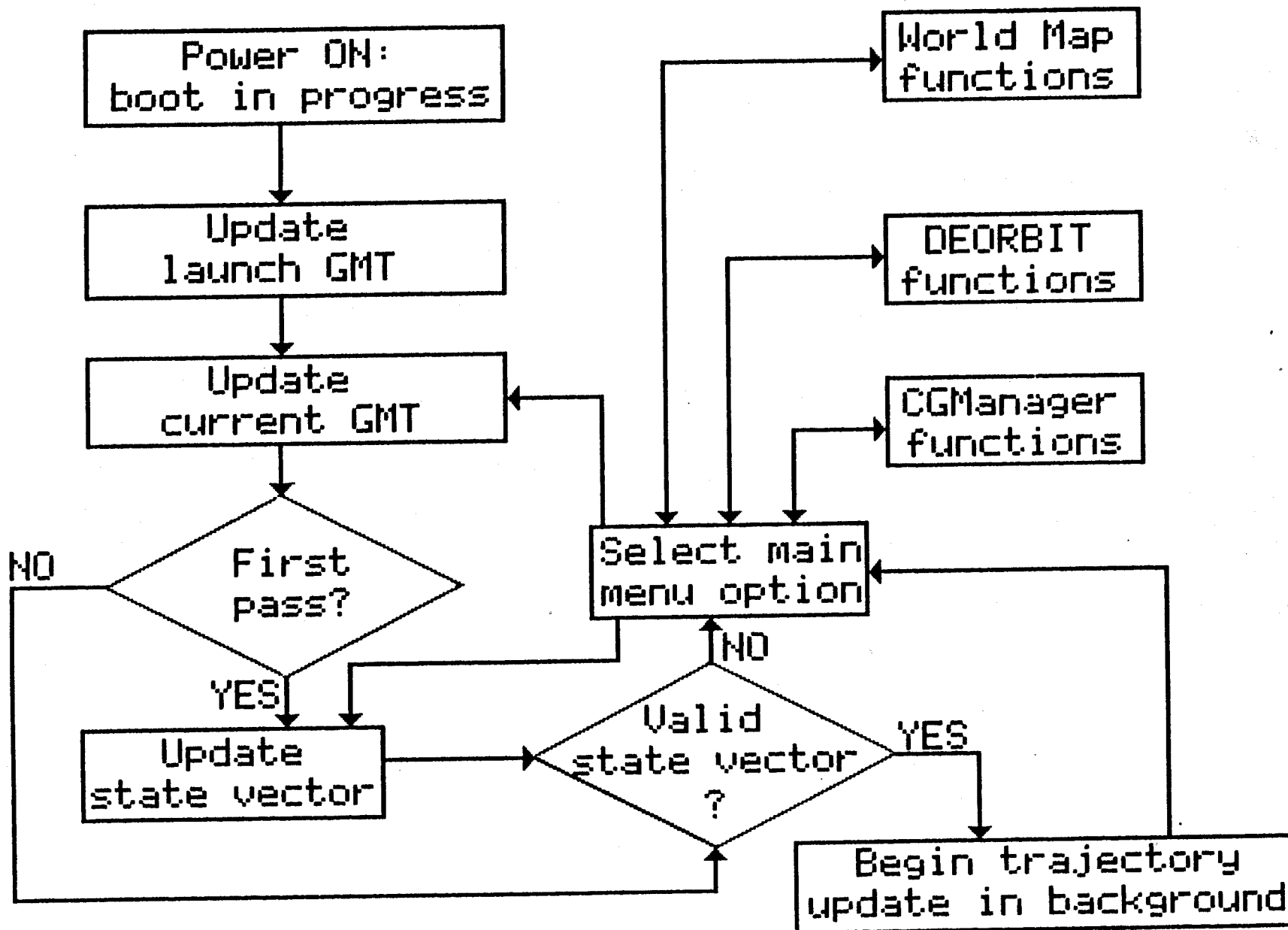


FIGURE 4.1

**SECTION 5.0
BOOT UP SCREEN**

When SPoC is turned ON, the Boot Up Screen is displayed after several seconds. At the bottom center of this screen will be displayed the message:

**Boot in Progress
Please Wait**

The contents of the rest of the screen will indicate:

- 1) Specific or Generic Flight Load
- 2) Flight or Training Load
- 3) Version Number

The Boot Up Screen is displayed while the computer is loading the operating system from bubble memory. The flickering squares in the lower right hand corner of the screen indicate that bubble memory is being accessed.

After the operating system has been loaded, the Boot Up Screen will be erased. The following message will be displayed at the bottom of the screen while SPoC EXECUTIVE searches for the necessary applications.

Searching for all the necessary SPoC programs

Next, SPoC EXECUTIVE will search for necessary data files. The following message will be displayed.

Searching for all the necessary SPoC data files

Upon completion of the data file search, the LAUNCH TIME UPDATE form will be displayed. If this form does not appear, a fatal error has been detected in the current SPoC software configuration by SPoC EXECUTIVE. Contact the SPoC Team at the Johnson Space Center for assistance.

SECTION 6.0
LAUNCH TIME UPDATE

YEAR	1987
DAY	300
HOUR	0
MINUTE	0
SECOND	0

GMT OF LAUNCH
 BACKSPACE OVER TIME TO ERASE
 TYPE IN NEW TIME AND PRESS RETURN
 PRESS CODE-RETURN WHEN COMPLETE

FIGURE 6.1

This program allows the user to manipulate the GMT of launch. Upon completion of the boot cycle, the LAUNCH TIME UPDATE form (FIGURE 6.1) is displayed. Initial settings displayed indicate nominal launch time. These settings can be updated by the user in the event of a launch delay.

If the launch form settings are correct, press CODE-RETURN. Otherwise, correct any erroneous data.

Acceptable inputs for LAUNCH TIME UPDATE FORM:

YEAR - 1983 through 1999
 DAY - 1 through 366
 HOUR - 0 through 23
 MINUTE - 0 through 59
 SECOND - 0 through 59

Possible Error Messages:

1) TIME PARAMETER(S) INPUT INCORRECTLY

Problem: One or more of the settings are not within acceptable limits.

Solution: Press CODE-ESC to reinitialize the form.

The symbols "*-" will appear next to out-of-range settings.

Re-enter data for settings that are not within acceptable limits.

SECTION 7.0
GMT UPDATE

MET 10/02:33:17

DAY <GMT>	111
HOUR <GMT>	14
MINUTE <GMT>	33
YEAR	1988

SET TIME IN GMT
 BACKSPACE OVER OLD TIME TO ERASE
 PRESS RETURN TO SELECT NEXT ITEM
 PRESS CODE-RETURN AT GMT ENTERED TO EXECUTE
 TO RETAIN CURRENT GMT PRESS CODE-ESC

FIGURE 7.1

After pressing CODE-RETURN from the LAUNCH TIME UPDATE form, the GMT UPDATE form will automatically appear (FIGURE 7.1). This form can also be accessed via the SPoC Main Menu. The time displayed in this form is used to set the internal SPoC clock when CODE-RETURN is pressed. The GMT will have to be updated to correct internal clock drift. SPoC clock drift will average approximately five seconds per day.

Acceptable inputs for GMT UPDATE form:

DAY - 1 through 366
 HOUR - 1 through 23
 MINUTE - 1 through 59
 YEAR - 1980 through 1999

Possible Error Messages:

1) ERROR: DAY, HOUR, MINUTE, AND YEAR
 PARAMETERS INPUT INCORRECTLY

Problem: The settings for the items listed in the error message are not within acceptable limits.

Solution: Press CODE-ESC to reinitialize the form.

The symbols "*-" will appear next to out-of-range settings.

Re-enter data for settings that are not within acceptable limits.

Possible Caution Messages:

1) CAUTION: VECTOR MORE THAN 2 DAYS OLD

Problem: SPoC GMT and the current SPoC state vector time tag are incompatible. The state vector time tag is two days older than current SPoC GMT.

Solution: If GMT settings are incorrect, press CODE-ESC to reinitialize the form. Correct erroneous data.

If GMT settings are correct, press CODE-RETURN. The state vector time tag settings can be updated in the STATE VECTOR UPDATE form.

2) CAUTION: VECTOR IS IN THE FUTURE

Problem: SPoC GMT and the current SPoC state vector time tag are incompatible. The time tag for the current SPoC state vector is in the future.

Solution: If GMT settings are incorrect, press CODE-ESC to reinitialize the form. Correct erroneous data.

If GMT settings are correct, press CODE-RETURN. The state vector time tag settings can be updated in the STATE VECTOR UPDATE form.

SECTION 8.0
STATE VECTOR UPDATE

MET 00/01:00:14

DAY (MET)	0
HOUR (MET)	0
MINUTE (MET)	50
SECOND (MET)	0
X POSITION (NM)	23.61635400
Y POSITION (NM)	3162.91960300
Z POSITION (NM)	-1713.37830800
X VELOCITY (NM/SEC)	-3.94707100
Y VELOCITY (NM/SEC)	0.03610700
Z VELOCITY (NM/SEC)	0.01351400

STATEVECTOR (NAUTICAL MILES) WITH MET TIME TAG
 BACKSPACE OVER OLD DATA TO ERASE
 TYPE IN NEW DATA AND PRESS RETURN
 PRESS CODE-RETURN WHEN COMPLETE
 Press CODE-ESC TO RETURN TO MAIN MENU

FIGURE 8.1

The STATE VECTOR UPDATE form allows users to update the SPoC state vector. This form will automatically appear after pressing CODE-RETURN from the GMT UPDATE form during the SPoC initialization sequence. STATE VECTOR UPDATE can also be accessed from the SPoC Main Menu.

Components of the previously input time tag and state vector are initially displayed in the STATE VECTOR UPDATE form. Prelaunch, a predicted nominal post-OMS-2 state vector is loaded into the SPoC.

Components of the current state vector are provided by the GPCs using the GNC SPEC 0 GPC Memory display. SPEC 0 item entries are listed in the Reference Data Book Flight Supplement. Remember, values displayed on the CRT are continuously updated. After the six state vector components have been requested and displayed, press SPEC to freeze the display. The time tag, along with position and velocity components, can now be entered into the SPoC STATE VECTOR UPDATE form. Note: The GPC time tag displayed with the state vector may have up to a 1.8 second delta from the state vector's true time tag. This is due to differing update rates for these quantities on the GPC Memory display.

When settings in the form reflect the frozen SPEC 0, press CODE-RETURN. The inclination, HA, and HP are displayed (FIGURE 8.2). This serves as a data check for state vector inputs. If values displayed are reasonable, press CODE-RETURN and the Main Menu will be displayed.

MET 00/01:00:44

DAY (MET)	0
HOUR (MET)	0
MINUTE (MET)	50
SECOND (MET)	0
X POSITION (NM)	23.61635400
Y POSITION (NM)	3162.91980300
Z POSITION (NM)	-1713.37830800
X VELOCITY (NM/SEC)	-3.94707100
Y VELOCITY (NM/SEC)	0.03610700
Z VELOCITY (NM/SEC)	0.01351400

INCLINATION = 28.445 DEGREES
 APPROX. ORBIT : HA=158; HP=153
 PRESS CODE-RETURN IF NUMBERS ARE REASONABLE
 IF NOT, PRESS CODE-ESC

FIGURE 8.2

If values are not reasonable, press CODE-ESC and the STATE VECTOR UPDATE form will be reinitialized. Correct any erroneous state vector settings and press CODE-RETURN. Again the inclination, HA, and HP will be displayed. If the values displayed are reasonable, press CODE-RETURN. Otherwise, press CODE-ESC to reinitialize the form.

Acceptable inputs for STATE VECTOR UPDATE time tag:

DAY (MET) - 0 through 19
 HOUR (MET) - 0 through 23
 MINUTE (MET) - 0 through 59
 SECOND (MET) - 0 through 59

Possible error messages:

- 1) ERROR: DAY, HOUR, MINUTE, AND SECOND
PARAMETERS INPUT INCORRECTLY

Problem: Settings for the MET items listed in the error message are not within acceptable limits.

Solution: Press CODE-ESC to reinitialize the form.
 The symbols "*-" will appear next to out-of-range settings.
 Re-enter data for settings that are not within acceptable limits.

Possible caution messages:

1) CAUTION: VECTOR MORE THAN 2 DAYS OLD

Problem: The SPoC GMT and the current SPoC state vector time tag are incompatible. The time tag is more than two days old based on the current SPoC MET.

Solution: If the state vector time tag settings are incorrect, press CODE-ESC to reinitialize the form. Correct erroneous data.

If the state vector time tag settings are correct, press CODE-RETURN. GMT settings can be updated in the GMT UPDATE form.

2) VECTOR IS IN THE FUTURE

Problem: The SPoC GMT and the current SPoC state vector time tag are incompatible. The time tag is in the future based on the current SPoC MET.

Solution: If the state vector time tag settings are incorrect, press CODE-ESC to reinitialize the form. Correct erroneous data.

If the state vector time tag settings are correct, press CODE-RETURN. GMT settings can be updated in the GMT UPDATE form.

SECTION 9.0
SPoC MAIN MENU

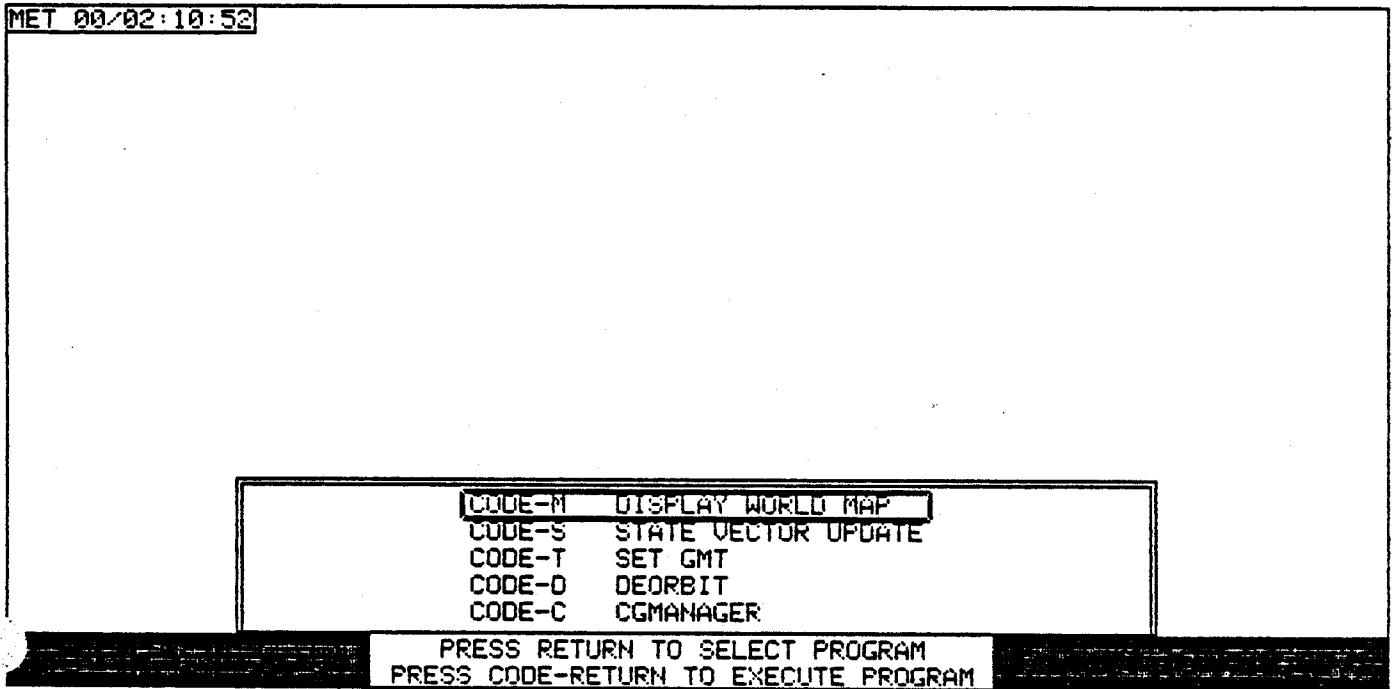


FIGURE 9.1

The Main Menu allows users to invoke SPoC applications. After the SPoC initialization sequence has been completed, the SPoC Main Menu will be displayed. This menu will also be displayed upon exiting any SPoC application.

Once the user has executed a menu option to select an application, status messages will appear at the bottom of the screen. These messages provide status on files being loaded or any processing in progress.

Possible error messages:

- 1) STATE VECTOR TIME IS INCOMPATIBLE WITH GMT

Problem: SPoC current MET and the SPoC state vector MET time tag are incompatible. The time tag for the current SPoC state vector is either in the future, or two days older than the current SPoC MET.

Solution:

- A) Press any key and return to the SPoC Main Menu.
- B) If the displayed MET is correct, select STATE VECTOR UPDATE from the SPoC Main Menu. Otherwise, proceed to Step D.
- C) Verify that state vector time tag settings are correct.
 - 1) If time tag settings are incorrect, correct erroneous settings,

- press CODE-RETURN, and return to the SPoC Main Menu.
- 2) If time tag settings are correct, press CODE-ESC to return to the SPoC Main Menu without changing form settings.
 - 3) Proceed to Step F.
 - D) Select SET GMT from the Main Menu.
 - E) Verify that GMT settings are correct.
 - 1) If GMT settings are incorrect, correct erroneous settings and return to the SPoC Main Menu.
 - 2) If GMT settings are correct, press CODE-ESC to return to the SPoC Main Menu.
 - F) Make selection from the Main Menu.

2) The user needs to install the EPROM labeled :

SPoC
CGManager
Version X.X.X

Problem: The EPROM loaded with CGMANAGER has not been installed.

Solution: Install a CGMANAGER EPROM (see Section 2.4).

NOTE: "X.X.X" represents a version number such as "3.1.0".

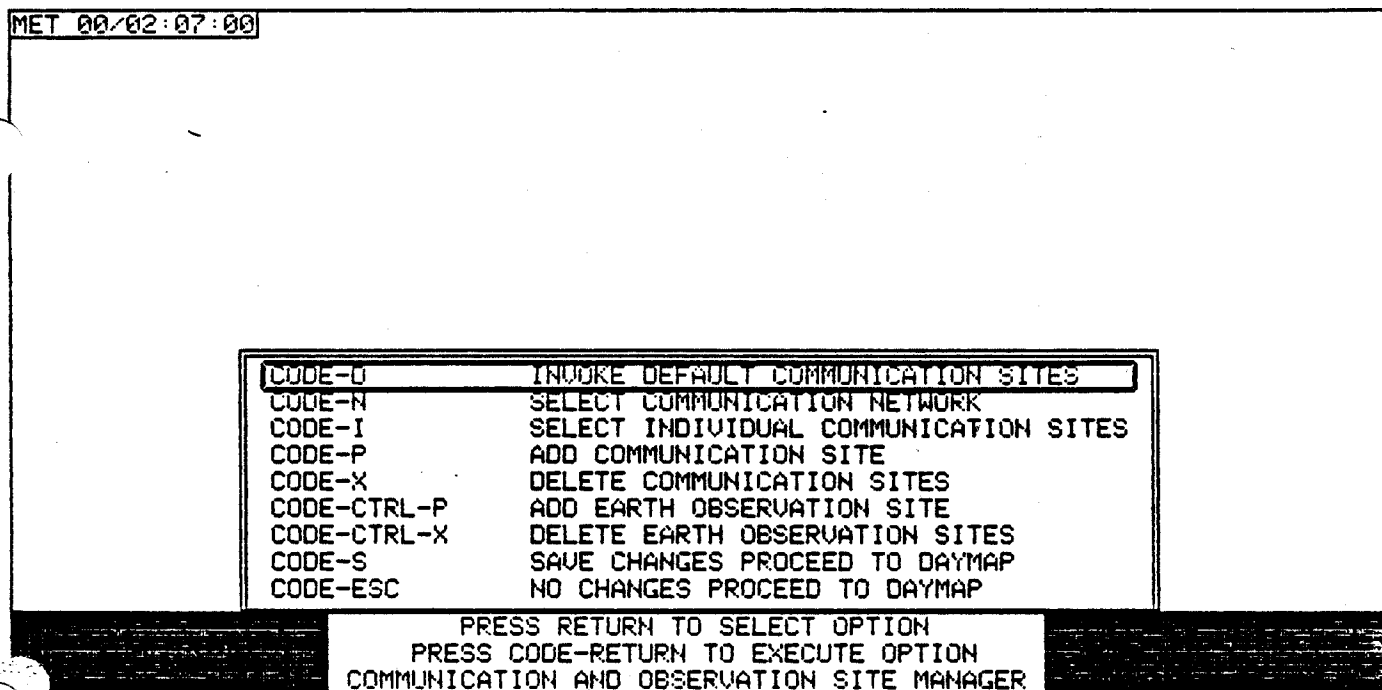
SECTION 10.0
WORLD MAP

FIGURE 10.1 SITE MANAGER Main Menu

The first time WORLD MAP is selected from the SPoC Main Menu, the SITE MANAGER Main Menu (FIGURE 10.1) will be displayed. SITE MANAGER is a WORLD MAP function which will be detailed in Section 10.4. For now, execute the first menu item INVOKE DEFAULT COMMUNICATION SITES and proceed to the WORLD MAP display.

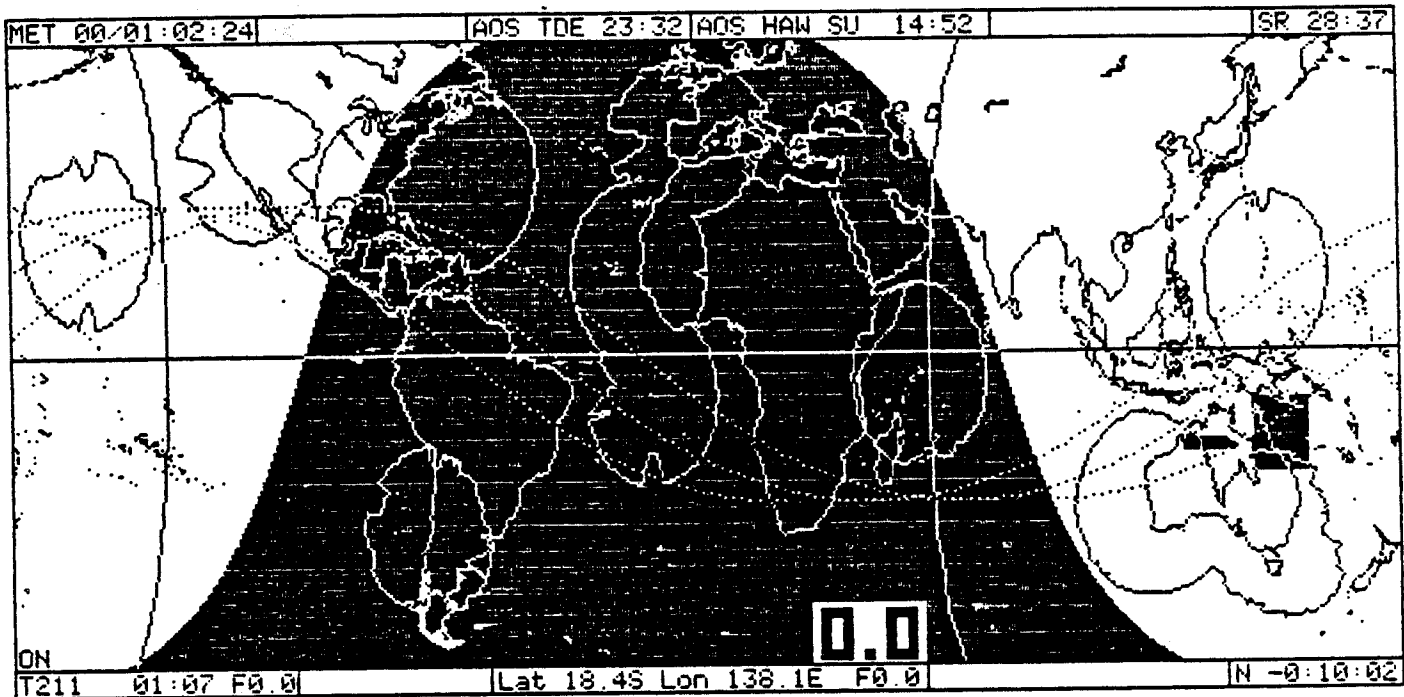


FIGURE 10.2 WORLD MAP Display

WORLD MAP serves as a crew aid which provides a situation display (FIGURE 10.2), various timers, and tables. The situation display includes a map with a longitude range from 180° West to 180° East, and a typical latitude range from 65° North to 65° South. A map with any valid latitude range can be provided by the SPoC Team upon request.

AT 00/02:07:22

CODE-E	Earth Observation/Communication Site Manager
CODE-F	Move Forward One Earth Obs Site
CODE-CTRL-F	Toggle On Or Off Large F-Stop
CODE-G	Sun Glint Angle And Azimuth
CODE-L	Select / Freeze / Unfreeze Latitude And Longitude And F/Stop
CODE-N	Display Next Ascending Node
CODE-CTRL-N	Display Previous Ascending Node
CODE-P	Display PSAT Table
CODE-R	Return To First Available Earth Obs Site
CODE-S	Toggle Between Space Craft Sunrise, Sunset And Sunnoon
CODE-T	Toggle On Or Off Earth Obs Tone
CODE-ESC	Return To Worldmap

Press Return To Select Option
Press Code Return To Execute Option

FIGURE 10.3 WORLD MAP Help Menu

10.1 World Map Help Menu

The WORLD MAP Help Menu (FIGURE 10.3) may be invoked by pressing CODE-? with the WORLD MAP display active. This menu provides the CODE-[key] combinations associated with each WORLD MAP function. WORLD MAP functions may be invoked from the Help Menu, or may be invoked from the WORLD MAP display directly with the proper CODE-[key] input. To return to the WORLD MAP Display, press CODE-ESC.

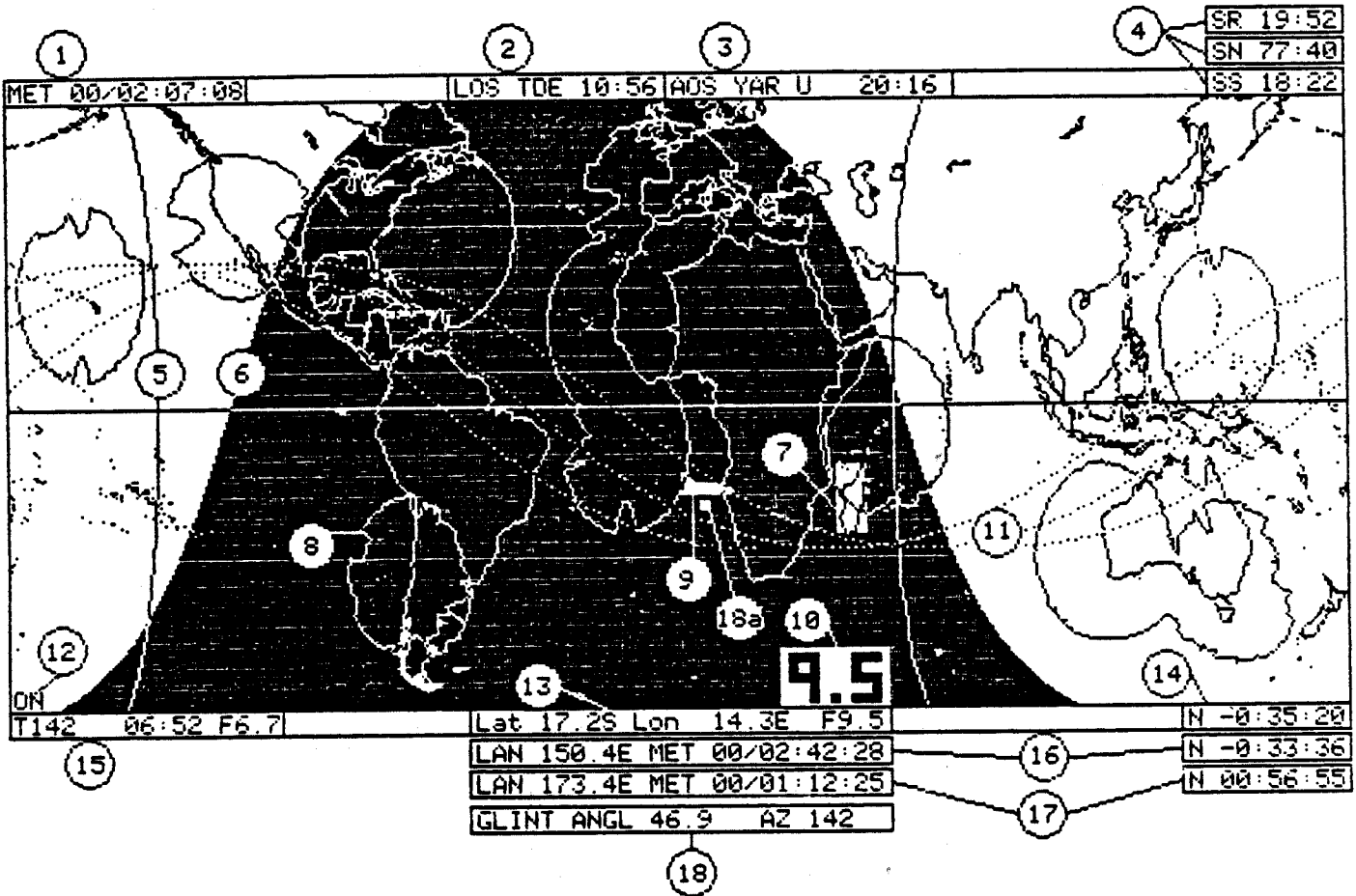


FIGURE 10.4

10.2 World Map Display

The contents of the WORLD MAP Display are number coded in FIGURE 10.4. Each item is described in detail below.

10.2.1 Current MET (Item 1)

DD/HH:MM:SS fields will update approximately every second and are displayed continuously. These are calculated based on the current GMT and the GMT of launch.

10.2.2 AOS/LOS of TDRS Coverage (Item 2)

The ID and countdown time to AOS or LOS of TDRS coverage is displayed in this window. If multiple satellites have overlapping coverage, the AOS countdown time to the first TDRS will be displayed. After AOS of the first TDRS, the ID and LOS of the last TDRS

with overlapping coverage is displayed. STAND BY will be displayed in this window until AOS/LOS times have been calculated.

10.2.3 AOS/LOS of Ground Communication Site (Item 3)

This window displays the ID, radio frequency band(s), and countdown time to AOS or LOS of a ground communication site. AOS and LOS are defined as an elevation of the Orbiter, viewed from the ground site, of 0.0 degrees. Neither terrain masking nor atmospheric refraction are considered in this calculation. If sites have overlapping coverage, the AOS countdown time of the first site will be displayed. After AOS of the first site, the ID and LOS of the last site in this overlapping coverage is displayed. The radio frequency band(s) displayed will be that of the currently acquisitioned site(s). STAND BY will be displayed in this window until AOS/LOS times have been calculated.

10.2.4 Spacecraft Sunrise, Noon, Sunset (Item 4)

The countdown time to spacecraft sunrise (SR), noon (SN), or sunset (SS) is displayed in this window. If the time to spacecraft sunrise/sunset or noon is greater than 100 minutes, the timer will countdown from 99:59 to 99:00 then cycle until 99:59 is the correct time. Shuttle sunrise and sunset are defined with respect to the upper limb of the sun with a fixed bias to offset the effects of refraction. Press CODE-S to toggle between spacecraft sunrise/sunset and noon. Spacecraft sunrise, noon, and sunset functions share this window on a mutually exclusive basis.

10.2.5 TDRS Coverage (Item 5)

Limits of TDRS coverage are displayed assuming average nominal orbital altitude for a flight.

10.2.6 Earth Day/Night (Item 6)

The sunlight terminator separates day/night regions on earth's surface and is updated in real time. The region in daylight is displayed with inverse video.

10.2.7 Earth Observation Area (Item 7)

The flashing rectangle highlights an earth observation site. The area approximates extent of the site to be observed. A site is acquired when any part viewed from the Orbiter is within 40° of the current nadir. The next available site will initially be displayed. Press CODE-F to move forward one available site at a time until the last predicted ground track point is encountered. To return to the next available site, press CODE-R. The displayed site is shown until acquired, then the next site is highlighted with a flashing rectangle.

10.2.8 Ground Communication Sites (Item 8)

Limits of selected ground communication sites, with terrain masking, are displayed assuming average nominal orbital altitude for a flight.

10.2.9 Shuttle Bug (Item 9)

The nose of the flashing Shuttle Bug indicates current position of the Orbiter. Every thirty seconds, the Shuttle Bug's position is updated to the next predicted ground track point.

10.2.10 Enlarged F-Stop Display (Item 10)

For ease of viewing, the current camera F-Stop is enlarged and displayed. This is the same camera F-Stop value described in Item 13. The enlarged F-Stop display may be toggled ON or OFF by pressing CODE-CTRL-F. For high inclination orbits, position of the enlarged F-Stop display will vary slightly. This is done to avoid display conflicts with predicted ground tracks and the Shuttle Bug.

10.2.11 Current and Two Predicted Ground Tracks (Item 11)

Predicted ground tracks are updated when the Shuttle Bug reaches the predicted ground track point 5400 seconds (90 minutes) from the first. The Shuttle Bug then occupies the first ground track point in a series extending 4.5 hours into the future. Adjacent ground track points are separated in time by 30 seconds.

10.2.12 Tone Indicator (Item 12)

ON indicates a tone will be generated when the currently displayed earth observation site countdown timer reaches two minutes. OFF indicates no tone will be generated. The default setting is ON. The tone indicator may be toggled ON and OFF by pressing CODE-T.

10.2.13 Latitude, Longitude, and Current F-Stop (Item 13)

The Orbiter's current latitude, longitude, and the camera F-Stop required for an average albedo target at the current spacecraft nadir are updated once every 30 seconds. CODE-L immediately updates this display and toggles it from dynamic to frozen. While frozen, the display will flash approximately once/second. This display window is shared, on a mutually exclusive basis, with items 16, 17, and 18.

10.2.14 Ascending Node Time (Item 14)

This window displays elapsed time since previous ascending node or countdown to the next ascending node. The display is controlled in conjunction with items 16 and 17.

10.2.15 Earth Observation Site (Item 15)

The site ID is displayed along with the countdown time to acquisition of the displayed earth observation site. The program searches for acquisition only. Once acquisition is achieved, the program will search for acquisition of the next available site. If no earth observation site has been found within the predicted ground tracks, **** XX:XX will be displayed. The F-Stop for this site is also displayed. This F-Stop is based on a predetermined albedo for the current site, a set film and shutter speed, and the computed sun angle. Since F-Stop values are computed in discrete 1/2 F-Stop steps, a difference of 1/2 F-Stop between the SPoC value and a premission value is not unusual.

SPoC observation site F-Stops are computed for acquisition, but the premission albedos consider an average across the entire site. For sites with significant physical size, this can result in F-Stop differences of as much as 1 and 1/2 to 2 full F-Stops in extreme cases.

10.2.16 Longitude, MET, and Countdown Timer For Next Ascending Node (Item 16)

A keyboard input of CODE-N will display the longitude and MET of the next ascending node in the bottom center window, replacing any data previously displayed there. Also the countdown time for this node will be displayed in the Ascending Node Time window (Item 14). This function shares the bottom middle window, on a mutually exclusive basis, with Items 13, 17, and 18.

10.2.17 Longitude, MET, and Time Since Previous Ascending Node (Item 17)

A keyboard input of CODE-CTRL-N will display the longitude and MET of the previous ascending node in the bottom center window, replacing any data previously displayed there. Elapsed time since the previous ascending node will also be displayed in the Ascending Node Time window (Item 14). This function shares the bottom middle window, on a mutually exclusive basis, with Items 13, 16, and 18.

10.2.18 Sun Glint Angle and Azimuth (Item 18)

A keyboard input of CODE-G will display the sun glintpoint angle-of-reflection and azimuth relative to the Orbiter. These data are displayed in the bottom center window, replacing any data previously displayed there. GLINT ANGL is the angle-of-reflection of the sun's image off the Earth's surface. AZ is the angle measured from the vehicle true heading in the Orbiter local horizontal plane to the glintpoint azimuth and accumulated in the direction "east of north". In other words, the difference "true azimuth of the sun glintpoint minus current Orbiter true heading" is AZ. Sun glint data are displayed only if the GLINT ANGL is between 9.99° and 80.21° . Otherwise, Xs are displayed in place of the data. This function shares the bottom middle window, on a mutually exclusive basis, with Items 13, 16, and 17.

10.2.19 Sun Glintpoint Area (Item 18a)

A CODE-G keyboard input will also graphically display the sun glintpoint relative to the Shuttle by flashing a small square on the WORLD MAP.

10.3 PSAT

MET 00/01:04:43						
SITE	BAND	TYPE	AOS	LOS	DURATION	
TDE	K	TDRSS	00/01:25:55	00/02:18:04	52:09	
TDE	K	TDRSS	00/03:01:33	00/03:53:30	51:57	
TDE	K	TDRSS	00/04:36:58	XX/XX:XX:XX	XX:XX	
↑	HAW	SU	STDN	00/01:17:15	00/01:25:25	08:10
	UAN	S	STDN	00/01:27:00	00/01:34:58	07:58
	UTS	SU	RTS	00/01:27:03	00/01:34:57	07:54
	GDX	SU	STDN	00/01:27:51	00/01:35:44	07:53
	MLX	SU	STDN	00/01:35:31	00/01:44:21	08:50
	MIL	SU	STDN	00/01:35:31	00/01:44:21	08:50
	BDA	SU	STDN	00/01:39:29	00/01:46:54	07:25
	DKR	S	STDN	00/01:52:52	00/01:58:27	05:35
	ACN	SU	STDN	00/01:55:06	00/02:03:38	08:32
↓	YAR	U	STDN	00/02:27:24	00/02:34:37	07:13

PRESS UP/DOWN ARROWS TO SCROLL GROUND SITES
 PRESS SHIFT-UP/DOWN ARROWS TO SCROLL TDRSS
 PRESS CODE-ESC TO RETURN TO DAYMAP

FIGURE 10.5 PSAT Display

A Predicted Site Acquisition Table (PSAT) is available for the current and two predicted ground tracks. Press CODE-P to call up the PSAT Display (FIGURE 10.5). There are two windows for this display. The upper window displays TDRS data, while the lower window displays ground site data. Each window has a light bar which serves as an aid for reading data across a row. Press UPARROW and DOWNARROW to control light bar movement in the lower window. Press SHIFT-UPARROW and SHIFT-DOWNARROW to control light bar movement in the upper window.

If there are more lines of data than can be displayed in a PSAT window at one time, only sites with LOS in the future will be visible when the display appears. Users may scroll up or down to view data not currently in the window. Small up/down arrows indicate if more data are available. Users may scroll in the direction of the arrows to view the additional data. When the bottom or top of the table is reached, the appropriate arrow will vanish. PSAT features are labeled in FIGURE 10.6.

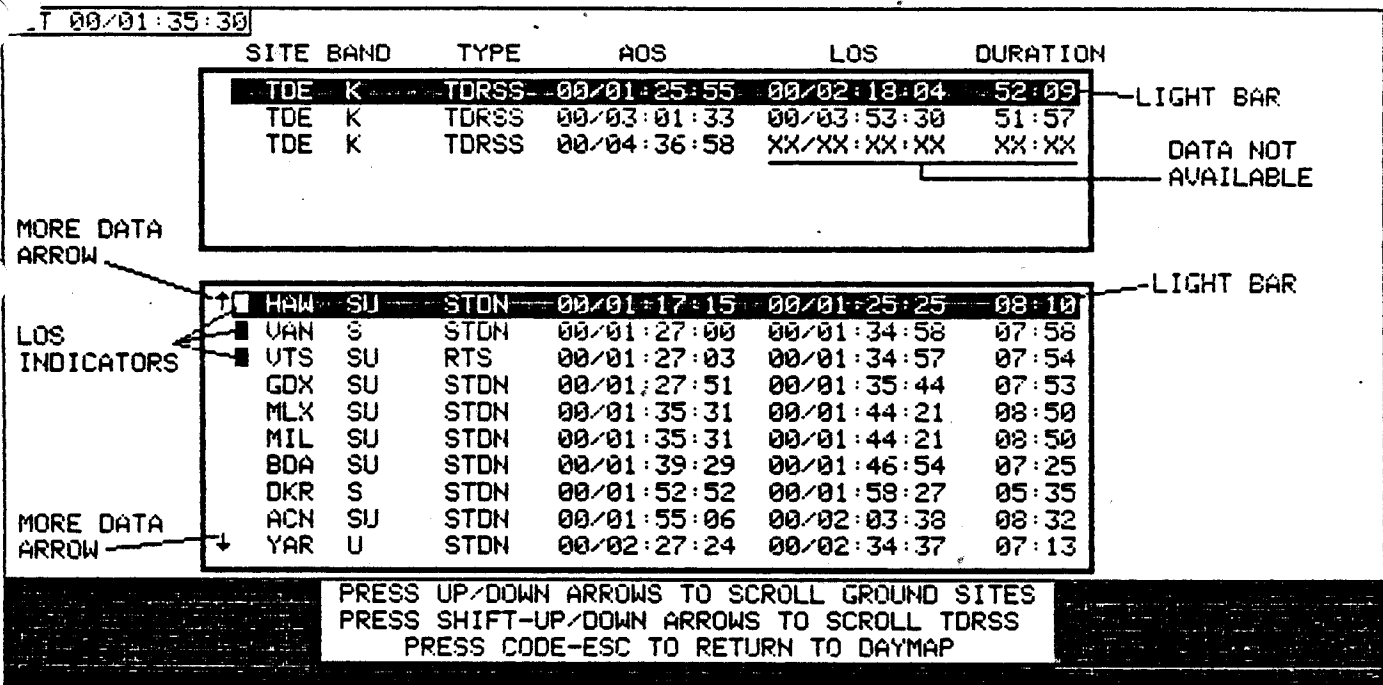


FIGURE 10.6

More Data Arrows: Indicate that more data are available above or below those currently visible.

LOS Indicators: Indicate the site has an LOS in the past.

Light Bar: Visual aid in reading across a row. May be moved with the arrow keys as described above.

XX/XX:XX:XX XX:XX: Indicates the data are not currently available.

To return to the WORLD MAP Display, press CODE-ESC

10.4 SITE MANAGER

SITE MANAGER allows users to:

- 1) Turn communication sites ON or OFF.
- 2) Add/edit communications site data.
- 3) Delete user input communications sites.
- 4) Add/edit earth observation site data.
- 5) Delete user input earth observation sites.

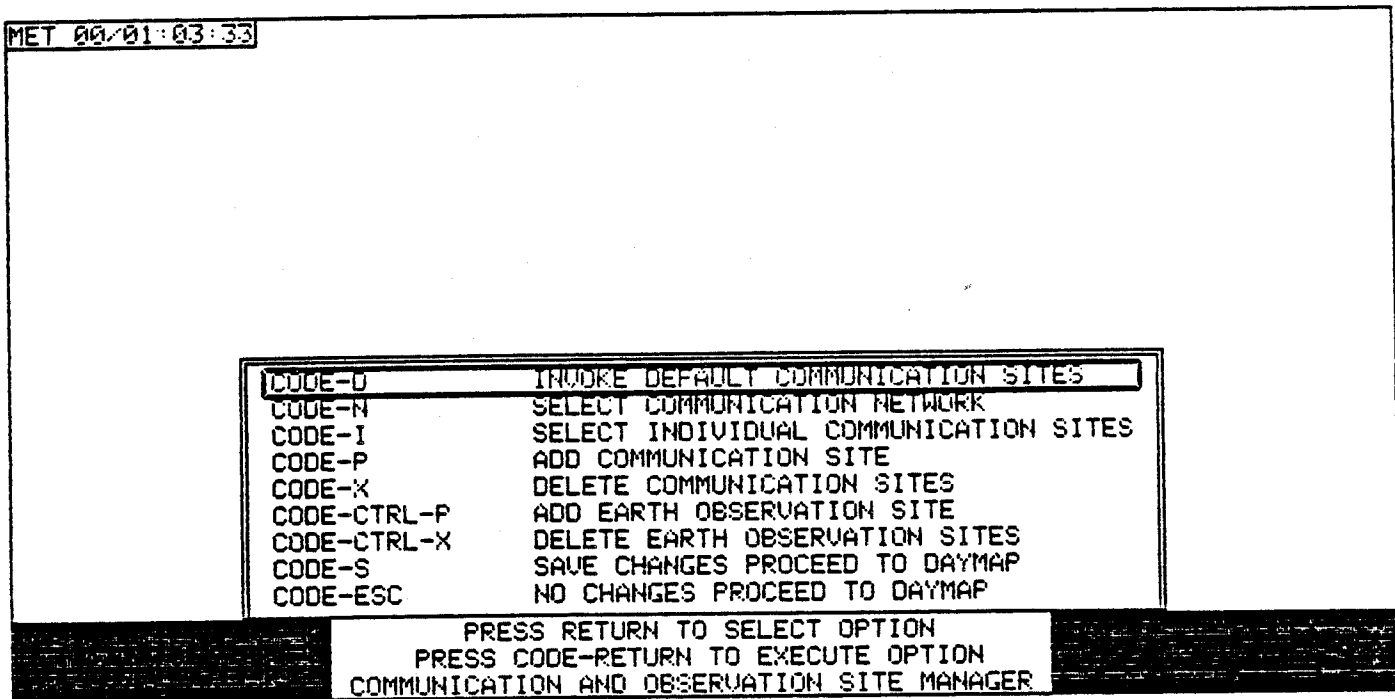


FIGURE 10.7 SITE MANAGER Main Menu

On the first call to WORLD MAP from the SPoC Main Menu, the SITE MANAGER Main Menu (FIGURE 10.7) will be displayed. During subsequent calls to WORLD MAP, control will pass directly to the WORLD MAP Display. SITE MANAGER may also be invoked from the WORLD MAP Help Menu or by pressing CODE-E from the WORLD MAP Display.

The SITE MANAGER Main Menu is displayed on the first call to WORLD MAP as a reminder that the previous user may have reconfigured communication or earth observation sites. This allows users easy access to verify configuration of the sites.

If a communication site is ON, the site will be included in AOS/LOS searches. If it is OFF, the site will not be included in AOS/LOS searches. The AOS/LOS search drive the WORLD MAP AOS/LOS countdown windows and PSAT Display. SPoC permission site data cannot be altered or deleted by users. Only user input site data may be altered or deleted by users.

10.4.1 SITE MANAGER Exit Options

Three options on the SITE MANAGER Main Menu will exit SITE MANAGER and proceed to the WORLD MAP program.

10.4.1.1 CODE-D INVOKE DEFAULT COMMUNICATION SITES

The communication site list will revert to the premission default configuration. Any user input sites marked for deletion will be deleted. All other sites, including user input sites, will be turned OFF. SITE MANAGER is exited and the WORLD MAP Display appears.

10.4.1.2 CODE-S SAVE CHANGES PROCEED TO DAYMAP

Any changes made during this SITE MANAGER session will be saved. User input sites marked for deletion will be deleted. SITE MANAGER is exited and the WORLD MAP Display appears.

10.4.1.3 CODE-ESC NO CHANGES PROCEED TO DAYMAP

Any changes made during this SITE MANAGER session will be ignored. SITE MANAGER is exited and the WORLD MAP Display appears. NOTE: If changes were made, users will be warned with the following message:

PRESS CODE-RETURN TO EXIT SITE MANAGER WITHOUT SAVING CHANGES
PRESS CODE-ESC TO RETURN TO SITE MANAGER

This prevents users from inadvertently losing any changes that may have been made during this SITE MANAGER session.

10.4.2 SITE MANAGER Functions

10.4.2.1 CODE-N SELECT COMMUNICATION NETWORK

MET 00/01:05:05

ON	OFF
ALL STDN SITES	OFF
ALL RTS SITES	OFF
ALL INPUT SITES	OFF

PRESS RETURN TO SELECT COMMUNICATION NETWORK
USE LEFT & RIGHT ARROWS TO SELECT STATUS
PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
PRESS CODE-ESC TO ABANDON THIS OPERATION

FIGURE 10.8 Network Form

This option displays the Network form (FIGURE 10.8) which allows users to configure entire communication networks ON or OFF. If ON is selected, all communications sites in that network will be turned ON. Otherwise, all sites for that network will be turned OFF.

10.4.2.2 CODE-I SELECT INDIVIDUAL COMMUNICATION SITES

MET 00:01:05:47

		ON	OFF
TDE	K TDRSS	DEF	ON
TDW	K TDRSS		ON
TDX	K TDRSS		OFF
ACN	SU STDN	DEF	ON
AGO	SU STDN	DEF	ON
BDA	SU STDN	DEF	ON
CAN	SU STDN	DEF	ON
DFR	U STDN		OFF
DKR	S STDN	DEF	ON
GDX	SU STDN	DEF	ON
GWM	SU STDN	DEF	ON
HAW	SU STDN	DEF	ON
MAX	SU STDN	DEF	ON
MIL	SU STDN	DEF	ON
MLX	SU STDN	DEF	ON
PDL	SU STDN		OFF
SPR	SU STDN		OFF
STL	SU STDN		OFF

PRESS RETURN TO SELECT SITE
 USE LEFT & RIGHT ARROWS TO SELECT STATUS
 PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
 PRESS CODE-ESC TO ABANDON THIS OPERATION

FIGURE 10.9 Communication Site Selection Form

This option displays the Communication Site Selection form (FIGURE 10.9). Users may configure each communication site ON or OFF. Sites configured premission as ON are indicated by DEF (default) in the fourth column from the left. Sites are grouped by site type in alphabetical order. TDRS satellites are at the top of the form, followed by STDN and Remote Tracking Station (RTS) sites. If any user input sites have been added, they will appear at the bottom of the form.

10.4.2.3 CODE-P ADD COMMUNICATION SITE

This option allows users to add or edit user input site data. Site data loaded permission can not be altered by users. Only user input site data may be altered.

MET 00/01:06:55

ENTER THREE ALPHA CHARACTERS	
SITE NAME	<input type="text"/>
GROUND SITE OR TDRSS	GROUND SITE

PRESS RETURN TO SELECT ITEM
USE LEFT & RIGHT ARROWS TO SELECT GROUND SITE OR TDRSS
PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
PRESS CODE-ESC TO ABANDON THIS OPERATION
COMMUNICATION SITES

FIGURE 10.10 Site ID Form

The Site ID form (FIGURE 10.10) appears after CODE-P is pressed. A site name composed of three alpha characters is the first item to be entered on this form. In the following examples, ABC will be used as the site name. The characters entered may be either upper or lower case.

NET 00:01:07:00

GROUND-SITE TDRSS	
SITE NAME	ABC
GROUND SITE OR TDRSS	GROUND SITE

IMPROPER COMMUNICATION SITE ID (REENTER ID)
 PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
 PRESS CODE-ESC TO ABANDON THIS OPERATION

FIGURE 10.11 Site ID Form

The second Site ID form item (see FIGURE 10.11) allows users to select whether inputs pertain to a ground site or TDRS.

Acceptable inputs for the Site ID form:

Site Name : Exactly three alphabetic characters.

Possible error messages:

1) IMPROPER COMMUNICATION SITE ID (REENTER ID)

Problem: Three alphabetic characters were not entered for the site ID.

Solution: Enter three alphabetic characters.

2) DUPLICATE SITE ID
 IMPROPER COMMUNICATION SITE ID (REENTER ID)

Problem: The site ID entered was used for a premission site.

Solution: Use a different site ID for the input site.

10.4.2.3.1 Adding a Ground Communications Site

If GROUND SITE was selected from the Site ID form, the Site Data form will appear as shown in FIGURE 10.12. At the top of the form, ENTERING ABC DATA is displayed. Also notice that the latitude and longitude settings are blank. Enter the latitude and longitude (in decimal degrees).

MET 00/01:11:40

ENTERING ABC DATA	
LATITUDE (-90 TO 90 IN DEC. DEG.)	<input type="text"/>
LONGITUDE (-180 TO 360 IN DEC. DEG.)	<input type="text"/>
FREQUENCY BAND	S-BAND

PRESS RETURN TO SELECT ITEM
USE LEFT & RIGHT ARROWS TO SELECT FREQUENCY BAND
PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
PRESS CODE-ESC TO ABANDON THIS OPERATION
COMMUNICATION SITES

FIGURE 10.12

Select the correct frequency band for this input site (FIGURE 10.12a) with the LEFTARROW and RIGHTARROW keys.

MET 00/01:58:53

S-BAND	UHF	S-BAND AND UHF
LATITUDE	(<-90 TO 90 IN DEC. DEG.)	27.5
LONGITUDE	(<-180 TO 360 IN DEC. DEG.)	-90.0
FREQUENCY BAND		S-BAND

PRESS RETURN TO SELECT ITEM
USE LEFT & RIGHT ARROWS TO SELECT FREQUENCY BAND
PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
PRESS CODE-ESC TO ABANDON THIS OPERATION
COMMUNICATION SITES

FIGURE 10.12a

10.4.2.3.2 Adding a TDRS

If TDRSS was selected from the Site ID form, the Site Data form will appear as shown in FIGURE 10.13. At the top of the form, ENTERING ABC DATA is displayed. Notice that the longitude setting is blank. Enter the longitude (in decimal degrees).

MET 00/01:21:58

ENTERING ABC DATA

LONGITUDE (-180 TO 360 IN DEC. DEG.)

PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
PRESS CODE-ESC TO ABANDON THIS OPERATION
COMMUNICATION SITES

FIGURE 10.13

10.4.2.3.3 Editing User Input Ground Site Data

If a site has previously been input and GROUND SITE was selected from the Site ID form, the Site Data form will appear as shown in FIGURE 10.14. At the top of the form, EDITING ABC DATA is displayed. The form will display site data for editing.

MET 00/02:51:39

EDITING ABC DATA	
LATITUDE (-90 TO 90 IN DEC. DEG.)	27.50
LONGITUDE (-180 TO 360 IN DEC. DEG.)	-90.00
FREQUENCY BAND	S-BAND

PRESS RETURN TO SELECT ITEM
USE LEFT & RIGHT ARROWS TO SELECT FREQUENCY BAND
PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
PRESS CODE-ESC TO ABANDON THIS OPERATION
COMMUNICATION SITES

FIGURE 10.14

10.4.2.3.4 Editing User Input TDRS Data

If a TDRS has previously been input and TDRSS was selected from the Site ID form, the Site Data form will appear as shown in FIGURE 10.15. At the top of the form, EDITING ABC DATA is displayed. The TDRS longitude may then be updated.

MET 00/02:03:46

EDITING ABC DATA

LONGITUDE (-180 TO 360 IN DEC. DEG.) 150.00

PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
PRESS CODE-ESC TO ABANDON THIS OPERATION
COMMUNICATION SITES

FIGURE 10.15

Acceptable inputs for the Site Data forms:

Latitude: -90 through +90 (ground sites only)

Longitude: -180 through +360

Possible error messages:

- 1) IMPROPER LONGITUDE (REENTER LONGITUDE)
IMPROPER LATITUDE (REENTER LATITUDE)

Problem: The inputs are out of range.

Solution: Correct erroneous inputs.

10.4.2.4 CODE-X DELETE COMMUNICATION SITES

Only user input communication sites may be deleted. To mark one or more sites for deletion, select CODE-X DELETE COMMUNICATION SITES from the SITE MANAGER Main Menu. If there are currently any user input sites, the Communication Site Deletion form (FIGURE 10.16) will appear. If there are currently no user input sites, this message will be displayed:

THERE ARE NO "INPUT" SITES TO DELETE
PRESS ANY KEY TO CONTINUE
COMMUNICATION SITES

MET 00/02:07:00

<input checked="" type="checkbox"/>	KEEP THIS SITE	<input type="checkbox"/>	DELETE THIS SITE
ABC INPUT	<input checked="" type="checkbox"/>	KEEP THIS SITE	
ABD INPUT	<input type="checkbox"/>	DELETE THIS SITE	
ABF INPUT	<input type="checkbox"/>	KEEP THIS SITE	

PRESS RETURN TO SELECT SITE
USE LEFT & RIGHT ARROWS TO SELECT STATUS
PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
PRESS CODE-ESC TO ABANDON THIS OPERATION

FIGURE 10.16 Communication Site Deletion Form

Note that sites marked for deletion on this form will only be purged from bubble memory when CODE-D or CODE-S is selected from the SITE MANAGER Main Menu. Users may return to the Communication Site Deletion form and mark or unmark sites for deletion on multiple occasions before they are purged.

User input sites marked for deletion will be accompanied by an asterisk when displayed in the Site Selection form (FIGURE 10.17).

MET 00/02:07:30

	ON	OFF			
† PDL SU STDN					OFF
SPR SU STDN					OFF
STL SU STDN					OFF
UAN S STDN			DEF		ON
VDT S STDN					OFF
YAR U STDN			DEF		ON
GDS SU RTS					OFF
GTS SU RTS			DEF		ON
HTS SU RTS					OFF
IOS SU RTS			DEF		ON
NHS SU RTS			DEF		ON
OTS SU RTS					OFF
TTS SU RTS					OFF
UTS SU RTS			DEF		ON
ABC S INPUT					ON
*ABD S INPUT					ON
ABE S INPUT					ON

PRESS RETURN TO SELECT SITE
 USE LEFT & RIGHT ARROWS TO SELECT STATUS
 PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
 PRESS CODE-ESC TO ABANDON THIS OPERATION
 "*" INDICATES THE INPUT SITE WILL BE DELETED UPON RETURN TO DAYMAP

FIGURE 10.17 Site Selection Form

10.4.2.5 CODE-CTRL-P ADD EARTH OBSERVATION SITE

This option allows users to add or edit a user input earth observation site. All user input earth observation sites are point sites. A point site is one point on the earth's surface defined by its latitude and longitude. Sites that are loaded premission cannot be altered by users. Only user input site data may be altered.

To add or edit earth observation site data, select **CODE-CTRL-P ADD EARTH OBSERVATION SITE** from the **SITE MANAGER Main Menu**. The Observation Site ID form will be displayed (FIGURE 10.18). For the following examples, T104B will be used as the site name.

MET 00/02:34:16

MAXIMUM OF FIVE CHARACTERS

SITE NAME

PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
PRESS CODE-ESC TO ABANDON THIS OPERATION
OBSERVATION SITES

FIGURE 10.18 Observation Site ID Form

After pressing **CODE-RETURN** in the Observation Site ID form, the Observation Site Data form will appear. The format of the Observation Site Data form will vary based on the inputs into the Observation Site ID form. See FIGURES 10.19 and 10.20.

Acceptable inputs for the Observation Site ID form:

Site Name : Maximum of five alpha-numeric characters.

Possible error messages:

1) **IMPROPER EARTH OBSERVATION SITE ID (REENTER ID)**

Problem: Improper site name was entered.

Solution: Reenter site name.

2) DUPLICATE SITE NAME
 IMPROPER EARTH OBSERVATION SITE ID (REENTER ID)

Problem: The site name entered was used for a premission site.

Solution: Use a different site name for the input site.

10.4.2.5.1 Adding An Earth Observation Site

MET 00/02:49:19

ENTERING T104B DATA

LATITUDE (-90 TO 90 IN DEC. DEG.)

LONGITUDE (-180 TO 360 IN DEC. DEG.)

ALBEDO (6 TO 18)

PRESS RETURN TO SELECT ITEM
PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
PRESS CODE-ESC TO ABANDON THIS OPERATION
OBSERVATION SITES

FIGURE 10.19 Observation Site Data Form

If this is a new site to be added, ENTERING T104B DATA is displayed at the top of the Observation Site Data form (FIGURE 10.19), indicating that data for the new site T104B are being entered. Since this is a new site, the form settings are blank. Enter the setting for each item.

10.4.2.5.2 Editing User Input Earth Observation Site Data

MET 00/03:00:51

EDITING T104B DATA	
LATITUDE (-90 TO 90 IN DEC. DEG.)	-30
LONGITUDE (-180 TO 360 IN DEC. DEG.)	175
ALBEDO (6 TO 18)	13

PRESS RETURN TO SELECT ITEM
 PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
 PRESS CODE-ESC TO ABANDON THIS OPERATION
 OBSERVATION SITES

FIGURE 10.20

If the site name entered into the Site ID form has previously been added, the Observation Site Data form (FIGURE 10.20) will be displayed with EDITING T104B DATA at the top of the form. The data for this site will be displayed in the form. Edit the necessary settings.

Acceptable inputs for the Site Data form:

Latitude: -90 through +90
 Longitude: -180 through +360
 Albedo: 6 through 18

Possible error messages:

- 1) IMPROPER LONGITUDE (REENTER LONGITUDE)
 IMPROPER LATITUDE (REENTER LATITUDE)
 IMPROPER ALBEDO (REENTER ALBEDO)

Problem: The inputs are out of range.

Solution: Correct erroneous inputs.

10.4.2.6 CODE-CTRL-X DELETE EARTH OBSERVATION SITES

Only user input earth observation sites may be deleted. To mark one or more sites for deletion select CODE-CTRL-X DELETE EARTH OBSERVATION SITES from the SITE MANAGER Main Menu. If there are currently any user input sites, the Observation Site Deletion form (FIGURE 10.21) will appear. If there are currently no user input sites, this message will be displayed:

THERE ARE NO "INPUT" SITES TO DELETE

PRESS ANY KEY TO CONTINUE
OBSERVATION SITES

MET 00/03:01:00

KEEP THIS SITE	DELETE THIS SITE
1	KEEP THIS SITE
12B	KEEP THIS SITE
2345	KEEP THIS SITE
1005B	KEEP THIS SITE

PRESS RETURN TO SELECT SITE
USE LEFT & RIGHT ARROWS TO SELECT STATUS
PRESS CODE-RETURN TO RETAIN DATA AND CONTINUE
PRESS CODE-ESC TO ABANDON THIS OPERATION

FIGURE 10.21 Earth Observation Site Deletion Form

Note that sites marked for deletion on this form will only be purged from bubble memory when CODE-D or CODE-S is selected from the SITE MANAGER Main Menu. Users may return to the Earth Observation Site Deletion form and mark or unmark sites for deletion on multiple occasions before they are purged.

**SECTION 11.0
DEORBIT****11.1 Overview**

DEORBIT calculates landing opportunities and deorbit maneuver targets in a process similar to deorbit targeting by the MCC. SPoC DEORBIT targets are only utilized in the event of a total loss of communications with the ground or a time critical systems failure during a loss of communication period requiring an emergency deorbit before ground assistance can be provided.

To invoke DEORBIT from the SPoC Main Menu, press **CODE-D** or move the selection box to **CODE-D DEORBIT**, and press **CODE-RETURN**. The following message will be displayed:

**One Moment Please
Loading Deorbit**

After DEORBIT is loaded into RAM, a second message will be displayed.

Retrieving Data...

After the necessary data have been retrieved, the Initialization form (FIGURE 11.1) will be displayed.

11.2 Initialization Form

# of Hours	
Window	6
Site Selection	Select
Vehicle Weight (lbs)	241226
Primary/Backup Thruster	2 OMS/1 OMS
Propellant Weight	0
Pre Bank	0
Start Day (MET)	0
Start Hour (MET)	0
Start Minute (MET)	0
Start Second (MET)	0

Type In Initial Conditions
Press CODE-RETURN To Compute Opportunities
Press CODE-ESC To Exit Program

FIGURE 11.1

The Initialization form allows users to input parameters used by DEORBIT to calculate landing opportunities and maneuver targets. With this form, users can select search window duration for opportunities, landing sites, vehicle weight at Time of Ignition (TIG), propulsion system downmoding, propellant weight to be used/wasted, prebank, and MET at which to start the opportunities search.

11.2.1 Initialization Form Inputs

1. Window: Number of hours to search for landing opportunities. This input must be an integer. If zero is input, the program searches for the next landing opportunity only.
2. Site Selection: Users may select all mission specific Emergency Landing Sites and Conus Landing Sites, or a subset of these sites. If All is selected, DEORBIT will search for landing opportunities associated with all approved mission sites. If Select is chosen, the Site Selection form (FIGURE 11.2) will be displayed.
3. Vehicle Weight: Users may input weight of the vehicle (100000-500000) at deorbit TIG. The default vehicle weight setting is calculated by CGMANAGER. This weight is used in calculation of deorbit maneuver targets.
4. Primary/Backup Thruster: Users may select one of three Orbital Maneuvering System (OMS) and/or Reaction Control System (RCS) propulsive downmoding options: 2 OMS/1 OMS, 1 OMS/RCS, or RCS. For the 2 OMS/1 OMS option, TIG is optimized for the instant at which Delta V total would be the same for either a 2 OMS or a 1 OMS burn. This is the so-called "crossover point". With either 1 OMS/RCS or RCS selected, TIG is optimized for an RCS burn.
5. Propellant Weight: This item is used to produce a burn out-of-plane acceleration component. A user's input is interpreted as the minimum weight of propellant to be burned during the deorbit maneuver. Below are the two possible outcomes for this item.
 - 1) Propellant weight entered is less than or equal that required for an inplane burn. The burn will consume a propellant weight greater than the amount entered, with all of the burn being inplane.
 - 2) Propellant weight entered is greater than that required for an inplane burn. The burn will have both inplane and out-of-plane components, with the total propellant weight consumed equal to the amount entered.

The default value is zero, and nominally this is the value used. For off-nominal cases, users may enter a non-zero value (20000 lbs maximum). If users need to manage Orbiter CG/Weight or minimize crossrange, follow the procedure below.

Complete the Initialization form using the default value for propellant weight. Press CODE-RETURN to enter the Landing Opportunities Table (LOT) display. Move the light bar to the desired landing opportunity. Press CODE-RETURN to calculate maneuver targets for the selected opportunity. When the Maneuver Target display appears, copy the maneuver target data. Press CODE-S to save the calculated inplane delta V total which will be used by the CGMANAGER program. Exit DEORBIT and return to the SPoC Main Menu. Press CODE-C to execute CGMANAGER. From CGMANAGER's Main Menu select CODE-D Deorbit CG Results. A graphic representation of the CG envelope will be

displayed (see SECTION 12.7). Determine if propellant wasting is necessary. If propellant wasting is necessary, execute DEORBIT again. Enter the Deorbit Burn Total weight calculated by CGMANAGER (see FIGURE 12.14) as the Propellant Weight in the Initialization form.

6. Prebank: Desired prebank angle (0 - 90 deg) may be entered. This is the prebank used from MM304 until closed loop guidance is initiated. As the prebank angle increases, the EI flight path angle becomes more shallow.
7. Start Time: This is the MET after which landing opportunities are desired for targeting. Settings are initially driven by current MET when DEORBIT is invoked from the SPoC Main Menu. These settings may be changed if a different start time is desired. Unpredictable results will be obtained if Start Time is prior to the State Vector time tag (see Section 8).

Possible Initialization Form Error Messages:

1) ERROR: Vehicle Weight Parameter Input Incorrectly

Problem: The input vehicle weight (Item 5) is less than 100000 lbs or greater than 500000 lbs.

Solution: Correct erroneous inputs.

11.3 Site Selection Form

	Yes	No
AML		No
DKR		No
DDM		No
EDW	Yes	
HAQ		No
HDS		No
HNL		No
GDU		No
GUA		No
JDG		No
KIN		No
KSC	Yes	
MRN		No
NOR		No
SUD		No
RIY		No

Select Choice Of Landing Sites
 Use Left and Right Arrow Keys To Select
 Press CODE-RETURN To Accept Landing Site Selection
 Press CODE-ESC To Return To Initialization Form. No Selection

FIGURE 11.2 Site Selection Form

The Site Selection form allows users to choose landing sites for the landing opportunities search. This form will be displayed only if **Select** is chosen for the Site Selection item on the Initialization form. With this setting, Site Selection will appear the first time **CODE-RETURN** is pressed on the Initialization Form. A second **CODE-RETURN** (or the first if **Site Selection** is set to **ALL**) invokes the LOT Display (see Section 11.4). Initial Site Selection form configuration sets **KSC** and **EDW** to **Yes**, while other landing sites are set to **No**. Only sites with settings set to **Yes** will be included in the landing opportunities search.

11.4 LOT Display

Site	TIG	XRNG	S
EIL	0/01:01:42	123	D
EDW	0/01:09:30	797	N
NDR	0/01:11:31	441	N
KSC	0/01:15:18	601	N
EGD	0/01:34:28	756	N
JDG	0/02:02:14	740	D
EIL	0/02:31:43	376	N
EDW	0/02:40:16	78	N
NDR	0/02:41:52	537	N
EGD	0/03:04:21	67	N
JDG	0/03:32:40	467	D
EIL	0/04:01:17	785	N
EGD	0/04:35:00	448	N
HDS	0/04:54:38	119	D
KKI	0/05:08:09	471	D
HNL	0/05:37:35	118	N
HAO	0/05:50:22	134	N

Flight Rules Dispersed XRNG Limit : 727 N.M.
 Use Arrow Keys/ CODE-RETURN To Compute Targets
 Press CODE-ESC To Return To Initialization Form

FIGURE 11.3 LOT Display

FIGURE 11.3 is an example of a LOT display. Initially, the display will flash the message "Please Wait - Computing Opportunities." Landing opportunities within the mission's nominal undispersed crossrange limits are displayed in chronological order. Items displayed are landing site identifier, approximate TIG in d/hh:mm:ss MET, crossrange to the site in nm, and lighting conditions at landing (D = day, N = night). In DEORBIT "day" is defined as the period starting 15 minutes before sunrise and ending 15 minutes after sunset.

The LOT display operates differently than forms or menus.

- 1) To move the light bar, use the UPARROW and DOWNARROW keys.
- 2) To view the next page of opportunities, move the light bar below the bottom opportunity on the current page.
- 3) To view the previous page, move the light bar above the top opportunity on the current page.

Pressing CODE-ESC from the LOT display will return the user to the Initialization form only if no maneuver targets have been computed. If maneuver targets for any landing opportunity were computed, then a CODE-ESC must be followed by a CODE-RETURN to return to the Initialization form. Any other key pressed will retain the current LOT display and maneuver targets. The following message will also appear at the bottom of the LOT display when a CODE-RETURN is required to exit.

CAUTION: All computed targets will be lost
 Press CODE-RETURN to continue to initialization form
 Press any other key to retain computed targets

Possible Error Messages.

1) No opportunities found

Problem: No landing opportunities were found corresponding to data entered in Initialization and Site Selection forms.

Solution: Press CODE-ESC and enter new data into Initialization form Items 1 and 7 (see Section 11.2.1). It may also be necessary to activate additional landing sites (see Section 11.3).

Site	TIG	XRNG	S
*EIL	0/01:01:42	123	D
EDW	0/01:09:30	797	N
NOR	0/01:11:31	441	N
KSC	0/01:15:18	501	N
EGO	0/01:34:28	756	N
JOG	0/02:02:14	740	D
EIL	0/02:31:43	376	N
?EDW	0/02:40:16	78	N
NOR	0/02:41:52	537	N
EGO	0/03:04:21	67	N
JOG	0/03:32:40	467	D
EIL	0/04:01:17	785	N
EGO	0/04:35:00	448	N
HDS	0/04:54:38	119	D
KKI	0/05:08:09	471	D
HNL	0/05:37:35	118	N
HAO	0/05:50:22	134	N

Flight Rules Dispersed XRNG Limit : 727 N.M.
 Use Arrow Keys/CODE-RETURN To Compute Targets
 Press CODE-ESC To Return To Initialization Form

FIGURE 11.4

After landing opportunities have been displayed, DEORBIT will automatically compute targets for each landing opportunity in chronological order. An asterisk (*) next to a landing site ID (FIGURE 11.4) indicates maneuver targets for the opportunity have been computed. Users may also select the order in which targets for landing opportunities are computed as follows:

- 1) Move the light bar to the desired landing site and press CODE-RETURN.
- 2) Repeat Step 1 for each site in the order desired.

Maneuver targets for the selected sites will be computed in the order the sites were selected. NOTE: A maximum of nine landing opportunities can be input to the user selection queue at one time. A question mark (?) is displayed next to the identifier of a user-selected landing opportunity to indicate maneuver targets are being computed for this landing opportunity (FIGURE 11.4). When targets from the selection queue have been computed, they will automatically be displayed.

To display maneuver targets for a landing opportunity, move the light bar to a

landing opportunity with an asterisk and press **CODE-RETURN**. The targets for the site will be displayed (FIGURE 11.5). Pressing **CODE-ESC** will return program control to the LOT display unless another set of targets from the selection queue is ready to be displayed. In this case, the new set of targets will be displayed and an additional **CODE-ESC** will be required to return to the LOT display.

11.5 Maneuver Targeting Display

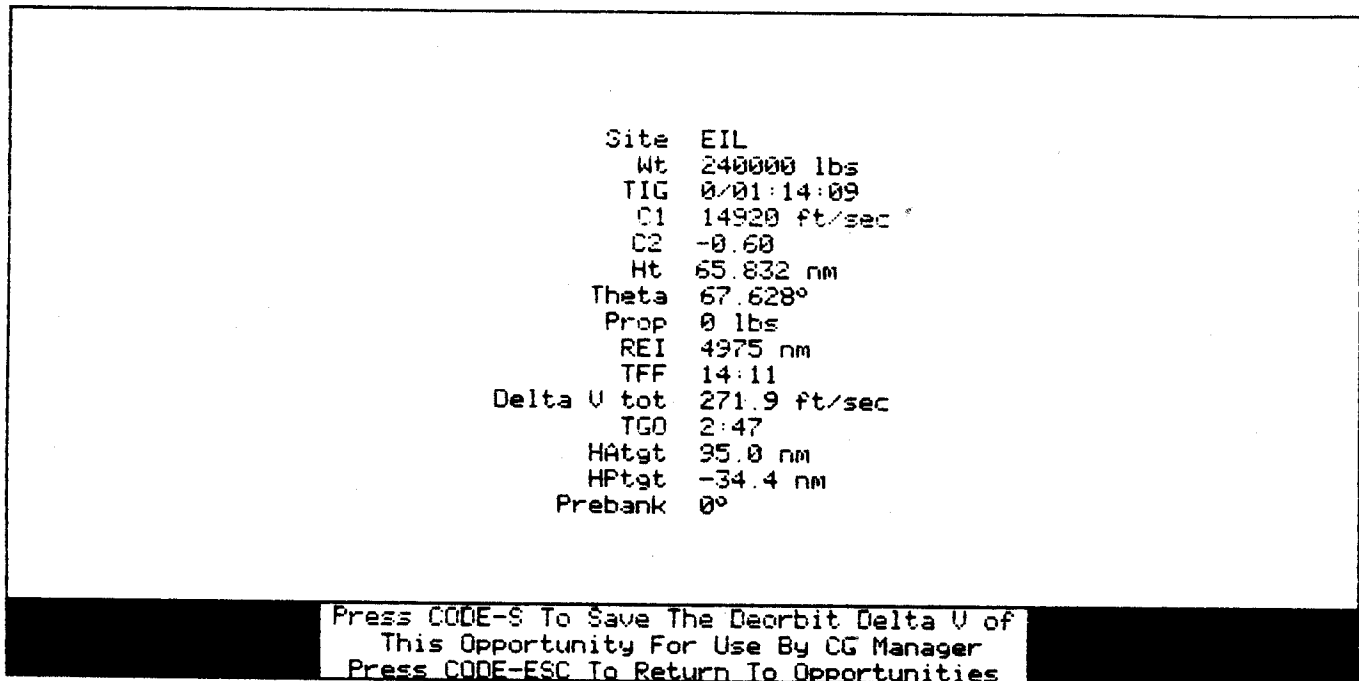


FIGURE 11.5 Maneuver Targeting Display

FIGURE 11.5 is an example of a Maneuver Targeting display. If a landing opportunity selected from the LOT display exceeds the nominal mission-specific dispersed crossrange, an additional message **This target exceeds the Flight Rule XRNG limits** will be displayed at the bottom of the screen.

Maneuver Targeting displays PEG4 input data for input to the GPC Deorbit Maneuver Execute Display. Also displayed are SPoC predictions of the GPC PEG4 solution. SPoC DEORBIT targeting computations are similar to those of the MCC, except C2 (-0.60) and Ht (65.832) are invariant for SPoC.

Wt, TIG, C1, C2, Ht, Theta, and Prop are data that will be entered into the Deorbit Maneuver Execute Display. If propellant weight was entered into Item 5 of the Initialization form (see Section 11.2.1), Prop will have a sign convention which is given by the equation $SIGN(Prop) = -SIGN(Peg7_VGO_Y)$. Positive Prop will indicate a negative Y LVLH burn acceleration and negative Prop will indicate a positive Y LVLH burn acceleration. Below are Deorbit Maneuver Execute Display item numbers that correspond to SPoC Maneuver Targeting display data.

Item 9	Wt
Item 10	TIG
Item 14	C1
Item 15	C2
Item 16	Ht
Item 17	Theta
Item 18	Prop

When SPoC data are loaded into the Deorbit Maneuver Execute Display, an actual REI will be computed. It may be different than the REI computed by the SPoC DEORBIT program.

To save displayed Delta V tot for use by CGMANAGER, press CODE-S. To return to the LOT display, press CODE-ESC.

SECTION 12.0 CGMANAGER

12.1 Overview

The SPoC CGMANAGER program allows the Orbiter's CG, and weight to be computed onboard according to current propellant quantities, cargo status, and non-propellant consumable quantities. CGMANAGER also allows users to enter a deorbit change in velocity and an optional target CG to obtain mass property information for pertinent entry check points. If an optional target CG is entered, the user may be given OMS wasting, FRCS dumping, or OMS crossfeeding recommendations. The program will also communicate with the SPoC DEORBIT program by passing current Orbiter weight and receiving the desired deorbit maneuver change in velocity. CGMANAGER uses the same computational method as the MOC Mass Properties Processor.

Prior to deorbit, there are three updates of interest in CG management: consumables, cargo, and constants. The consumables are fuel, water, oxygen, cryogenics, waste etc. Cargo includes any deployable or jettisonable items in the payload bay. The constants are elements that do not normally change during the mission: inert Orbiter weight, trapped propellants, fixed payloads, etc.

The program utilizes the standard SPoC user interface described in Section 3, together with special enhancements documented throughout Section 12.

12.2 CGMANAGER Main Menu

Upon selecting CGMANAGER from the SPoC Main Menu, messages will appear indicating the program is executing and retrieving necessary data from CGMANAGER files.

Once the initialization is complete, the CGMANAGER Main Menu (FIGURE 12.1) will be displayed. This menu contains six items, each of which will be covered in detail later. Attached to the first four items is an MET which indicates the last time information was updated and saved to a file. Current mass properties of the Orbiter are displayed at the top of the screen.

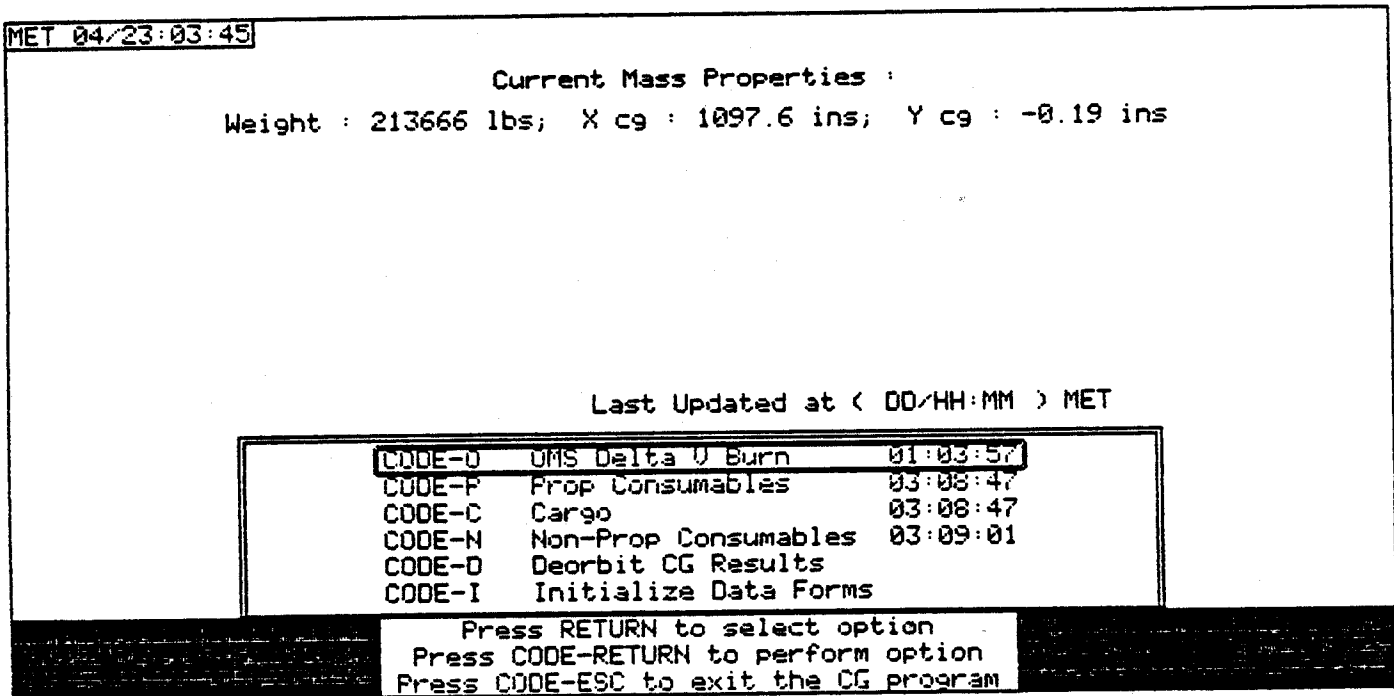


FIGURE 12.1

12.3 CODE-P: The Propellant Consumables Form

The second item in the CGMANAGER Main Menu (FIGURE 12.1) is used to update the OMS and RCS tank quantities. This data form (FIGURE 12.2) is an example of extensions CGMANAGER makes to the standard SPoC data form. The form contains current settings, not in the selection box, but on the form itself. Only items to be updated require inputs. In this manner, the FIGURE 12.2 example would update only left OMS fuel and oxidizer and right OMS oxidizer, while retaining all other settings.

MET 04/23:06:39

0 - 100 % or [1001 - 2000 lbs He press.]			
OMS Fuel	Left:	38.1 %	37.8
	Right:	39.0 %	
OMS Oxidizer	Left:	39.0 %	38.8
	Right:	38.3 %	1378
RCS Fuel	Left:	64.0 %	
	Forward:	2.0 %	
	Right:	65.0 %	
RCS Oxidizer	Left:	63.0 %	
	Forward:	0.0 %	
	Right:	63.0 %	

Press RETURN to select item, then enter data
 Press CODE-ESC to ignore data and go back
 Press CODE-RETURN to retain data and continue

FIGURE 12.2

Due to current onboard OMS gaging performance, OMS data can be entered either directly as a percentage quantity, or indirectly through helium pressure gaging. If an OMS quantity is being computed from helium pressure input, the computed quantity will appear in brackets as in FIGURE 12.3.

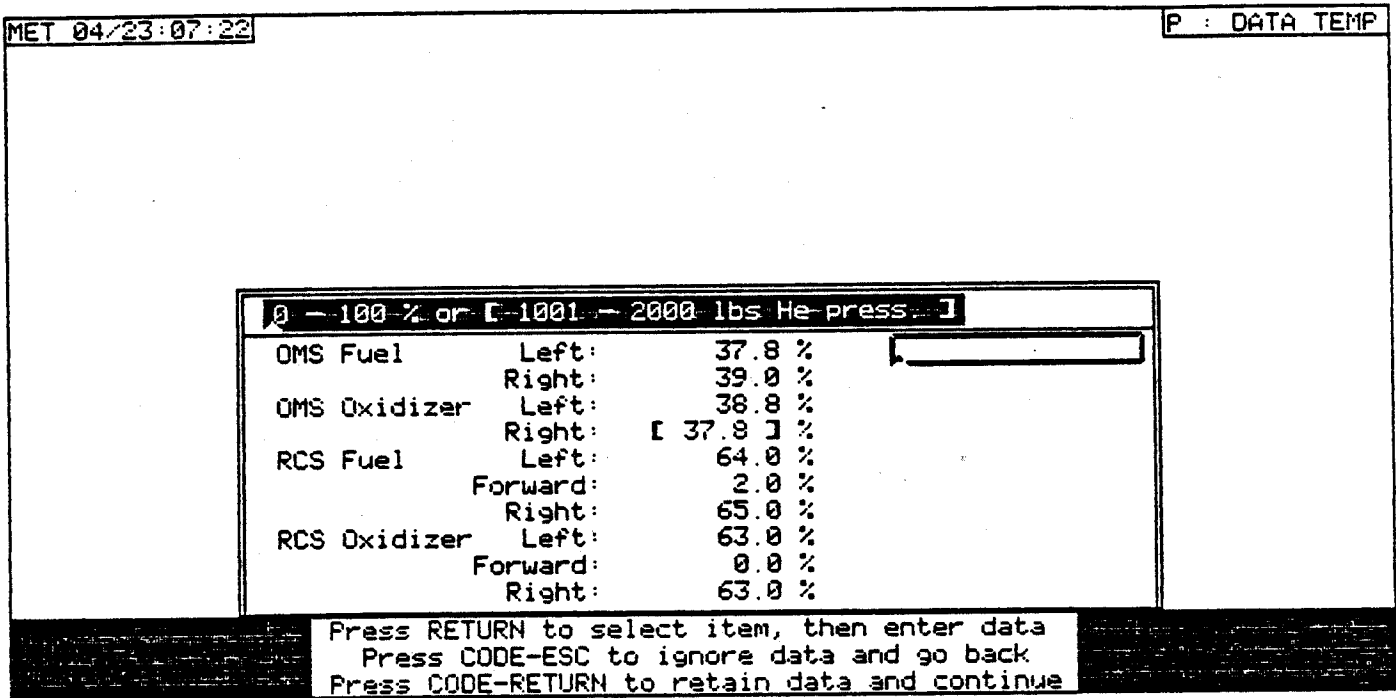


FIGURE 12.3

Panel 03 contains a dedicated propellant tank quantity display from which ten tank quantities may be obtained. The GPC GNC System Summary 2 Display (SPEC 19) can also be used to obtain tank quantities and will be discussed in detail later. OMS quantities may be entered in tenths of a percent. RCS and all other tank quantities should be entered as integer values.

The Propellant form, like other SPoC forms, will trap bad data inputs and inform the user. An example of this can be seen in FIGURE 12.4.

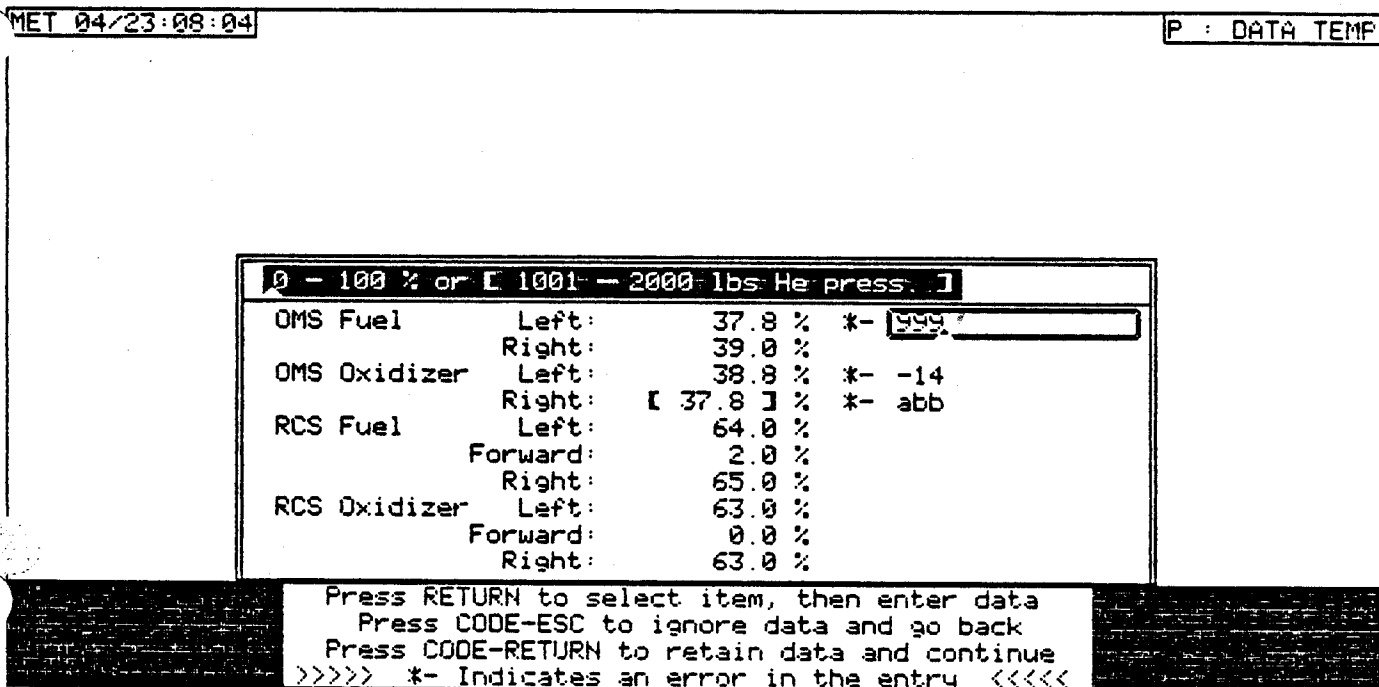


FIGURE 12.4

If the user enters valid propellant quantities and presses CODE-RETURN, a Save menu will appear (FIGURE 12.5). The first two options in this menu, Save Data to File and Save Data Temporarily, imply the two modes of data retention that CGMANAGER allows. If a user is performing valid updates, the first option should always be exercised. If, however, the user is simply performing "what if" cases, the program's file data may be protected by saving the data temporarily. In either case, the data in RAM are updated. Data saved to a file may be restored in place of temporary data by exiting CGMANAGER, then pressing CODE-C from the SPoC Main Menu.

If the user chooses to save propellant data temporarily, a P : DATA TEMP indicator will appear in the screen's upper right hand corner upon returning to the CGMANAGER Main Menu. Appearing with the propellant temporary data flag may be any other (cargo or non-propellant) temporary data flags, i.e. P C : DATA TEMP or P C N : DATA TEMP.

If the user wishes to return to the Propellant form from the Save menu, the third option should be invoked. This will recall the propellant data form as before, but now the user's latest updates will be displayed on the form. If this data configuration is now deemed bogus, the user may press CODE-ESC and return to the CGMANAGER Main Menu (FIGURE 12.1). In this case, propellant quantities will retain values in RAM when the user invoked the Propellant form.

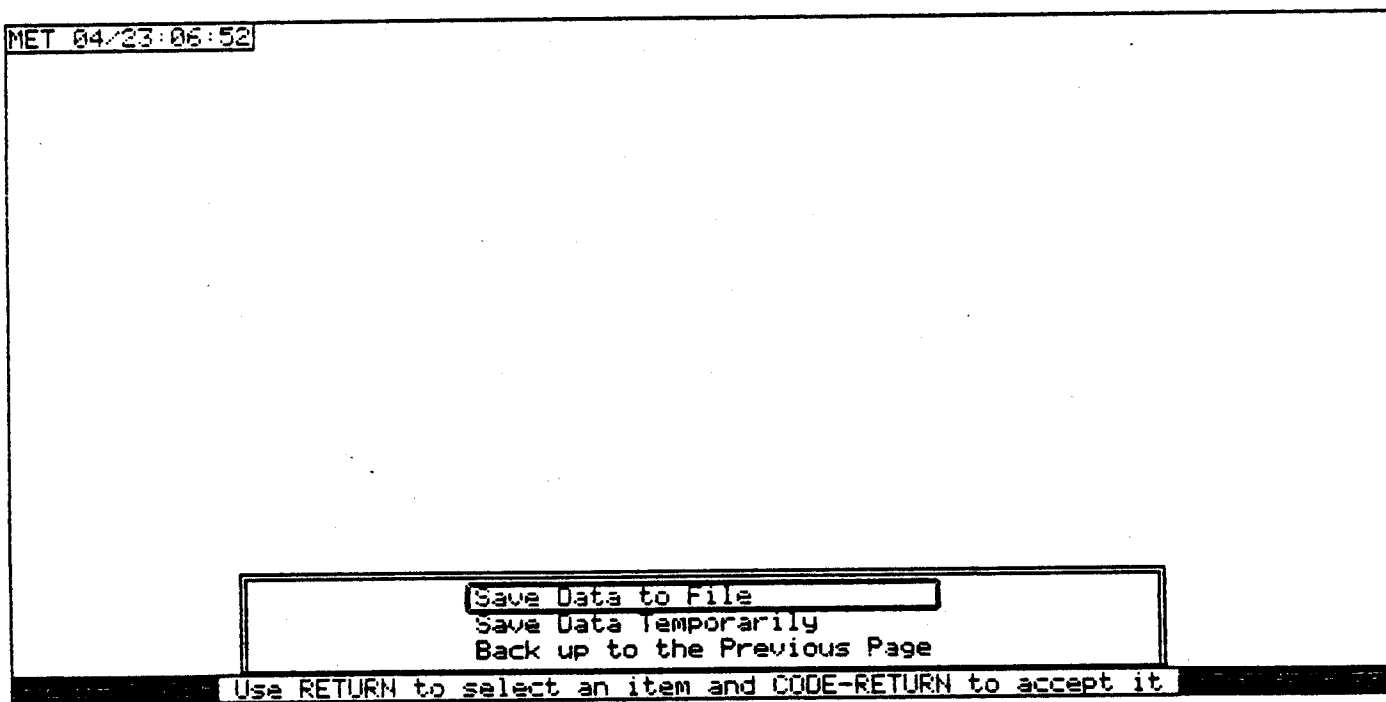
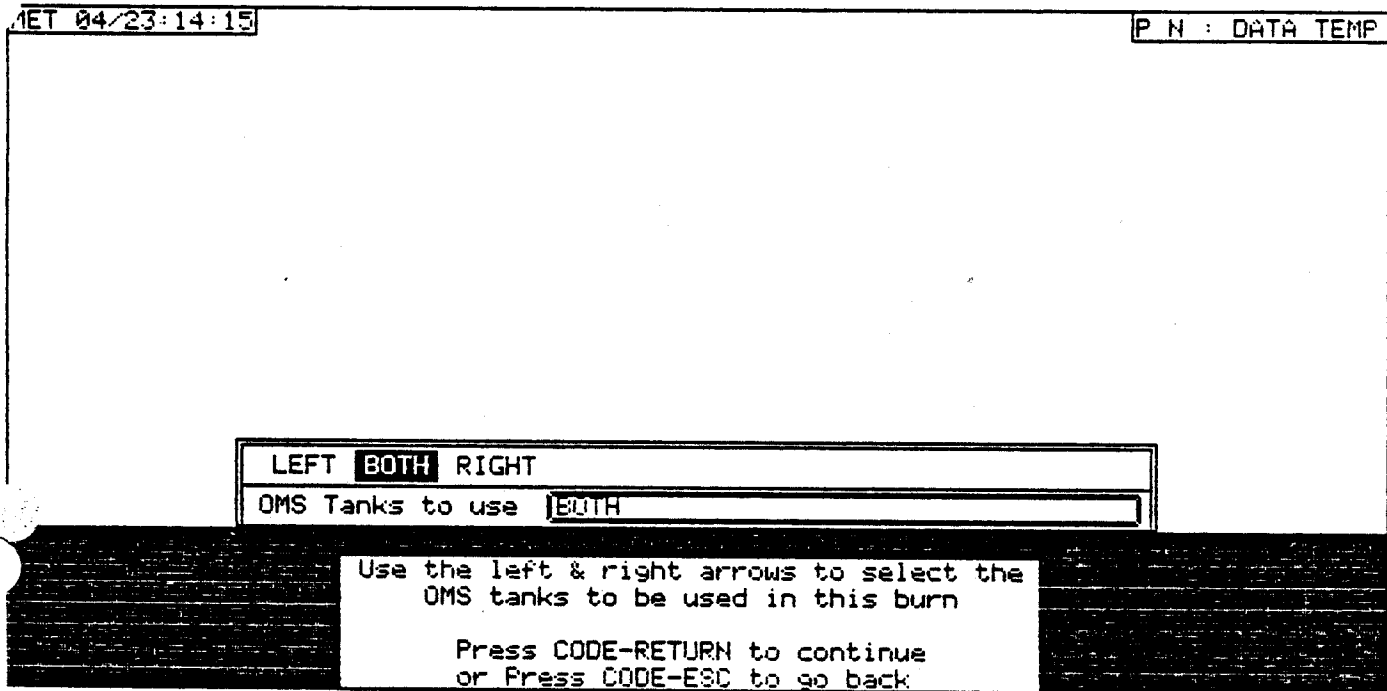


FIGURE 12.5

12.4 CODE-0: Tracking OMS With Delta V Magnitude

Since there are situations in which the OMS onboard gaging could be erroneous, CGMANAGER provides a method of computing OMS quantities by tracking OMS burns. By selecting CODE-0 OMS Delta V Burn from the CGMANAGER Main Menu, a one-line form will appear (FIGURE 12.6). Here the user has the ability to select from which OMS pod(s) (left, right, or both) the burn is performed.



MET 04/23:14:15 P N : DATA TEMP

LEFT **BOTH** RIGHT

OMS Tanks to use BOTH

Use the left & right arrows to select the
OMS tanks to be used in this burn

Press CODE-RETURN to continue
or Press CODE-ESC to go back

FIGURE 12.6

After selecting the correct pod or pods for the OMS burn, a one-line OMS Burn form (FIGURE 12.7) will appear allowing the user to enter the burn's change-in-velocity magnitude. The burn is limited by the lower fuel or oxidizer quantity for the selected pod(s). If the user enters a valid velocity magnitude and presses CODE-RETURN, the Save menu (FIGURE 12.5) will appear. If the user chooses not to enter any data or presses CODE-ESC, the CGMANAGER Main Menu (FIGURE 12.1) reappears.

MET 04/23:16:42 P N : DATA TEMP

0.0 — 449.6 fps

Burn From Both OMS Pods 442

Press CODE-ESC to ignore data and go back
Press CODE-RETURN to retain data and continue

FIGURE 12.7

Upon pressing CODE-RETURN on an OMS Burn form having valid data entered, CGMANAGER will check to see if the burn would result in a depleted or nearly depleted OMS propellant tank condition. An OMS tank is considered depleted if the burn would result in a quantity of less than 3%. An OMS tank is considered nearly depleted if the burn would result in a quantity between 3% and 5%. If an OMS tank is depleted or nearly depleted, warning messages will be displayed (FIGURE 12.8).

The screenshot shows a terminal window with a black background and white text. At the top left, a box contains the text 'MET 04/23:16:53'. At the top right, a box contains the text 'P N : DATA TEMP'. In the center, there is a large empty rectangular area. At the bottom, there is a dark horizontal bar containing a white box with the following text: 'Burn From Both OMS Pods' followed by a small box containing the number '442'. Below this, there are three lines of warning text: 'WARNING : The RDMS will be burned to near depletion', 'WARNING : The LOMS will be burned to depletion', and 'Press CODE-RETURN to accept this condition'.

FIGURE 12.8

NOTE: If the user enters a valid velocity magnitude and chooses to save data to a file, the MET tags for the first and second items on the CGMANAGER Main Menu (FIGURE 12.1) would be updated to the current MET. Both items are updated to indicate the latest propellant update was performed by entering an OMS burn delta V.

12.5 CODE-C: The Cargo Form

The Cargo form (FIGURE 12.9) allows the user to select status of certain deployable/jettisonable cargo in the payload bay. This data form is a choice-only form as described in Section 3.5. The first two items should always be RMS (Remote Manipulator System) and Ku Band Antenna, and their choices will be Stowed, or Jettisoned. If there are other deployable cargo items, their applicable status will be Berthed or Deployed.

MET 04/23:08:42 P : DATA TEMP

Berthed	Deployed
RMS	Stowed
Ku Band Antenna	Jettisoned
Satcom	Deployed
Morelos	Deployed
Aussat 2	Deployed
EAS/AXS Jettisonable	Berthed

Press RETURN to select item
 Use left & right arrows to select status
 Press CODE-ESC to ignore data and go back
 Press CODE-RETURN to retain data and continue

FIGURE 12.9

Press CODE-RETURN and the Save menu (FIGURE 12.5) will appear.

12.6 CODE-N: Non-Propellant Consumables Forms

Non-Propellant Consumables forms are three forms through which the user must proceed in order to update the non-propellant consumable quantities. The sequence is entered from the CGMANAGER Main Menu.

Each form operates in the same manner as previous forms, except the user will note three lines of text above the form, with an arrow initially pointing to the first line of text (FIGURE 12.10). The arrow indicates which form is currently active. It also indicates which Orbiter GPC SPEC display should be invoked to obtain inputs.

The user should note that pressing CODE-RETURN at the first or second form in the list displays the next form in the list instead of the CGMANAGER Main Menu (FIGURE 12.1) or the Save menu (FIGURE 12.5). If the user presses CODE-ESC from the second or third form, the previous form in the list appears instead of the CGMANAGER Main Menu (FIGURE 12.1).

To save changes, press CODE-RETURN at the last form. The Save menu (FIGURE 12.5) will be displayed, allowing the user to save changes. If no changes were made, pressing CODE-RETURN at the last form returns the user to the CGMANAGER Main Menu.

12.6.1 The Environment Form

The first of the Non-Propellant Consumables forms is the Environment form (FIGURE 12.10). The Environment form allows the user to update quantities in the two nitrogen tanks, the five potable water tanks, and the single waste tank. Data for this form should be obtained from GPC SM SPEC 66. Quantities can be entered directly from this GPC display, since the units are compatible.

MET 04/23:09:02
P : DATA TEMP

→ENVIRONMENT (SPEC 66)
 CRYO SYSTEM (SPEC 68)
 SM SYS SUMM (SPEC 79)

0 - 132 lbs

N2	TK 1 :	94 lbs	
	2 :	94 lbs	
H2O Supply	TK A :	100 %	
	B :	77 %	
	C :	77 %	
	D :	77 %	
	Waste :	19 %	

Press RETURN to select item, then enter data
 Press CODE-ESC to ignore data and go back
 Press CODE-RETURN to retain data and continue

FIGURE 12.10

12.6.2 The Cryogenics Form

The second of the Non-Propellant Consumables forms is the Cryogenics form (FIGURE 12.11). The Cryogenics form allows the user to update quantities in the cryogenic tanks. Data for this form should be obtained from GPC SM SPEC 68. Quantities can be entered directly from this GPC display, since the units are compatible.

MET 04/23:09:19 P : DATA TEMP

ENVIRONMENT (SPEC 66)
→CRYO SYSTEM (SPEC 68)
SM SYS SUMM (SPEC 79)

0 - 104 %	
O2 TK 1 :	47 %
2 :	47 %
3 :	42 %
4 :	42 %
5 :	0 %
H2 TK 1 :	53 %
2 :	53 %
3 :	36 %
4 :	36 %
5 :	0 %

Press RETURN to select item, then enter data
Press CODE-ESC to ignore data and go back
Press CODE-RETURN to retain data and continue

FIGURE 12.11

12.6.3 The SM System Summary Form

The last of the Non-Propellant Consumables forms is the SM System Summary form (FIGURE 12.12). The SM System Summary form allows the user to update quantities in the APU fuel and water boiler tanks. Data for this form should be obtained from GPC SM SPEC 79. Quantities can be entered directly from this GPC display, since the units are compatible.

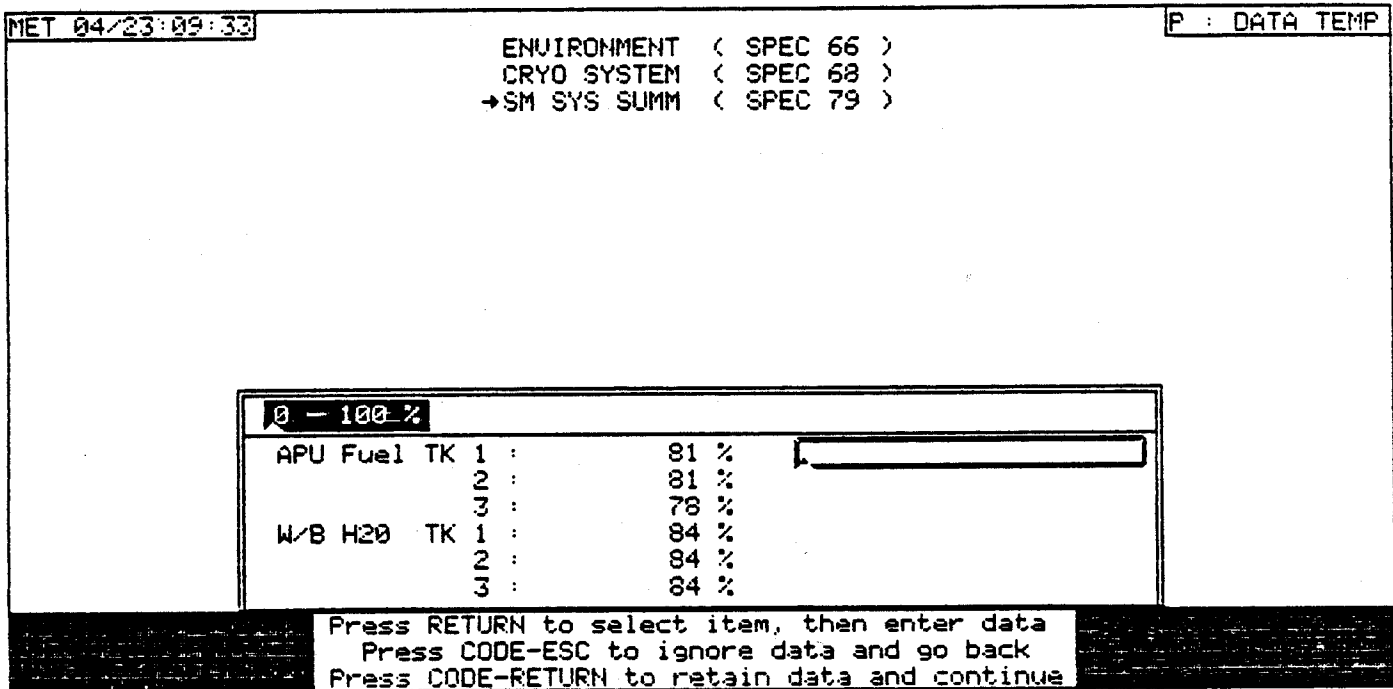


FIGURE 12.12

12.7 CODE-D: Deorbit CG Results

Assuming an emergency deorbit is necessary for which CG management ground support is unavailable, the user may select CODE-D Deorbit CG Results from the CGMANAGER Main Menu to display weight and CG at four different check points during entry. Recommendations may be obtained for OMS wasting, FRCS dumping, or OMS crossfeeding to manage CGs that are exceeding or close to exceeding the Orbiter's CG envelope.

When this option is selected from the CGMANAGER Main Menu (FIGURE 12.1), a graphic representation of the CG envelope is displayed above a form (FIGURE 12.13). The Orbiter's CG envelope is plotted as a boldface rectangle. The X-CG is plotted horizontally from 1075 to 1111 inches. The Y-CG is plotted along the vertical from 2 to -2 inches. The current CG will be displayed with a 1/8" X 1/8" dot accompanied by C. Directly below the plot, the current mass property values will be displayed.

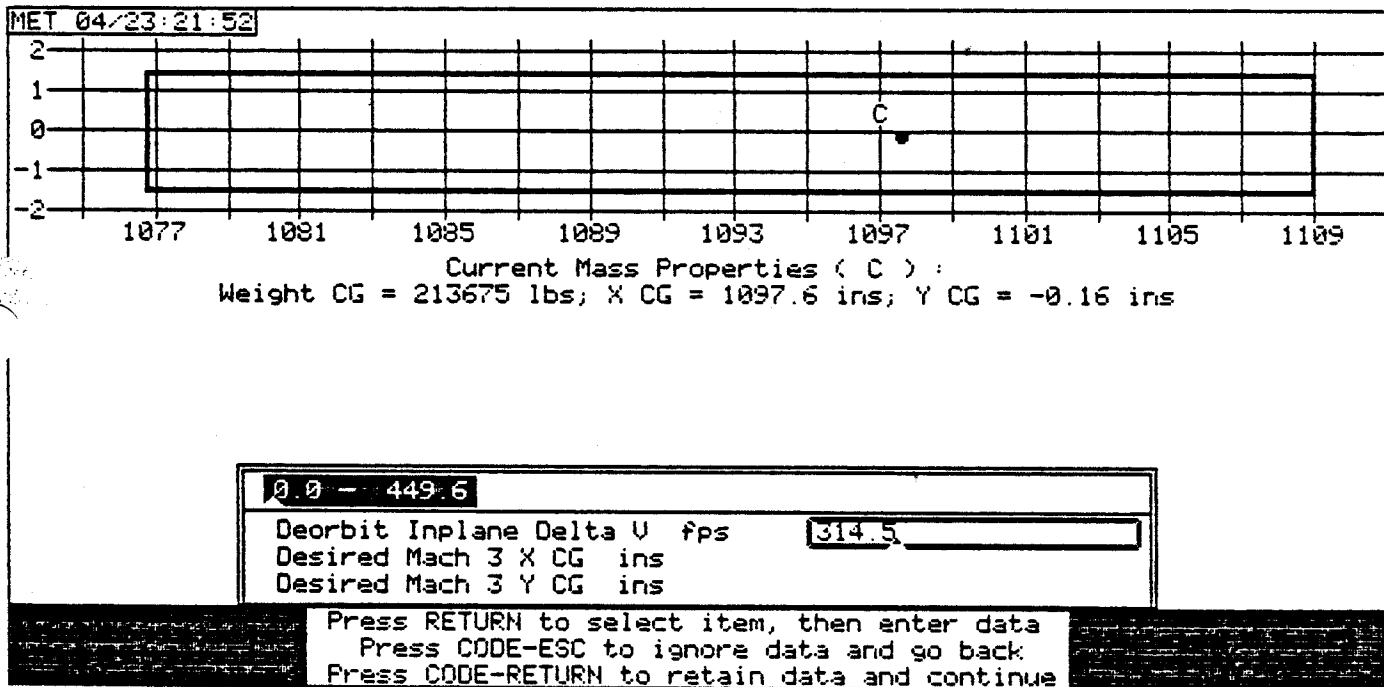


FIGURE 12.13

The first item in the form is the planned OMS deorbit burn velocity delta in feet per second. If the user has executed the SPoC DEORBIT program prior to the CGMANAGER program, which should be the nominal procedure, the velocity delta entry will have an initial value equal to the minimum maneuver necessary to achieve a particular landing opportunity. In this case the value should not be changed, since CGMANAGER interprets it as the inplane deorbit burn and will compute additional information based upon this assumption. If the user has an inplane deorbit velocity delta from another source (i.e. preplanned, uplinked, etc.), the current value can be erased and the user's value entered. It must, however, be the inplane deorbit velocity delta

using 2 QMS.

The second and third items are the targeted X-and-Y-CGs. These items are optional. If left blank, CGMANAGER will solve for the entry weights and CGs according to the deorbit burn only. If an X-CG or a Y-CG target is entered, the program will achieve the inplane velocity delta and then try to accommodate the requested CG. If both X-and-Y-CG targets are provided, the program will attempt to achieve the inplane velocity delta and X-CG first, then the Y-CG.

Once the user has pressed CODE-RETURN from the Deorbit CG Results form, a display similar to FIGURE 12.14 will appear. A good deal of information is now being displayed. First note the plot now contains a flashing point connected to the previously displayed point. Initially, this point is the location of the CG for the post-deorbit check point. On the left side of the display, the title Current (C): can be found. This indicates the weight and CG information under this heading are the current values. Below this will be a title which will vary, depending upon which deorbit entry check point is currently being viewed. Initially the title will read, Deorbit (D):, and the information following will pertain to the post-deorbit check point. Below all of this will be three lines showing which keystrokes are needed to display the other three remaining points not currently being displayed. The user may press these keystrokes and obtain the plot, entry check point data, and valid keystrokes reflecting the request. A one second delay, from the time the user makes the request until the screen is updated, is typical.

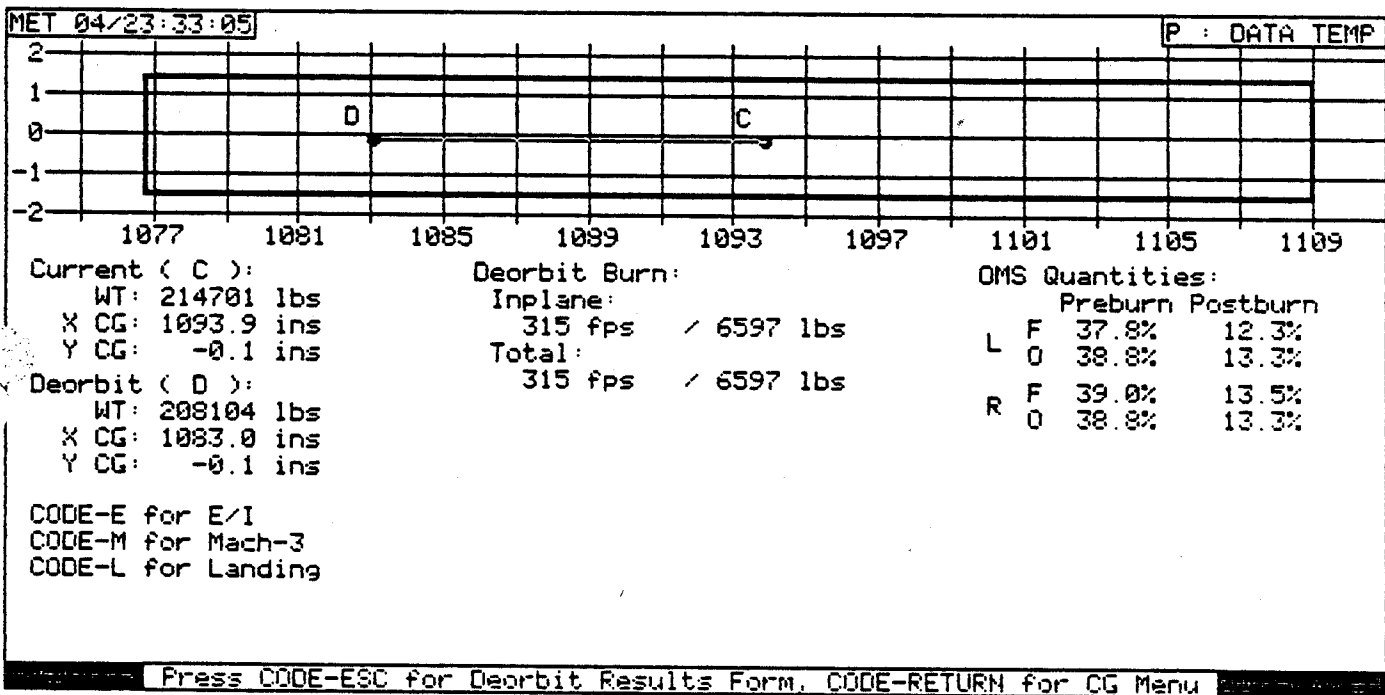


FIGURE 12.14

To the right of the current information is the heading Deorbit Burn:. Under this heading, Inplane and Total deorbit parameters are displayed in feet per second and pounds of propellant. Values in pounds may be entered as ITEM 18 in the GPC's Deorbit Maneuver Execute display. In cases requiring an out of plane deorbit burn, the Total: weight may be entered to DEORBIT's Initialization form Item 3 (see Section 11.2.1). For a deorbit burn with no requested X-CG, Total and Inplane values will be equal, indicating inplane deorbit velocity delta was the only input accommodated. Also shown on this display, in the upper right corner under the plot, are the current and post-deorbit OMS quantities.

If an X-CG is targeted forward of the inplane deorbit solution, and OMS propellant is available for wasting, there will be an out-of-plane solution component. This is indicated by Total values greater than Inplane values (FIGURE 12.15).

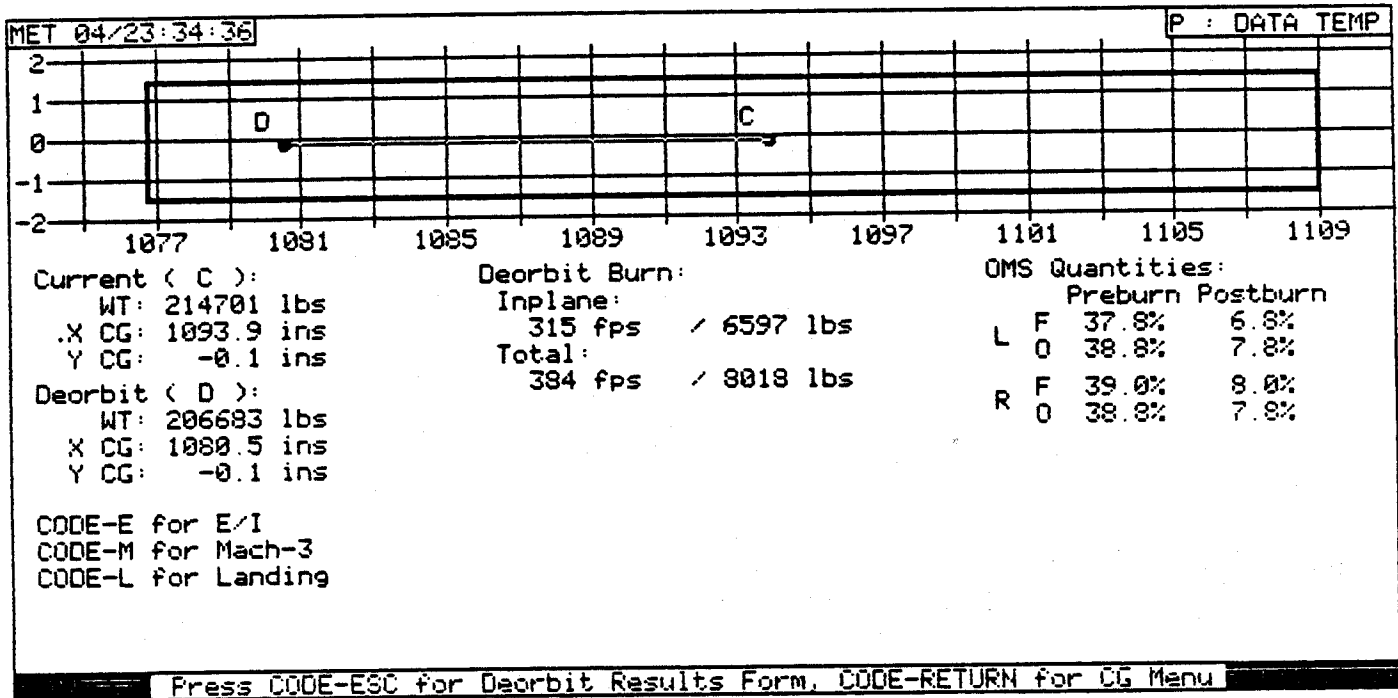


FIGURE 12.15

If an X-CG is targeted aft of the inplane deorbit solution, and FRCS can be dumped, FRCS dump parameters will be computed. Initially the Deorbit Results Display (FIGURE 12.16) will contain a note under the OMS Quantities data, indicating FRCS should be dumped after the deorbit maneuver.

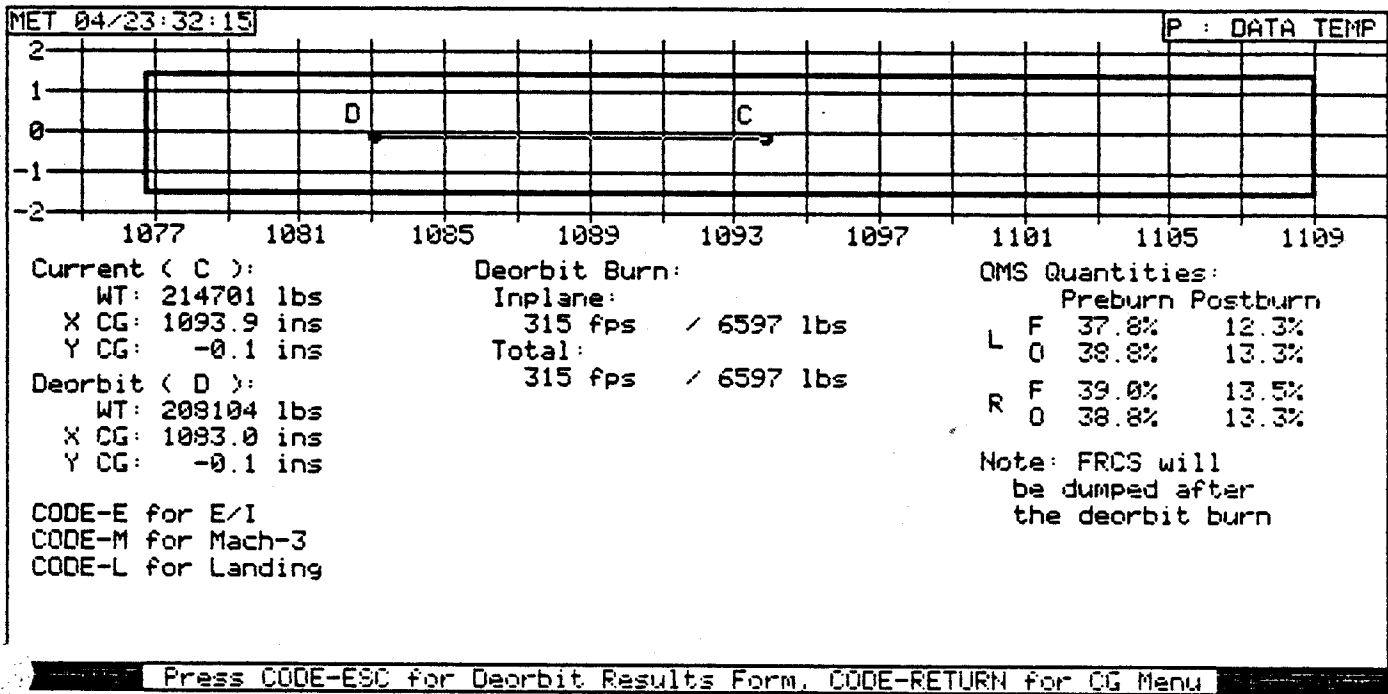


FIGURE 12.16

Once the user requests any check point after Deorbit, information will be displayed (FIGURE 12.17) showing to what level the FRCS should be dumped. Time necessary to achieve the dump using two or four jets is also displayed in minutes:seconds.

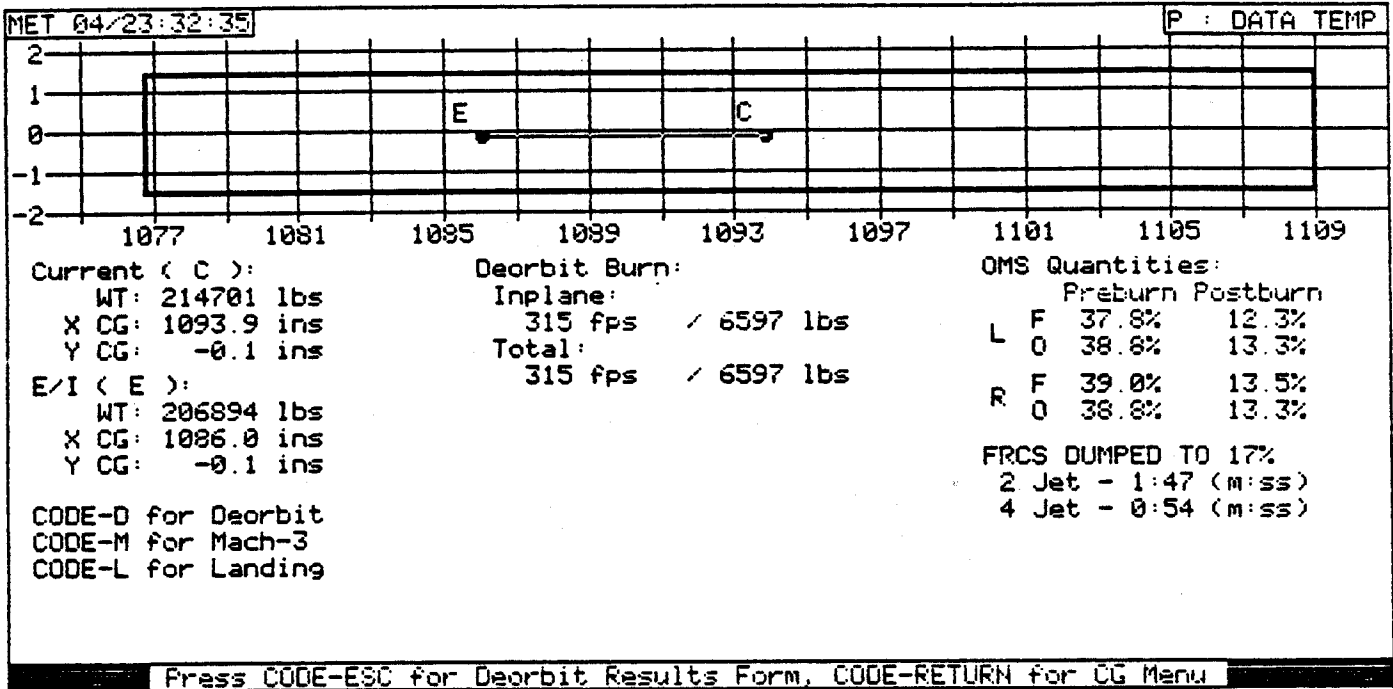


FIGURE 12.17

The user may enter a deorbit velocity delta or target CG which results in an OMS propellant tank being depleted or nearly depleted. In each case, CGMANAGER will display DRY or LOW, respectively, next to the pertinent Postburn OMS quantity (FIGURE 12.19).

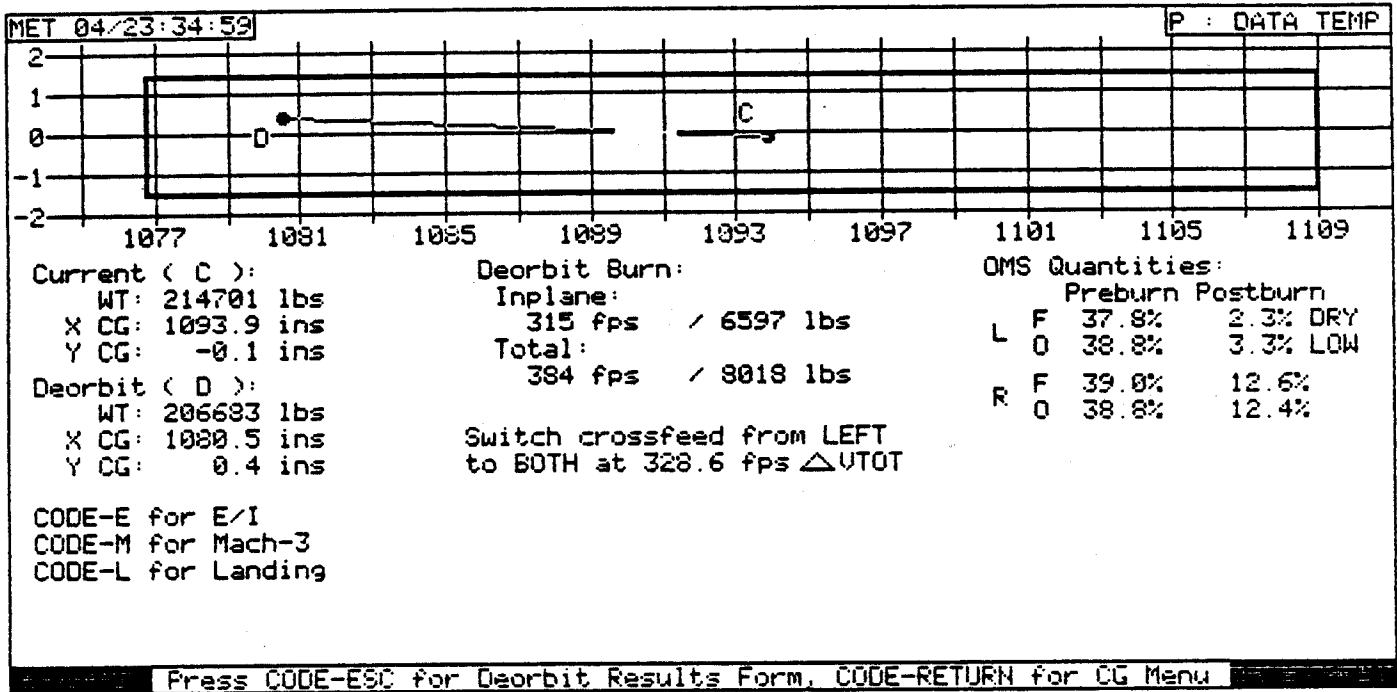


FIGURE 12.19

The user should note the Deorbit CG Results display does not flag every OMS depleted or nearly depleted condition. The display will flag these conditions only if they resulted from a deorbit velocity delta or target CG. As an illustration (FIGURE 12.20), note the left pod's fuel levels under OMS Quantities. Since the Preburn LOMS fuel value is less than the DRY threshold, no flag accompanies the Postburn value.

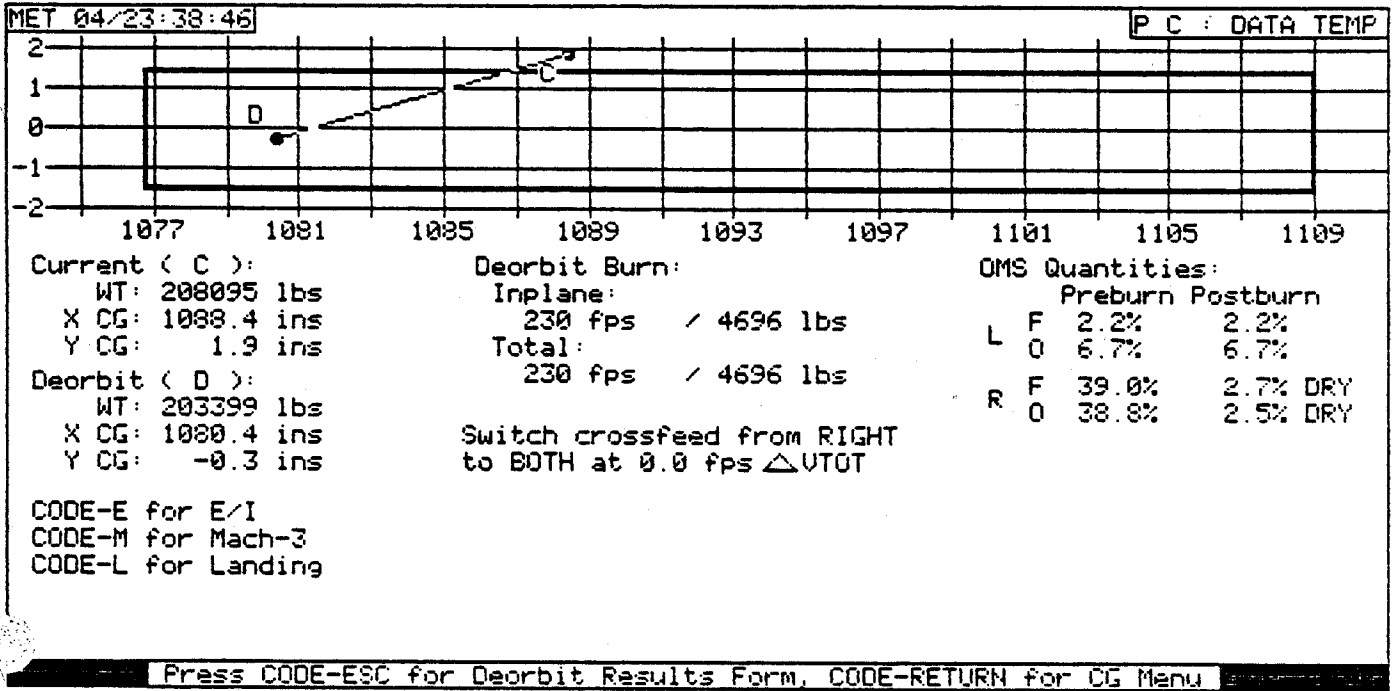


FIGURE 12.20

If the user is utilizing helium pressure gaging to determine OMS quantities, an indeterminate amount of error could be present in the weight and CG calculations. In this case, a warning message will be flashed to the user (FIGURE 12.21).

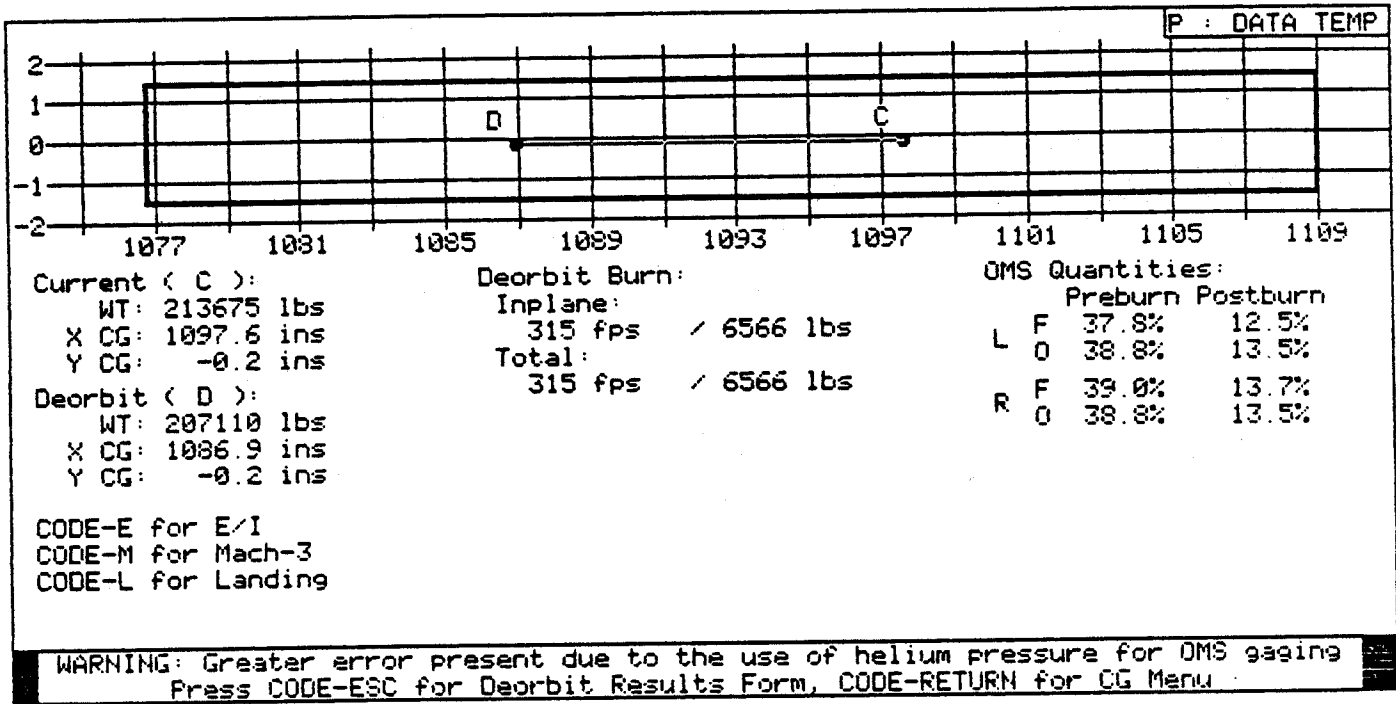


FIGURE 12.21

12.8.1 Constants Initialization Data Forms

This option allows the user to enter data such as the inert Orbiter, fixed payloads, line-trapped propellant, and other mass property data which should remain constant throughout the mission. This option will take the user into a circular loop of ten forms which are similar to FIGURE 12.23, a three-line form which allows the user to enter pertinent weight, X-CG and Y-CG.

MET 04/23:19:45

CONSTANTS INITIALIZATION

ITEM # 1 - INERT ORBITER

Weight lbs	174586.0000
X CG in.	1095.1899
Y CG in.	0.3200

Press RETURN to select item, then enter data
Press CODE-ESC to ignore data and go back
Press CODE-RETURN to retain data and continue
Press CODE-S to save entries to file

FIGURE 12.23

The user may move forward into the circular loop by pressing CODE-RETURN, and any data changes on the current form will be accepted. By pressing CODE-ESC, any data changes on the current form will be ignored. Finally, a CODE-S is used to save all the data in the ten forms to a file and return the user to the Initialize Data Forms menu.

The ten constants available for initialization in the circular loop are:

<u>ITEM #</u>	<u>ITEM</u>
1	Inert Orbiter
2	Trapped OMS Fuel
3	Trapped RCS Fuel
4	Pressurants
5	NH ₃ Tank 1
6	NH ₃ Tank 2
7	Fixed Payloads
8-10	Miscellaneous

12.8.2 Cargo Initialization Data Forms

This option allows the user to enter and edit jettisonable or deployable cargo items which appear in the Cargo form (FIGURE 12.9). There are ten possible items here, and operation is exactly the same as in the Constants Initialization option except the forms (FIGURE 12.24) have 4 entry lines. The additional line accepts the cargo name, a 24 character alphanumeric string. If the cargo item was previously configured, its name will appear above the data form and in the fourth line. The user should reserve the first two forms for the RMS and the Ku-band antenna. CGMANAGER assumes the first two cargo items to be jettisonable, an action not pertinent to other items which are deployable. Consequently, eight other deployable items are available. A CODE-S, as in the first Initialize Data Forms option, must be performed to return to the Initialize Data Forms menu. Note that upon saving the data, the user should invoke the Cargo form (FIGURE 12.9) to check cargo status.

MET 04/23:18:28		CARGO INITIALIZATION		P N : DATA TEMP	
ITEM # 3 - Satcom					
Weight	lbs	12350	0000		
X CG	in.	1093	0000		
Y CG	in.	0	0000		
Name	Satcom				
Press RETURN to select item, then enter data Press CODE-ESC to ignore data and go back Press CODE-RETURN to retain data and continue Press CODE-S to save entries to file					

FIGURE 12.24

12.8.3 Entry Delta Initialization Data Forms

This option permits the user to edit the nominal mass property deltas (deorbit to EI, EI to mach 3 without PTIs, and mach 3 to landing) which are used to compute the Orbiter's weight and CG at EI, mach 3, and landing check points. Operation of this option (FIGURE 12.25) is exactly like the Constants Initialization Data forms with only three items.

The entry mass property deltas are:

ITEM #	ITEM
1	Deorbit to EI
2	EI to mach 3 without PTIs
3	Mach 3 to landing

MET 04/23:20:32

ENTRY MASS PROPERTY DELTAS

ITEM # 3 - M3 To Landing

Weight lbs	148.0000
X CG in.	-1032.7500
Y CG in.	-10.9500

Press RETURN to select item
 Press CODE-ESC to ignore data and go back
 Press CODE-RETURN to retain data and continue
 Press CODE-S to save entries to file

FIGURE 12.25

12.8.4 Helium Pressure Gaging Initialization Data Form

This option invokes a single four-line data form (FIGURE 12.26). OMS tank percentage quantities can be computed from a two-point linear helium-pressure-to-OMS-quantity relationship. This form initializes the relationship with two data points which include a helium pressure value and its corresponding OMS percentage. This form operates exactly like a normal SPoC form.

MET 3/22:52:14	HELIUM PRESSURE VS. OMS GAGING INITIALIZATION	C N : DATA TEMP										
<table border="1" data-bbox="316 945 1234 1113"> <tr> <td colspan="2" style="text-align: left;">Pounds of Helium Pressure:</td> </tr> <tr> <td>1st point OMS He Pressure</td> <td>2000.0000</td> </tr> <tr> <td>1st point OMS % Gage</td> <td>100.0000</td> </tr> <tr> <td>2nd point OMS He Pressure</td> <td>1000.0000</td> </tr> <tr> <td>2nd point OMS % Gage</td> <td>0.0000</td> </tr> </table>			Pounds of Helium Pressure:		1st point OMS He Pressure	2000.0000	1st point OMS % Gage	100.0000	2nd point OMS He Pressure	1000.0000	2nd point OMS % Gage	0.0000
Pounds of Helium Pressure:												
1st point OMS He Pressure	2000.0000											
1st point OMS % Gage	100.0000											
2nd point OMS He Pressure	1000.0000											
2nd point OMS % Gage	0.0000											
Press RETURN to select item, then enter data Press CODE-ESC to ignore data and go back Press CODE-RETURN to retain data and continue												

FIGURE 12.26

12.9 Exiting CGMANAGER

When ready to exit CGMANAGER and return to the SPoC Main Menu, press CODE-ESC at the CGMANAGER Main Menu. If the user has any temporary data still unsaved, the program will warn the user (FIGURE 12.27) and require a CODE-RETURN to exit, or a CODE-ESC to return to the CGMANAGER Main Menu (FIGURE 12.21).

NOTE: If the user wishes to save temporary data to a file, return to the appropriate data form and make at least one entry into the form. The Save menu will appear when CODE-RETURN is pressed. Select Save Data to File to save the data. The user may repeat this procedure for each type of temporary data (Prop Consumables, Cargo, Non-Prop Consumables).

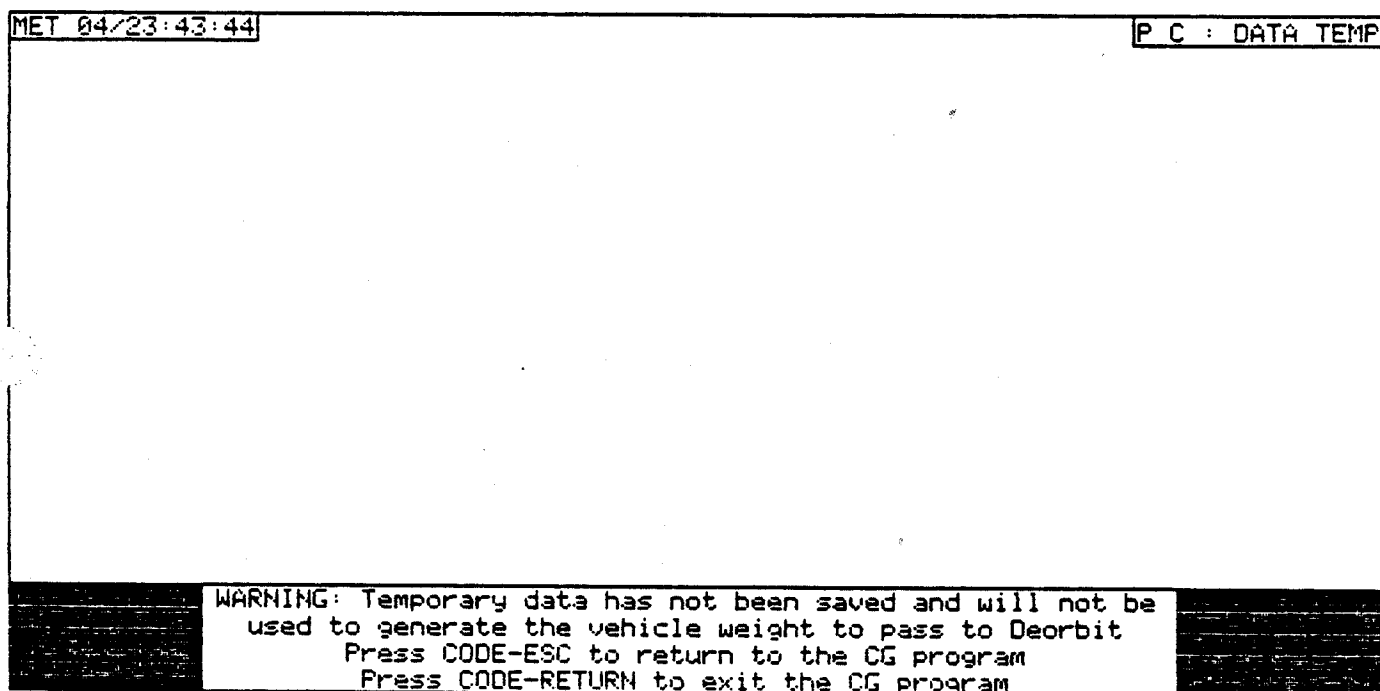


FIGURE 12.27

When the user exits CGMANAGER, the current vehicle weight is saved to a file as the default value at TIG to be used by DEORBIT.

SECTION 13.0
FLIGHT DATA FILE DOCUMENTATION

Flight Data File (FDF) support for the SPoC includes the following publications.

- 1) Post Insertion Checklist
- 2) Operations/Malfunctions Cue Card and Decal
- 3) Deorbit Prep Checklist
- 4) Deorbit Prep Flight Supplement
- 5) Entry Checklist
- 6) Contingency Deorbit Prep
- 7) Contingency EVA OPS
- 8) FDF Reference Data Book Flight Supplement

Addresses for the state vector are in the FDF Reference Data Book Flight Supplement. These addresses are dependent on the GPC software load.

APPENDIX A
INITIALIZING THE SPoC

The following set of instructions leads a user through the procedures to initialize the SPoC. After SPoC initialization is completed, the user may proceed to APPENDIX B (WORLD MAP), C (DEORBIT), or D (CGMANAGER) for a demonstration of SPoC applications. Familiarity with basic SPoC operation is assumed. For the user unfamiliar with the SPoC, hardware setup procedures for ground operation are found in Section 2.2. Details of basic SPoC operations are contained in Section 3.

When the SPoC is turned on, the Boot UP Screen is displayed after several seconds. After the operating system has been loaded, the Boot Up Screen will be erased. Messages will then be displayed informing users the SPoC EXECUTIVE is searching for programs and data files.

Upon completion of the file search, the first initialization form will be displayed (LAUNCH TIME UPDATE form). For this demo, follow the steps below to enter the launch date/time, the current SGMT, and state vector.

LAUNCH TIME UPDATE Form

- 1) Press CODE-BACK SPACE to erase old data.
YEAR: enter 1988
press RETURN.
- 2) Press CODE-BACK SPACE to erase old data.
DAY: enter 1
press RETURN.
- 3) Press CODE-BACK SPACE to erase old data.
HOUR: enter 12
press RETURN.
- 4) Press CODE-BACK SPACE to erase old data.
MINUTE: enter 0
press RETURN.
- 5) Press CODE-BACK SPACE to erase old data.
SECOND: enter 0
press CODE-RETURN.

GMT UPDATE Form

- 6) Press CODE-BACK SPACE to erase old data.
DAY (GMT): enter 1
press RETURN.
- 7) Press CODE-BACK SPACE to erase old data.
HOUR (GMT): enter 13
press RETURN.
- 8) Press CODE-BACK SPACE to erase old data.

MINUTE (GMT): enter 0
press RETURN.

- 9) Press CODE-BACK SPACE to erase old data.
YEAR: enter 1988
press CODE-RETURN.

NOTE: If a warning message appears at this point, press CODE-RETURN.

STATE VECTOR UPDATE Form

- 10) Press CODE-BACK SPACE to erase old data.
DAY (MET): enter 0
press RETURN.
- 11) Press CODE-BACK SPACE to erase old data.
HOUR (MET): enter 0
press RETURN.
- 12) Press CODE-BACK SPACE to erase old data.
MINUTE (MET): enter 50
press RETURN.
- 13) Press CODE-BACK SPACE to erase old data.
SECOND (MET): enter 0
press RETURN.
- 14) Press CODE-BACK SPACE to erase old data.
X POSITION (NM): enter 23.61635400
press RETURN.
- 15) Press CODE-BACK SPACE to erase old data.
Y POSITION (NM): enter 3162.91980300
press RETURN.
- 16) Press CODE-BACK SPACE to erase old data.
Z POSITION (NM): enter -1713.37830800
press RETURN.
- 17) Press CODE-BACK SPACE to erase old data.
X VELOCITY (NM/SEC): enter -3.94707100
press RETURN.
- 18) Press CODE-BACK SPACE to erase old data.
Y VELOCITY (NM/SEC): enter 0.03610700
press RETURN.
- 19) Press CODE-BACK SPACE to erase old data.
Z VELOCITY (NM/SEC): enter 0.01351400
press CODE-RETURN.

At the bottom of the screen the inclination, HA, and HP are displayed. This serves as a data check for state vector inputs. For the above inputs, the following values

will be displayed.

INCLINATION = 28.445
APPROX. ORBIT : HA=158; HP=153

20) Press CODE-RETURN.

The SPoC Main Menu will now be displayed. The user may select SPoC applications for execution. Step-by-step demos are available for WORLD MAP (Appendix B), DEORBIT (Appendix C), and CGMANAGER (Appendix D). The STATE VECTOR UPDATE and SET GMT programs are also available from the SPoC Main Menu, and were demonstrated during the initialization procedures.

You are now ready to proceed to a SPoC demo of your choice.

APPENDIX B
WORLD MAP DEMONSTRATION

Before exercising WORLD MAP demonstration procedures, the user should complete procedures outlined in APPENDIX A (Initializing The SPoC). The SPoC Main Menu should be currently displayed. The following instructions will lead the user through a WORLD MAP demo.

- 1) Select DISPLAY WORLD MAP from the SPoC Main Menu.

The first time WORLD MAP is selected from the SPoC Main Menu, the SITE MANAGER Main Menu will be displayed. SITE MANAGER is a WORLD MAP function which may be exercised later during this demo. For now, continue on to the WORLD MAP display.

- 2) Select INVOKE DEFAULT COMMUNICATION SITES from the SITE MANAGER Main Menu.

After a few seconds, the WORLD MAP Display will appear (FIGURE B.1). Notice that the communication site AOS/LOS windows display the words STAND BY.

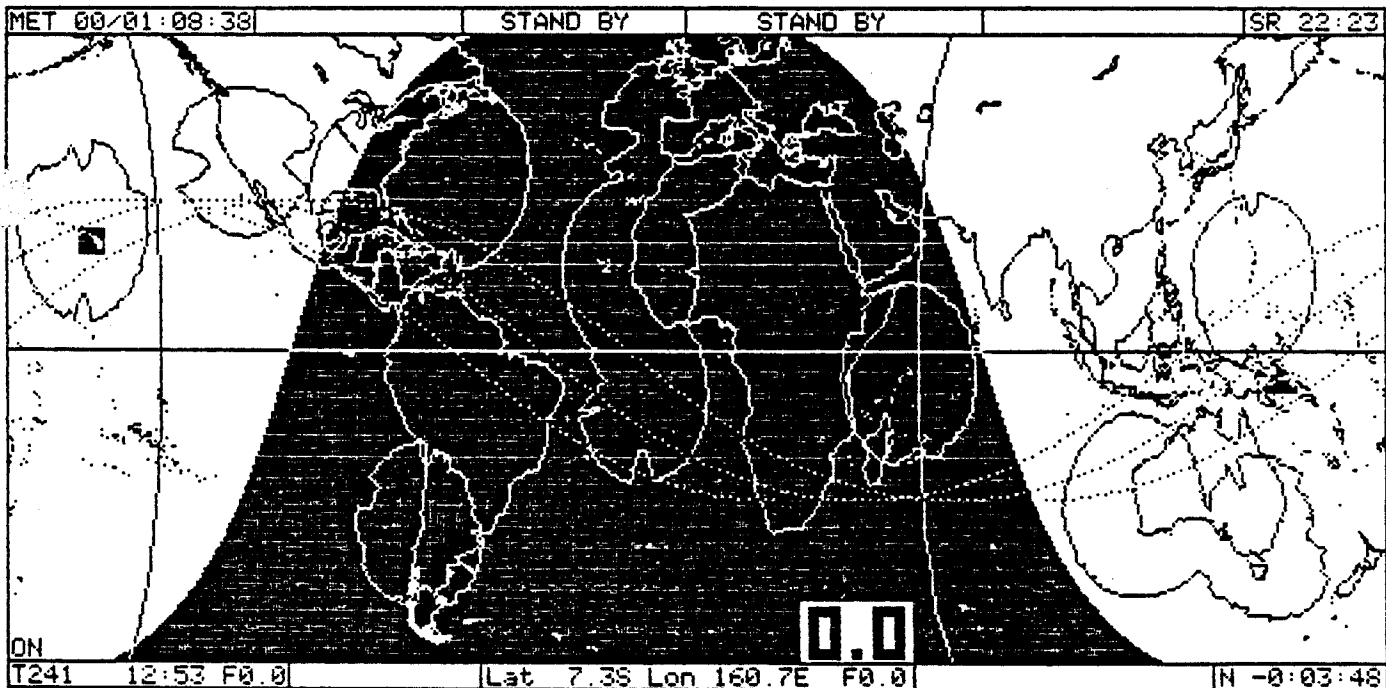


FIGURE B.1

As soon as the AOS/LOS search has been completed, these windows will display AOS/LOS countdown times (see FIGURE B.2).

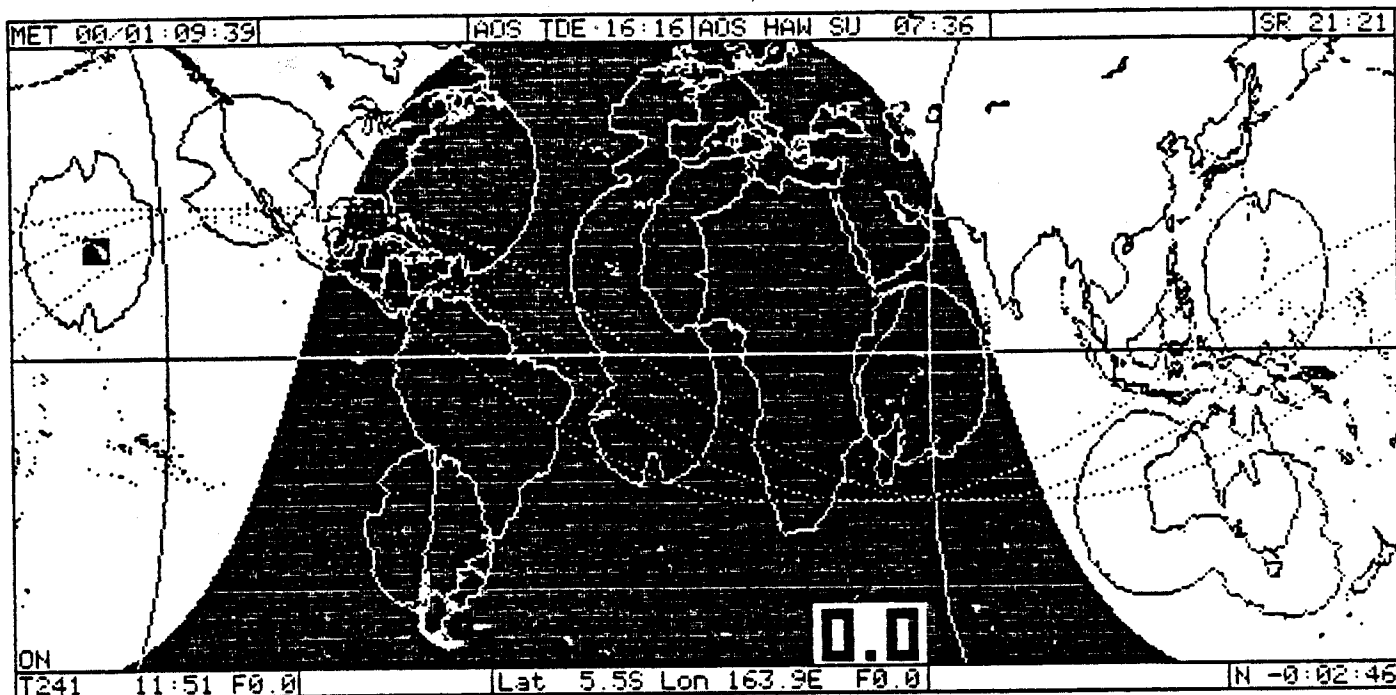


FIGURE B.2

3) Press CODE-? to display the WORLD MAP Help Menu.

This menu provides the CODE-[key] combinations associated with each WORLD MAP function. WORLD MAP functions may be invoked from the Help Menu. They may be invoked from the WORLD MAP display directly with the proper CODE-[key] input.

4) To return to the WORLD MAP Display, press CODE-ESC.

At this time, you may want to explore various WORLD MAP functions. For a detailed explanation of each WORLD MAP function, refer to Section 10.2. Section 10.3 details the PSAT Display, and Section 10.4 details SITE MANAGER functions.

5) When you are ready to exit WORLD MAP and return to the SPoC Main Menu, press CODE-ESC.

APPENDIX C
DEORBIT DEMONSTRATION

This section gives users a demonstration of SPoC DEORBIT operation. In order to have the same data displays that are shown in this appendix, launch time, state vector, and GMT must correspond to data entered in APPENDIX A.

Select DEORBIT from the SPoC Main Menu. Wait until the Initialization form appears on the screen (FIGURE C.1).

# of Hours	
Window	12
Site Selection	All
Vehicle Weight (lbs)	241226
Primary/Backup Thruster	2 OMS/1 OMS
Propellant Weight	0
Pre Bank	90
Start Day (MET)	0
Start Hour (MET)	1
Start Minute (MET)	0
Start Second (MET)	32

Type in initial conditions
Press CODE-RETURN to execute
Press CODE-ESC to exit program

FIGURE C.1

Enter data shown above into the Initialization form and press CODE-RETURN.

MET 00/01:01:03

Site	TIG	XRNG	S
AML	0/01:04:18	712	D
HDS	0/01:21:44	49	D
DOM	0/01:46:28	73	N
HNL	0/02:07:04	166	N
EDW	0/02:16:43	393	O
NOR	0/02:19:18	344	O
KSC	0/02:25:17	466	O
HDS	0/02:57:15	218	O
GUA	0/03:29:22	184	N
HNL	0/03:42:47	412	N
EDW	0/03:51:47	589	O
NOR	0/03:54:23	654	O
HDS	0/04:32:49	224	N
JDG	0/04:44:15	528	N
GUA	0/05:03:54	392	N
HNL	0/05:18:37	387	O
HDS	0/06:08:22	33	N
JDG	0/06:19:48	112	N
HNL	0/06:54:18	95	D

Flight Rules Dispersed XRNG limit : 680 N.M.
 Use arrow keys/CODE-RETURN to compute targets
 Press CODE-ESC to return to initialization form

FIGURE C.2

After CODE-RETURN is pressed, the LOT form (FIGURE C.2) will be displayed. Note that, due to landing site data reconfiguration, the LOT may contain opportunities different from the figures in this appendix. Press the DOWNARROW key to move the light bar below the bottom landing opportunity on the current page. This will bring up the next page of landing opportunities (FIGURE C.3).

ET 00:01:01:25

Site	TIG	XRNG	S
HDS	0/07:43:40	505	N
HNL	0/08:29:40	408	N
KIN	0/09:17:45	355	N
GUA	0/09:52:15	710	N
HAO	0/10:13:49	478	N
KIN	0/10:53:14	329	N
RIY	0/11:03:52	351	N
GUA	0/11:28:05	278	N
HAO	0/11:49:12	98	N
RIY	0/12:39:14	57	N
GUA	0/13:03:33	329	N
HAO	0/13:24:53	491	N

Flight Rules Dispersed XRNG limit : 630 N.M.
 Use arrow keys/CODE-RETURN to compute targets
 Press CODE-ESC to return to initialization form

FIGURE C.3

Now press the UPARROW key and move the light bar above the top landing opportunity. This will again display the previous page.

Site	TIG	XRNG	S
*HNL	0/01:04:18	712	D
HDS	0/01:21:44	49	O
DDN	0/01:46:28	73	N
HNL	0/02:07:04	166	N
EDW	0/02:16:43	393	O
NOR	0/02:19:18	344	O
KSC	0/02:25:17	466	O
HDS	0/02:57:15	218	O
GUA	0/03:28:22	184	N
HNL	0/03:42:47	412	N
EDW	0/03:51:47	589	O
NOR	0/03:54:23	654	O
HDS	0/04:32:49	224	N
JDG	0/04:44:15	528	N
GUA	0/05:03:54	392	N
HNL	0/05:19:37	387	O
HDS	0/06:08:22	33	N
JDG	0/06:19:48	112	N
HNL	0/06:54:18	95	O

Flight Rules Dispersed XRNG limit : 680 N.M.
 Use arrow keys/CODE-RETURN to compute targets
 Press CODE-ESC to return to initialization form

FIGURE C.4

Wait two to three minutes for an asterisk to appear next to the first landing opportunity. This indicates maneuver targets for that landing opportunity have been computed. To display maneuver targets (FIGURE C.5) of the first landing opportunity, move the light bar to that opportunity and press CODE-RETURN. Note that, due to reconfiguration of aerodynamic data, small variations in the FIGURE C.5 targets will be experienced.

T 00:01:03:18

```

Site  AML
Wt    241226 lbs
TIG   0/01:03:07
C1    15137 ft/sec
C2    -0.60
Ht    65.832 nm
Theta 131.705°
Prop  0 lbs
REI   4540 nm
TFF   28:31
Delta V tot 224.7 ft/sec
TGO   2:19
HAtgt 153.2 nm
HPtgt 30.0 nm
Prebank 90°L

```

```

This target exceeds the Flight Rules XRNG limit
Press CODE-S to save the deorbit delta v of
this opportunity for use by the CG Manager
Press CODE-ESC to return to opportunities

```

FIGURE C.5

Press CODE-S to save the targeted current Delta V tot for use by CGMANAGER.

Exiting DEORBIT is a multi-step process from the maneuver target display. First press CODE-ESC. This will again activate the LOT display. To exit the LOT display, press CODE-ESC. Since maneuver targets have been computed, the following message appears at the bottom of the display.

```

CAUTION: All computed targets will be lost
Press CODE-RETURN to return to initialization form
Press any other key to retain current form

```

Next, press CODE-RETURN to return to the Initialization form. Proceed to the Main Menu by pressing CODE-ESC.

APPENDIX D
CGMANAGER DEMONSTRATION

Introduction

The following is a demonstration of the SPOC CGMANAGER program using STS 61-H1B data from a 7/28/87 SMS procedures validation. It assumes that the user has successfully completed the SPOC boot-up procedures and has invoked CGMANAGER from the SPOC Main Menu. The demonstration is intended to take users through a majority of the program's functions while not concentrating on every possible detail.

Initializing CGMANAGER

By pressing CODE-I in response to the SPOC CGMANAGER Main Menu, the Initialization Menu will appear. Press CODE-N and begin initializing the program's mass property constants, pressing CODE-RETURN after entering each complete item, with the following data:

Inert Orbiter	:	182239 lbs @	1093.50 in.,	-0.50 in.
Trapped OMS	:	154 lbs @	1468.70 in.,	0.00 in.
Trapped RCS	:	912 lbs @	960.47 in.,	1.96 in.
Pressurants	:	528 lbs @	1026.00 in.,	-2.00 in.
NH3 Tank A	:	49 lbs @	1350.00 in.,	66.00 in.
NH3 Tank B	:	49 lbs @	1370.00 in.,	67.00 in.
Fixed Payload	:	8476 lbs @	1098.00 in.,	0.00 in.

All remaining items should be set to zero. Press CODE-S to exit this procedure and save the data to their appropriate file. The user will be returned to the Initialization Menu, where a CODE-C will initialize the program's cargo items. Press CODE-RETURN after entering each complete item with the following data:

RMS	:	900 lbs @	978.10 in.,	-88.29 in.
KuBand	:	129 lbs @	873.12 in.,	84.23 in.
Skynet	:	10620 lbs @	1241.00 in.,	0.00 in.
Palapa	:	7592 lbs @	1092.00 in.,	0.00 in.
Westar	:	7603 lbs @	931.20 in.,	0.00 in.

All remaining items should be set to zero. Press CODE-S to save the data and return to the Initialization Menu. Press CODE-E to begin initializing the entry mass property deltas. Press CODE-RETURN after entering each complete item with the following data:

Deorbit to E/I	:	547 lbs @	880.15 in.,	-3.79 in.
E/I to Mach 3	:	1043 lbs @	1617.72 in.,	-2.46 in.
Mach 3 to Landing	:	148 lbs @	-1032.78 in.,	-10.95 in.

Press CODE-S to save these data and return to the Initialization Menu. Press CODE-ESC to exit the Initialization Menu and return to the CGMANAGER Main Menu.

Initialize propellant quantities by pressing CODE-P and entering the following data:

OMS Fuel Left : 31.0%
 Right : 31.0%
 OMS Oxidizer Left : 32.0%
 Right : 32.0%
 RCS Fuel Left : 85%
 Forward : 86%
 Right : 85%
 RCS Oxidizer Left : 79%
 Forward : 86%
 Right : 79%

Press CODE-RETURN and the Save Menu will appear. Press CODE-RETURN again to save the propellant data to its appropriate file. Press CODE-C and initialize each item in the Cargo form to STOWED or BERTHED. Press CODE-RETURN and the Save Menu will appear. Press CODE-RETURN again to save the cargo data to their appropriate file. Initialize the non-propellant consumable data by pressing CODE-N and entering:

N2 : Tank 1 : 131 lbs
 Tank 2 : 131 lbs
 Potable H2O : Tank A : 48%
 Tank B : 47%
 Tank C : 93%
 Tank D : 93%
 Waste H2O : 5%

Press CODE-RETURN and continue entering the following data:

Liquid O2 : Tank 1 : 96%
 Tank 2 : 96%
 Tank 3 : 96%
 Tank 4 : 0%
 Tank 5 : 0%
 Liquid H2 : Tank 1 : 94%
 Tank 2 : 94%
 Tank 3 : 95%
 Tank 4 : 0%
 Tank 5 : 0%

Press CODE-RETURN and continue entering the following data:

APU Fuel : Tank 1 : 78%
 Tank 2 : 77%
 Tank 3 : 77%
 W/B H2O : Tank 1 : 83%
 Tank 2 : 83%
 Tank 3 : 83%

Press CODE-RETURN and the Save Menu will appear. Press CODE-RETURN again to save all of the non-propellant data to their appropriate file. Save these data and return to

the CGMANAGER Main Menu. The total Orbiter mass properties will be displayed at the top of the screen and should be equal to:

Weight : 237348 lbs.
 X-CG : 1101.4 in.
 Y-CG : -0.54 in.

CGMANAGER is now initialized for this demonstration.

Emergency Deorbit Situations

In this section, four SPoC emergency deorbit cases will be performed:

- 1) Nominal deorbit (no CG optimization required).
- 2) OMS wasting to manage final OMS quantity restraints.
- 3) OMS crossfeed and FRCS dumping for both X-CG and Y-CG optimization.
- 4) 2 OMS engine failures requiring RCS completion via OMS interconnect and subsequent X CG optimization through FRCS dumping.

Case 1

An emergency deorbit situation has arisen, and the crew has computed a set of deorbit targets using the SPoC DEORBIT program (APPENDIX C). Since the crew has kept the Orbiter's mass property data up to date in CGMANAGER, the crew had the correct vehicle weight to use in the DEORBIT program. Once the targets have been computed and the deorbit change in velocity saved, CGMANAGER has been re-invoked to check the Orbiter's mass properties during the emergency entry.

From the CGMANAGER Main Menu, press CODE-D to obtain the deorbit CG results. For this demonstration, the Deorbit Inplane Delta V should be equal to 224.4 fps. If it is not, enter 224.4 fps. No X CG or Y CG should be requested at this time. Press CODE-RETURN and the Deorbit Results display should appear and the post-deorbit check point CG location should begin flashing. By pressing CODE-E, CODE-M and CODE-L, the E/I, Mach 3, and Landing check points will be displayed. They should be equal to:

	Post-Deorbit	E/I	Mach 3	Landing
Weight	232121 lbs	231574 lbs	230531 lbs	230383 lbs
X-CG	1093.8 in	1094.3 in	1091.9 in	1093.3 in
Y-CG	-0.6 in	-0.5 in	-0.5 in	-0.5 in

The post-burn OMS quantities should be as follows:

LOMS Fuel: 10.8%	ROMS Fuel: 10.8%
Oxidizer: 11.8%	Oxidizer: 11.8%

The inplane deorbit burn (224 fps / 5227 lbs) should be equal to the total deorbit burn since no OMS wasting has been performed. Because all of the CGs during entry did not approach or exceed the Orbiter's CG envelope, the nominal burn is acceptable and no further CG management is required. Press CODE-RETURN and the CGMANAGER Main Menu will appear.

Case 2

The same Orbiter mass properties in Case 1 will be used here with the exception of the OMS quantities. In this case, the OMS quantities will be initialized to:

LOMS Fuel: 48.0%	ROMS Fuel: 48.0%
Oxidizer: 49.0%	Oxidizer: 49.0%

resulting in the following total Orbiter mass properties:

Weight : 241751 lbs.
 X-CG : 1107.3 in.
 Y-CG : -0.53 in.

Using the same 224.4 fps inplane deorbit change in velocity, the following entry check points are computed:

	Post-Deorbit	E/I	Mach 3	Landing
Weight	236427 lbs	235880 lbs	234837 lbs	234689 lbs
X-CG	1100.1 in	1100.6 in	1098.3 in	1099.7 in
Y-CG	-0.5 in	-0.5 in	-0.5 in	-0.5 in

The inplane deorbit burn (224 fps / 5324 lbs) should be equal to the total deorbit burn (224 fps / 5324 lbs) since no OMS wasting has been performed. While the CG check points are acceptable, the post-burn OMS quantities:

LOMS Fuel: 27.4%	ROMS Fuel: 27.4%
Oxidizer: 28.4%	Oxidizer: 28.4%

exceed landing constraints. Therefore, OMS wasting will be necessary and is accomplished by targeting an X-CG at mach 3.5 of 1094.0 in. This is entered in the Deorbit Results form. The following entry check points should result:

	Post-Deorbit	E/I	Mach 3	Landing
Weight	233476 lbs	232929 lbs	231886 lbs	231738 lbs
X-CG	1095.8 in	1096.3 in	1094.0 in	1095.4 in
Y-CG	-0.5 in	-0.5 in	-0.5 in	-0.5 in

The inplane deorbit burn (224 fps / 5324 lbs) is no longer equal to the total deorbit burn (351 fps / 8275 lbs), indicating that OMS wasting has been performed by CGMANAGER. Check points CGs are acceptable, and post-burn OMS quantities are permissible for landing:

LOMS Fuel: 16.1%	ROMS Fuel: 16.1%
Oxidizer: 17.1%	Oxidizer: 17.1%

Case 3

The same Orbiter mass properties in Case 1 will be used here with the exception of one payload. The Skynet payload will be re-positioned (use the initialize cargo function) to 880.0 in. along the X-axis and -8.00 in. along the Y-axis. Remember to reset the OMS quantities to their Case 1 values:

LOMS Fuel: 31.0%	ROMS Fuel: 31.0%
Oxidizer: 32.0%	Oxidizer: 32.0%

The total Orbiter mass properties should be equal to:

Weight : 237348 lbs.
 X-CG : 1085.2 in.
 Y-CG : -0.90 in.

Using the same 224.4 fps inplane deorbit change in velocity, the entry check points should be equal to:

	Post-Deorbit	E/I	Mach 3	Landing
Weight	232121 lbs	231574 lbs	230531 lbs	230383 lbs
X-CG	1077.3 in	1077.8 in	1075.3 in	1076.7 in
Y-CG	-0.9 in	-0.9 in	-0.9 in	-0.9 in

There are some obvious X-CG violations during the entry, implying the X-CG should be adjusted. While the Y-CG is within the CG envelope, for this example it too will be optimized.

By targeting an X-CG of 1085.0 in. and a Y-CG of 0.0 in. into the Deorbit Results form, a crossfeed deorbit maneuver and FRCS dump are computed by CGMANAGER. The entry check points should be:

	Post-Deorbit	E/I	Mach 3	Landing
Weight	232121 lbs	229683 lbs	228640 lbs	228492 lbs
X-CG	1077.3 in	1084.0 in	1081.6 in	1082.9 in
Y-CG	0.0 in	0.0 in	0.0 in	0.0 in

Note that even though the targeted CGs were not obtained, the entry check points are acceptable. The DRY and LOW indicators which accompany post-burn LOMS quantities warn that the crossfeed burn could result in propellant depletions.

Press CODE-E, CODE-M, or CODE-L and note the FRCS has been dumped to 0%. Since CGMANAGER does not account for FRCS entry attitude maneuver requirements in its FRCS dump computations, the user should not rely on the complete FRCS dump to achieve an acceptable X-CG.

By backing off from the originally targeted CG, Deorbit results can be repeatedly calculated to find an acceptable compromise. Target an X-CG of 1080.0 in. and a Y-CG of -0.3 in. The following entry check points will result:

	Post-Deorbit	E/I	Mach 3	Landing
Weight	232121 lbs	230157 lbs	229114 lbs	228966 lbs
X-CG	1077.3 in	1082.4 in	1080.0 in	1081.4 in
Y-CG	-0.3 in	-0.3 in	-0.3 in	-0.3 in

All of the entry check points are acceptable, the final LOMS quantities are acceptable, and 22% of the FRCS propellant remains following the FRCS dump. The program has computed a crossfeed deorbit burn, which will start both OMS engines on the LOMS pod and terminate this crossfeed with 159.8 fps remaining in the burn.

The FRCS dump time computed for 2 jets is 3 minutes and 48 seconds, while that for 4 jets is 1 minute and 56 seconds.

Case 4

The same Orbiter mass properties in Case 1 will be used here with the exception of one payload. The Skynet payload will be re-positioned (use the initialize cargo function) to 920.0 in. along the X-axis and 0.00 in. along the Y-axis.

The total Orbiter mass properties are:

Weight : 237348 lbs.
 X-CG : 1087.0 in.
 Y-CG : -0.54 in.

Using the same 224.4 fps inplane deorbit change in velocity, the following entry check points are generated:

	Post-Deorbit	E/I	Mach 3	Landing
Weight	232121 lbs	231574 lbs	230531 lbs	230383 lbs
X-CG	1079.1 in	1079.6 in	1077.2 in	1078.5 in
Y-CG	-0.6 in	-0.5 in	-0.5 in	-0.5 in

Even though the mach 3.5 X-CG is fairly far forward, it is still within the CG envelope. Therefore, no FRCS dump is anticipated. During the deorbit burn, however, both OMS engines failed with a 100.0 fps change in velocity remaining. Since an unsafe Hp resulted, the remaining burn was performed using the +X ARCS jets interconnected to OMS propellant.

Since the RCS engines are not as efficient as the OMS, more OMS propellant was used than anticipated. Because the anticipated X-CG was so far forward, a violation of the X-CG envelope may exist. To check mass properties for actual post-burn conditions, the off-nominal deorbit burn can be entered into CGMANAGER through the OMS Delta V Burn function.

From the CGMANAGER Main Menu, press CODE-0. Using BOTH OMS pods, the first part of the deorbit burn (124.4 fps), should be entered. After saving the burn's effect, the OMS Delta V Burn function is reinvoked. This time, the remaining part of the deorbit burn (100 fps) needs to be obtained from BOTH OMS pods. Since this portion of the burn was performed with RCS jets, which have an efficiency ratio of 1.17 (OMS Engine Isp / RCS Engine Isp), a 117 fps burn should be entered and saved.

Deorbit CG results can now be examined by erasing the Deorbit Inplane Delta V value in the Deorbit Results form. This tells CGMANAGER that the current propellant quantities reflect their post-burn values. Entry check point values are:

	Post-Deorbit	E/I	Mach 3	Landing
Weight	231730 lbs	231182 lbs	230139 lbs	229991 lbs
X-CG	1078.5 in	1079.0 in	1076.5 in	1077.9 in
Y-CG	-0.6 in	-0.5 in	-0.5 in	-0.5 in

An X-CG violation at the mach 3.5 check point is indicated. Therefore, a FRCS dump is required to obtain an acceptable X-CG. By requesting a mach 3.5 X-CG of 1081.0 in., a FRCS dump to a final 25% quantity is computed. The new entry check points are:

	Post-Deorbit	E/I	Mach 3	Landing
Weight	231730 lbs	229834 lbs	228791 lbs	228643 lbs
X-CG	1078.5 in	1083.4 in	1081.0 in	1082.4 in
Y-CG	-0.6 in	-0.6 in	-0.6 in	-0.6 in

All entry check points are within the CG envelope. The FRCS dump time computed for 2 jets is 3 minutes and 37 seconds, while that for 4 jets is 1 minute and 50 seconds.

APPENDIX E
SPoC HISTORY

The concept of an independent computational capability aboard the Shuttle has been operational since STS-1. Originally, an HP41 calculator was employed for this purpose. Data storage and manipulation capabilities, absent from the GPC's because of core storage limitations, were provided by this hand-held calculator. Also provided by the HP41 were capabilities similar to existing ground-based processors in the event that the Shuttle and crew were in a no-communication situation. As of April 5, 1983 the HP41 flight programs included the following:

- a) The CG program allowed the crew to track current X and Y-CG location as a function of MET, OMS, and RCS propellant loadings, and whether payloads were berthed or deployed.
- b) The AOS program supplied the crew with information concerning the next time the spacecraft would acquire a communications site.
- c) The LANDTRACK program provided observation pass information for any stored earth observation site.
- d) The DEORBIT program provided the crew with deorbit maneuver targets in the event of total loss of communications with the ground and a time-critical systems failure requiring an emergency deorbit.
- e) The ORBIT program provided the crew with data concerning attitudes and rates involved in the star sighting function and with orbit sunrise and sunset.
- f) The ALARM program gave the crew a personalized reminder of upcoming events of particular interest by having the calculator sound a tone and display a pre-stored message.
- g) The LANDING program computed data necessary for the approach and landing phase of flight.

Although the HP41 has proven to be a useful tool, it has a very limited memory capacity (only one of the above programs can be stored in memory at a time), very limited text displays, and there is no graphics capability.

As new requirements developed for independent computational capabilities aboard the Shuttle, the HP41 became inadequate for the task. To augment the hand-held calculator, the SPoC was introduced. SPoC is an expansion of the HP41 calculator concept and enhances independent computation and display capabilities by providing more memory, more mass storage, and graphic displays. In 1983, the Ascent/Entry Procedures Section of the Operations Branch began evaluating microcomputers for onboard implementation. After evaluating several machines, a GRiD microcomputer was selected because it met the hardware and software requirements and constraints fully. A proposal was made to the Government Furnished Equipment (GFE) Configuration Control Board (CCB) to obtain the necessary funding for the project. The GFE CCB denied the request. To gain necessary support for the project, presentations were made at the branch, division, and directorate levels. After a SPoC presentation was made to the Program Office Manager, Glynn Lunny, approval for the SPoC project was given.

Proposals were again made to the GFE CCB, and on 08/15/83 a Crew Related GFE CCB Directive (#3D149) was issued authorizing purchase, testing, certification, and preparation for flight of a GRiD Compass Computer on STS-9.

Purchased commercially and modified, the original SPoC was a GRiD Compass 1101 lap top computer. The Compass 1101 has a 4.75 by 3.5 inch electroluminescent screen, 384K bytes of non-volatile bubble memory and 256K bytes of RAM. Modifications included replacing the internal modem with a fan for cooling, since the standard Model 1101 computer uses convective cooling. The lithium battery circuit, which provides power for the internal clock while the Compass is not connected to an external power supply, had supplemental diodes and a fuse installed to insure failsafe operation. A power cable was designed for Orbiter power connector compatibility. EMI tests showed the SPoC was out of specification. Since the out-of-spec condition for SPoC would cause no problems for Orbiter systems, communications, or payloads, the Space Shuttle Program Requirements Control Board issued a directive (#S23562) to authorize a waiver permitting the radiated EMI out-of-spec condition.

SPoC was initially flown on STS-9 as a proof of concept engineering evaluation. During this flight, it proved useful as an aid to crew awareness and productivity. SPoC flight software for STS-9 included programs that calculated and/or displayed the following data:

MET

The world map (facsimile of the MCC world map)
Day and night areas on the earth's surface
AOS/LOS ID of the current/next ground communication site
AOS/LOS and ID of current/next TDRSS coverage
Current and two predicted ground tracks
Current position of the Orbiter on the world map
AOS of the next earth observation site

Brewster Shaw, pilot for STS-9, stated "It's really a big asset to know where we are all the time." Since SPoC was such an asset on STS-9, Flight Equipment Project Office Configuration Control Board Directive #G1309 authorized one SPoC and power cord be manifested for STS-11 and subsequent missions.

An upgrade occurred in late 1984, with the Compass 1129 replacing the 1101 for STS-51C and subsequent missions. The GRiD Compass 1129 is the same size as the 1101, with a 4.75 by 3.5 inch electroluminescent screen and 384K bytes of non-volatile bubble memory. Improvements gained with the 1129 include twice as much RAM (512K bytes) and four accessible slots for PROM or EPROM chips. At this time, the necessary hardware and software were purchased to develop EPROMs for flight. Use of socketed PROM and EPROM chips was viewed as a possible interim solution for expanded mass memory until a mass memory device was certified for flight. Compass 1129s were purchased commercially and modified. The internal modem was replaced with a fan for cooling and an EMI reducing "Tempest" screen was installed. For crew safety, the lithium battery which provided power for the internal clock was exchanged for a replaceable silver oxide battery and a clock reset circuit. Also the foot was milled out to promote internal ventilation while in the closed position for flight operation.

In 1985, the SPoC was upgraded to a GRiD Compass 1139 for STS-51G and subsequent missions. The GRiD Compass 1139 is similar to the 1129, having the same memory capacity. It is an improvement over the 1129 because it has a larger electroluminescent screen (7.5 by 3.5 inches) and a standard internal fan for cooling. Like the 1129, this unit was purchased commercially and modified for flight. Modifications include an EMI-reducing "Tempest" screen, a replaceable silver oxide battery, a clock reset circuit, a milled out foot, and the modem is removed.

The original flight software configuration has been augmented since STS-9 to satisfy expanding functional requirements levied on the SPoC. The flight software configuration now includes programs that calculate and/or display the following data:

- Predicted Site Acquisition Table
- Table of TDRSS AOS/LOS
- Communication/Earth Obs site reconfiguration
- Latitude and longitude of the Orbiter
- AOS of future earth observation sites
- Time to Orbiter sunrise, noon, sunset
- Current F stop
- F stop for the selected earth observation site
- Sun glint position on the world map
- Sun glint look angles
- Longitude and MET of the next/previous ascending node
- Time until/from the next/previous ascending node
- Deorbit opportunities
- Deorbit maneuver targeting
- Orbiter CG and weight
- CG management procedures

The SPoC has also been used to provide computational support for special purpose applications on a flight-specific basis. The Orbital Refueling System (ORS) and the Gravity Gradient Free Drift experiments set a precedent for using microprocessors to support payload experiments.

Since 41-G, two SPoCs have been manifested for each Shuttle mission. The primary unit is usually positioned on the forward flight deck above the eyebrow panel, while the backup nominally supports middeck operations. Even during emergency power-downs, one of these units remains running.

NONCRITICAL BUT MANDATORY

Although the SPoC was classified as noncritical hardware by Configuration Control Board Directive 1253, it is considered mandatory equipment. If the SPoC fails, neither the crew nor the mission is threatened: thus the noncritical classification. However, the SPoC is such an asset to the crew and to MCC that it is mandatory equipment for flight.

The following excerpts from reports and memos illustrate the importance of the SPoC to Shuttle missions.

STS-9 Flight Crew Report (Dec. 1983): "The SPoC proved to be a great asset. It was unstowed and set up during the post insertion timeframe and remained active until

deorbit prep... The SPoC allowed the crew to see where they were at all times and served as an accurate source of communications coverage information. In light of the many dropouts of TDRSS S-Band signal that were experienced, the SPoC AOS/LOS information allowed the crew to manage the comm system in an efficient manner and eliminated unnecessary trouble shooting. The SPoC appears to have great potential that deserves further development for future Shuttle missions."

Memo from the Space Shuttle Earth Observations Project Manager (03/02/84, #SC5-84-32): "The GRiD SPoC has been of great value to the Space Shuttle Earth Observations Project... Our contact with the crews that have used the SPoC ...reflect extreme interest in its present capabilities and proposed updates."

The value of the SPoC in monitoring a payload was demonstrated for the STS-41G ORS test:

Memo from John Young (04/18/84, #CB-84-042): "The SPoC has been determined by the crew to be not just useful, but mandatory for proper crew monitoring of ORS hydrazine transfer operations. It provides the proper displays that provide the crew their only insight into the hydrazine heat transfer occurring during an ORS transfer operation for all initial conditions. Using the SPoC information and the other ORS displays and controls, timely and proper response can be made by the crew to any ORS anomaly."

STS-41G Debrief Notes (10/18/84): "[The SPoC was] very helpful because no one had time to just sit by a window and watch for sites and phenomena."

STS-51C Crew Report: "The presence of SPoC on our mission was a major asset in helping us perform many of our tasks. Future capabilities for SPoC will increase its utility even more...these computers have proven to be very reliable..."

Memo from On-Orbit Flight Techniques Panel (01/25/88, #DA8- 88-04): "After reviewing the functions provided by the SPoC and assessing the significant degree of support it provides for routine flight crew operations, the FTP considers it to be a very important part of crew equipment and recommends the Program consider it to be 'mandatory' for all STS flights.

"The FTP also recommends that the SPoC should continue to be classified as criticality 3. These recommendations are based on two considerations.

- a) The primary SPoC function, that of an orbit trajectory status display, does not jeopardize the crew, vehicle, or mission in the event of malfunction.
- b) The secondary SPoC function of providing a backup deorbit targeting capability for emergency deorbit would only be used when the Mission Control Center is unavailable for Orbiter support and an immediate deorbit was required. The probability of this happening is extremely remote because for every case except a large cabin leak, it takes multiple failures before this capability would be needed, and most of those combinations of failures, such as failure of both freon loops, are considered non-credible.

"Retaining the SPoC's criticality 3 classification is highly desirable because it allows a flexible and rapid response to new requirements. To retain these desirable

characteristics, functions considered inappropriate for this classification should be integrated into other processors of an appropriate classification."

APPENDIX F
GLOSSARY

AOS: Acquisition of Signal

Boot Cycle: Period during which the computer is loading the operating system and SPoC EXECUTIVE software.

CG: Center of Gravity

Choice Band: Rectangular area at the top of a form which will contain choices or pertinent information.

Choices: Predefined values for a setting.

Command Key: RETURN key, ESCAPE key, and any other keys that select a menu option.

Confirm: Keyboard input of CODE-RETURN.

Edit Prompt: A small triangular symbol which indicates a user input is expected.

EMCC: Emergency Mission Control Center

EMI: Electromagnetic Interference

EPROM: Erasable Programmable Read Only Memory

FDO: Flight Dynamics Officer

Form: User interface display which allows the user to enter or edit data for one or more items.

FRCS: Forward Reaction Control System

GFE CCB: Government Furnished Equipment Configuration Control Board

GMT: Greenwich Mean Time

GNC: Guidance Navigation and Control

GPC: General Purpose Computer

Highlighted Box: If choices are available in the choice band, the highlighted box indicates the current choice or highlights pertinent information.

I_{sp}: Specific Impulse

Item: Label which identifies the data to be modified in a form.

LOS: Loss of Signal

LOT: Landing Opportunities Table

MCC: Mission Control Center

Menu: User interface display which allows the user to select one of the available options.

MET: Mission Elapsed Time

MOC: Mission Operations Computer

MOCR: Mission Operations Control Room

Modifier Keys: CODE keys, SHIFT key, and CONTROL key.

Nadir: Projection of the Orbiter's position along the local vertical onto the Earth's surface.

OMS: Orbital Maneuvering System

ORS: Orbital Refueling System

PROM: Programmable Read Only Memory

PSAT: Predicted Site Acquisition Table

Prompt: Message informing the user what action should be taken next.

PTI: Program Test Input

RAM: Random Access Memory

RCS: Reaction Control System

RMS: Remote Manipulator System

ROM: Read Only Memory

RTS: Remote Tracking Station

Selection Box: Rectangular outline enclosing the current item in a form or the current option in a menu.

Setting: Data value in a form.

SGMT: Simulated GMT

SPEC: GPC display used to view and modify parameters.

SPoC: Shuttle Portable Computer

STDN: Spaceflight Tracking and Data Network

TDR: True of Date Rotating

TDRS: Tracking and Data Relay Satellite

TDRSS: Tracking and Data Relay Satellite System

TIG: Time of Ignition

APPENDIX G
SPoC MALFUNCTION PROCEDURES

The malfunction procedure for SPoC failures is to cycle SPoC power.

- 1) Insure no bubble memory access is in progress (see Section 2.1.1).
- 2) Turn SPoC OFF.
- 3) Wait five seconds.
- 4) Turn SPoC ON.

This will clear RAM and allow SPoC to be reinitialized.

APPENDIX H
SPoC SOFTWARE ENVIRONMENT

The matrix below may be of help to remote users. It defines the necessary files for WORLD MAP, DEORBIT, and CGMANAGER.

	WORLD MAP	DEORBIT	CGMANAGER
AEROH~TEXT~		R	
AEROL~TEXT~		R	
BACKGROUND~RUN~	R	R	R
CARGO~TEXT~			R
CGMANAGER~RUN~			R
CONSUM~TEXT~			R
CSITES~TEXT~	R		
DAYMAP~RUN~	R		
DEORBIT~RUN~		R	
ESITES~TEXT~	R		
EXECUTIVE~RUN~	R	R	R
LAUNCHFORM~RUN~	R	R	R
LSITES~TEXT~		R	
LTIME~TEXT~	R	R	R
*MAPXXX~MAP~	R		
MET~RUN~	R	R	R
PROP~TEXT~			R
PSAT~RUN~	R		
RNP~TEXT~	R	R	R
SCREEN.INIT~SCREENIMAGE~	O	O	O
SETTIME~RUN~	R	R	R
SITEMANAGER~RUN~	O		
STATEVECTOR~TEXT~	R	R	R
VECTORFORM~RUN~	R	R	R
VEHWGHT~TEXT~		R	R

O - Optional file R - Required file

Operating Environments

In each environment, the screen frame must be ON. If the screen frame is OFF, displays may be distorted.

GRiD Compass

Common~Shared~ (Version 3.1.6)
CCOS~System~ (Version 85.5.7)
*MAP1139~MAP~

GRiD Case Under GRiD-OS

Common~Shared~ (Version 3.1.6)
CCOS~System~ (Version 85.12.18)
*MAPCASE~MAP~

PC & Compatibles Under GRiD-OS For The PC

Common~Shared~ (Version 3.1.6)
CCOS~System~ (Version 86.11.19)
*MapCase~Map~