Precise Differential GPS Navigation and Surveying

PNAV Software User's Guide

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How To Use This Manual

This manual describes the use of the PNAV (Precise Differential GPS Navigation and Surveying) software.

Before processing data with PNAV, we recommend that you read through the *Introduction* to this manual to become familiar with PNAV's capabilities.

In this *PNAV User's Guide*, the chapter *PNAV and Your Application* describes the PNAV software architecture, provides general and detailed guidelines for field procedures and postprocessing.

The *Getting Started* chapter summarizes the main tasks associated with PNAV processing: downloading data, running PNAV, batch processing, data processing, post-mission functions, and PNAV utility functions, results evaluation, reprocessing hints, and navigating PNAV screens.

For downloading procedures, see the *Transfer User's Guide*.

Standard PNAV execution from WinWinPrism and prerequisite input file editing is accomplished via the WinPrism/PROCESS function; for detailed procedures, see the *Process User's Guide*.

In this PNAV manual, the chapters *Batch Processing* and *Data Processing* describe PNAV data processing.

The chapter *Post Mission* describes the creation of post-processing plot files, interpolation of photogrammetry files, and comparison of navigation solutions.

The chapter *PNAV Utility* describes the modification of default parameter used in PNAV processing and manipulation of B-files and navigation solutions.

The *Setup Menus* chapter describes the setup of display attributes, output file selection, Kalman filter parameters, runtime parameters, miscellaneous parameters, station positions, and waypoints.

The *Graphics Display Window* chapter describes the in-process graphical trajectory display.

The *Command Line Options* chapter describes advanced PNAV options which are only available when running PNAV from a DOS prompt.

The *Program Input and Output Data Files* chapter defines the input files used by PNAV and output files generated by PNAV.

For any problems encountered while running PNAV, check the *PNAV Error Messages* chapter for more detail on the problem and its resolution. Should you need further assistance, see the *Customer Support* chapter at the end of this manual.

Program Identification

This PNAV.EXE is protected by Sentinel key. The functionality and version ID of the PNAV program is determined based on the Sentinel key. The ID letter appended to the version number of the software and indicates the functionality shown in Table 1.1.

Table 1.1: PNAV Functionality

Sentinel Key	Version ID	PNAV Functionality
None	D	Only allows surfing of menu screens. Data can not be processed.
PNAV	T	Process data in NAVIGATION mode only. Process single and dual frequency data.
PNAVL1 PRISML1 PRISMWL1	m	Process data in SURVEY and NAVIGATION mode. Process CA psuedo-ranges and L1 carrier phase (single frequency data) only.
PRISM PRISMW	M	Process darta in SURVEY and NAVIGATION mode. Process single and dual frequency data.

Introduction

PNAV (Precise Differential GPS Navigation and Surveying) allows you to post-process data collected by Ashtech Global Positioning System (GPS) receivers to provide precise relative positioning between a static or moving Base receiver and a static or moving Rover receiver. This chapter introduces the following PNAV-relevant topics: differential processing, on-the-fly ambiguity resolution, forward and backward processing, static processing, photogrammetry interpolation, basic field configuration, and PNAV positioning accuracy.

Differential Processing

PNAV processes GPS data differentially, i.e., it calculates the relative position of one receiver to another receiver by processing together data from both receivers collected simultaneously. Data from Ashtech GPS receivers contains either code phase or code phase and carrier phase. PNAV can use whatever type of GPS data is available, and you can select which data type to process for the types available in the data files. PNAV was designed primarily to do high-accuracy (centimeter-level) carrier-phase processing with dual-frequency, full-wavelength (P-code) data, but is also capable of performing low-accuracy (1-3 meter) code-phase differential processing if only code-phase data is available. PNAV can process data from up to 11 satellites simultaneously.

On-The-Fly Ambiguity Resolution

A major advantage of PNAV is the ability to resolve or fix the carrier-phase integer ambiguities while the receiver is in motion or "on-the-fly" with dual-frequency data. Unlike standard kinematic processing, PNAV does not require a static initialization or an antenna swap to solve the ambiguities and does not require the field operator to return to a known point if lock on the satellites is lost while the receiver is moving from point to point.

Forward and Backward Processing

Another advantage of PNAV is that it offers Forward and Backward Processing which can expand the range of good solutions. By processing data in both forward and backward directions and combining both solutions, PNAV can provide the same positioning

accuracy throughout the data collection period (assuming continuous tracking of the same set of satellites during that period). That is, there will be the same level of accuracy during the settling-down period and the final period.

Static Processing

Although designed especially for dynamic data collection (such as navigation/ trajectory computation and kinematic survey), PNAV also works in static mode, achieving centimeter-level accuracy with as little as 2-10 minutes of good-quality, dual-frequency data.

Photogrammetry Interpolation

Another powerful application of PNAV is in photogrammetry. The PHOTO.DAT file containing precise time tags of a photo pulse is combined in the PNAV program with the output files from the PNAV carrier-phase processing to create an output file with precise positions at the photo time tag. Plots showing the position of the photo pulse along the trajectory are also created.

Basic Field Configuration

The basic field configuration for PNAV consists of two receivers. One is placed at a stationary point with a known position and serves as the Base station. The other receiver is generally in motion, either moving along a desired trajectory, or moving from point to point. This receiver is called the Rover, and PNAV will calculate the relative position of the Rover receiver to the Base receiver using the data collected. When PNAV processes the data, the first 2-10 minutes constitutes a "settling down" period, as PNAV solves for the ambiguities and converges on the position. The field operator should take this initial period into account during data collection. If no loss of lock occurs after this period, and the satellite geometry remains strong, maximum accuracy is maintained for every epoch of data. If a loss of lock occurs, particularly on all satellites, PNAV will have to recompute the ambiguities once lock on the satellites is regained.

PNAV Positioning Accuracy

PNAV is a powerful processing tool capable of computing relative positions with centimeter-level accuracy in less than ten minutes if the following conditions are met:

- dual-frequency, full-wavelength data,
- PDOP < 4,
- a minimum of five satellites and preferably six or more satellites,
- a minimum number of cycle slips caused by obstructions,
- a baseline separation of less than ten kilometers, and,
- a low multi-path field environment.

If any of these conditions are not met, PNAV is still capable of producing accurate float ambiguity positions or highly accurate fixed ambiguity positions.

The accuracy of the results is indicated by the one-sigma RMS position error calculated for each epoch during processing. This value of the position error can be trusted if the chi-square value is less than 1.0 and the averaged post-fit carrier-phase residual is less than 0.02 meters. These parameters are discussed in detail in the *Verbose Result Display* section of the chapter *Data Processing*.

The maximum possible accuracy of the results is strongly dependent upon the data type used. The following table shows various level of accuracy and the approximate time needed to initially achieve that accuracy for each data type. This table assumes a minimum of five satellites, PDOP < 4, separation between the Base receiver and the Rover receiver of less that ten kilometers, and infrequent loss of lock.

Table 2.1: PNAV Processing Accuracy

PNAV Processing Accuracy (PDOP < 4.0)	
Data Type	**Accuracy**
Unsmoothed C/A-code phase	3-10 meters
Smoothed C/A-code phase	1-3 meters
Smoothed P-code phase	0.2-1 meters
L1-only C/A-code + carrier phase, float ambiguities	1-3 meters in first 2-10 minutes, 0.1-1.0 meters thereafter. Best results (0.05-0.3 meters overall) can be achieved by forward and backward processing.
Dual-frequency code (P-code) + carrier phase, float ambiguities	0.5-2 meters in first 2-5 minutes, 0.1-0.5 meters thereafter. Best results (0.05-0.3 meters overall) can be achieved by forward and backward processing.
Dual-frequency code (P-code) + carrier phase, fixed ambiguities	0.5-2 meters in first 2-5 minutes, 0.01-0.1 meters when the ambiguities are fixed.

The next chapter provides a more complete description of PNAV applications and accuracy.

PNAV and your Application

PNAV Software Architecture

This chapter provides guidelines for using the PNAV software for your application. First, the underlying PNAV software principles and architecture are discussed. Then, general guidelines for field procedures for data collection and data processing are presented. Finally, the recommended data collection and data processing procedures are described for the two most common applications, trajectory computation and survey.

PNAV is a Kalman filter-based program which processes GPS observables sequentially. This differs from other Ashtech postprocessing software such as QUICK which uses batched least squares.

PNAV processes the data in a single path, i.e., it takes each epoch's raw measurement data, checks for data blunders, incorporates the valid data into the Kalman filter, and generates a solution for that epoch. It does not reprocess data from previous epochs.

When using the Kalman filter to process data in Navigation Mode, PNAV computes each epoch's solution based on not only current measurement data but past measurement data also, as opposed to the single-epoch least-squares solution which uses only the current measurement to compute the current position. This is based on a simple logic that a current position is related to a past position. (You cannot be here from nowhere.) Because of this "weighted averaging" of all data available, logically any solution would be better with more data. This introduces an initial solution transition in the Kalman filter. This initial transient, or "settling-down period", is required to achieve the desired accuracy. For dual-frequency data, PNAV takes 1-2 minutes to reach submeter accuracy.

You can process the measurement data in the reverse order of data collection (backward) in addition to processing the data in the order of data collection (forward). This backward processing can be totally independent from the forward processing. After achieving results from both processing in both directions, at each epoch, both the forward solution and the backward solution are independent of each other and thus can be combined by a simple weighted least-squares fit. Note that the initial "settling-down period" (which has larger solution errors) in the forward processing is the "final" solution period (which has smaller solution errors) in the backward processing. When combining both solutions through a weighted least squares, an accurate solution can be achieved. This is the fundamental reason that forward and backward processing can achieve accurate solutions over the whole data span.

When processing data in Survey Mode, PNAV checks for the four-character site identifier which can be edited via the WinPrism/PROCESS/EDIT LOGTIME function to determine whether the receiver is in moving mode or in stationary mode. Any site ID starting with a

"?" will be considered to be moving, otherwise it is considered to be stationary. Based on this site ID, PNAV adjusts its data processing model:

- The filter is opened up to allow position changes while the receiver is in moving mode.
- The filter is adjusted to a recursive least squares while the receiver is in stationary mode.

As mentioned previously, since PNAV processes data sequentially in a single path, the stationary site's solution would be the last epoch solution for that stationary site.

General Guidelines for Field Procedures

This section discusses the issues the field crew should consider when collecting navigation/trajectory data or survey data for subsequent PNAV processing: satellite geometry, multiple reference stations, maintaining lock, low multi-path effect, and data recording interval.

Satellite Geometry

The recommended satellite geometry is at least five satellites (preferably six or more) and PDOP less than 4. With the full GPS constellation, these requirements are not hard to meet.

At least five satellites, preferably six or more. PDOP less than 4.

With the full GPS constellation, these requirements are not hard to meet.

Multiple Reference Stations

Using multiple reference stations can provide multiple trajectories (solutions) from each reference station. These multiple trajectories (solutions) are excellent solution cross-checks. Whenever possible, establishing at least two reference stations is highly recommended. In addition, in analog to the satellite constellation (PDOP), these

reference stations should be distributed over the data collection field. For example, in the following setup, plan B is preferred to plan A.

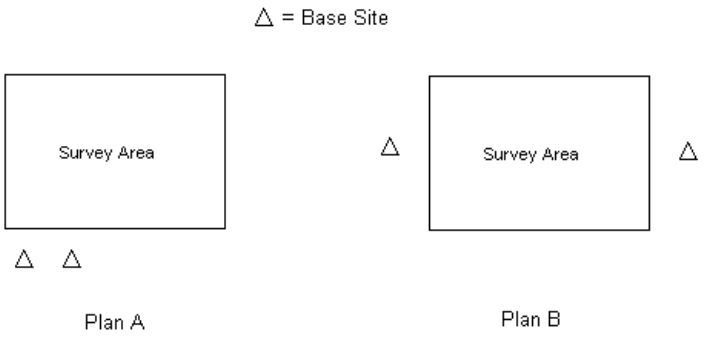

Figure 3.1: Survey Planning

In order to take advantage of PNAV batch processing, the field crew must set up one reference station throughout the data collection period. This station will be used as the control site during PNAV batch processing.

Maintaining Lock

As discussed in the *PNAV Software Architecture* section above, having uninterrupted data means more data for achieving a "weighted averaging" solution for each epoch, which in turn means higher accuracy. During the data collection, any attempts to maintain lock throughout whole data collection will provide the best possible PNAV solutions.

Low Multi-path Effect

Multi-path is by far the most unpredictable error source in GPS observables. It cannot be canceled by a double difference because it is a local effect; and, because it has strong temporal correlation, it requires a longer time to average out its effect. We recommend that the survey crew place a GPS antenna in a low multi-path environment. Avoid antenna placement close to buildings, trees, or metal structures. In cases where it is impossible to avoid these multi-path sources, we recommend occupation of the site for a longer period of time.

Data Recording Interval

The data recording interval depends on several factors, such as rover dynamics, final solution requirement, and the receiver's internal memory capacity or the data logging device's memory capacity. The following guidelines are helpful in determining the recording interval:

- Trajectory computation: 0.5 to 2 seconds; the higher the rover dynamics is, the shorter the data recording interval should be.
- Survey: 5 seconds for most point surveying applications; if the trajectory is of interest also, such as in contour profiling, consider a one-second recording interval.

The advantages of a longer recording interval are:

1. The measurement data is less subject to temporal correlation, thus improving the Kalman filter performance.
2. Less data logging memory is required. However, in trajectory computation, consider a two-second or shorter recording interval.

General Guidelines for PNAV Data Processing

PNAV data processing, the following general guidelines apply to either trajectory or survey processing:

1. For best results with PNAV's on-the-fly ambiguity resolution, the following conditions should be met:
   - Full-wavelength dual-frequency observables.
   - Less than 10-kilometer baseline separation.
   - Six or more satellites with PDOP less than 4.
2. The PNAV default parameters are optimized for data collected in a normal multi-path environment, such as an open field. When processing data collected in a high multi-path environment, such as in the forest or in the city, increase the Kalman measurement noise parameters in the <Alt-K> Kalman Setup Menu by at least a factor of 2.0, especially the pseudo-range measurement noise. See the *Setup Menus* chapter for details.

If there are more than 10 Kinematic or rapid static files in a directory, the COMBFILE utility should be run (See Option E - Merge B-files under the PNAV Utility Menu). If this utility is not run, a Windows system error may occur.

PNAV for Navigation

If an epoch-by-epoch position solution are desired, select NAVIGATION in Menu 3.0/PROCESSING MODE. During the data processing, PNAV will ignore the site ID in the B-file, and will create an independent epoch-by-epoch solution.

Normal differential GPS (DGPS) requires a stationary site as the Base station. An extension of this conventional DGPS is to compute the relative position between two moving receivers. To perform this type of data processing, select the Relative Navigation Mode in appropriate menus.

This section discusses the following special considerations required to achieve the best position solutions: field procedures for Navigation Mode, code-phase processing, carrier-phase processing, dual-frequency receiver, single-frequency receiver, and Relative Navigation field and processing procedures.

Field Procedures in Navigation Mode

This paragraph describes the following requirements for the collection of navigation data: Recording Interval and Initialization Period.

Recording Interval

The recording interval of the measurement data is important for PNAV's Kalman filter to process the data properly (i.e., predict the next epoch's position) in the PNAV Navigation Processing Mode. The recording interval necessary directly corresponds to the Rover motion dynamics; in general, the faster the Rover is moving, the shorter the recording interval. We recommend:

- static or walking - 5 to 10 seconds
- automobile - 2 to 5 seconds
- aircraft - 0.5 to 1 second

Settling-Down Period

While neither a static initialization nor an antenna swap is necessary with PNAV, the field crew should plan for a "settling-down" period. The settling-down period is the time PNAV requires to converge on a solution during processing and requires continuous carrier-phase tracking. The length of the settling-down period is a function of the number of satellites available, PDOP, baseline separation, recording interval (RCI), and type of data collected.

Whenever you lose lock, you do not have to reinitialize on a known point, but do plan for another settling-down period. While PNAV can recover from a cycle slip without having to reinitialize on a known point, we do not recommend it for use in areas with several obstructions, or in high-multi-path environments.

The following recommended settling-down times are only guidelines; the period may decrease or increase depending upon your environment.

Ambiguity-free Solutions: Dual-frequency (P-code) Data

One to five minutes with six or more available satellites, good PDOP, and an RCI of five seconds or less.

Ambiguity-fixed Solutions: Dual-frequency (P-code) Data

With six or more available satellites and good PDOP, the settling-down time (time-to-fix, *tfix*) approximately follows the formula

tfix (min) = [baseline separation (kilometers) + RCI (seconds)]/2

For example, if the Base and the Rover receivers are initially five kilometers apart, and the recording interval is five seconds, then the time-to-fix to the ambiquities will be about five minutes.

For processing in the Navigation Mode, if the calculated time-to-fix is less than five minutes, assume a minimum of five minutes.

Ambiguity-fixed Solutions: Single-frequency (C/A Code) Data

With six or more available satellites and good PDOP, 30 minutes minimum to fix ambiguities, and 10 minutes minimum to settle down to sub-half-meter accuracy.

Code-Phase Processing

If submeter- or meter-level accuracy will satisfy your accuracy requirement, processing carrier-phase-smoothed code phase (pseudo-range) will provide the most robust solution with minimum amount of processing time. For Ashtech receivers (except Dimension), the carrier-phase smooth corrections are stored in the B-file.

To perform this type of data processing:

1. In Menu 3.0, select **FORWARD EXECUTION MODE**. (FORWARD AND BACKWARD processing will only provide up to 10% accuracy improvement.)
2. In Menu 3.0, select the appropriate **ROVER MOTION DYNAMICS**.
3. In Menu 3.1, select **DATA TO PROCESS All Codes** (if it is available in the menu) or CA code if the data is from single-frequency receiver.
4. In Menu 3,1, verify that **USE SMTHCOR** is set to **Yes**.
5. If either BASE receiver or the ROVER receiver was placed in a high-multi-path environment, via the <Alt-K> Kalman Setup Menu, increase the **Pseudo-Range** errors in the **Kalman Filter Measurement Noise Parameters**.

6. Process the data.

This processing technique is also recommended if a quick view of overall trajectory and data collection status is desired. Its processing results can also serve as a cross check for larger error (> 5 meters) carrier-phase processing results which will be discussed next.

Carrier-Phase Processing

The carrier-phase observable provides much lower measurement noise than the code-phase (pseudo-range) observable does. However, it is subjected to an unknown initial integer ambiguity. Processing both types of observables together will provide better solutions. Smoothing pseudo-ranges with carrier phase as discussed above provides a suboptimal solution. An optimal solution would be processing both types of raw measurements through a Kalman filter and treating each type of data as independent measurements. Averaging code phase determines the integer ambiguities while the carrier phase tracks the Rover's motion. This is the approach PNAV takes.

Dual-Frequency Receiver

Dual-frequency observables provide the following advantages:

- Form wide-lane ambiguities for fast integer ambiguity resolution.
- Remove ionosphere delay for long baseline separations (larger than 10 kilometers).

The dual-frequency observables mentioned throughout this manual refer to full-wavelength carrier-phase observables along with P-code pseudo-range measurements. We recommend the following procedures for processing dual-frequency data.

Less than 10 Kilometer Baseline

1. Select either **FORWARD** or **FORWARD AND BACKWARD EXECUTION MODE**.
2. Select **ALL OBSERVABLES**.
3. Set **FIX AMBS** to **Yes**.

Long Baseline up to 1000 Kilometers

When processing data in which the baseline exceeds 10 kilometers, PNAV may not be able to fix integer ambiguities even if you set **FIX AMBS** to **Yes**.

By default, PNAV starts to model the residual ionosphere when the baseline separation is longer than 15 kilometers. Use the **A**utomatic default in the <Alt-R> RunTime Setup Menu, or set **Model Ionospheric Delay** to **Y**es.

In summary, the recommended processing procedure is:

1. Select **FORWARD AND BACKWARD EXECUTION MODE**.
2. Set **FIX AMBS** to **No**.
3. Set **MODEL IONOSPHERE DELAY** to **Y**es or **A**utomatic.

You may wish to set FIX AMBS to Yes, if you desire to carry on the fixed ambiguity solution from a baseline less than 10 kilometers to a basleine longer than 10 kilometers, and if the following conditions are met:

- The integer ambiguities are fixed.
- The initial baseline is less than 10 kilometers.
- There was no loss-of-lock.
- At least five satellites with good geometry have no cycle slips in any case.

Ionospheric Free Combination of Observables

Processing data using ionospheric-free combinations can provide an cross check for results produced by other processing methods. The summary procedure is:

1. Select **FORWARD AND BACKWARD EXECUTION MODE**.
2. In the <Alt-R> RunTime Setup Menu, set **Form LC Observables** to **Y**es.
3. In the <Alt-K> Kalman Setup Menu, change the **Kalman Filter Measurement Noise Parameters** as follows:

   CA Pseudo-Range:100.0 meters

   L1 Carrier Phase: 0.15 cycles

Single-Frequency Receiver

For single frequency uses, the recommended procedure is:

1. Select **FORWARD AND BACKWARD EXECUTION MODE**.
2. Set **FIX AMBS** to **No**.

Relative Navigation

In order to achieve best relative navigation solution, a good position solution in the Base receiver's B-file is required, besides all the requirements for the best standard navigation solution. The position stored in the B-file is computed in real-time in the receiver. Due to atmospheric delay and Selective Availability imposed by the Department of Defense, a standalone receiver without real-time differential correction provides a solution accuracy of about 80 meters. In addition, the position will jump on a scale of 10 meters when the number of satellites used in the position computation is changed. These errors will reduce the PNAV relative navigation solution accuracy. There are two ways to improve the position solution in the Base receiver's B-file:

1. Operate both the Base receiver and the Rover receiver in real-time differential mode as described in the operating manual for your receiver. The collected B-files can then be directly used in PNAV relative navigation processing.
2. Postprocess (in PNAV Navigation Mode) the moving B-file which is going to be used as Base station in relative navigation processing with a stationary reference station, use the resulting C-file to modify the moving Base B-file, and then process (in PNAV Relative Nav Mode) the modified moving Base B-file with the desired moving Rover B-file. The summary procedure is:
    a. Select the **NAVIGATION PROCESSING MODE**.
    b. Select the stationary B-file as the **BASE FILE** and the moving B-file as the **ROVER FILE**.
    c. Process the B-files to create a C-file.
    d. Modify the moving B-file with the C-file created in the above step, using the option PNAV UTILITY/ B-FILE UTILITY/MODIFY NAV SOLUTION.
    e. Select the **RELATIVE NAV PROCESSING MODE**.
    f. Select the modified moving Base B-file as the **BASE FILE** and the moving Rover B-file as the **ROVER FILE**, and process the two files.

PNAV for Survey

If a baseline vector solution is desired, select SURVEY in Menu 3.0/PROCESSING MODE or Menu 1.0/PROCESSING MODE. During the data processing, PNAV will retrieve the LOGTIMES file, which can be edited either via the WinPrism/ PROCESS/EDIT LOGTIME function or under the EDIT LOGTIME selection in menu 2.0/SURVEY PRE-PROCESSING in PNAV. PNAV will create vector solutions and store them in a binary O-file. Follow the GENERAL GUIDELINES FOR FIELD PROCEDURES and GENERAL GUIDELINES FOR PNAV DATA PROCESSING discussed in earlier sections. For details on processing survey data see the WinPrism Process User's Guide and the *Getting Started* chapter in this manual.

This section discusses the special field procedures for Survey Mode and single-frequency receiver considerations required to achieve the best vector solution.

Field Procedures for Survey Mode

This section describes the following requirements for the collection of survey data: Static Sites and Site ID, Recording Interval, Settling-Down Period, and Survey Mode Methodologies.

Static Sites and Site ID

Four characters are used to identify a site which you can edit via the WinPrism/ PROCESS/EDIT LOGTIME screen.

A site name is classified into static site name and non-static site name. Any site name which starts with a non-question mark is considered to be a static site name and an averaged solution will be output to the vector O-file and SUMMARY.OUT file. For example: 111, PLAZ, and Z??? are valid static site names.

A non-static site name is any site name which starts with a question mark. For example: ????, ?101, and ?RST are valid non-static site names.

Ensure that a static site name only always appears during any static site occupation period; otherwise the results of subsequent PNAV processing may be invalid.

PNAV processing capacity is limited to no more than 80 static sites in a Rover file.

Recording Interval

For general PNAV surveying, we recommend 1-10 seconds, depending on memory capacity and production speed desired. If the ROVER MOTION DYNAMICS are WALKING or AUTOMOBILE, we recommend 5 seconds.

Settling-Down Period

While neither a static initialization nor an antenna swap is necessary with PNAV, the field survey crew should plan for a "settling-down" period. The settling-down period is the time PNAV requires to converge on a solution during processing and requires continuous carrier-phase tracking. The length of the settling-down period is a function of the number of satellites available, PDOP, baseline separation, recording interval (RCI), and type of data collected.

Whenever you lose lock, you do not have to reinitialize on a known point, but do plan for another settling-down period. While PNAV can recover from a cycle slip without having to reinitialize on a known point, we do not recommend it for use in areas with several obstructions, or in high-multi-path environments.

To decrease the required settling-down period, perform an antenna swap or begin data collection over a known baseline.

The following recommended settling-down times are only guidelines; the period may decrease or increase depending upon your environment.

Ambiguity-free Solutions: Dual-frequency (P-code) Data

one to five minutes with six or more available satellites, good PDOP, and an RCI of five seconds or less.

Ambiguity-free Solutions: Single-frequency (C/A Code) Data

two to ten minutes under the same conditions.

Ambiguity-fixed Solutions: Dual-frequency (P-code) Data

With six or more available satellites and good PDOP, the settling-down time (time-to-fix, *tfix*) approximately follows the formula:

tfix (min) = [baseline separation (kilometers) + RCI (seconds)]/2

For example, if the Base and the Rover receivers are initially five kilometers apart, and the recording interval is five seconds, then the time-to-fix to the ambiquities will be about five minutes.

For the Survey Processing Mode, if the calculated time-to-fix is less than five minutes, assume a minimum of five minutes.

Antenna Swap

For best results with single-frequency data and ambiguities-fixed solutions, we recommend that you either perform an antenna swap or start on a known baseline. PNAV accepts "?SSS" or "?SWP" as valid site identifiers indicating the start of an antenna swap and then checks the site IDs in the Base and Rover B-files for the next 30 minutes to determine whether a swap actually occurred, i.e. whether the correct site IDs for the known point and the swap point were actually swapped. Place the rover antenna on the initial swap point, enter ?SSS or ?SWP in the rover receiver to mark the swap, and perform the swap as described in the operating manual for your receiver.

An example of LOGTIMES with antenna swap is shown below.

```
INT#   TSTART      TEND       R1   R2   R3   Comments
0  22:30:00.00 22:35:10.00  _TG3 ???? ????  antenna swap between R2 and R3 only
1  22:35:10.00 22:36:00.00  _TG3 111M ?SSS  at least one epoch in B-files
2  22:36:00.00 22:40:20.00  _TG3 111M SSSM  HOME LEG
3  22:40:20.00 22:40:30.00  _TG3 ???? SSSM
4  22:40:30.00 22:42:10.00  _TG3 ???? ????
5  22:42:10.00 22:46:10.00  _TG3 SSSM 111M  AWAY LEG
6  22:46:10.00 22:46:20.00  _TG3 ???? 111M
7  22:46:20.00 22:47:10.00  _TG3 ???? ????
8  22:47:10.00 22:51:10.00  _TG3 111M SSSM  HOME LEG
9  22:51:10.00 23:00:40.00  _TG3 111M ????
10 23:00:40.00 23:03:40.00  _TG3 111M HYD1  Survey point
11 23:03:40.00 23:08:40.00  _TG3 111M ????
```

```
12 23:08:40.00 23:11:40.00  _TG3 111M CHSX  Survey Point
13 23:11:40.00 23:15:00.00  _TG3 111M ????
```

Survey Mode Methodologies

Three surveying methods are appropriate when processing with PNAV in the Survey Mode: Kinematic, Fast Static, and Fast Static/Kinematic Combination.

Kinematic

In kinematic mode, data is collected throughout the trajectory. If the receiver traverses among obstructions such as trees and buildings and loss-of-lock occurs, then the integer ambiguities need to be re-acquired.

After the initialization period has passed, then the field operator need only stay on the static points for one to two minutes, like a conventional kinematic survey. Again, if a loss-of-lock occurs in the middle of data collection, the operator has to plan for another initialization period.

This initialization period may be dynamic.

A variation of the kinematic method would be to begin data collection over a known baseline which would substantially reduce the initialization period requirement.

Advantages:

- Increase in production speed.
- Trajectory information is available.

Disadvantages:

- Data is more susceptible to failure.
- Operator must carefully monitor data collection.
- May require more memory capacity and battery power.

Kinematic: Data Collection Procedure

We recommend that the field operator:

1. Set MIN SV to 6 in receiver. (See the receiver operating manual for details.) Then if the receiver cannot maintain lock on at least six satellites, it will issue a loss-of-lock alarm and display an appropriate text message.
2. If lock is lost, either:
    - Occupy the next site, and reinitialize the integer ambiguities for at least the initialization period. Enter a special site name "?RST" in receiver menu 9 and record at least one epoch of data with this site name before entering the desired site name.

[or]

- Record the site information for reinitialization during PNAV processing.

Kinematic: PNAV Processing Procedure

We recommend that the processor do the following (using either the WinPrism/ PROCESS/EDIT LOGTIME screen or the EDIT LOGTIME screen under the Survey PRE-PROCESSING MENU of PNAV. In either case use the SITE popup, **RESET** data entry field):

1. If no loss-of-lock occurred during data collection (or the next site was used to reinitialize the ambiguities during the survey), set the Reset Ambiguities parameter to **N**o.
2. If loss-of-lock occurred during data collection and the next site was not used to reinitialize the ambiguities during the survey, set the Reset Ambiguities parameter to **Y**es for that site.

Fast Static

If data is not collected throughout the trajectory, but is collected at the stations for at least the initialization period, then the field operator either sets the data record to N between sites or turns the receivers off between sites.

Advantages:

- Increased data reliability.
- May require less memory capacity.
- Simple field procedures

Disadvantages:

- Decrease in production speed.
- Trajectory information is lost.
- Trajectory portion of the run is not available for use as part of the initialization period.

Fast Static: Set Data Record to N or Turn Receivers Off Between Sites

Proceed as follows:

1. Enter site name "????" in receiver menu 9. (See the receiver operating manual for details.)
2. Record at least one epoch of data with site name "????"
3. Set record to "N", or turn receiver power off.
4. After you are ready to record data at next site (turn receiver power on, if required), set record to "Y" and make sure the site name is still "????".
5. Record at least one epoch of data with site name "????".
6. Set the site name to the desired name.

7. Stay at the site for at least the initialization period.
8. Repeat steps 1 through 7 above.

Fast Static: Turn Receivers Off Between Sites

You must add another 2 to 3 minutes to the initialization period, since the receiver needs 2 to 3 minutes to retrack satellites in view.

Fast Static/Kinematic Combination

Data is collected at the stations for at least the initialization period, and data is also collected throughout the trajectory.

Advantages:

Increased data reliability

Trajectory information is retained

Simple field procedures

Disadvantages:

Decrease in production speed

May require more memory capacity and battery power

Single-Frequency Receiver

The On-the-Fly ambiguity resolution algorithm in PNAV cannot handle single frequency data well. The field crew should perform a conventional kinematic survey in order to get reliable centimeter-level survey results, i.e. an antenna swap or a static site initialization is required to initialize the integer ambiguities.

Suggested Parameter Settings For Typical Applications

Tabulated below are the suggested parameter settings to suit typical applications when using the DATA PROCESSING option from the main menu. To use BATCH PROCESSING, see the chapter titled *Batch Processing*. Except as noted, leave all other parameters at the default values. (You should always use the appropriate **ROVER MOTION DYNAMICS** in **Menu 3.0 PROGRAM EXECUTION MODE AND ROVER DYNAMICS** rather than default to **AUTOMOBILE**.) In any of the cases, processing the data forward and backward should increase the range of good solutions.

PNAV does not support codeless (or half-wavelength) dual-frequency data. PNAV treats codeless dual-frequency data as single-frequency, C/A code plus carrier data.

In the following table, Menu 3.0 is accessed via Overview Menu DATA PROCESSING, Menu 3.1 follows Menu 3.0, and the Setup Menu follows Menu 3.1.

Table 3.1: Suggested Parameter Setting

Typical Application	Parameter Settings	Accuracy (PDOP < 4.0)
Dual-frequency receiver Pseudo-range and carrier phase Positioning with baseline < 10 kilometers	Forward processing only (**EXECUTION MODE: FORWARD** in **Menu 3.0**) Fixed integer ambiguity (**FIX AMBS: Yes** in **Menu 3.1**)	0.01-0.1 meters when ambiguities are fixed
Dual-frequency receiver Pseudo-range and carrier phase Positioning with baseline < 10 kilometers	Forward and backward processing (**EXECUTION MODE: FORWARD AND BACKWARD** in **Menu 3.0**) Float integer ambiguity (**FIX AMBS: No** in **Menu 3.1**)	0.05-0.3 meters
Dual-frequency receiver Pseudo-range and carrier phase Positioning with baseline < 10 kilometers	Forward processing only (**EXECUTION MODE: FORWARD** in **Menu 3.0**) Float integer ambiguity (**FIX AMBS: No** in **Menu 3.1**)	0.5-2 meters in first 2-4 minutes, 0.1-0.5 meters thereafter
Dual-frequency receiver Pseudo-range and carrier phase Positioning with baseline > 10 kilometers	Forward and backward processing (**EXECUTION MODE: FORWARD** AND BACKWARD in **Menu 3.0**) Float integer ambiguity (**FIX AMBS: No** in **Menu 3.1**) **Model Ionospheric Delay Y**es or **A**utomatic in <Alt-R> RunTime Setup Menu	0.5-2 meters in first 2-4 minutes, 0.05-0.3 meters thereafter
Single-frequency receiver Pseudo-range and carrier phase Positioning with all baselines	Forward and backward processing (**EXECUTION MODE: FORWARD AND BACKWARD** in **Menu 3.0**) Float integer ambiguity (**FIX AMBS: No** in Menu 3.1)	0.05-0.3 meters

Table 3.1: Suggested Parameter Setting (continued)

Typical Application	Parameter Settings	Accuracy (PDOP < 4.0)
Smoothed P-code pseudo-range	**USE SMTHCOR: Yes** in **Menu 3.1**	0.2-1 meters
Smoothed C/A-code pseudo-range	**USE SMTHCOR: Yes** in **Menu 3.1**	1-3 meters
Unsmoothed C/A-code pseudo-range	**USE SMTHCOR: No** in **Menu 3.1**	3-5 meters

Getting Started

This chapter provides an overview of the procedures required to effectively use PNAV: Downloading Data, Running PNAV, Data Processing, Post Mission (output analysis), Evaluating Your Results, Survey Mode Reprocessing Hints, Exiting PNAV, and Navigating PNAV Screens.

Downloading Data Using WinPrism Transfer

After you have collected the data following the tips described in the previous chapter, use the WinPrism/TRANSFER function to download the data into a separate directory on your computer. We recommend that you divide the data into days - one directory for each day. (For details, see the Transfer User's Guide, *Download Option* section.) After you have downloaded the data, you are ready to run PNAV.

Running PNAV from WinPrism

This section shows you how to start PNAV from WinPrism and introduces the options available in the PNAV Overview Menu.

If WinPrism has been installed as described in the Introduction to WinPrism manual, you can run PNAV as follows:

1. Perform the following procedures in order as described in the *Process User's Guide*, *Getting Started* chapter:
   a. Run WinPrism.
   b. Verify WinPrism SETUP.
   c. Select Directory (change to the directory containing the B-files you want to process).

PNAV will not process B-files if they reside in the WinPrism software installation directory; move B-files you want to process with PNAV into a different directory.

   d. Select PROCESS.
2. If either or both of the following messages appear:

```
Use Existing STATIC PROJFILE?
[or]
```

```
Use Existing PSEUDO PROJFILE?
```

select **NO**.

3. In the main PROCESS screen:

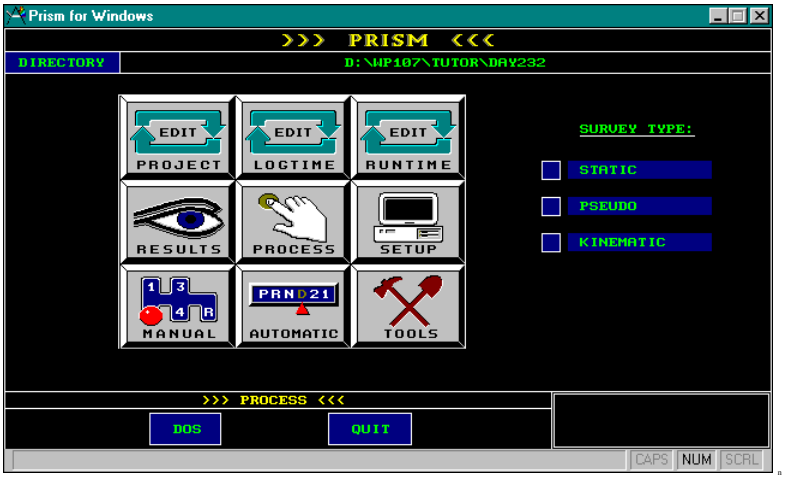

Figure 4.2: WinPrism Process Screen

select **SURVEY TYPE KINEMATIC**.

4. If either or both of the following messages appear:

```
Save The PSEUDO PROJFILE?
          [or]
Save The STATIC PROJFILE?
```

select **NO**.

5. If a kinematic project file already exists in the current directory, PROCESS prompts **`Use Existing KINEMATIC PROJFILE?`**; if you answer **NO**, PROCESS creates a new project file.

When you select SURVEY TYPE KINEMATIC, the MANUAL and AUTOMATIC icons are changed to show the two available kinematic engines. This manual is only concerned with PNAV.

6. Select **EDIT LOG** to access the WinPrism/PROCESS/EDIT LOGTIMES screen. (For details on the following steps, see the *WinPrism Process* manual, *Program Reference* chapter, *Edit Logtime Option* section.) In EDIT LOGTIMES:

   a. Ensure that all the site names were entered correctly at the receiver, that all site names are valid, and that all sites between which you want to process baselines share common collection intervals.

b. Set the Reset Ambiguities flag as appropriate for the field procedures used.

c. Edit the antenna height information as needed.

d. Check that "special site codes" are entered properly if desired; examples are **?RST** or **?RRR** (for reset ambiguities), **?SSS** or **?SWP** (for antenna swap), and the **_RBS** (Remote Base Station) site.

e. Once you are satisfied, **ACCEPT** the LOGTIMES file to return to the **Main Process Menu Screen**.

For kinematic processing, PNAV uses the antenna height from the LOGTIMES file and ignores the antenna parameters from PROJFILE.KIN.

7. Select **EDIT PROJECT** to access the WinPrism/PROCESS/EDIT SITE LIST screen. (For details on the following steps, see the *WinPrism Process* manual, *Program Reference* chapter, *Edit Project Option* section.) In EDIT SITE LIST:

   a. Define the fixed site (control point) by setting its knowness to zero and entering its correct position in WGS84 coordinates.

   b. Enter the appropriate coordinates for new sites added to the LOGTIMES file.

   c. Once you are satisfied, **ACCEPT** the project file to return to the PROCESS screen.

For kinematic processing, PNAV uses the antenna height from the LOGTIMES file and ignores the antenna parameters from PROJFILE.KIN.

8. Select **PNAV** to access the PNAV Overview Menu:

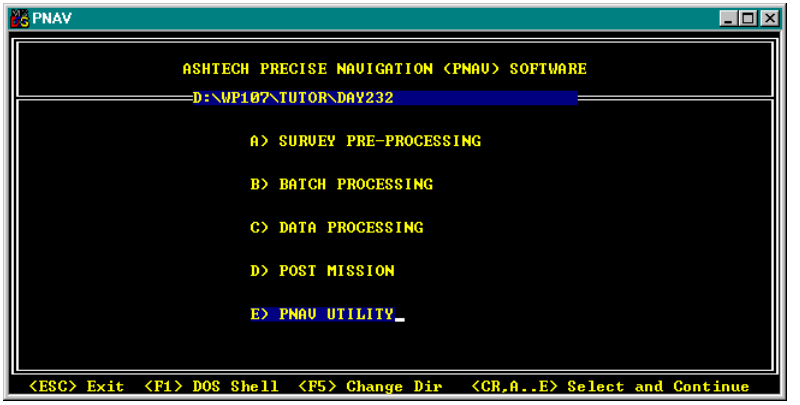

Figure 4.3: PNAV Overview Menu

This screen contains:

- at the top, the current directory display line;
- in the middle, the five main PNAV options: **SURVEY PRE-PROCESSING**, **BATCH PROCESSING**, **DATA PROCESSING**, **POST MISSION**, and **PNAV UTILITY; and,**
- at the bottom, the command prompts in effect in this screen: **<ESC> Exit**, **<F1> DOS Shell**, **<F5> Change Dir**, **<CR,A..E> Select and Continue**.

As in all PNAV screens, <F10> means continue to next step and is therefore equivalent to <ENTER> even though it is not prompted in this menu.

Exiting PNAV

In the PNAV Overview Menu, pressing **<ESC>** terminates PNAV and returns you to the WinPrism PROCESS screen.

Shelling Out to DOS

To shell out temporarily to the DOS prompt from the PNAV Overview Menu, press **<F1>**. To return to PNAV from the DOS prompt, type **EXIT<ENTER>**.

Changing Directory

Press <F5> to change directory if you are not in the same directory as the collected B-files; observe, typically:

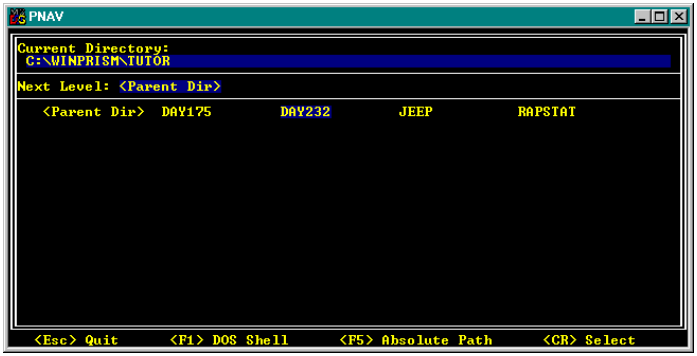

Figure 4.4: Changing Directories

Next Level initially displays the first subdirectory (in alphabetical order) contained within the current directory or the parent directory when the current directory is anything except the root.

1. To change directories, select the desired directory (i.e. highlight it using the arrow keys, and press **<ENTER>**); observe, typically:

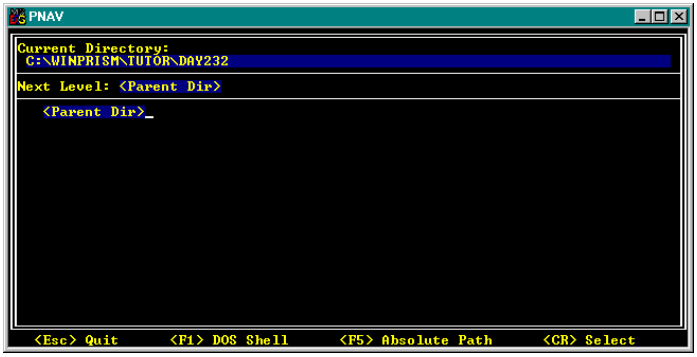

Figure 4.5: Changing to a subdirectory

   Initially, the **<Parent Dir>** entry is highlighted.

2. Press **<ENTER>** to change to the directory one level higher.

3. If you highlight a directory which is one level lower, its name appears in the **Next-Level** window. When you press **<ENTER>**, that directory becomes the current directory.
4. To specify an absolute path, press **<F5>** for the current path:

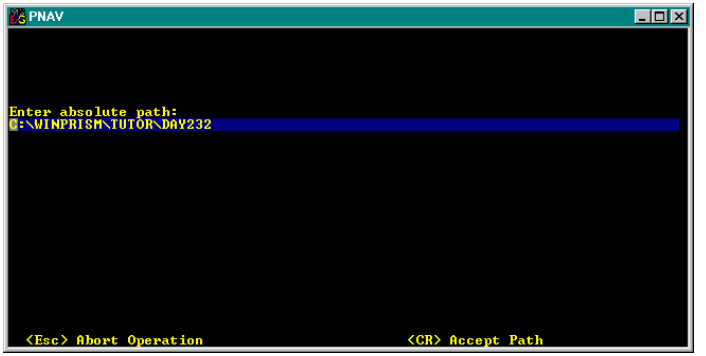

Figure 4.6: Changing directory via absolute path

You can add to the path that is displayed or modify it to a legal directory name. Be careful to follow DOS naming conventions.

5. Use the arrows to move the cursor in the **Enter absolute path** field as desired, and type in the change.
6. Press **<ENTER>** to change to that directory.
7. If the directory does not exist, PNAV prompts:

```
That directory does not exist, create it (Y/N)?
```

8. If you enter **Y**, the new directory is created and becomes the current directory. Press **<ESC>** to quit to the PNAV Overview Menu.

Running PNAV as a standalone DOS Program

This section shows you how to run PNAV by itself, from the DOS prompt. The first step is to create a DOS command prompt session from within Windows 95 or NT. Once you have done this (refer to your Windows Manual for details), follow the steps outlined below.

1. At the prompt, change to the directory containing the data files you wish to process - this must not be the same directory where PNAV is installed.
2. At the prompt, type PNAV <ENTER>.

At this point, PNAV will execute and you will see the same screen as detailed in Figure 4.4. All other details about launching and exiting PNAV are the same as if you were running it from WinPrism, except that when you exit, you are returned to the DOS prompt.

Option A - Survey Pre-Processing

This section introduces PNAV Overview Menu Option A) SURVEY PRE-PROCESSING. This option accessed a menu through which you can edit various parameters of the sites you occupied during your survey including their initial coordinates, selecting a base station, and editing the times when you were at the sites. This information is stored in two files, called the PROJECT file and the LOGTIMES file. There is an option to create these files from the raw data if they are not already present e.g., if you are running PNAV outside WinPrism.

These options are covered in detail in the chapter titles Survey Pre-Processing.

Option B - Batch Processing

This section introduces the Overview Menu Option A) BATCH PROCESSING. This type of processing is very convenient when you have multiple sets of B-files, E-files, and S-files in the same directory and wish to process them in an automated fashion.

When you choose this option, PNAV proceeds to Menu 1.0 PNAV BATCH PROCESSING SELECTION.

Menu 1.0 PNAV BATCH PROCESSING SELECTION

In this menu you can select between two methods of batch processing:

- Batching by file for kinematic processing. This method requires at least one file to contain only one sitename to act as the base file.
- Batching by site for rapid static processing. This requires one site to be designated as the fixed site. This may be done in the EDIT PROJECT screen.

For more information on these options see the chapter titled Batch Processing.

See the chapter *Program Input and Output Data Files* for a discussion of the format and data quality analysis of the the following PNAV output files.

Output Files

This section introduces the output files resulting from batch processing:

Table 4.1: Output Files

Item	Description
J-file	is an ASCII file containing the trajectory information and data processing information. By default the trajectory (rover relative position and velocity) is in the ENU coordinate system with the origin of the system at the _RBS or base site; PNAV can also output the data in XYZ coordinates.
C-file	is an ASCII file containing the WGS-84 coordinates (latitude, longitude, and ellipsoidal height) of the Rover's position for each epoch processed.
L-file	is an ASCII PNAV data processing log file containing a time-history of what occurred while PNAV was processing the data.
O-file	is a binary file containing a list of the averaged site positions that were occupied. It is compatible with O-files from the GPPS KINSRVY program.
Plot file	is an Ashtech-format plot file that graphically shows the trajectory and velocity of the Rover, as well as various statistics.
SUMMARY.OUT file	is an ASCII file containing the main processing input parameters and a summary of the results of processing.

Option C - Data Processing

This section introduces PNAV Overview Menu Option B) DATA PROCESSING. This option accesses a series of menus through which you can process the collected receiver measurement data from individual sets of B-files, E-files, and S-files located in the current directory. For details, see the following chapters later in this manual: *Data Processing* and *Setup Menus.*

When you choose this option, PNAV proceeds to Menu 3.0 PROGRAM EXECUTION MODE AND ROVER DYNAMICS.

Menu 3.0. Program Execution Mode and Rover Dynamics

In this menu, you set the options for EXECUTION MODE, PROCESSING MODE, and ROVER DYNAMICS. The defaults are displayed below the options. To choose another option, use the arrow keys to highlight the desired option, and press <ENTER>.

For more information about these parameters, see the chapter *Data Processing*, section *Menu 3.0. Program Execution Mode and Rover Dynamics.*

When you accept the selections by pressing <F10> on Menu 3.0, PNAV proceeds to Menu 3.1. PNAV DATA PROCESSING OPTIONS.

Menu 3.1. PNAV Data Processing Options

In this menu, PNAV searches for and displays the B-files available for processing in the current directory. You select the desired BASE FILE and ROVER FILE, the type of DATA TO PROCESS, whether to fix the integer ambiguities (FIX AMBS), and whether to use the pseudo-range smoothing corrections from the B-file (USE SMTHCOR).

The current selections are displayed at the bottom of the menu. To select another option, use the arrow keys to highlight the desired option, and press <ENTER>.

For more information about these parameters, see the chapter *Data Processing*, section *Menu 3.1. PNAV Data Processing Options.*

1. When you accept the selections on by pressing <F10> on Menu 3.1, PNAV:
    a. Uses the factory default display attributes from the PNAV.CNF file and the default parameter settings from the PNAVPMT.DFT file and creates the PNAV.PMT file in the current directory.
    b. Generates a COMMON.NAV file in the current directory, if one does not already exist.

c. Determines the data sampling interval, common start epoch, and common end epoch.

d. Checks the site position file PNAV.POS to determine if a position has been entered for the Base station (if **PROCESSING MODE: NAVIGATION** is selected in Menu 3.0).

2. If PNAV finds no position for the Base station it computes and displays an average position for the Base station. PNAV then asks whether to use this position. Enter <Y>.

If you are processing in Navigation Mode and a more accurate position for the Base station is available, enter it in the <Alt-P> Position Setup Menu.

3. PNAV then displays the PROCESSING SETUP MENUS screen.

Setup Menus

These menus allow you to further change PNAV control parameter settings.

You access Setup Menus with <Alt-?> hot-key commands. <Alt-?> means to hold the <Alt> key while pressing the second key, e.g. <Alt-A> means hold the <Alt> key and press <A>.

The available <Alt-?> Setup Menus are:

Table 4.2: Setup Menu Descriptions

Command	Description
<Alt-A>	Attribute: edit display attributes.
<Alt-F>	File: DISPLAY, FILE, AND OUTPUT SELECTION--set output data interval, select verbose/concise result display, turn on/off PNAV output files.
<Alt-K>	Kalman: Kalman Filter System Parameters and Kalman Filter Measurement Noise Parameters.
<Alt-O>	Other: PROCESSING EPOCHS, MATCH SITE ID and ROVER ANTENNA OFFSET.
<Alt-P>	Position: edit Base station and waypoint coordinates and antenna offsets when processing in the Navigation Mode.
<Alt-R>	RunTime: Run-Time Parameters
<Alt-W>	WayPoints

The <Alt-P> Menu is not available when processing in the Survey Mode because site information is in the file called PROJFILE.KIN rather than in the PNAV.POS file.

In general, the defaults in the Setup Menus are adequate for most processing. However, be sure that the correct Base station coordinate and antenna heights have been entered in the <Alt-P> Position Setup Menu (when processing in the Navigation Mode), and the antenna height for the Rover has been set in the <Alt-O> Other menu.

For more information, see the chapter *Setup Menus*.

Continue Processing

Once you are satisfied with the setup parameters, press F10 to continue processing. As PNAV processes the data, it shows the results and status of processing on the screen and saves the results to hard disk. Once it has finished processing, it returns you to the Overview Menu.

See the chapter *Program Input and Output Data Files* for a discussion of the format and data quality analysis of the the following PNAV output files.

Output Files

This section lists the output files resulting from data processing. After processing in Navigation Mode, PNAV has always created J-files and C-files and may have created optional R-files and/or L-files. After processing in Survey Mode, in addition to J-files, C-files, R-files, and/or L-files, PNAV may have created O-files.

Table 4.3: Processing Output Files

Command	Description
J-file	is an ASCII file containing the trajectory information and data processing information. By default the trajectory (rover relative position and velocity) is in the ENU coordinate system with the origin of the system at the _RBS or base site; PNAV can also output the data in XYZ coordinates.
C-file	is an ASCII file containing the WGS-84 coordinates (latitude, longitude, and ellipsoidal height) of the Rover's position for each epoch processed.
R-file	is an ASCII file for the complete rover position, compatible with R-file from GPPS KINSRVY program.
L-file	is an ASCII PNAV data processing log file containing a time-history of what occurred while PNAV was processing the data.
O-file	is a binary file containing a list of the averaged site positions that were occupied. It is compatible with O-files from the GPPS KINSRVY program.
SUMMARY.OUT file	is an ASCII file containing the main processing input parameters and a summary of the results of processing.

Option D - Post Mission

This section introduces PNAV Overview Menu Option D) POST MISSION. This option allows you to:

- Interpolate collected photogrammetry data.
- Create graphical plot files from rover trajectory output files (J-files) for subsequent viewing.
- Compare two navigation solutions (J-files or C-files).
- Convert binary O-files to ASCII.
- View results of processing.

When you choose this option, PNAV proceeds to Menu 4.0 POST MISSION DATA ANALYSIS:

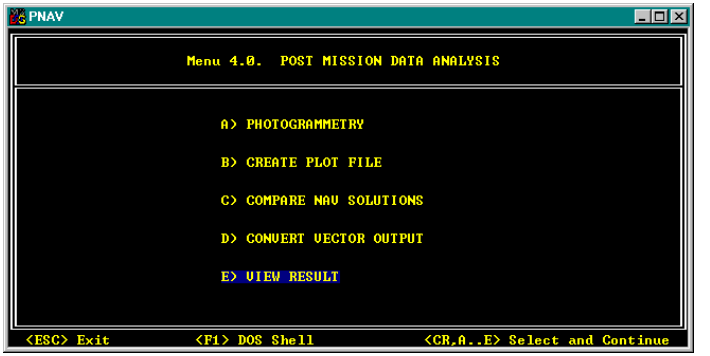

Figure 4.7: Post Mission Analysis Menu

The options in this menu are introduced below.

Option A - Photogrammetry

This option generates J*@- and C*@-files interpolated to the precise time tag of any photogrammetry files in the current directory.

1. When you select **A) PHOTOGRAMMETRY** in Menu 4.0, PNAV accesses the Select Photo-file for Interpolation menu.
2. When you select a file from that menu, PNAV performs the interpolation, and redisplays the Select Photo-file for Interpolation menu.
3. When you are finished, press <ESC> to exit to Menu 4.0.

Option B - Create Plot File

This option generates an Ashtech-format plot file that graphically shows the trajectory and velocity of the Rover, as well as various statistics.

If you selected Overview Menu Option B) BATCH PROCESSING, PNAV automatically creates plot files. If you selected Option C) DATA PROCESSING, you must select CREATE PLOT FILE to create plot files.

When you select B) CREATE PLOT FILE in Menu 4.0, PNAV automatically makes a plot file from any J-file in the current directory and returns to Menu 4.0.

Option C - Compare NAV Solutions

1. When you select **C) COMPARE NAV SOLUTIONS** in Menu 4.0, PNAV accesses the appropriate menu, typically:

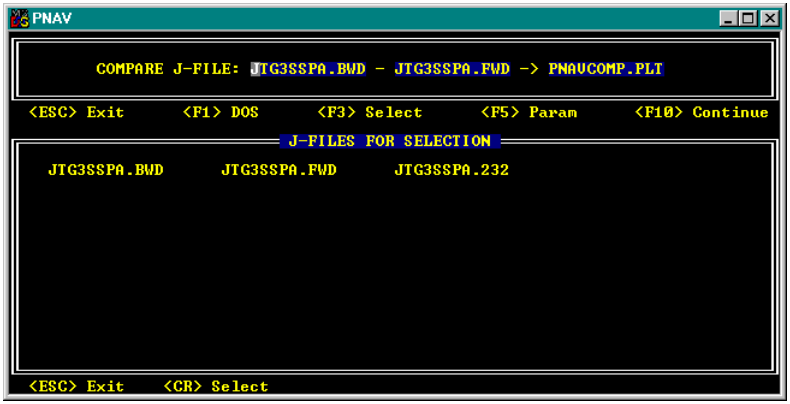

Figure 4.8: Compare NAV Solutions

2. For a detailed procedure, see the *Post Mission* chapter.
3. When you are finished, press <ESC> to exit to Menu 4.0.

Option D - Convert Vector Output

This option allows you to convert Ashtech binary O-files to ASCII V-files. you may then view the V-files earlier under Option E, View Results.

Option E - View Results

This allows you to conveniently view several types of output files on the screen.

Option E - PNAV Utility

This section introduces PNAV Overview Menu Option E) PNAV UTILITY. This option allows you to modify the default processing runtime and Kalman filter parameter settings in the Default Parameters file (PNAVPMT.DFT) and run B-file utility functions.

When you choose this option, PNAV proceeds to Menu 5.0 PNAV UTILITY:\

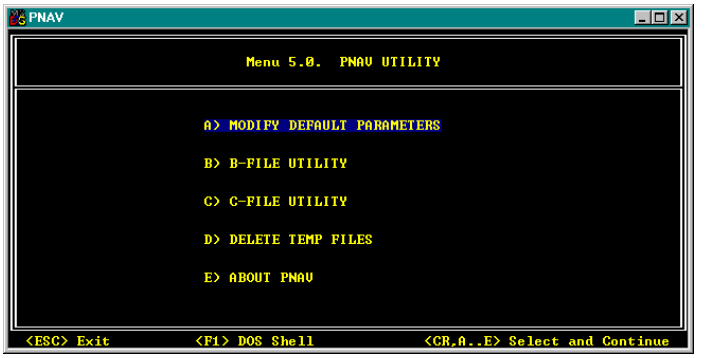

Figure 4.9: PNAV Utility Menu

The options in this menu are introduced below.

Option A - Modify Default Parameters

This option lets you modify the full set of runtime and Kalman filter parameters for subsequent use in processing.

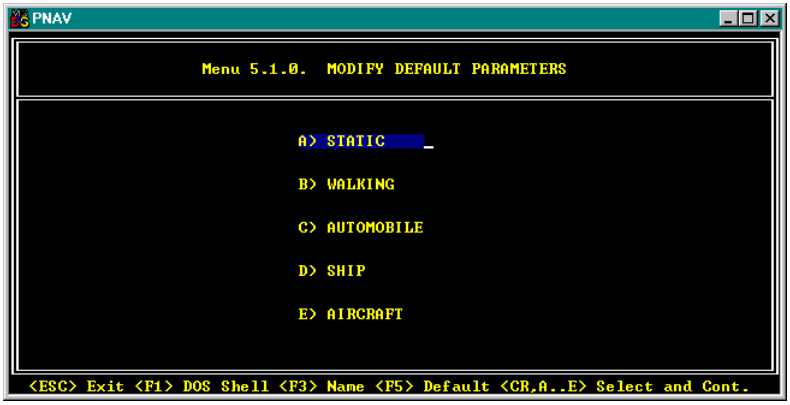

Figure 4.10: Modify Default Parameters

These options correspond to the ROVER MOTION DYNAMICS displayed in the PNAV POST-PROCESSING OPTIONS (<F3> command) submenu accessed via Overview Menu Option B) BATCH PROCESSING menu and in MENU 3.0. PROGRAM EXECUTION MODE AND ROVER DYNAMICS accessed via Overview Menu OPTION C) DATA PROCESSING.

4. When you select one of these options PNAV displays the appropriate MODIFY DEFAULT PARAMETERS Setup Menu Screen, e.g., for option **A) STATIC**, observe:

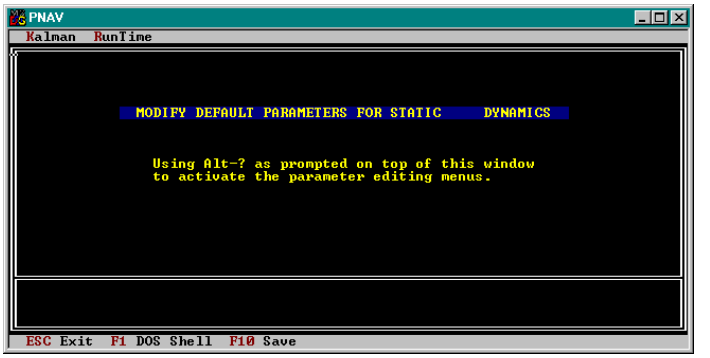

Figure 4.11: Modify Default Static Parameters

5. To specify the default parameters for all subsequent runs of Overview Menu Option B) BATCH PROCESSING or Overview Menu Option C) DATA PROCESSING, press the <Alt-K> Kalman or <Alt-R> RunTime keys to access the corresponding Setup Menus. For a description of these menus, see the *Setup Menus* chapter.
6. Once you have set the parameters as desired, press <F10> to **Save** them, and then press <ESC> to exit to Menu 5.1.0.

Option B - B-File Utility

This option is described in the *PNAV Utility* chapter.

Option C - C-File Utility

This option is described in the *PNAV Utility* chapter.

Option D - Delete Temp File

This option is described in the *PNAV Utility* chapter.

Option E - About PNAV

Displays the current PNAV version number.

Evaluating Your Results

This section describes the criteria for evaluating the output from processing in the Navigation Mode and in the Survey Mode.

Navigation Mode

In Navigation Mode, every epoch of data processed can be considered as a separate solution since both a unique relative position vector and a Rover position are calculated for each epoch. Solution statistics are also calculated for each epoch in order to provide the capability to evaluate the accuracy of the results.

The solution statistics can be viewed in two ways:

- epoch-by-epoch from the Processing Results Screen (Verbose or concise) during processing, or
- for the entire session from either the plot generated in the Post Mission menu or in the output C-file and J-file.

The important statistics are the RMS position error (RMS), the chi-square (CHI2) value, and the phase residual (RESID). The RMS is the one-sigma position error in meters. The CHI2 is a goodness-of-fit solution-quality indicator (unitless). The RESID is the averaged post-fit carrier-phase residual in meters. The RMS indicates the accuracy of the solution, and the CHI2 and RESID indicate the goodness-of-fit or quality of the solution.

The RMS can be trusted to indicate the correct accuracy of the position only if the CHI2 is less than 1.0 and the RESID is less than 0.02 meters or below the RESID threshold. If either the CHI2 or the RESID is above these cutoff values, then the RMS value is not valid.

The RESID threshold is by default 0.02 + (1.5 ppm * baseline length). For details on RESID threshold, see the *Program Input and Output Data Files* chapter, *J-file* section, *Chi^2 and Averaged Carrier Phase Residual (RESID)* paragraph.

Besides checking the absolute values of CHI2 and RESID, check the time history of these parameters by examining the plot file. When the CHI2 or RESID ramps up when fixing the integer ambiguities and reaches the thresholds, it usually indicates the integer ambiguities are not fixed correctly. A sudden increase in the CHI2 or RESID indicates that there are small cycle slips.

We recommend that you watch these statistics during processing to get an idea of the quality of the results, but use either the plot file or the output J-file or C-file to evaluate the session as a whole.

Survey Mode

Examine the results as described above for the navigation mode or examine the SUMMARY.OUT file or the O-file. A solution is considered to be reliable if the following criteria are met:

- CHI2 < 1.0 and consistent with the other CHI2 values for the other vector solutions in the session.
- standard deviation within the desired accuracy limits.
- RESID < RESID threshold. (See the chapter *Program Input and Output Data Files*, *J-file Format* section for a discussion of CHI2 and RESID parameters.)
- When **Lowest RATIO** is 95% or more, the solution is a fixed solution.
- When Lowest RATIO is less than 95%, the solution is a float solution.

Survey Mode Processing Hints

This section describes hints for reprocessing survey data.

Default Processing Results Unsatisfactory

1. Change **Search Algorithm** from **3** (default) to **1** or **2**.
2. Depending on how the data was collected you may or may not wish to reset ambiguities at the static sites. To reset this parameter for each static site in the rover file, select **RESET Y**es via the EDIT LOGTIME screen, SITE popup; otherwise, select **RESET N**o.
3. Verify that the LOGTIMES file shows a continuous time flow. Jumps in time in the LOGTIMES file will cause PNAV to reset the ambiguities.

If you reprocess a data set, be sure to reset the knowness of the rover static sites to 9 EDIT PROJECT [EDIT SITE] screen).

If you wish to speed up the processing, switch to the concise mode during processing.

Exiting PNAV

To exit PNAV to the WinPrism/PROCESS/MANUAL/KINEMATIC/PNAV flowchart screen, press <ESC> from the Overview Menu.

Navigating PNAV Screens

PNAV provides three screen types: selection menus (e.g. Overview Menu, Menu 1.0, Menu 3.0, Menu 4.0, Menu 5.0), setup menus (<Alt-?> menus), and display windows. In these screens, PNAV typically accepts function key <F?> commands.

Selection Menus

These contain option selection fields. To select among options:

- Use the arrow or <TAB> keys to highlight the desired option and then press <ENTER>.

[or]

- Type the letter opposite the desired option.

Setup Menus (<Alt-?> Menus)

To select among the listed menus, press the corresponding Alt-? hot-key combination. Within these menus, to edit, use the arrow keys to move the cursor to the desired data entry field, and then type alphanumeric characters.

Display Windows

No option selection fields or data entry fields. The data fields are display only, there are function key commands; e.g., press the <ESC> key to quit current processing and the window.

Function Key <F?> Commands

Some screens accept function key <F?> commands, listing those available. Normally, in all screens, <F10> means continue to next step, while <ESC> means exit from the current display.

For example, in a typical PNAV Overview Menu screen:

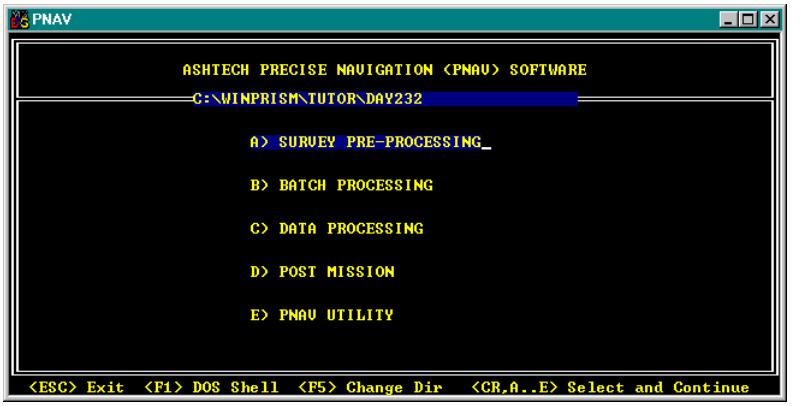

Figure 4.12: PNAV Overview Menu

- To select option **D) POST MISSION** and continue to the next menu level, type **D**, or highlight the option and press **<ENTER>**.
- To exit PNAV and return to the WinPrism Process screen, press the **<ESC>** key.
- To shell out temporarily to DOS, press the **<F1>** function key.
- To change directories, press **<F5>**.

Mouse-Driven Interface

You now have the ability to use your mouse to run PNAV, besides the original keyboard control. The PNAV screens have not changed for this specific addition (there are changes for other functionality additions). There are three ways to use your mouse:

Function Keys

Instead of pressing keys to activate choices (e.g., F10) you may clock on the equivalent “button” along the bottom of the screen. The “button” is the key code part of the test, which is withing < > in most of the cases. For example:

```
<ESC> Exit <F1> DOS Shell <F5> Change Dir <CR,A..E> Select and Continue
```

You must click on any of the character in ESC in order to activate <ESC> Exit function, on any of the character in F1 in order to activate <F1> Dos Shell function.

In this document, whenever you are instructed to press a function key, you may also click on the “button” on the screen with a mouse.

Edit Fields

Several menus allow you to edit data directly on the screen - an example is editing run-time parameters (ALT-R menu). You may still use the arrow and TAB keys to traverse from field to field, but a more convenient method is to click directly on the desired item and edit it.

Menu Choices

Whenever you are presented with a menu you may select any one of the items in the list by clicking on it. Note that this also applies when a list of files/options is presented for you to choose from.

Survey Pre-Processing

This chapter describes how to create and edit a project file and a logtimes file. If you are running PNAV from WinPrism, you will already have created these files. However, you may edit them in PNAV as detailed here. PNAV Overview Menu option A) SURVEY PRE-PROCESSING accesses a series of menus through which you can pre-process data collected via survey methodologies. The resulting project and logtimes files are used in subsequent processing in the Survey Mode via Overview Menu option B) BATCH PROCESSING or C) DATA PROCESSING. When you choose this option, PNAV accesses Menu 2.0 SURVEY PRE-PROCESSING and creates logtimes and project files (if they do not already exist) using receiver measurement data from B-files, E-files, and S-files located in the current directory.

This option generates the logtimes and project files required for subsequent data processing in the Survey Mode; if you will process your data in Navigation Mode, omit survey pre-processing.

1. Select PNAV Overview Menu option A) SURVEY PRE-PROCESSING.
2. PNAV checks whether the current directory contains the following files: PROJFILE.KIN, COMMON.NAV, and LOGTIMES; if any are missing, PNAV reads the B-, E-, and S-files in the current directory to create the missing files.
3. PNAV then displays Menu 2.0 SURVEY PRE-PROCESSING:

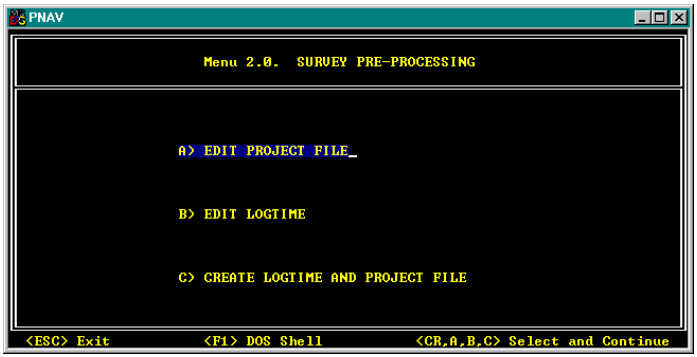

Figure 5.1: Menu 2.0 SURVEY PRE-PROCESSING

In this screen you can select the options A) EDIT PROJECT FILE, B) EDIT LOGTIME and C) CREATE LOGTIME AND PROJECT FILE

Option A) Edit Project File

The project file contains, for each site in the input B-files: site name; description; session; knowness; position in latitude, longitude, and ellipsoidal height; and position in XYZ coordinates.

1. When you select A) EDIT PROJECT FILE in Menu 2.0, PNAV opens a window into the project file, typically:

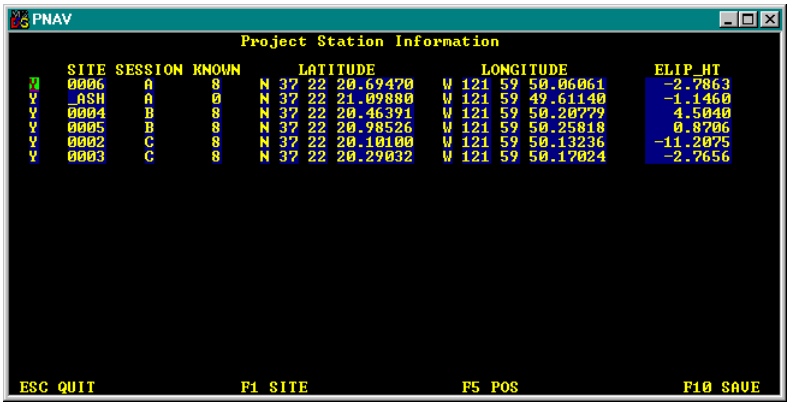

Figure 5.2: Project Station Information

2. You can change any of the data entry fields in this screen except SITE and SESSION; move the cursor to the field and type in the desired value.
3. Press <PAGE UP>/<PAGE DOWN> to scroll through the file.
4. For further editing, <F1> accesses the SITE popup menu, and <F5> accesses the POSition popup.

<F1> SITE Command

This command accesses a popup menu for editing additional site information for the line item where the cursor resides in the Project Station Information screen. Press <F1>, and observe, typically:

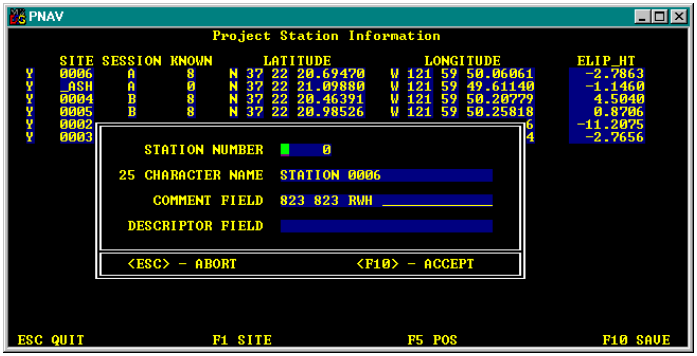

Figure 5.3: Additional Site Information Screen

You can select and type desired changes to the fields: STATION NUMBER, 25 CHARACTER NAME, COMMENT FIELD, and DESCRIPTOR FIELD. You control the application of any changes with keys <ESC> - ABORT and <F10> - ACCEPT.

<F5 POS> Command

This command accesses a popup menu for editing the site position for the line item where the cursor resides in the Project Station Information screen. Press <F1>, and observe, typically:

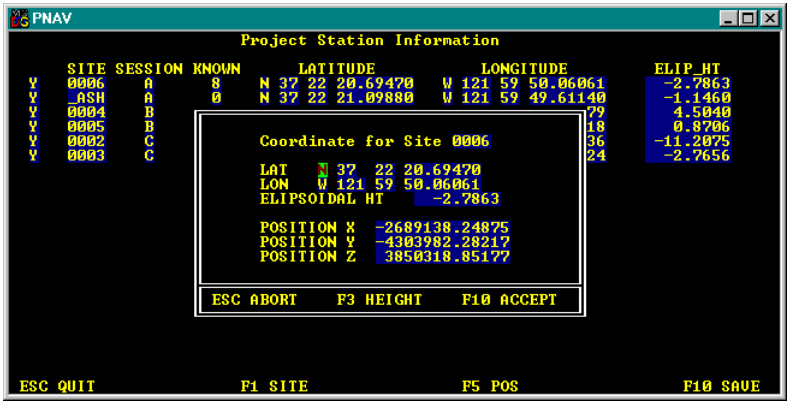

Figure 5.4: Site Position Screen

LAT, LON, and ELLIPSOIDAL HT Data Entry Fields

are the same as LATITUDE, LONGITUDE, and ELIP_HT in the Project Station Information screen.

POSITION X, POSITION Y, and POSITION Z Data Entry Fields

are WGS-84 Cartesian coordinates, the distances in meters from the geocenter; they are the Cartesian equivalent of the Latitude/Longitude/ Ellipsoidal Height.

You can select and type desired changes to the fields, and PNAV will translate them into Latitude/Longitude/Ellipsoidal Height (and vice-versa) on the lines above in the popup and in the Project Station Information screen. You control the application of any changes with the keys <ESC> - ABORT and <F10> - ACCEPT.

<F3> HEIGHT Command

This command accesses a popup menu for editing GEOIDAL HEIGHT and MEAN SEA LEVEL for the line item where the cursor resides in the Project Station Information screen. Press <F1>, and observe, typically:

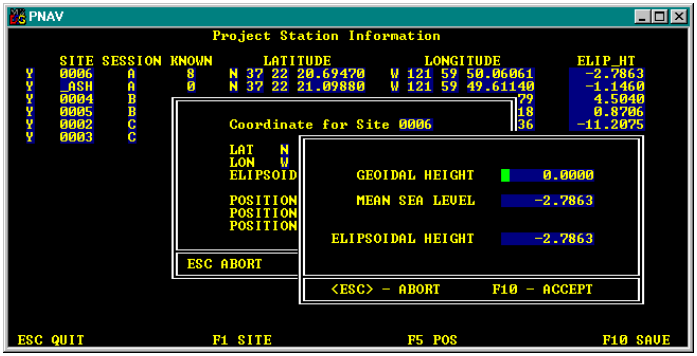

Figure 5.5: Last Site Line Screen

You can select and type desired changes to the GEOIDAL HEIGHT and MEAN SEA LEVEL fields from which PNAV automatically computes ELLIPSOIDAL HEIGHT and inserts it in the F5 POS popup menu and in the Project Station Information screen.

If a site is marked as "F", you are stating that the site is to remain fixed in process; therefore the KNOWNESS will automatically be set to "0" and vice versa.

If a site is marked with a "S" the LOGTIMES will automatically by modifed for antenna swap processing. A ? SSS will be inserted at the beginning of the swap point specified.

<F10> SAVE Command

Saves any changes to this screen for subsequent use by Overview Menu options B) BATCH PROCESSING or C) DATA PROCESSING.

<ESC> QUIT Command

Quits this menu without saving any changes.

SITE Data Display Field

Site identifier; you cannot edit this field.

SESSION Data Display Field

Session identifier; you cannot edit this field.

KNOWN Data Entry Field

Degree of knowness

Knowness is the accuracy to which this site's position is known. A 9 indicates that the position is completely unknown. A "0" specifies that the site's displayed coordinates are to be used as a fixed control. The following tabulates knowness with the RMS position in meters:

Table 5.1: RMS Position Knowness and Meaning

KNOWN	MEANING
0	RMS = 0
1	0 < RMS ≤ 0.01m
2	0.01m < RMS ≤ 0.05m
3	0.05m < RMS ≤ 0.1m
4	0.1m < RMS ≤ 0.5m
5	0.5m < RMS ≤ 1m
6	1m < RMS ≤ 5m
7	5m < RMS ≤ 10m
8	10m < RMS ≤ 200m
9	RMS > 200m

When you enter a 0 for a fixed control site, PNAV computes all baseline vectors from that site to the other sites. After processing is complete, the project file contains positions with a knowness based on the resultant RMS of the baseline solution.

You must set the KNOWNess to 0 for the base station SITE identifier and select the B-file corresponding to that base station via Overview Menu option A) DATA PROCESSING, Menu 1.2 PNAV DATA PROCESSING OPTIONS, in the BASE FILE selection field.

LATITUDE Data Entry Fields

Four fields: quadrant (N or S) - degrees - minutes - seconds to five decimals

LONGITUDE Data Entry Fields

Four fields: quadrant (E or W) - degrees - minutes - seconds to five decimals

ELIP_HT Data Entry Field

Ellipsoidal height, distance from the WGS84 reference ellipsoid in meters.

Option B) Edit Logtimes

The LOGTIMES file contains information on the time intervals each site was measured for a set of GPS receivers. The LOGTIMES file lists all site identifiers for all the receivers that collected data during common time intervals and shows the common time intervals. (It applies to the B-, E-, and S-files in the current directory.) Each line is a logtime interval, that is, a period of time. Whenever the site identifier changes in any of the receivers, a new interval is created.

IMPORTANT
Ensure that the time in the LOGTIMES file is contiguous. If there is a break in the time somewhere in the LOGTIMES file, PNAV will assume that there is a break in the data as well.

1. When you select B) EDIT LOGTIME in Menu 2.0, PNAV opens a window into the logtimes file, typically:

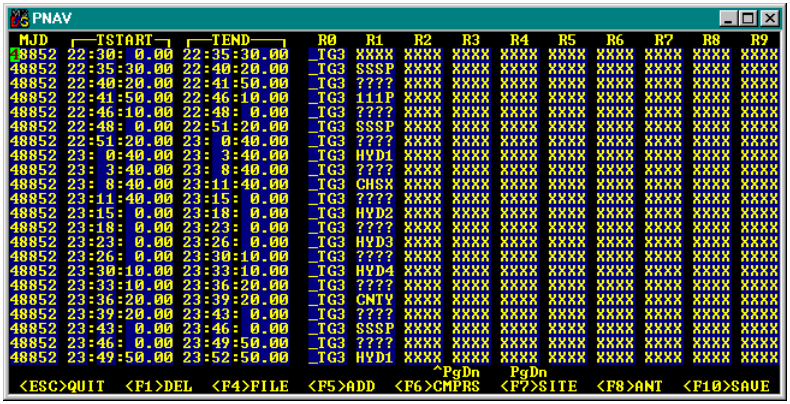

Figure 5.6: Edit Logtime

where:

Table 5.2: Edit Logtimes Field Information

Field	Description
MJD	Modified Julian Day
TSTART	Start time of occupation (UTC); start of the time interval in hours, minutes, and seconds (to two decimals).
TEND	End time of occupation (UTC); end of the time interval.
R0 to R9	Site names corresponding to receivers 0 to 9. These are site names that are entered via receiver menu 9 during kinematic site occupations. Each column label corresponds to a given receiver, and the data in the column identifies the receiver file (B-file) obtained from each site. A base receiver would have the same site identifier throughout the list. A roving receiver has an alphanumerical identifier while sitting on a point, and while moving to a new site the rover identifier is ????. If the site identifier in any receiver changes, a new interval is created.

2. You can change any of the data entry fields in this screen; move the cursor to the field and type in the desired value.
3. Press <PAGE UP>/<PAGE DOWN> to scroll through the file.
4. For further editing, <F7> accesses the SITE popup menu, and <F8> accesses the ANT HT popup.

<F1> DEL LINE Command

DELetes the LINE where the cursor resides in the Edit Logtime screen.

<F4> FILE Command

Displays the file name for each receiver.

<F5> ADD LINE Command

ADDs a logtime line after the line where the cursor currently resides in the Edit Logtime screen. The new logtime line is identical to the logtime line after the line where the cursor currently resides.

<F6> Compression of similar lines

After editing the logtimes screen, you may have two or more consecutive lines that have similar entries, i.e., the site names for each receiver do not change for two or more slots in the logtimes table. You can essentially refresh the display by pressing the F6 key - this will cause ELOG to scan through the logtimes list and combine any such similar lines into a single entry in the table. This serves to reduce confusion.

<F7> SITE Command

This command accesses a popup menu for editing the site identifier for each of the ten possible receivers in the logtimes line where the cursor resides in the Edit Logtime screen, e.g., for the first line, typically:

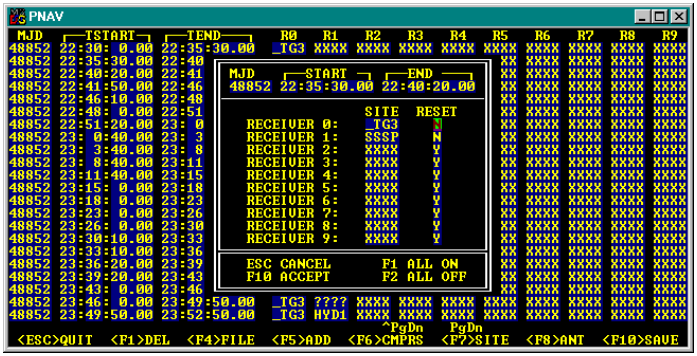

Figure 5.7: Edit Logtime Screen

Table 5.3: Edit Logtimes Screen Field Description

Field	Description
SITE Data Display	Identifies the site name for each receiver RX column in the Edit Logtime screen.
RESET Data Entry	Each RECEIVER X data field row lists whether to reset the ambiguities for the static site (default Yes) and matches the corresponding RX column in the Edit Logtime screen; type Y or N. If the data was collected by the fast static method, enter Yes; if it was collected by the kinematic method, enter No.
ESC CANCEL Command	Removes the popup without changing any values.
F10 ACCEPT Command	Accepts the values and removes the popup.
F1 ALL ON Command	Resets the ambiguities for the static site for all receivers in the popup menu and all RX columns in the Edit Logtime screen.
F2 ALL OFF Command	Does not reset the ambiguities for the static site for all receivers in the popup menu and all RX columns in the Edit Logtime screen.

<F8> ANT HT Command

This command accesses a popup menu for editing the antenna parameters (slant height, radius and offset) for each of the ten possible receivers in the Edit Logtime

screen in the logtimes line where the cursor resides, e.g., for the second line, typically:

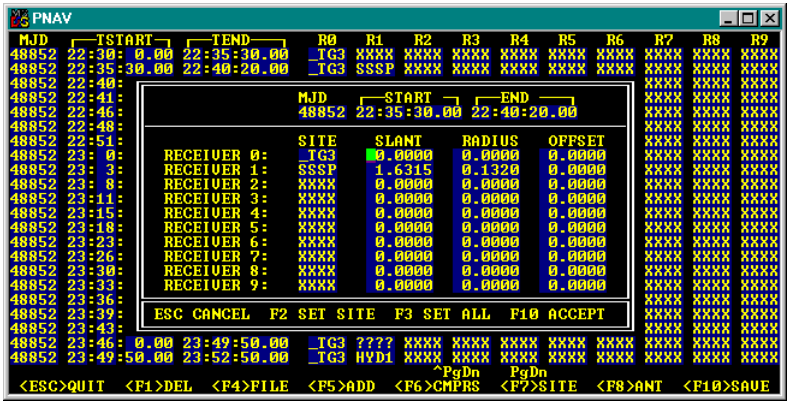

Figure 5.8: Antenna Parameters Screen

Because the antenna height is associated with time, the field operator can have different antenna heights for revisits to a point during the same session. You can use this popup screen to correct the difference between the antenna and the point. Since it is difficult to measure from the point directly to the center of the antenna, the field survey crew measures from the point to the edge of the antenna platform, along a slant. (The Ashtech sectioned measuring rod [HI rod for height of instrument] facilitates this task when used with an Ashtech antenna.) PNAV uses slant height, radius, and added offset (if any) to compute the actual vertical distance from point to antenna center. Check the slant height number and compare it with the field survey data sheets to be sure the number has been entered correctly.

PNAV reads the initial default values of SLANT, RADIUS, and OFFSET from the S-file corresponding to the display SITE identifier.

Table 5.4: Antenna Edit Fields

Field	Description
SITE Data Display Field	Site identifier; you cannot edit this field
SLANT Data Display Field	Distance from the mark to the edge of the antenna.
RADIUS Data Display Field	Distance from the center to the edge of the antenna. If the Topcon HI rod is used to make the measurement with a Revision B Topcon geodetic antenna, the radius from the antenna center to the measurement mark of the "dogleg" HI rod hole is 0.132 meter. (This radius will vary with the type of antenna used.)

Table 5.4: Antenna Edit Fields (continued)

Field	Description
OFFSET Data Display Field	Any additional vertical offset between: • The plane where the slant is measured and the actual antenna phase center, or, • The point from which the slant antenna height is measured and the actual station mark.

You are also able to change the antenna height for all occurences of a particular site ID within a single receiver column. To do this:

1. Select the occupation you wish to change by moving the cursor to the appropriate line.
2. Enter the correct values for the slant, radius and offset of the antenna.
3. Press <F2> to propagate this change through all occupations with this site name for this receiver.
4. You will be prompted if you wish to make this change. Press Y to accept, N to cancel all changes.

<F3> SET ALL Command

Sets the SLANT, RADIUS, and/or OFFSET of all the sites for the RECEIVER X line where the cursor resides to the value listed in the field where the cursor resides.

<ESC> CANCEL Command

removes the popup without changing any values.

<F10> ACCEPT Command

accepts the values and removes the popup.

<F10> WRITE Command

Saves any changes to this screen for subsequent use by Overview Menu option B) BATCH PROCESSING or C) DATA PROCESSING.

<ESC> QUIT Command

QUITs the Edit Logtime screen without saving any changes and returns to Menu 2.0 SURVEY PRE-PROCESSING.

New sites entered in LOGTIMES will automatically use approximate coordinates based on those of nearby sites, to make adding coordinates easier.

An antenna swap file pair will always be processed first regardless of where they appear in the LOGTIMES to allow automatic initialization.

<F4> displays the file name for each receiver.

LOGTIMES and PROJFILE.KIN are crossed checked to ensure all sites are included and there are no unused sites.

Option C) Create Logtime and Project File

When you select C) CREATE LOGTIME AND PROJECT FILE in Menu 2.0, PNAV reads the B-files and S-files in the current directory, re-creates the logtimes file (LOGTIMES) and project file (PROJFILE.KIN), and returns to Menu 2.0.

This option is used if the logtimes and/or project file has been modified and you want to recreate the original project and logtimes files. PNAV recreates the files from the raw data.

Batch Processing

This option accesses a series of menus through which you can process the collected receiver measurement data from multiple sets of B-files, E-files, and S-files located in the current directory. Before selecting batch processing, ensure that:

- The current directory contains at least two sets of B-files and E-files, a LOGTIMES file, and a kinematic project file (PROJFILE.KIN).
- At least one of the B-files has data collected only from one static site throughout the data collection period. This site is called the control site (or fixed site). (See the *PNAV and Your Application* chapter for field procedures.)
- LOGTIMES has been edited (via the WinPrism/PROCESS/EDIT LOGTIME screen) to ensure that:
  - All the site names were entered correctly at the receiver and are valid.
  - All sites between which you want to process baselines share common collection intervals.
  - Antenna heights are correct.
  - The reset parameter is correct.

(For details, see the *Process User's Guide, Program Reference* chapter, *Edit Logtime Option* section.)

- PROJFILE.KIN has been edited (via the WinPrism/PROCESS/EDIT PROJECT [EDIT SITE] screen) to:
  - Set the control site knowness to 0 and enter its correct position in WGS84 coordinates.
  - Enter the appropriate coordinates for new sites added to the LOGTIMES file.

(For details, see the *Process User's Guide, Program Reference* chapter, *Edit Project Option* section.)

- The default runtime and Kalman filter parameters have been edited to suit your processing needs via PNAV Overview Menu Option E) PNAV UTILITY/ MODIFY DEFAULT PARAMETERS. (See the corresponding chapter for details.)

When you choose this option, PNAV proceeds to Menu 1.0 PNAV BATCH PROCESSING SELECTION.

If there are more than 10 Kinematic or rapid static files in a directory, the COMBFILE utility should be run (See Option E - Merge B-files under the PNAV Utility Menu). If this utility is not run, a Windows system error may occur.

Menu 1.0 PNAV BATCH PROCESSING SELECTION

Select from the PNAV Overview Menu, Option B) BATCH PROCESSING, and observe typically:

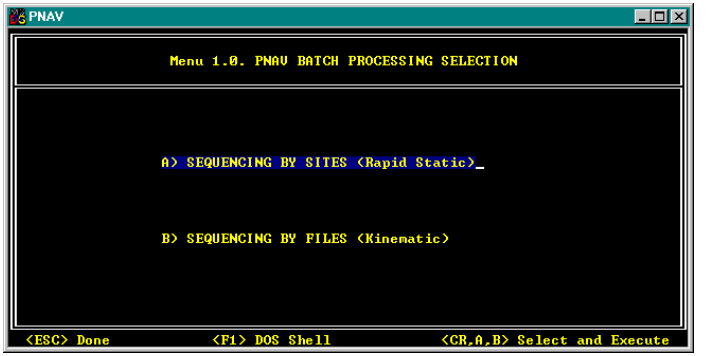

Figure 6.1: PNAV Overview Menu

In this menu you can select between two methods of batch processing:

- Batching by site for rapid static processing. This requires one site to be designated as the fixed site. This may be done in the EDIT PROJECT screen.
- Batching by file for kinematic processing. This method requires at least one file to contain only one sitename to act as the base file.

Each of these will be covered in turn.

Option A) Sequencing by Sites (Rapid Static)

Static GPS survey techniques have enabled the achievement of relative accuracies which were difficult or even impossible with terrestrial methods. High accuracy surveys can now be performed over large areas in a fraction of the time it took 10 years ago. As receiver hardware and processing software technology advance, surveyors spend less and less time occupying each station to attain desired results. “Rapid Static” or “Fast Static” surveying has evolved as the result of surveyors demanding more economical ways to use GPS and Ashtech continues to be at the forefront of this evolution.

The term “Rapid Static” is not a particularly well defined term throughout the GPS Survey industry due to the continuing advances in technology, it can however be defined with respect to Ashtech hardware and PNAV software. For example, a Z-12 (dual-frequency) user making uninterrupted measurements to 6 or more satellites above 10° and PDOP < 4, expecting to fix carrier phase ambiguities should spend about 5 min for baselines up to 5km. For baselines in the 5-20 km range, add 1min for each additional 2 km. For baselines longer than 20 km, add 1 min of occupation time for each additional 1km. Single frequency users making uninterrupted code and carrier phase measurements to 6 or more satellites above 15° and PDOP < 4, expecting to fix ambiguities should plan to spend a minimum of 15 min occupying baselines up to 5 km. For baselines in the 5-10 km range, add 1 min of occupation time per 1km of distance.

Table 6.1 offers a rough guideline for site occupation time, assuming the receiver is uninterrupted tracking of six or more satellites.

Table 6.1: Time Guideline

Baseline Length	Occupation Time (dual frequency)	Occupation time (single frequency)
Up to 5km (3 miles)	5 minutes	15 minutes
10km (6 miles)	8 minutes	20 minutes
20km (12.5 miles)	15 minutes	-
30km (19 miles)	20 minutes	-

Rapid Static Batch Processing (Tutorial)

PNAV has the ability to batch process entire Static or Rapid Static survey jobs with a single control site and a single setup. The following is a description of Rapid Static Batch survey processing with a typical network and setup configuration. This discussion does not cover the subjects of network design and specific field procedures. The default settings used with BATCH PROCESSING are optimized for most situations. For custom setup of parameters, refer to WinPrism/PNAV documentation, Change Default Parameters. For a verification of the positions yielded by PNAV processing, a network adjustment should be performed. The user is assumed to have basic knowledge of PNAV software, and GPS field procedures to perform this tutorial, if this is not the case please refer the WinPrism documentation.

Network Configuration and Observation Scheme

The network consists of one point which is precisely known (_ASH), and five new points which are to be surveyed.

Table 6.2: List of Sites

Station	Latitude	Longitude	Ellipsoid Height	Instrument Height
_ASH	N 37 22 21.05436	W 121 59 50.36578	-14.813m	1.790m
0002	To be determined	To be determined	To be determined	1.890m
0003	To be determined	To be determined	To be determined	2.061m
0004	To be determined	To be determined	To be determined	2.061
0005	To be determined	To be determined	To be determined	1.890m
0006	To be determined	To be determined	To be determined	2.061m

The observation scheme consists of three sessions of three stations each. The first session will include the previously known site (_ASH) and the following sessions will "leapfrog" ahead with each session providing one reference site for the following:

Table 6.3: Sessions

Session	Session B	Session C	Combined B-file name
_ASH	0005	0003	B_ASHA94.131
0006	0004	0006	B0006A94.131
0005	0003	0002	B0005A94.131

Data Processing

All data was collected into 9 sets of B/E/S files. This tutorial data is supplied with your WinPrism software package.

1. Begin by locating the tutorial raw data files to be processed in a DOS directory. These files are located in the TUTOR/RAPSTAT directory, found in the WinPrism Installation directory. If performing actual work, it is advisable to create a directory for each job and to backup original raw data files in another location before processing.
2. Start WinPrism, set the working directory to the one which contains tutorial raw data files.
3. Select PROCESS icon from WinPrism/MAIN menu and select KINEMATIC survey type.

4. Select PNAV icon to set the initial reference position for the batch job. Set the “knowness” of the reference site (site _ASH in this tutorial) to “0” and enter the known coordinate values into the appropriate fields. Refer to Table 1 for coordinates of site _ASH then select elect ACCEPT.
5. Select the PNAV icon from the WinPrism/PROCESS screen to enter PNAV main menu:

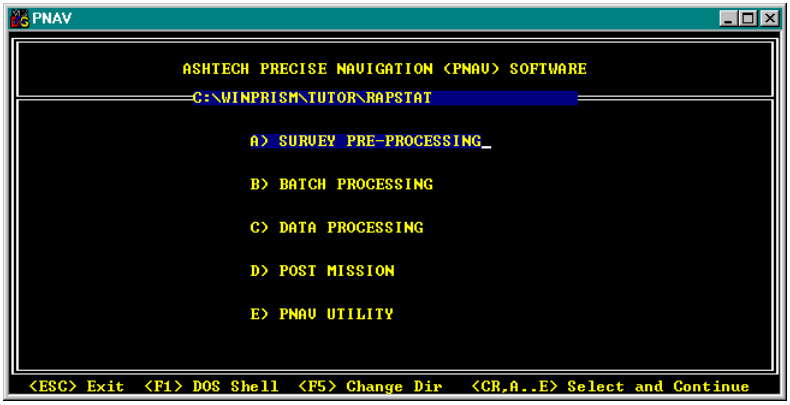

Figure 6.2: PNAV Software

6. In PNAV Main menu select B) BATCH PROCESSING. This leads to menu 1.0 PNAV BATCH PROCESSING SELECTION
7. In Menu 1.0 PNAV BATCH PROCESSING SELECTION. Select A) SEQUENCING BY SITES (Rapid Static). This leads to MENU 2.0 SURVEY PRE-PROCESSING.
8. In Menu 2.0 SURVEY PRE-PROCESSING, select B) EDIT LOGTIMES. At this stage you should see all the site ID’s and occupation times for the stations which are to be determined. Verify that all the sites are present in this display. Next, verify that the correct site ID’s correspond with the appropriate session time spans. If you will notice, some combinations do not appear to fit the scheme as described in Table 6.3. Misnamed sites often occur in survey jobs as they do in our example. The LOGTIMES file allows

the correction of these cases. The LOGTIMES without any editing looks as follows:

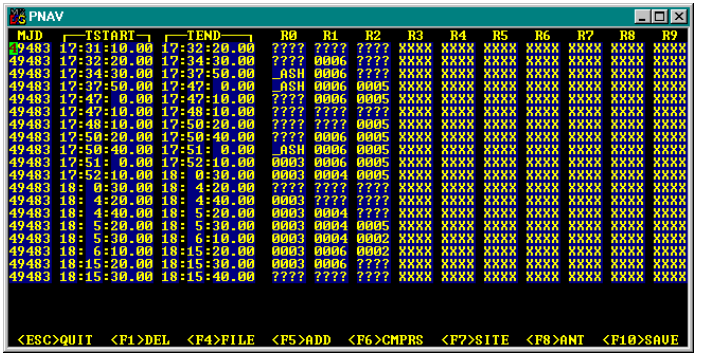

Figure 6.3: LOGTIMES unedited

In sessions B & C there are misnamed sites that are showing up in the LOGTIMES. There are two ways to change these site names (IDs).

- If you have a record of the site names, you can change the site name to match your record. For example, in session B, site 0006 in receiver #1 should be changed to 0004, site _ASH in receiver #1 should be changed to 0003; in session C, site 0004 in receiver #2 should be changed to 0006, site 0005 in receiver #2 should be changed to 0002. or
- If you don't have a record of the site names, but you are sure that the last site in each session is correct, you can then change the incorrect site name to ????. In this example, in session B, site 0006 in receiver #1 should be changed to ????, site _ASH in receiver #2 should be changed

to ????; in session C, site 0004 in receiver #1 should be changed to ????, site 0005 in receiver #2 should be changed to ????.

After this editing is completed, the LOGTIMES sessions should match those in Table 6.3. Selecting <F6> CMPRS will compress similar logtimes lines. The resulting LOGTIMES should look like:

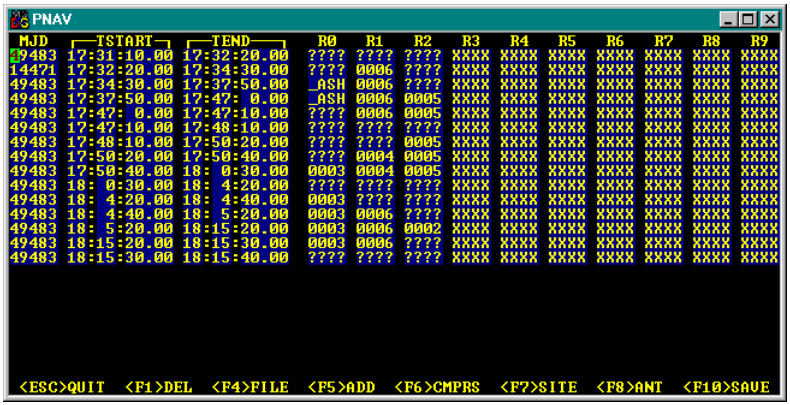

Figure 6.4: Resulting LOGTIMES

Select <F8> ANT to verify that all antenna heights match those displayed in Table 6.2.

Antenna heights for _ASH wasn't entered in the receiver, an antenna height of 1.79 should be entered here).

Select <F10> SAVE and select <ESC> to return to Menu 2.0 SURVEY PRE-PROCESSING.

9. In Menu 2.0 SURVEY PRE-PROCESSING, press <F10>. This leads to Menu 1.1.0 PNAV SITE BATCH DATA PROCESSING.

10. 10. In Menu 1.1.0 PNAV SITE BATCH DATA PROCESSING, select A) PROCESS ALL COMBINATIONS

    PNAV will process all 9 vectors. A typical processing status screen looks like

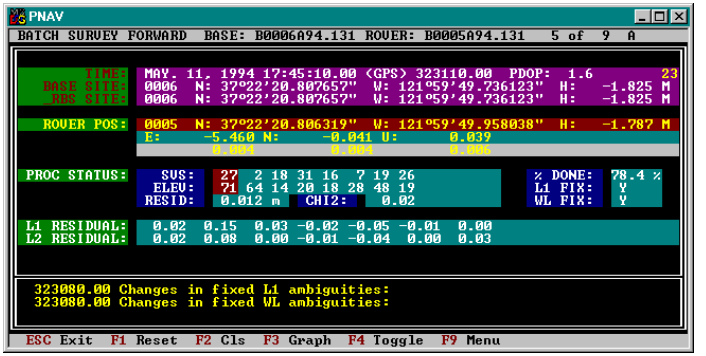

Figure 6.5: Status Screen

This screens shows that it is processing vector 0006 to 0003 in session C, it is 5th vector of the total 9 vectors.

After finishing the processing, PNAV brings you back to the main menu.

11. In the main menu, select D) POST MISSION. In next screen Menu 4.0 POST MISSION DATA ANALYSIS, select E) VIEW RESULT. In next screen Menu 4.5.0 VIEW DATA PROCESSING RESULTS, you can select A) SUMMARY.OUT to view the following SUMMARY.OUT file.

```
            Ashtech, Inc.    Program: PNAV     Version: 2.3.00M
Fri Oct 04 14:22:57 1996
Processing direction       : Forward
Processing mode            : SURVEY
Data sample period (sec)   :  10.00
Data type being processed  : PL1-code/PL2-code/PL2-phase/CAL1-phase/
Ambiguity search algorithm : Min QF search

           BASE  ROVR  LENGTH(m)  Std(m) Resid(m) Chi2   T(m) SVs DOP  Comment
A  R  X  Y  _ASH  0005      11.870   0.009  0.007   0.045   5.2  8  1.3
A  R  X  Y  _ASH  0006       9.015   0.008  0.007   0.035  12.3  8  1.4
A  R  X  Y  0006  0005       5.461   0.008  0.007   0.046   5.2  8  1.3
C  R  X  Y  0006  0002      12.307   0.008  0.007   0.051   8.0  6  1.6
C  R  X  Y  0006  0003      10.955   0.008  0.009   0.038   8.7  7  1.4
C  R  X  Y  0002  0003       5.499   0.007  0.006   0.053   8.0  6  1.7
B  R  X  Y  0003  0004       5.472   0.007  0.005   0.044   7.7  7  1.4
B  R  X  Y  0003  0005      12.242   0.006  0.006   0.050   7.7  7  1.4
B  R  X  Y  0005  0004      10.942   0.007  0.006   0.045   8.0  7  1.4
Fri Oct 04 14:34:41 1996
```

Figure 6.6: SUMMARY OUT

This SUMMARY.OUT file shows that all nine vectors have fixed ambiguities solutions. Refer to PNAV manual for more detailed explanation of each field.

12. To view the Vector file, in Menu 4.0 POST MISSION DATA ANALYSIS, select D) CONVERT VECTOR OUTPUT and select to convert ALL FILES. Then press <ESC> to back to Menu 4.0. Select E) VIEW FILES, then select F) VECTOR FILES. Refer to Section “O-file conversion to ASCII. (CONVOFIL.EXE).

Option B) Sequencing by Files (Kinematic)

Selecting this option will bring up the batch matrix, typically:

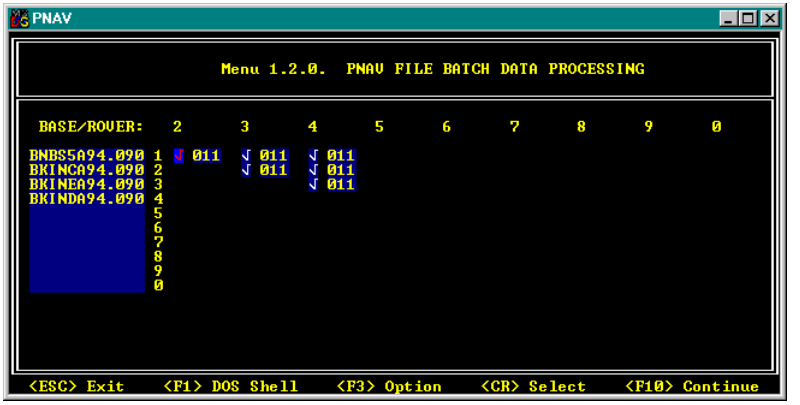

Figure 6.7: Batch matrix for sequencing by file

The batch-processing matrix is followed by the list of active control keys.

<ESC> Exit Command

Press <ESC> to exit to the PNAV Overview Menu.

<F1> DOS Shell Command

Press <F1> to shell out to DOS; type **EXIT<ENTER>** at the DOS prompt to return to PNAV.

<CR> Select Command

To select a B-file pair for processing, use the arrow keys to move the cursor to the desired intersection, and press <ENTER> to display the ✓; to deselect a pair, press <ENTER> to remove the ✓.

CAUTION
Do not use the <DELETE> key to deselect a B-file pair from processing. Pressing <DELETE> removes the ✓ from the the screen, but PNAV will still process the B-file pair.

<F3> Option Command

To edit the Post-processing Options code (and other Post-processing options) for a B-file pair, move the cursor to the desired intersection, and press <F3>; observe, the PNAV POST-PROCESSING OPTIONS FOR [ACTIVE PAIR] MENU described below.

<F10> Continue Command

When you are satisfied with the selections on Menu 1.0, press <F10> to continue processing as described later in this section.

Batch-Processing Matrix

BASE/ROVER, the first column, lists up to ten B-file names (stored in the LOGTIMES file), corresponding to rows 1 through 0 of the batch-processing matrix.

CAUTION
PNAV can batch-process a maximum of ten B-files at one time. If more than ten B-files exist in the current directory, WinPrism will not create the LOGTIMES and PROJFILE.KIN files and will display an error message. If this happens: move some of the files to another directory, and process the files in each directory separately; or combine some of the files via the TOOLS/ EDIT FILETOOL/Join 2 or More Files function, and process the combined files. (For details on combining files, see the WinPrism *Tools User's Guide*.)

The labels 2 through 0 across the top of the screen, identify the columns of the batch-processing matrix.

Each intersection of matrix row and column identifies the B-file pairs to process: ✓ means process the pair, blank means do not process. For example, if the intersection of row 1 and column 3 is blank, then do not process.

By default, PNAV selects all combinations for processing.

Next to each ✓ blank (process/no process) field is a three-digit default Post-processing Options code.

First digit: EXECUTION MODE Parameter

0-FORWARD PROCESSING (only, the default)

1-FORWARD AND BACKWARD PROCESSING

Second digit: PROCESSING MODE Parameter

0-NAVIGATION

1-SURVEY

2-RELATIVE NAVigation

The Relative Nav Mode is not tested and not supported in this release.

Third digit: FIX AMBIGUITIES Parameter

0-FIX AMBS: No (float ambiguity, default for single-frequency data)

1-FIX AMBS: Yes (fixed ambiguity, default for dual-frequency data)

Default Processing Mode

According the the site names in the LOGTIMES file, PNAV classifies the B-files into the following categories:

- Control File: has a static control site (knowness = 0) occupied throughout the data collection period.
- Static File: has one static site with knowness ≠ 0.
- Multistatic File: has occupied two or more static sites during the data collection period, e.g. data collected in a kinematic or "stop-and-go" survey.
- Moving File: has no static sites (always moving).

These file categories are based on the site name in the LOGTIMES file. Any site name beginning with "?" is treated as moving; otherwise it is a static site. It is therefore important to verify that the site names in LOGTIMES are correct in order to process the data properly. (For details, see the *Process User's Guide*, *Program Reference* chapter, *Edit Logtime Option* section.)

From the file category for each B-file, PNAV automatically determines the default PROCESSING MODE for each pair of B-files and displays it in the second digit of the processing code. The decision table is:

Table 6.4: Processing modes for different file categories

File 1	File 2	Processing Mode
Static	Static or Multistatic	SURVEY
Static	Moving	NAVIGATION
Multistatic	Multistatic	SURVEY
Multistatic	Moving	NAVIGATION
Moving	Moving	RELATIVE NAV

PNAV Post-Processing Options for [Active Pair] Menu

When you press <F3> in Menu 1.2.0, PNAV displays, typically:

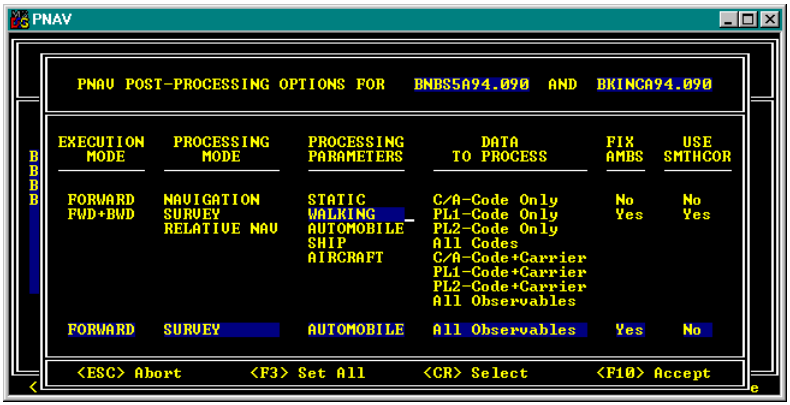

Figure 6.8: PNAV Post-Processing Option Screen

The top row lists the B-file names corresponding to the intersection containing the cursor on Menu 1.2.0, the menu options appear in the middle, and the bottom line lists the active control keys.

This submenu only lets you modify a subset of the processing parameters available. If you want to modify other Kalman filter parameters or Runtime parameters used in processing, you must do so via PNAV Overview Menu Option E) PNAV UTILITY before you elect to continue processing from Menu 1.0.

<ESC> Abort Command

Press <ESC> to abort any changes in this menu and return to Menu 1.0.

<F3> Set All Command

Press <F3> to apply the highlighted option setting to all B-file pairs selected for batch processing; observe a prompt of the form:

```
Set "option" to [selection] for all pairs [Y/N]?
```

For example, if **EXECUTION MODE FWD+BWD** is selected, with <F3>, PNAV prompts:

```
Set "EXECUTION MODE" to [FWD+BWD] for all pairs [Y/N]?
```

Type **Y**(es) or **N**(o).

<u>Only</u> the highlighted option will be set for all; the other options on the menu will be left unchanged.

<CR> Select Command

To select another configuration, highlight the desired option, and press <ENTER>.

<F10> Accept Command

Press <F10> to accept the current configuration for the current processing session and return to Menu 1.2.0.

Execution Mode

corresponds to the first digit of the Post-processing Options code on Menu 1.0., i.e.

FORWARD is 0-FORWARD PROCESSING (only, the default)

FWD+BWD is 1-FORWARD AND BACKWARD PROCESSING

Both modes can provide centimeter-level accuracy with good quality, full-wavelength, dual-frequency data. However, the results from FORWARD PROCESSING alone will contain one or more "holes" (periods when the solution accuracy is meter-level due to unresolved ambiguities). FORWARD AND BACKWARD PROCESSING will help to fill these holes in the results by solving for the ambiguities in both directions, maximizing the number of data points with resolved ambiguities and good solutions. The disadvantage of FORWARD AND BACKWARD PROCESSING is that it takes at least twice as long to process the data as FORWARD processing alone.

Processing Mode

corresponds to the second digit of the Post-processing Options code on Menu 1.0., based on the file category decision described above, i.e.

0-NAVIGATION

1-SURVEY

2-RELATIVE NAVigation

The Navigation Mode is used when the epoch-by-epoch position solutions are desired relative to the Base receiver from the entire trajectory of the Roving receiver. Survey Mode is used when the primary interest is in vector solutions from the Base receiver to one or more survey points, as in a kinematic or fast static survey. Relative Nav Mode is used when the relative positions of two moving Rovers are desired.

All modes will output the J-file (relative position in ENU or XYZ coordinates) and the C-file (Rover position in WGS-84 coordinates). The Survey Mode will also output vector solutions in an O-file to stations with a valid site ID.

The Survey Mode is suitable for measurements collected from a kinematic-type or a fast-static-type survey. The Survey Mode pays attention to the Rover's site name during processing while the Navigation Mode and Relative Nav Modes ignore it. A "?" as the first character of the site name indicates that the Rover is moving while any other character represents a stationary site.

CAUTION
If you are processing in Survey Mode, it is very important that: **The Rover is stationary while the first character in the site name is a character other than "?** **Different sites have different site names in the LOGTIMES file; edit LOGTIMES, if necessary. For details, see the *Process User's Guide, Program Reference* chapter, *Edit Logtime Option* section.)** **Data processing is unpredictable if these conditions are not met.**

The Relative Nav Mode is not tested and not supported in this release.

Processing Parameters

Allows you to choose among PNAV's several motion parameter settings (i.e., the Kalman filter parameters) for the type of vehicle on which the Rover antenna is mounted; the default is **AUTOMOBILE**. You should choose the Rover Motion Dynamics that match the fastest motion dynamics you experienced while collecting the Rover data. (For details on setting the Kalman filter parameters, see: (1) *Overview Menu Option D) PNAV Utility* chapter, *Option A) Modify Default Parameters: Menu 5.1.0* section; and, (2) the *Setup Menus* chapter, *<Alt-K> Kalman Setup Menu Command* section, *Kalman Filter System Parameters* paragraph.)

Data to Process

The data types displayed reflect only the data types common to both B-files of the active pair. In the typical PNAV POST-PROCESSING OPTIONS FOR [ACTIVE PAIR] menu described in this section, the DATA TO PROCESS fields show all the receiver data types and combinations that PNAV can process. The default is the most common data type contained in both selected B-files.

If available, **All Observables** generally provides the best results.

PNAV will not process L2 codeless data. Therefore, data from a dual-frequency codeless receiver (such as the MD-XII) will display only C/A-Code Only and C/A-Code+Carrier.

This display may vary for different active pairs, if the various B-files in the current directory each contain different types of data. For example, if the current directory contains B-files B_TG3A92.232, B1111A92.232, and BSSSSA92.232, and files B_TG3A92.232 and B1111A92.232 are Z-XII data, and file BSSSSA92.232 is SCA data then the DATA TO PROCESS list for B_TG3A92.232 and B1111A92.232 contains all eight types from C/A-Code Only to All Observables. However, the other two pairs B_TG3A92.232 to BSSSSA92.232 and B1111A92.232 to BSSSSA92.232 will have only two types: C/A-Code Only and C/A-Code+Carrier.

Fix AMBS

fix ambiguity to integers. For **All Observables**, the default is **Yes**; otherwise the default is **No**. If you are processing dual-frequency full-wavelength (P-code) data with good PDOP, and the baseline length is less than 10 kilometers, select **Yes.** Otherwise, we recommend that the ambiguities not be fixed. This option corresponds to the third digit of the Post-processing Options code on Menu 1.2.0., i.e.:

0-FIX AMBS: No (float ambiguity)

1-FIX AMBS: Yes (fixed ambiguity)

Use SMTHCOR

use the pseudo-range smoothing corrections from the B-files. We recommend using the default (**No**) when processing code and carrier and **Yes** when processing code only.

CAUTION
Do not attempt to use smoothing corrections on data collected from a Ashtech Dimension receiver because B-files from these receivers do not contain smoothing corrections.

Continue Processing

1. Press <F10> in Menu 1.2.0.
2. PNAV will then automatically batch-process the selected B-file pairs (according to the settings of the Kalman filter parameters and Runtime parameters from the PNAV UTILITY option and the POST-PROCESSING OPTIONS selections in Menu 1.0) in the following order of file categories: SURVEY, NAVIGATION, RELATIVE NAV.
3. Within each category, the DATA TO PROCESS types common to each selected pair are processed in the reverse order displayed, i.e. All Observables to C/A-Code Only.

4. Within each common data type, the pair including the fewest static sites is processed first.
5. Among pairs containing the fewest static sites, the pair with a control site is processed first.

Processing Results Screen

Selecting <F10> from Menu 1.2.0 initiates data processing. The processing results are displayed in the Processing Results Screen. In this screen:

- The top line summarizes your selections from Menu 1.2.0 PNAV BATCH PROCESSING, <F3> OPTIONS submenu, e.g.:

  ```
  BATCH SURVEY FORWARD  BASE: BSSSPA92.232  ROVER: B_TG3A92.232  1 of 1
  ```

- The upper display is the verbose or concise processing results window.
- The lower display area is the message log window.
- The bottom line lists the command keys active for this screen: ESC Exit, F1, Reset, F2 Cls, F3 Graph, F4 Toggle, and F9 Menu.

All these display elements are explained in the following paramgraphs.

ESC Exit Command

To exit processing and return to the PNAV Overview Menu:

1. Press <ESC>.
2. PNAV prompts:

   ```
   Terminate Processing (Y/N)?
   ```

3. If you type **Y**es, PNAV exits processing and returns to the PNAV Overview Menu.
4. If you type **N**o, PNAV continues data processing.

F1 Reset Command

Press <F1> to reset the Kalman filter.

CAUTION
Resetting the Kalman filter parameters in mid-process is for experienced PNAV users only.

F2 Cls Command

Press <F2> to clear the Processing Results Screen.

F3 Graph Command

Press <F3> to switch to the graphics display window during processing. This is a graphical representation of the Rover position with respect to the Base and/or waypoints from the PNAV.WAY file (if any) in the current directory. For details see the *Graphics Display Window* chapter.

F4 Toggle Command

Press <F4> to toggle between the verbose and concise versions of the Processing Results Screen during processing.

F9 Menu Command

Press <F9> to suspend processing and return to the PROCESSING SETUP MENU screen; in that screen, press <F9> (**Process**) again to resume processing. In the PROCESSING SETUP MENU screen, you can change parameters for the current processing session.

CAUTION
Changing parameters in mid-process is for experienced PNAV users only. Press the <Alt-?> keys to access the various Setup Menus. For details, see the Reference: Setup Menus chapter.

Processing Status Line

The top line lists the current processing status:

- PROCESSING MODE (NAVIGATION, SURVEY, RELATIVE NAV)
- Processing Direction (FORWARD, BACKWARD)
- BASE/ROVER B-file Names
- Progress (*n* of *m*: *n*th pair of total *m* pairs)

Verbose Result Display

The Processing Results Screen can be viewed in either verbose or concise format. The verbose format displays more information about the data processing than does the concise format. A typical Verbose Result Display would be:

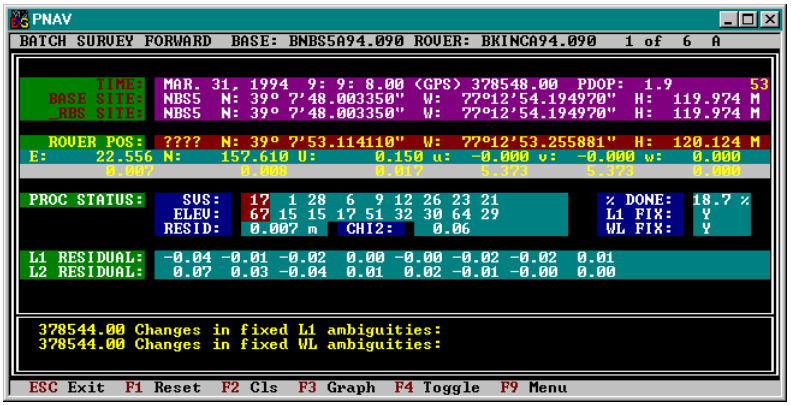

Figure 6.9: Processing Results Screen

Time

The first line in the Verbose Result Display lists the date, GPS time for the current epoch being processed, the PDOP, and (on the far right) a continuously updating epoch counter.

Base Site

The second line displays the base site name, and the geodetic latitude, longitude and ellipsoidal height in meters for the Base Station. These are the ground mark coordinates.

_RBS Site

The third line displays the geodetic latitude, longitude and ellipsoidal height in meters for the Remote Base Station.

- The _RBS site is the same as the BASE SITE, if you are processing in Survey Mode, and the _RBS site is not in the PROJFILE.KIN file. (For details on editing PROJFILE.KIN, see the *Process User's Guide, Program Reference* chapter, *Edit Project Option* section.).

- The _RBS site is the same as the Base site, if you are processing in Navigation Mode, and the _RBS site is not in the PNAV.POS file.
- The _RBS site is always the same as the Base site, if you are processing in Relative Nav Mode.

ROVER POS, Rover Position (second section)

The first line displays the Rover's geodetic position (latitude, longitude and ellipsoidal height in meters) for the current epoch being processed.

The second line displays the Rover's delta **E**ast, delta **N**orth, delta **U**p (ENU) position vector (in meters) with respect to the _RBS site.

The second line also displays the Rover's velocity vector (**uvw** in meters/second) where

u is the Rover's velocity in the east direction,

v is the velocity in the north direction, and

w is the velocity in the up direction.

The third line displays the respective one-sigma position RMS error values below each element of the **ENU** and **uvw** display on the second line.

PROC STATUS, Processing Status (third section)

Table 6.5: Processing Status

Item	Description
SVS	shows the satellites being used in the processing at the current epoch. The reference satellite (i.e., the satellite with the highest elevation angle) is shown as the first satellite in the list.
CHI2 (chi-square)	is a goodness-of-fit solution quality indicator. In general, a CHI2 value less than 1.0 is good. See the chapter *Program Input and Output Data Files* for details.
RESID	is the averaged post-fit carrier-phase residual (in meters). RESID provides an indication of how good the computed Rover position is. A RESID value under 0.02 meters is good. If the RESID is larger than 0.02 meters, the Rover position may still be good if the RESID is below the RESID threshold. See the chapter *Program Input and Output Data Files* for details.
% DONE	shows the percentage of data processed.
L1 FIX	indicates the status of the L1 double-difference phase ambiguities. **Y** means the L1 ambiguities have been fixed.
WL FIX	indicates the status of the wide-lane double-difference ambiguities (using both L1 and L2 frequencies), which exist for dual-frequency carrier measurements. **Y** means the ambiguities have been fixed.

L1 RESIDUAL and L2 RESIDUAL(fourth section)

indicate the L1 and L2 post-fit phase residuals for each of the double differences formed.

CAUTION

When the data being processed represents more than eight satellites, the data display fields for these lines are closer together and accurate to only two decimal places instead of three.

Concise Result Display

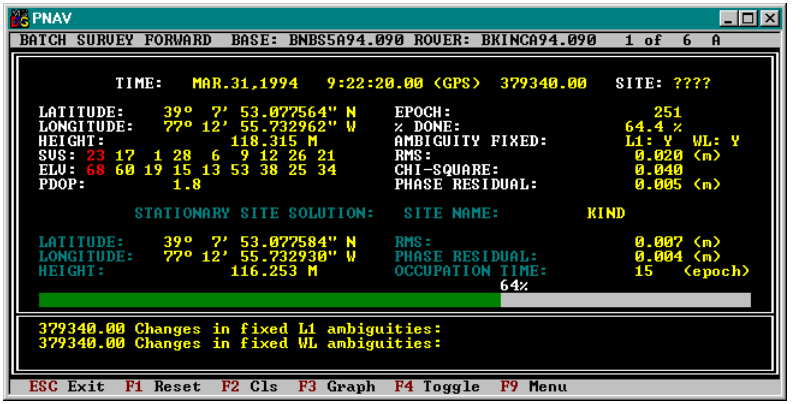

Figure 6.10: Concise Result Display Screen

The Concise Result Display is a succinct presentation of the same parameters displayed in the Verbose Result Display. All of these parameters are described above for the Verbose Result Display.

The first line of this window shows the date and current GPS time of the measurement data being processed.

Shown on the left-hand side of the display is the latitude, longitude and height of the Rover in WGS-84 coordinates, the satellites (SVS) being used in the processing (the reference satellite is shown as the first satellite in the list), and the PDOP of the current epoch.

The right-hand side of the display gives the epoch counter, the percentage done, the L1 and WL ambiguities fixed flags, the RMS value (in meters), the chi-square value, and the phase residual. (The RMS value is the square root of the sum of the squared one-sigma error values of each position component displayed on the verbose display.) The bottom line shows a graphical representation of the percentage of processing completed.

Message Log Window

The Message Log Window appearing at the bottom of the display in both verbose and concise modes, scrolls messages about the current status of PNAV processing (such as when the ambiguities have been fixed and when cycle-slips occur). These

messages are saved in the L-file. (For a description of this file, see the chapter *Program Input and Output Data Files*.).

End of Processing

After batch processing is complete, PNAV returns to the Overview Menu. PNAV has now automatically created the following new files: the J-file, containing the Rover's delta ENU positions with respect to the _RBS site; the C-file, containing the Rover's WGS-84 positions, a **Message Log File** (L-file), containing the status messages of processing, plot files that graphically show the trajectory and velocity of the Rover, as well as various statistics. If you processed in the Survey Mode, PNAV also created the O-file, containing a list of the baseline vector solutions.

To create interpolated photogrammetry files (photo-files), see the chapter *Reference: Overview Menu Option D) Post Mission,* section *Option A) Photogrammetry*.

For a description of the above files, see the chapter *Program Input and Output Data Files*.)

Data Processing

This option accesses a series of menus through which you can process the collected receiver measurement data from individual sets of B-files, E-files, and S-files located in the current directory. The first time you run PNAV and choose Option **C) DATA PROCESSING**, PNAV initializes the settings for Execution Mode, Processing Mode and Rover Motion Dynamics with factory default settings and proceeds to **Menu 3.0 PROGRAM EXECUTION MODE AND ROVER DYNAMICS** where you can accept or change these settings for the first processing session. In subsequent processing runs, as long as MODE.PMT remains in the current directory, PNAV will retrieve the current settings for EXECUTION MODE, PROCESSING MODE and ROVER MOTION DYNAMICS from this file.

Menu 3.0 Program Execution Mode and Rover Dynamics

From the PNAV Overview Menu, select Option **C) DATA PROCESSING**, and observe typically:

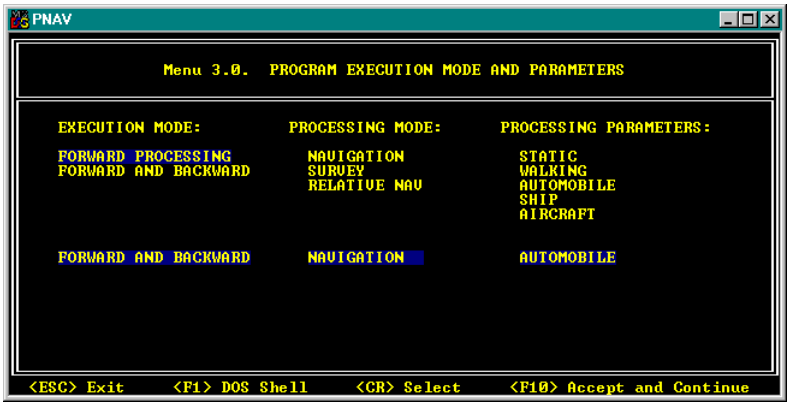

Figure 7.1: Menu 3.0 Execution Mode and Parameters

In this screen you can select: EXECUTION MODE, PROCESSING MODE and ROVER MOTION DYNAMICS; the current selection in this menu appears below the choices for

each category. This example shows the factory defaults: FORWARD PROCESSING, NAVIGATION, and AUTOMOBILE. The bottom line lists the active control keys.

<ESC> Exit Command

Press <ESC> to exit to the PNAV Overview Menu.

<F1> DOS Shell Command

Press <F1> to shell out to DOS; type **EXIT<ENTER>** at the DOS prompt to return to PNAV.

To select another configuration, highlight the desired option, and press <ENTER>.

Press <F10> to **Accept** the current configuration and **Continue** to **Menu 3.1 PNAV DATA PROCESSING OPTIONS**.

Execution Mode

The choices are **FORWARD PROCESSING** (the default) and **FORWARD AND BACKWARD**. Both modes can provide centimeter-level accuracy with good quality, full-wavelength, dual-frequency data. However, the results from FORWARD PROCESSING alone will contain one or more "holes" (periods when the solution accuracy is meter-level due to unresolved ambiguities). FORWARD AND BACKWARD processing will help to fill these holes in the results by solving for the ambiguities in both directions, maximizing the number of data points with resolved ambiguities and good solutions. The disadvantage of FORWARD AND BACKWARD processing is that it takes at least twice as long to process the data as FORWARD PROCESSING alone.

Processing Mode

The choices are **NAVIGATION** (the default), **SURVEY**, and **RELATIVE NAV**.

The Navigation Mode is used when only the epoch-by-epoch position solutions are desired relative to the Base receiver from the entire trajectory of the Roving receiver. Survey Mode is used when the primary interest is in vector solutions from the Base receiver to one or more survey points as in a kinematic or fast static survey. Relative Nav Mode is used when the relative positions of two moving Rovers are desired. (Relative Nav Mode is a special case of Navigation Mode in which the Base receiver is moving instead of stationary.)

All modes will output the J-file (relative position in either XYZ or ENU coordinates), the C-file (Rover position in WGS-84 coordinates), and optionally an R-file. The Survey Mode will also optionally output vector solutions in an O-file for stations with a valid site ID.

The Survey Mode is suitable for processing data collected from a kinematic-type or a fast-static-type survey. The Survey Mode pays attention to the Rover's site name

during processing while the Navigation Mode ignores it. A "?" as the first character of the site name indicates that the Rover is moving while any other character represents a stationary site.

CAUTION

If you are processing in Survey Mode, it is very important that:

- The Rover is stationary while the first character in the site name is a character other than "?.
- Different sites have different site names in the LOGTIMES file; edit LOGTIMES, if necessary. For details, see the *Process User's Guide*, *Program Reference* chapter, *Edit Logtime Option* section.)

Data processing is unpredictable if these conditions are not met.

The Relative Nav Mode is not tested and not supported in this release.

Rover Motion Dynamics

allows you to choose among PNAV's several motion parameter settings (i.e., the Kalman filter parameters) for the type of vehicle on which the Rover antenna is mounted; the default is **AUTOMOBILE**. You should choose the Rover Motion Dynamics that match the fastest motion dynamics you experienced while collecting the Rover data. (For details on setting the Kalman filter parameters, see the *Setup Menus* chapter, *<Alt-K> Kalman Setup Menu Command* section, *Kalman Filter System Parameters* paragraph.)

Menu 3.1. PNAV Data Processing Options

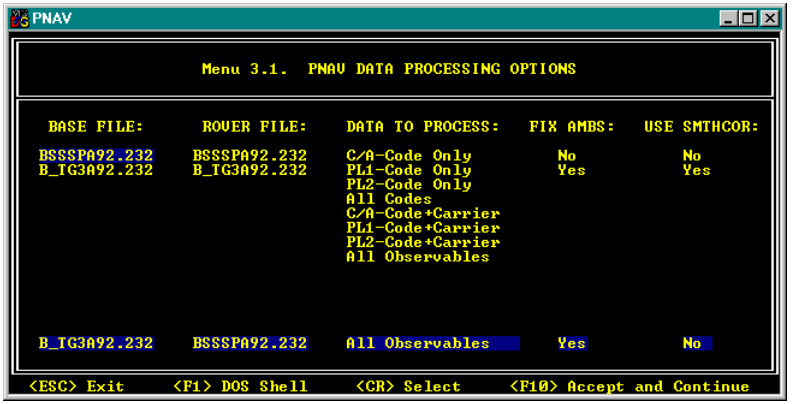

Figure 7.2: Menu 3.1 - PNAV Data Processing Options

The current selection appears below the option menus. The bottom line lists the active control keys.

<ESC> Exit Command

Press <ESC> to exit to Menu 3.0.

<F1> DOS Shell Command

Press <F1> to shell out to DOS; type **EXIT<ENTER>** at the DOS prompt to return to PNAV.

<CR> Select Command

To select another configuration, highlight the desired option, and press <ENTER>.

<F10> Accept and Continue Command

Press <F10> to **Accept** the current configuration and **Continue**; PNAV then performs the preliminary processing.

Base File

The default is the first B-file in the current directory. Select the file known to be the Base, i.e., the stationary site.

Rover File

The default is the second B-file in the current directory. Select the file known to be the Rover.

Data to Process

The data types displayed on Menu 3.1 reflect only the data types common to both the selected **BASE FILE** and the selected **ROVER FILE**.

CAUTION
PNAV will not process L2 codeless data, therefore, data from a dual-frequency codeless receiver (such as the MD-XII) will display only C/A-Code Only and C/A-Code+Carrier.

FIX AMBS

Fix ambiguity to integers. The default is **Yes**, if **DATA TO PROCESS** is **All Observables**; for all other **DATA TO PROCESS** the default is **No**. If you are processing dual-frequency full-wavelength (P-code) data with good PDOP, and the baseline length is less than 10 kilometers, select **Y**es. Otherwise, we recommend that the ambiguities not be fixed.

USE SMTHCOR

Use the pseudo-range smoothing corrections from the B-files. We recommend using the default (**No**) when processing code and carrier and **Yes** when processing code only.

CAUTION
Do not attempt to use smoothing corrections on data collected from a Ashtech Dimension receiver because B-files from these receivers do not contain smoothing corrections.

Preliminary Processing

1. After you press <F10> in Menu 3.1, PNAV then:
   a. Runs COMNAV.EXE to generate a COMMON.NAV (ephemeris) file if it does not already exist.
   b. Synchronizes the time tags of the first common epochs of the two selected B-files.

c. Determines the data sampling interval and the total number of epochs to process.

2. If you are processing in Survey Mode, PNAV reads the Base station position and the other site's preliminary position from the project file (PROJFILE.KIN) in the current directory and proceeds to the Setup Menus.
3. If you are processing in Navigation Mode, PNAV reads the Base station and waypoint positions from the Site Position File PNAV.POS (if any) in the current directory.
   a. If the Base station coordinate does not exist in the PNAV.POS file, PNAV calculates an averaged pseudo-range position and then displays:

      No Base coordinates in the list.

      The averaged BASE coordinates based on the B-filefollowed by the site name of the B-file selected as the Base, the averaged latitude, longitude and RMS, and then asks if you want to use these coordinates.

   b. If you answer **N**o, and there are no entries in the PNAV.POS file, PNAV creates a site position template with the four-character site name "___" for later editing.

CAUTION

In Navigation Mode, you must add the Base coordinate data to the PNAV.POS file (in the <Alt-P> Position Setup Menu; otherwise PNAV will not continue processing the data.

   c. If you answer **Y**es, PNAV uses the average site position as Base coordinates.

CAUTION

This averaged position is a rough estimate (10-50 meter accuracy) and will not provide precise WGS-84 results. Therefore, a precise Base station coordinate should be entered whenever possible. This precise Base coordinate can be entered by editing PNAV.POS in the <Alt-P> Position Setup Menu. For details, see the Setup Menus Chapter.

   d. In Navigation Mode, PNAV then checks whether the selected Base is really a stationary site.
   e. If the site is stationary, PNAV proceeds to the PROCESSING SETUP MENU screen.

f. If it is not stationary, PNAV prompts:

```
You probably have chosen a wrong B-file as the BASE
station.

Do you want to continue [Y/N]?
```

g. If you answer **Y**es, PNAV then proceeds to the PROCESSING SETUP MENU screen.

Processing Setup Menu Screen

The menus in this screen allow you to:

- Edit various parameter and position files:
  - Run-Time Parameters file
  - Site Position file (in Navigation Mode only)
  - Waypoint Navigation file
  - Rover Antenna Offset file
  - Simulation file
  - Kalman Filter Parameters file
- Change the menu display attributes.
- Save any changes for use in subsequent processing sessions.

1. After you press <F10> in Menu 3.1, and PNAV completes the preliminary processing, observe:

Figure 7.3: Processing Setup Menu Screen

when processing in Navigation Mode or Relative Nav Mode, or;

Figure 7.4: Survey Mode Screen

when processing in Survey Mode.

2. To quit processing at this point, exit the PROCESSING SETUP MENU screen, and return to the PNAV Overview Menu, press <ESC>.
3. To specify the parameters for the current processing session, press the <Alt-?> keys to access the various Setup Menus. For a description of these menus, see the *Setup Menus* chapter.

Critical parameters are the Base station position and the antenna height.

4. Once you have set the parameters as desired, press <F10> to **Continue**.

Processing Results Screen

Selecting <F10> from the PROCESSING SETUP MENU screen initiates data processing. The processing results are displayed in the Processing Results Screen. In this screen:

- The top line summarizes your selections from Menu 3.0 PROGRAM EXECUTION MODE AND ROVER DYNAMICS and Menu 3.1 PNAV DATA PROCESSING OPTIONS, e.g.:

  ```
  FORWARD NAVIGATION PROCESSING BASE:B_TG3A92.232
  ROVER:BSSSPA92.232
  ```

- The upper display is the verbose or concise processing results window.

- The lower display area is the message log window.
- The bottom line lists the command keys active for this screen: ESC Exit, F1, Reset, F2 Cls, F3 Graph, F4 Toggle, and F9 Menu.

All these display elements are explained in the following paragraphs.

If you set to Yes the parameter Iteration During Static Site (in the <Alt-R> RunTime Setup Menu, <f4> More [Quality Assurance Parameters] popup menu), PNAV overlays the processing results screen (both verbose and concise versions) at appropriate times during processing with a Static Site Iteration Window. This window is for information only and requires no action on your part.

The bottom line of the Processing Results screen lists the command keys active for this screen:

ESC Exit Command

To exit processing and return to the PNAV Overview Menu:

1. Press <ESC>.
2. PNAV prompts:

   ```
   Terminate Processing (Y/N)?
   ```

3. If you type Yes, PNAV exits processing and returns to the PNAV Overview Menu.
4. If you type **N**o, PNAV continues data processing.

F1 Reset Command

Press <F1> to reset the Kalman filter.

CAUTION
Resetting the Kalman filter parameters in mid-process is for experienced PNAV users only.

F2 Cls Command

Press <F2> to clear the Processing Results Screen.

F3 Graph Command

Press <F3> to switch to the graphics display window during processing. This is a graphical representation of the Rover position with respect to the Base and/or waypoints from the PNAV.WAY file (if any) in the current directory. For details see the *Graphics Display Window* chapter.

F4 Toggle Command

Press <F4> to toggle between the verbose and concise versions of the Processing Results Screen during processing.

F9 Menu Command

Press <F9> to suspend processing and return to the PROCESSING SETUP MENU screen; in that screen, press <F9> (**Process**) again to resume processing. In the SETUP MENU screen, you can change parameters for the current processing session.

CAUTION
Changing parameters in mid-process is for experienced PNAV users only.

Press the <Alt-?> keys to access the various Setup Menus. For details, see the *Setup Menus* chapter.

Processing Status Line

The top line lists the current processing status:

- PROCESSING MODE (NAVIGATION, SURVEY, RELATIVE NAV)
- Processing Direction (FORWARD, BACKWARD)
- BASE/ROVER B-file Names

Verbose Result Display

The Processing Results Screen can be viewed in either verbose or concise format. The verbose format displays more information about the data processing than does the concise format. A typical Verbose Result Display would be:

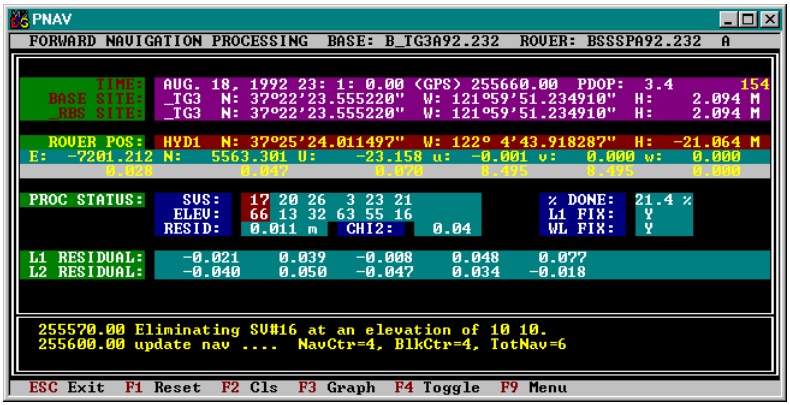

Figure 7.5: Verbose Processing Display

Time

The first line in the Verbose Result Display lists the date, GPS time for the current epoch being processed, the PDOP, and (on the far right) a continuously updating epoch counter.

Base Site

The second line displays the base site name, and the geodetic latitude, longitude and ellipsoidal height in meters for the Base Station. These are the ground mark coordinates.

RBS Site

The third line displays the geodetic latitude, longitude and ellipsoidal height in meters for the Remote Base Station.

- The _RBS site is the same as the BASE SITE, if you are processing in Survey Mode, and the _RBS site is not in the PROJFILE.KIN file. (For details on editing PROJFILE.KIN, see the *Process User's Guide, Program Reference* chapter, *Edit Project Option* section.).

- The _RBS site is the same as the Base site, if you are processing in Navigation Mode, and the _RBS site is not in the PNAV.POS file. (You can designate a different _RBS site as one of the waypoints in the
- The _RBS site is always the same as the Base site, if you are processing in Relative Nav Mode.

ROVER POS, Rover Position (second section)

The first line displays the Rover's geodetic position (latitude, longitude and ellipsoidal height in meters) for the current epoch being processed.

The second line displays the Rover's delta **E**ast, delta **N**orth, delta **U**p (ENU) position vector (in meters) with respect to the _RBS site.

The second line also displays the Rover's velocity vector (**uvw** in meters/second), where:

u is the Rover's velocity in the east direction,

v is the velocity in the north direction, and

w is the velocity in the up direction.

The third line displays the respective one-sigma position RMS error values below each element of the **ENU** and **uvw** display on the second line.

Before processing begins, you can change the ENU format to an XYZ format by setting the ENU Coordinate parameter to No in the

PROC STATUS, Processing Status (third section)

Table 7.1: Processing Status Fields

Item	Description
SVS	shows the satellites being used in the processing at the current epoch. The reference satellite (i.e., the satellite with the highest elevation angle) is shown as the first satellite in the list.
CHI2 (chi-square)	is a goodness-of-fit solution quality indicator. In general, a CHI2 value less than 1.0 is good. See the chapter *Program Input and Output Data Files* for details.
RESID	is the averaged post-fit carrier-phase residual (in meters). RESID provides an indication of how good the computed Rover position is. A RESID value under 0.02 meters is good. If the RESID is larger than 0.02 meters, the Rover position may still be good if the RESID is below the RESID threshold. See the chapter *Program Input and Output Data Files* for details.
% DONE	shows the percentage of data processed.
L1 FIX	indicates the status of the L1 double-difference phase ambiguities. **Y** means the L1 ambiguities have been fixed.
WL FIX	indicates the status of the wide-lane double-difference ambiguities (using both L1 and L2 frequencies), which exist for dual-frequency carrier measurements. **Y** means the ambiguities have been fixed.

L1 Residual and L2 Residual (fourth section)

indicate the L1 and L2 post-fit phase residuals for each of the double differences formed.

When the data being processed represents more than eight satellites, the data display fields for these lines are closer together and accurate to only two decimal places instead of three.

DELION (*units*)

Delta ionosphere is the ionosphere residual estimate. The *units* value corresponds automatically to the current scale. This line is blank if residual ionosphere is not modeled.

If you selected, in the <Alt-R> RunTime Setup Menu:

- Yes for **Model Ionospheric Delay**, or,
- **A**utomatic for **Model Ionospheric Delay**, and the baseline is greater than 15 kilometers,

this line displays, for each double difference, a data pair of the form *x.x|y.y*, where the first number is the estimate and the number after "|" is the one-sigma RMS value.

When the data being processed represents more than eight satellites, the data display fields for this line include only the estimate, not the RMS value.

Concise Result Display

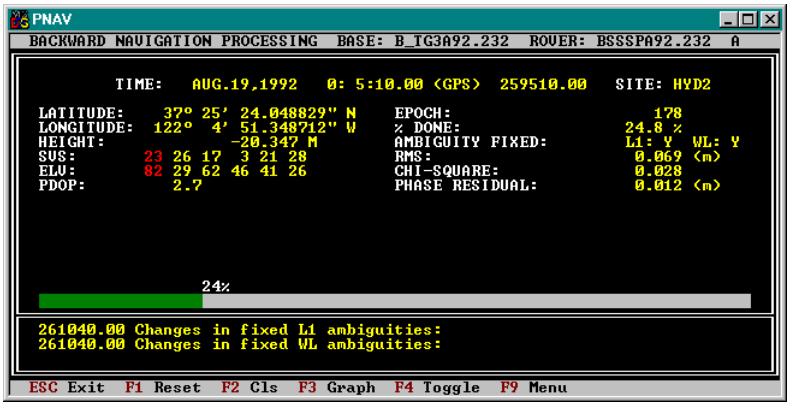

Figure 7.6: Concise Result Display

The Concise Result Display is a succinct presentation of the same parameters displayed in the Verbose Result Display. All of these parameters are described above for the Verbose Result Display.

The first line of this window shows the date and current GPS time of the measurement data being processed.

Shown on the left-hand side of the display is the latitude, longitude and height of the Rover in WGS-84 coordinates, the satellites (SVS) being used in the processing (the reference satellite is shown as the first satellite in the list), and the PDOP of the current epoch.

The right-hand side of the display gives the epoch counter, the percentage done, the L1 and WL ambiguities fixed flags, the RMS value (in meters), the chi-square value, and the phase residual. (The RMS value is the square root of the sum of the squared one-sigma error values of each position component displayed on the verbose display.) The bottom line shows a graphical representation of the percentage of processing completed.

In the Survey Processing Mode only the concise Result Display adds, to the lower half of the screen, the averaged position solution (**STATIONARY SITE SOLUTION**) for each site occupied during the survey. For example, in the following display the Rover has occupied site HYD2 for 18 epochs and its averaged position is given along with the corresponding RMS error and phase residual (in meters):

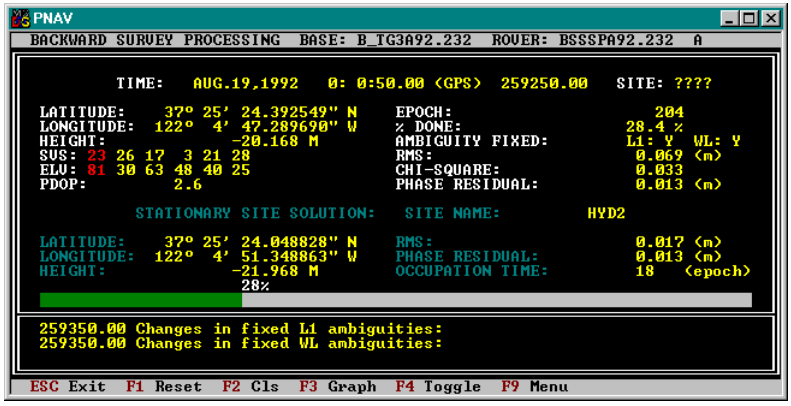

Figure 7.7: Concise display for survey mode

Message Log Window

The Message Log Window scrolls messages about the current status of PNAV processing (such as when the ambiguities have been fixed and when cycle-slips occur). These messages are saved in the L-file. (For a description of this file, see the chapter *Program Input and Output Data Files*.) .

End of Processing

After the data processing is complete, PNAV returns to the Overview Menu. PNAV has now created two new files: the J-file, which contains the Rover's delta ENU positions or delta X, Y, Z with respect to the _RBS station, and the C-file, which contains the Rover's WGS-84 positions. Depending on your settings in the <Alt-F> File Setup Menu prior to processing, PNAV also creates, optionally:

- a **Message Log File** (L-file) which contains the status messages of processing and/or
- a **Rover Trajectory File** (R-file) similar to the R-files created by the KINSRVY program of the GPPS software.

The default is to create the L-file and not to create the R-file.

If you processed in the Survey Mode, PNAV also created by default a file containing a list of the averaged site positions that were occupied, called the O-file unless you disabled **Vector Solution File** in the <Alt-F> File Setup Menu.

For a description of the above files, see the chapter *Program Input and Output Data Files*.)

Post Mission

Choosing the **POST MISSION** option in the Overview Menu, accesses a Post Mission menu which allows you to:

- Interpolate collected photogrammetry data.
- Create graphical plot files from rover trajectory output files (J-files) for subsequent viewing.
- Compare two navigation solutions (J-files or C-files).
- Convert binary O-files to ASCII files.
- View a number of different output files.

Menu 4.0 Post Mission Data Analysis

Select from the PNAV Overview Menu, Option **D) POST MISSION**; observe:

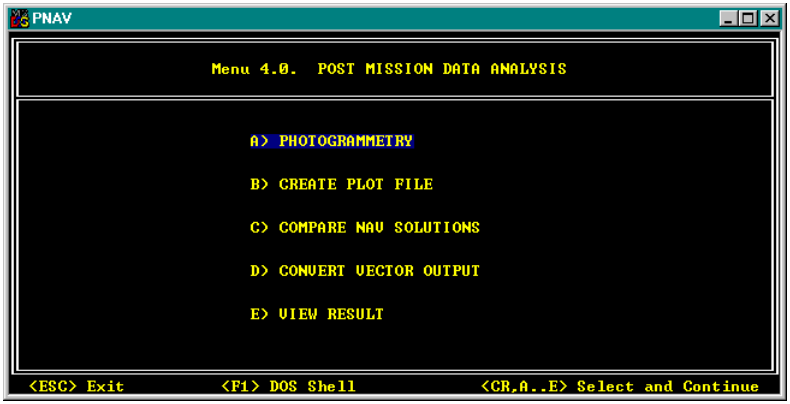

Figure 8.1: PNAV Overview Menu - Option D

The options are followed by the active control keys.

<ESC> Exit Command

Press <ESC> to exit to the PNAV Overview Menu.

<F1> DOS Shell Command

Press <F1> to shell out to DOS; type **EXIT<ENTER>** at the DOS prompt to return to PNAV.

<CR,A - E> Select and Continue Command

Press the letter for the desired option, or highlight it and press <ENTER>.

Option A - Photogrammetry

This option generates J*@- and C*@-files interpolated to the precise time tag of any photogrammetry files in the current directory. A photogrammetry file (photo-file) is an ASCII file containing precise time tags and site names. If the current directory contains one or more photo-files, and corresponding PNAV output J-files and C-files, selection of this option will interpolate the position data in the J-file and C-file to the appropriate time tags in the photo-file and store the results in a J*@-file and a C*@-file. (For a description of these files, see the chapter *Program Input and Output Data Files*.)

Select Photo-File for Interpolation Menu

1. In Menu 4.0, select **A) PHOTOGRAMMETRY**.
2. If PNAV finds photo-files in the current directory, observe, typically:

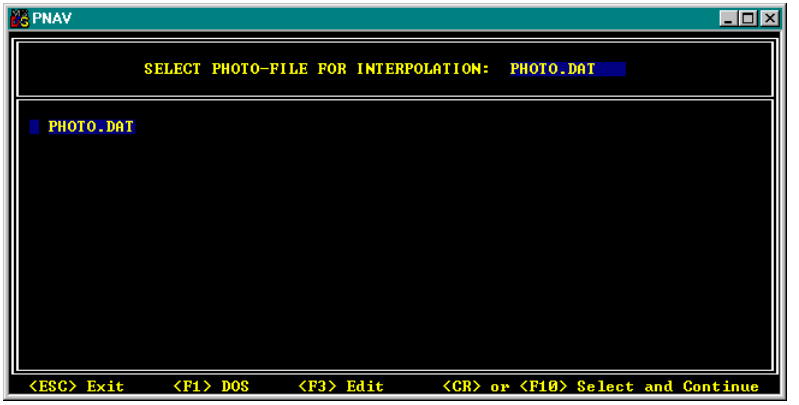

Figure 8.2: Menu 4.0 - Option A, Photogrammetry File Selection

This menu lists the photo-files in the current directory for your selection.

3. If PNAV finds no photo-files in the current directory, it briefly displays an appropriate error message and returns to Menu 4.0.

<ESC> Exit Command

Press <ESC> to exit Menu 4.0.

<F1> DOS Command

Press <F1> to shell out to DOS; type **EXIT<ENTER>** at the DOS prompt to return to PNAV.

<F3> Edit Popup Menu

This option specifies the maximum time span in which interpolation will take place (default is 10 seconds). If the time span in the J-file or C-file is larger than this value, PNAV will not produce @-files.

1. Press <F3>; observe the default popup screen:

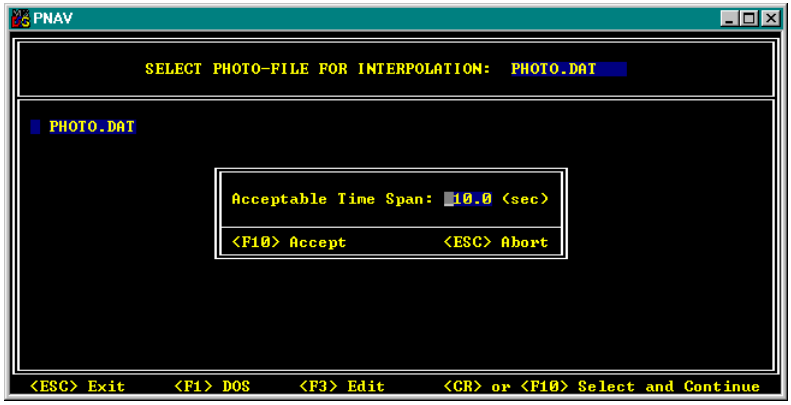

Figure 8.3: <F3> Default Pop-up Menu

2. Type in the desired value.
3. Press <F10> to Accept any change and remove the popup.
4. Press <ESC> to Abort any change and remove the popup.

<CR> or <F10> Select and Continue Command

1. In the SELECT PHOTO-FILE FOR INTERPOLATION Menu, highlight the desired file, and press <ENTER> or <F10> to select it.

2. PNAV performs a linear interpolation between the selected photo-file and the data in the J-file and C-file; observe, typically:

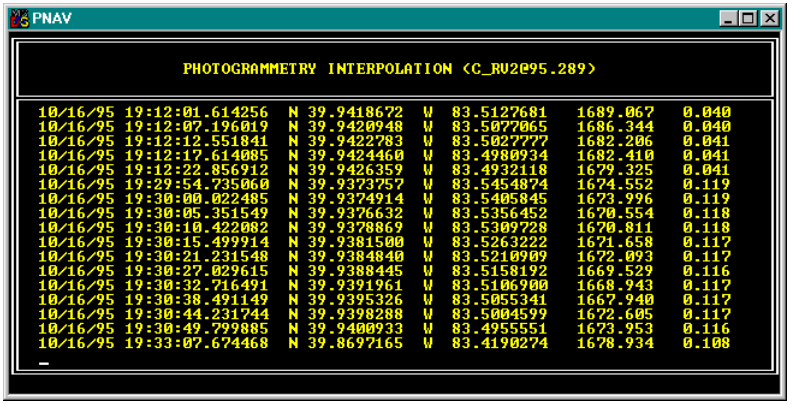

Figure 8.4: Photofile Screen

followed by:

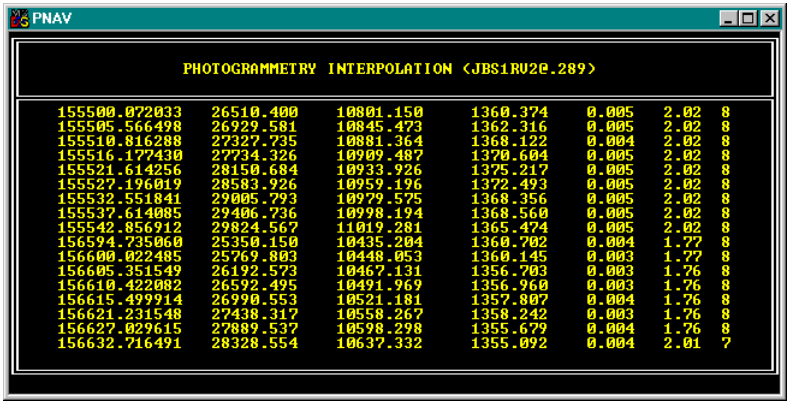

Figure 8.5: Select Photofile

3. PNAV then returns to the Select Photo-file for Interpolation menu.
4. When you are finished, press <ESC> to exit to Menu 4.0. POST MISSION DATA ANALYSIS and press <ESC> again to exit to the Overview Menu.

The current directory will now contain a new J*@-file and a new C*@-file named after the input J-file and C-file, respectively. These files are in exactly the same

format as the J-file and C-file except the data is interpolated to the photo-file time tags and there are more digits in the time tag. (For a description of these files, see the chapter *Program Input and Output Data Files*.)

Option B - Create Plot File

This option generates plot files from all the J-files in the current directory. The plot files graphically show the trajectory and velocity of the Rover, as well as various statistics, specifically:

- Plots of the horizontal and vertical trajectories and speeds of the Rover.
- Plots of the PDOP and satellites used.
- RMS position errors.
- Post-fit phase residuals.
- Chi-square values.
- Interpolated data based on the photo-file's time tags-represented as circles on the plots.

You may inspect this file via the RESIDUAL PLOTS function in the PROCESS/ RESULTS screen.

This option requires at least one J-file in the current directory. If a J*@-file exists, the interpolated positions from that file will be marked with a circle.

1. In Menu 4.0, select **B) CREATE PLOT FILE**; observe, typically:

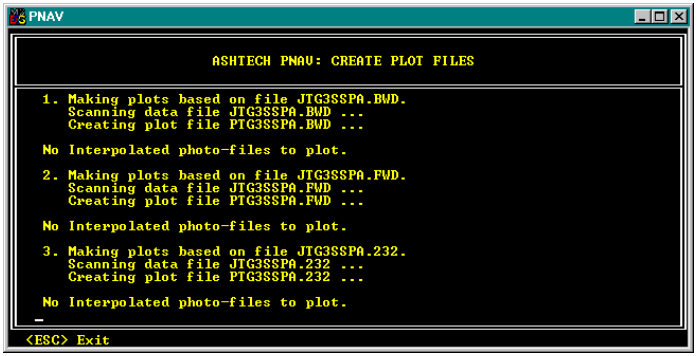

Figure 8.6: Create Plot File Screen

2. PNAV automatically makes a plot file from any J-file in the current directory.

3. When plot file creation is complete, PNAV returns to Menu 4.0. POST MISSION DATA ANALYSIS.
4. The plot file generated is described in the chapter *Program Input and Output Data Files*.

Option C - Compare NAV Solutions

This option generates a plot file that compares two PNAV solutions (J-files or C-files) in the current directory. You may inspect the plot file via the RESIDUAL PLOTS function in the PROCESS/RESULTS screen.

The plot file from the J-file comparison contains the following plots versus Seconds of Week.

- East Difference and corresponding RMS values (meters).
- North Difference and corresponding RMS values (meters).
- Up Difference and corresponding RMS values (meters).
- East Velocity Difference and corresponding RMS values (meters/second).
- North Velocity Difference and corresponding RMS values (meters/second).
- Up Velocity Difference and corresponding RMS values (meters/second).
- Phase residuals (meters).
- Post-fit Chi values (dimensionless).

The plot file from the C-file comparison contains the same information as the plot file from the J-file comparison, except:

- No corresponding RMS values.
- No phase residuals.
- No post-fit Chi values.

This option also produces an optional ASCII Result file (*.DIF file) with the above information in tabular form.

Compare J-File Menu

1. In Menu 4.0, select **C) COMPARE NAV SOLUTIONS;** observe, typically:

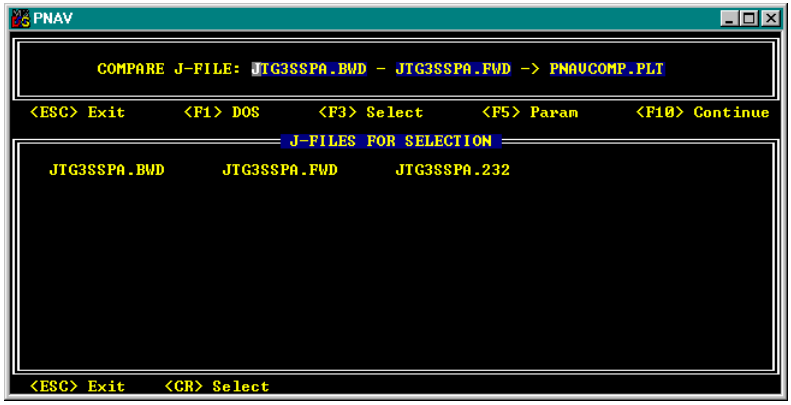

Figure 8.7: Compare NAV Solutions

The **J-FILES FOR SELECTION** area lists all the J-files n the current directory. By default, PNAV is ready to compare the first two J-files and place the result in a plot ile called PNAVCOMP.PLT.

2. To change a file name in the **COMPARE J-FILE** area, <TAB> to it and type as desired.
3. To select a J-file from the **J-FILES FOR SELECTION** area, press **<F3> Select**, highlight the desired file, and press <ENTER>.

Compare C-File Menu

To compare C-files:

1. In the COMPARE J-FILE menu, access the **<F5> Param** popup menu (fully described later in this section):

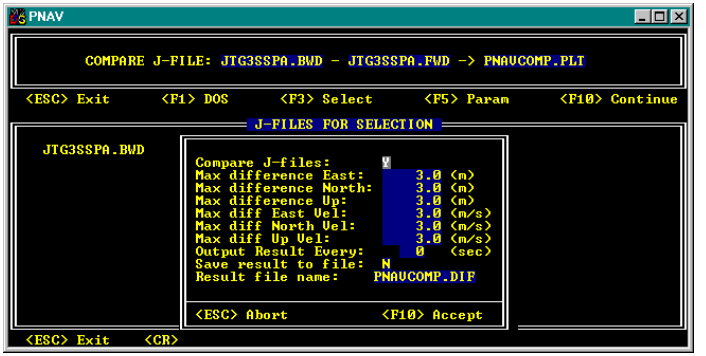

Figure 8.8: Compare J-File Menu

2. Select **Compare J-files: N**o.
3. Press <F10> accept the selection.
4. Observe, typically:

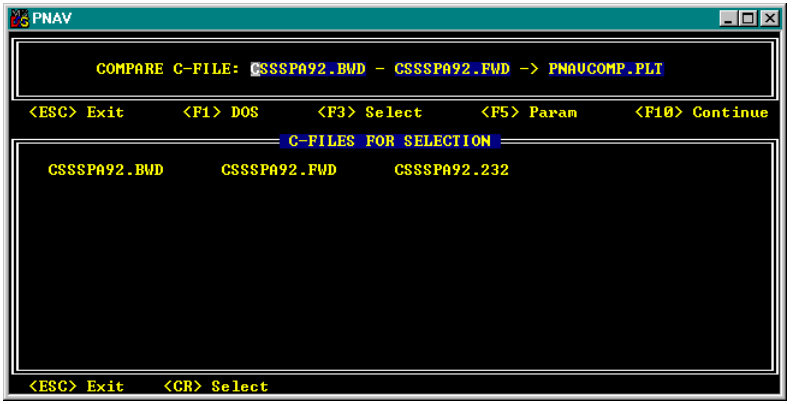

Figure 8.9: Compare J-File Selection Screen

5. To change any file name in the **COMPARE C-FILE** area, <TAB> to it and type as desired. (PNAVCOMP.PLT is the default comparison plot file name.)
6. To select a C-file from the **C-FILES FOR SELECTION** area, press **<F3> Select**, highlight the desired file, and press <ENTER>.

<ESC> Exit Command

With the cursor in the **J/C-FILES FOR SELECTION** area, press <ESC> to move to the **COMPARE J/C-FILE** area. In the **COMPARE J/C-FILE** area, press <ESC> to exit Menu 4.0.

<F1> DOS Command

Press <F1> to shell out to DOS; type **EXIT<ENTER>** at the DOS prompt to return to PNAV.

<F5> Param Popup Menu

To set **Param**eter limits for the comparison, with the cursor in the **COMPARE J/C-FILE** area, press <F5>; observe the default popup screen:

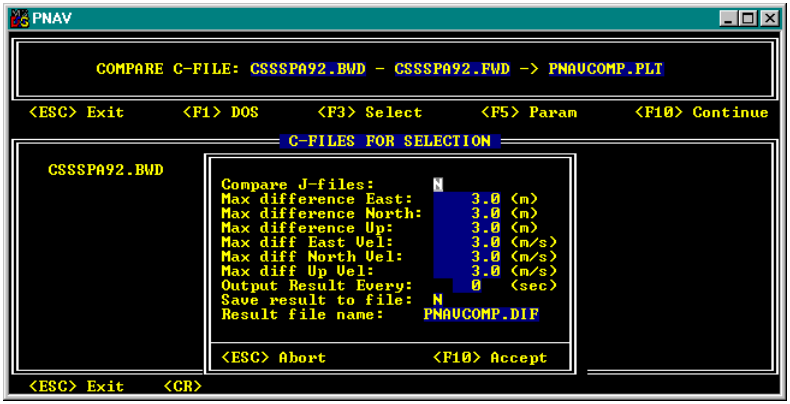

Figure 8.10: Param Pop-up Menu Screen

where **Compare J-files: N**o if <F5> is pressed from the **COMPARE C-FILE** area.

1. To change a parameter, highlight it and type in the desired value.
2. To save the comparison to a tabular ASCII **Result file**, set **Save result to file: Y**es.
3. To change the **Result file** name, type as desired.
4. Press <F10> accept the selection and return to the **COMPARE J/C-FILE** area.

<F10> Continue Command

1. Press <F10> to perform the comparison.

2. If the selected comparison plot file name (or the optional Results file) already exists in the current directory, PNAV prompts, typically:

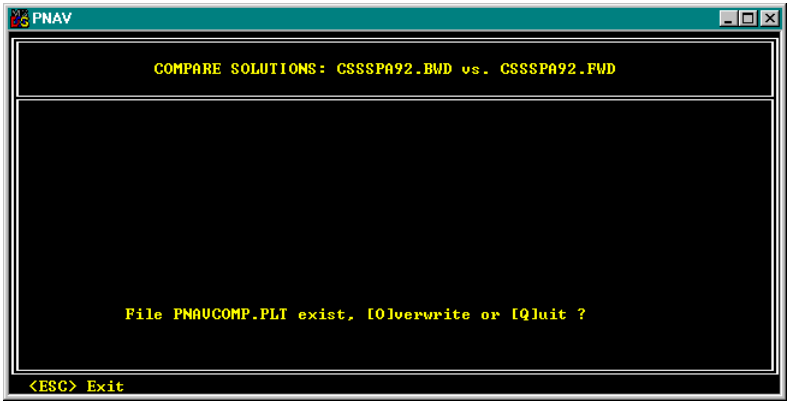

Figure 8.11: Overwrite Plot File Prompt

3. Type **O** to continue the comparison.
4. PNAV then reports its progress epoch-by-epoch, and, when finished, restores the **COMPARE J/C-FILE** menu.
5. Compare another pair of files, or press <ESC> to return to Menu 4.0.
6. PNAVCOMP.PLT and the optional *.DIF file generated are described in the chapter *Program Input and Output Data Files*.

Option D - Convert Vector Output

This options allows you to convert Ashtech binary O-files to ASCII V-files. PNAV will automatically scan for any O-files in the working directory and convert them. If no files are found, in an error message is displayed and the program returns to the Post Mission menu.

Option E - View Results

This option allows you to view a number of types of PNAV output files. You will see a screen like the one in Figure 8.12.

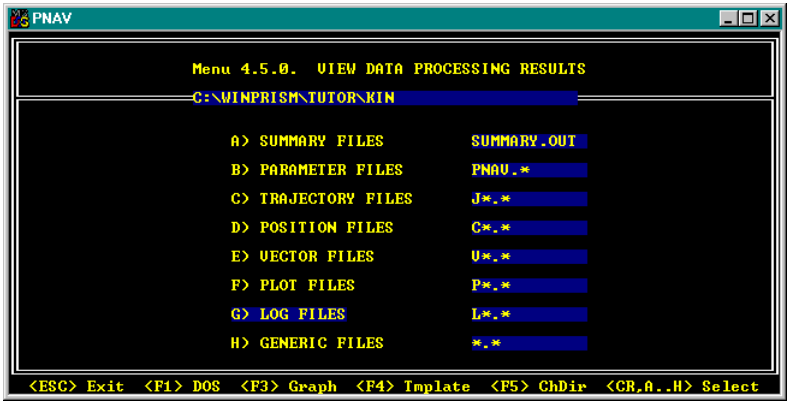

Figure 8.12: View Results Screen - Option E

The file types are summary files, parameter files, trajectory files, position files, vector files, plot files, log files and generic files which allows you to view any test file in the current directory. Next to each selection is a filter that will be applied to the files in the current directory. Selecting one of the options will take you to a file selection screen, typically like that shown in Figure 8.13.

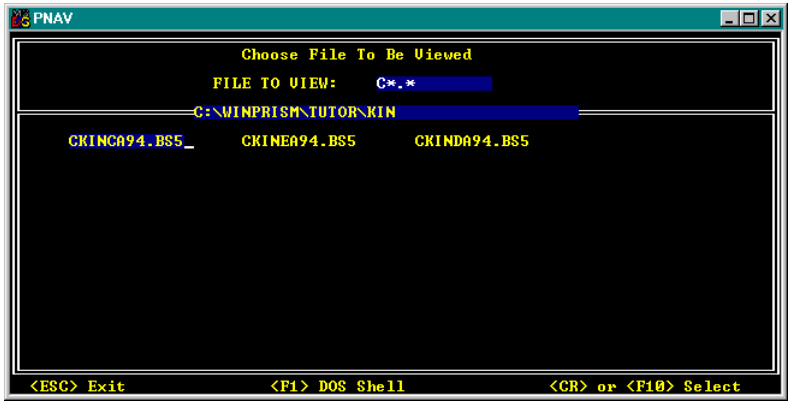

Figure 8.13: File Option Screen

You may navigate through a list of available files using the arrow keys or mouse. Pressing <Enter> or <F10> will open the file for viewing.

PNAV Utility

This option accesses a menu through which you can modify the default processing runtime and Kalman filter parameter settings in the Default Parameters file (PNAVPMT.DFT) and run other utility functions.

Menu 5.0 PNAV Utility

Select from the PNAV Overview Menu, Option **E) PNAV UTILITY**; observe:

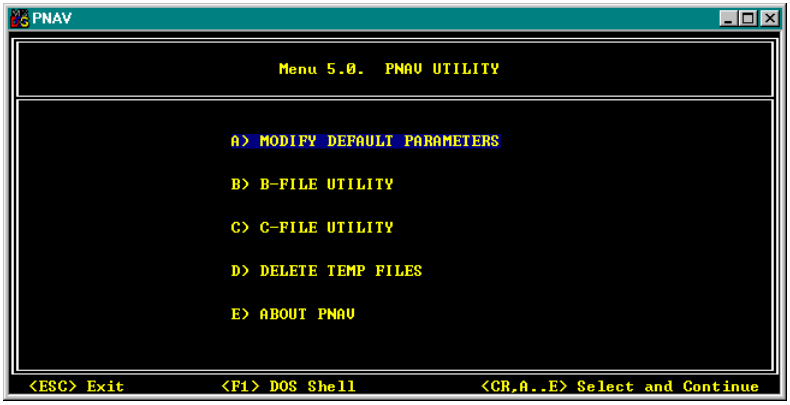

Figure 9.1: PNAV Utility Screen

The options are followed by the active control keys.

<ESC> Exit Command

Press <ESC> to exit to the PNAV Overview Menu.

<F1> DOS Shell Command

Press <F1> to shell out to DOS; type **EXIT<ENTER>** at the DOS prompt to return to PNAV.

<CR,A,B,C,D,E> Select and Continue Command

Press the letter for the desired option, or highlight it and press <ENTER>.

Option A - Modify Default Parameters: Menu 5.1.0

If you want to modify the full set of runtime and Kalman filter parameters for batch processing, you must do so in this menu before you select Overview Menu Option B) BATCH PROCESSING. (In the BATCH PROCESSING menus you can access only a small subset of the parameters available.) The modification is associated with each ROVER DYNAMICS selection. Making changes in one rover dynamics will not affect the other dynamics.

In Menu 5.0, select **A) MODIFY DEFAULT PARAMETERS**; observe:

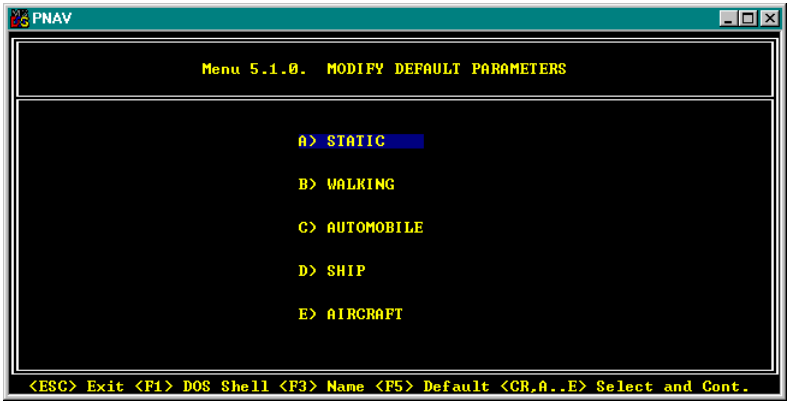

Figure 9.2: Modify Default Parameters Screen

These options correspond to the ROVER MOTION DYNAMICS displayed in the PNAV POST-PROCESSING OPTIONS (<F3> command) submenu accessed via Overview Menu Option B) BATCH PROCESSING menu and in MENU 3.0. PROGRAM EXECUTION MODE AND ROVER DYNAMICS accessed via Overview Menu Option C) DATA PROCESSING. The bottom line lists the active control keys.

<ESC> Exit Command

Press <ESC> to exit to Menu 5.0.

<F1> DOS Shell Command

Press <F1> to shell out to DOS; type **EXIT<ENTER>** at the DOS prompt to return to PNAV.

<F5> Default Command

To restore the runtime and Kalman filter parameters for all rover dynamics to their factory default settings:

1. Press <F5>; PNAV then reports:

```
Using factory default parameters - OK
```

2. When you press any key, PNAV proceeds with the restoration.

Modify Default Parameters Setup Menu Screen

The first time you access this screen, PNAV copies the current contents of the Default Parameters file (PNAVPMT.DFT) to a read-only Factory Default Parameters file called PNAVPMT.FAC from which it can restore the default settings when you press <F5>.

To modify the runtime and Kalman filter parameters, highlight the desired option (**STATIC**, **WALKING**, **AUTOMOBILE**, **SHIP**, or **AIRCRAFT**), and then press <ENTER>; PNAV then displays the appropriate MODIFY DEFAULT PARAMETERS Setup Menu Screen, e.g., for option **A) STATIC**, observe:

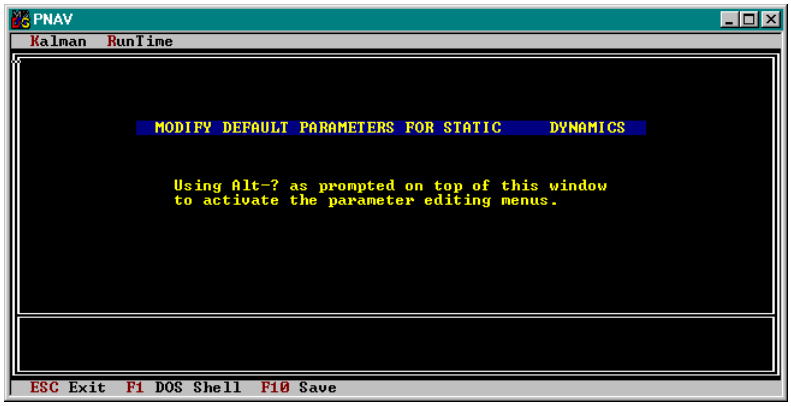

Figure 9.3: Modify default parameters for static processing

1. To specify the default parameters for all subsequent runs of Overview Menu Option B) BATCH PROCESSING or Overview Menu Option C) DATA PROCESSING, press the <Alt-K> Kalman or <Alt-R> RunTime keys to access the corresponding Setup Menus. For a description of these menus, see the *Setup Menus* chapter.

2. Once you have set the parameters as desired, press <F10> to **Save** them in the Default Parameters file (PNAVPMT.DFT); PNAV prompts:

   ```
   Are you sure you want to save the changes [Y/N].
   ```

   Type **Y**es or **N**o.

3. To exit to Menu 5.1.0, press <ESC>; PNAV prompts:

   ```
   Are you sure you want to quit [Y/N].
   ```

   Type **Y**es or **N**o.

Option B - B-File Utility

In Menu 5.0, select **B) B-FILE UTILITY**; observe:

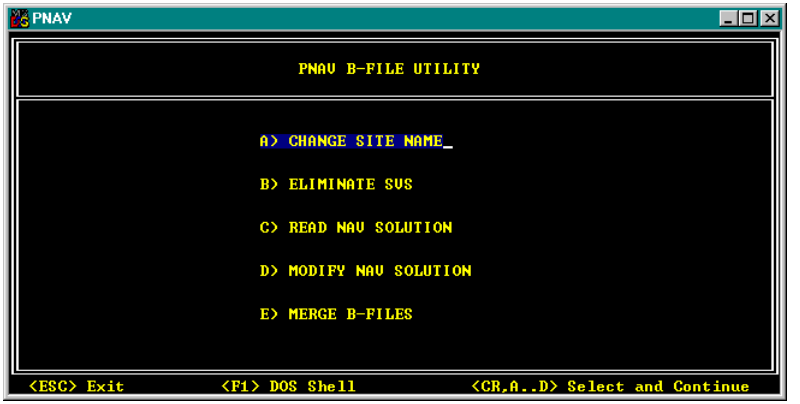

Figure 9.4: B-file Utility Screen

The options are followed by the active control keys.

<ESC> Exit Command

Press <ESC> to exit to Menu 5.0.

<F1> DOS Shell Command

Press <F1> to shell out to DOS; type **EXIT<ENTER>** at the DOS prompt to return to PNAV.

<CR,A..E> Select and Continue Command

Press the letter for the desired option, or highlight it and press <ENTER>.

Option A - Change Site Name

This option changes all the site identifiers in a selected B-file to a single site ID. This is useful to indicate a moving receiver for trajectory (navigation) data.

We do not recommend changing the site name for survey data where unique site names are important for post-processing analysis.

The **B-Files For Selection** area lists all the B-files in the current directory. By default, PNAV is ready to modify the first B-file.

1. Press **<F5> Param**; observe the popup, typically:

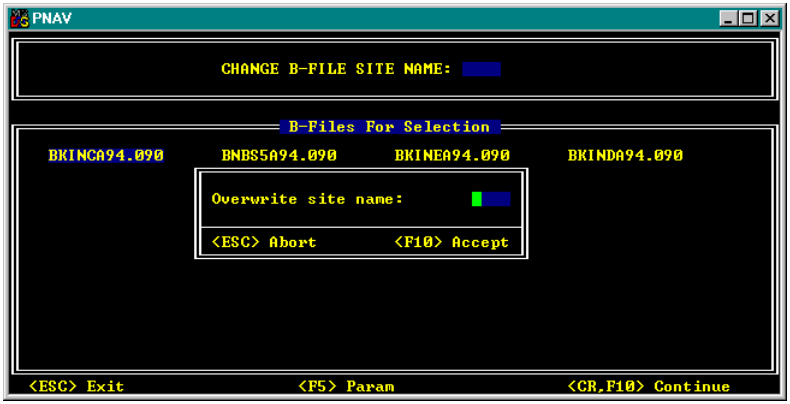

Figure 9.5: <F5> Param Pop-Up Screen

2. Type the desired four-character **Overwrite site name**, e.g., **?FLT**.

The first time you select the CHANGE SITE NAME option, the site ID is blank. PNAV saves the last entry you accepted in the popup to the PNAVFILE.PMT and uses it in subsequent runs.

3. Press <F10> to accept the change and remove the popup or <ESC> to abort the change.
4. If accepted, PNAV displays the new name in the **CHANGE B-FILE SITE NAME** field.
5. Highlight the desired file where you want to change the site ID, and press <ENTER> or <F10> to continue the name change.

6. PNAV then prompts, typically:

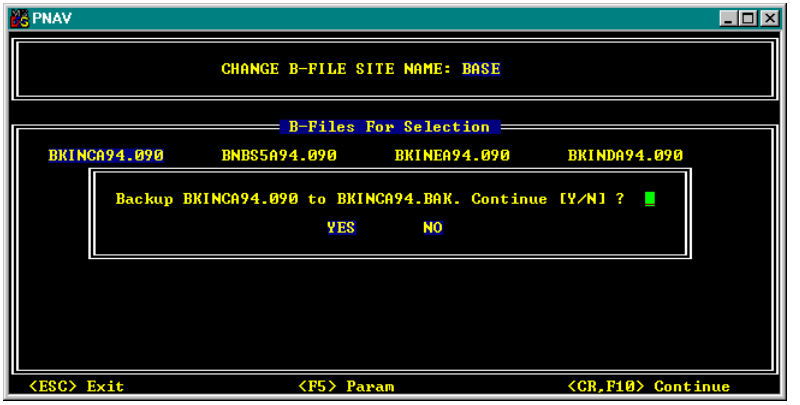

Figure 9.6: Change Site ID

7. When you press any key, PNAV displays a spinner until finished; the current directory then contains the B*.BAK file with the site ID before renaming and the selected B-file with the renamed site ID.
8. If you attempt to rename the site ID for a B-file while a corresponding B*.BAK file exists in the current directory, PNAV notifies you and cancels the operation.
9. When finished, press <ESC> to exit to the PNAV B-FILE UTILITY menu.

Option B - Eliminate SVs

This option eliminates one or more satellites and associated data from a selected B-file. In the PNAV B-FILE UTILITY screen, select **B) ELIMINATE SVS**.

1. The **B-Files For Selection** area lists all the B-files in the current directory. By default, PNAV is ready to eliminate SVs from the first B-file.

   Press **<F5> Param**; observe the popup, typically:

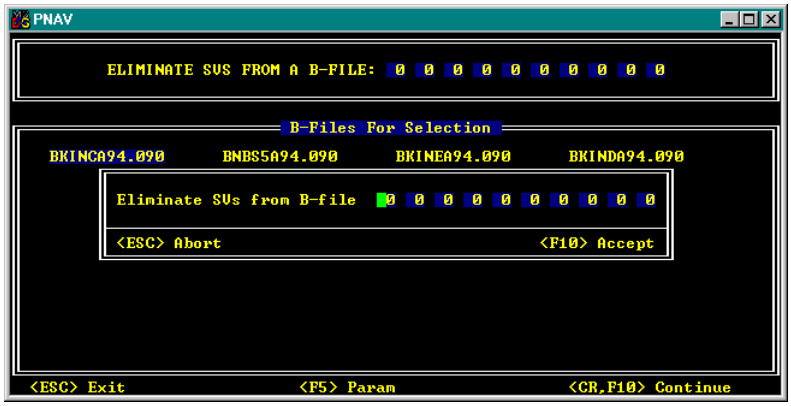

Figure 9.7: <F5> Param Pop-up Screen

2. Type in the **Eliminate SVs from B-file** fields the PRN numbers of the satellites to eliminate, starting with the first slot. (The factory default is **0**.) For example, if SVs 3 and 13 are to be eliminated, this specification would look like:

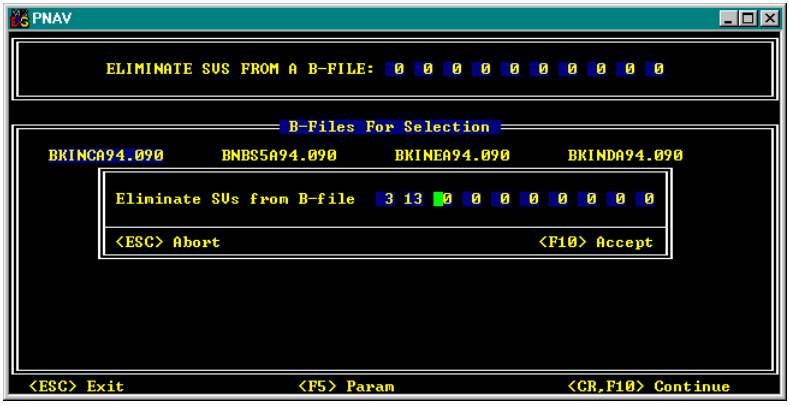

Figure 9.8: Eliminating SVs from a B-file

The first time you select the ELIMINATE SVS option, the ELIMINATE SVS FROM A B-FILE fields are all zero. PNAV saves the last entry you accepted in the popup to the PNAVFILE.PMT and uses it in subsequent runs.

3. Press <F10> to accept the change and remove the popup or <ESC> to abort the change.
4. If accepted, PNAV displays the PRNs in the **ELIMINATE SVS FROM A B-FILE** field.
5. Highlight the desired file where you want to eliminate SVs, and press <ENTER> or <F10> to continue the name change.
6. PNAV then prompts, typically:

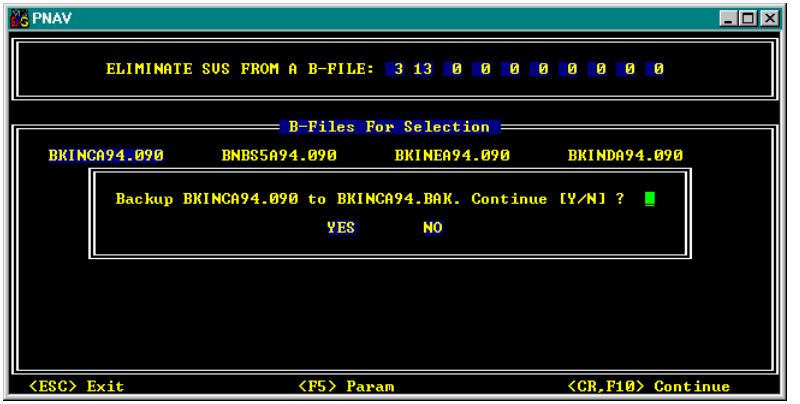

Figure 9.9: Prompt for backing-up B-file

7. When you press any key, PNAV displays a spinner until finished; the current directory then contains the B*.BAK file containing the satellites and data before eliminating and the selected B-file minus the eliminated satellites and data.
8. If you attempt to omit SVs from a B-file while a corresponding B*.BAK file exists in the current directory, PNAV notifies you and cancels the operation.
9. When finished, press <ESC> to exit to the PNAV B-FILE UTILITY menu.

Option C - Read NAV Solution

This option reads the raw navigation (receiver) solution (**navx**, **navy**, **navz**, **navxdot**, **navydot**, **navzdot** in the **rawnav** structure) from a selected B-file to create a C-file or J-file with the same format as the PNAV output C-file or J-file.

For details on the B-file structures, see the *Tools User's Guide*.

In the PNAV B-FILE UTILITY screen, select **C) READ NAV SOLUTION**

The **B-Files For Selection** area lists all the B-files in the current directory. By default, PNAV is ready to read the solution from the first B-file.

1. Press **<F5> Param**; observe the popup, typically:

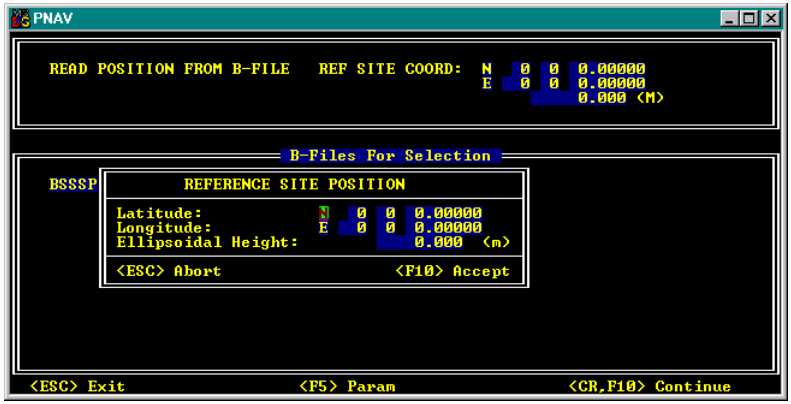

Figure 9.10: Read NAV Solution

2. Type the desired **REFERENCE SITE POSITION** in the **Latitude**, **Longitude**, and **Ellipsoidal Height** (in meters) fields. If no position is entered (**Latitude** = **Longitude** = 0), PNAV will create a C-file. If a position is entered, PNAV will create a C-file and a J-file, using this position as the reference station. (The J-file will contain the relative position with respect to this reference site position.)

The first time you select the READ NAV SOLUTION option, the REF SITE COORD and REFERENCE SITE POSITION fields are all zero. PNAV saves the last entry you accepted in the popup to the PNAVFILE.PMT and uses it in subsequent runs.

3. Press <F10> to accept the change and remove the popup or <ESC> to abort the change.
4. If accepted, PNAV displays the new position in the REF SITE COORD fields.
5. Highlight the desired file, and press <ENTER> or <F10> to read the position.

6. PNAV displays a spinner until finished. The file name of the resulting J-file or C-file in the current directory is formed by replacing the first character of the B-file name with J or C and the extension by .UTL.
7. When finished, press <ESC> to exit to the PNAV B-FILE UTILITY menu.

Option D - Modify NAV Solution

This option replaces the raw navigation (receiver) solution (**navx**, **navy**, **navz**, **navt**, **navxdot**, **navydot**, **navzdot**, **navtdot** in the **rawnav** structure) in a selected B-file with the post-processed solution from a selected PNAV C-file. This is useful for subsequent PNAV processing in the Relative Nav Mode.

For details on the B-file structures, see the *Tools User's Guide*.

The Relative Nav Mode is not tested and not supported in this release.

In the PNAV B-FILE UTILITY screen, select **D) MODIFY NAV SOLUTION**; observe, typically:

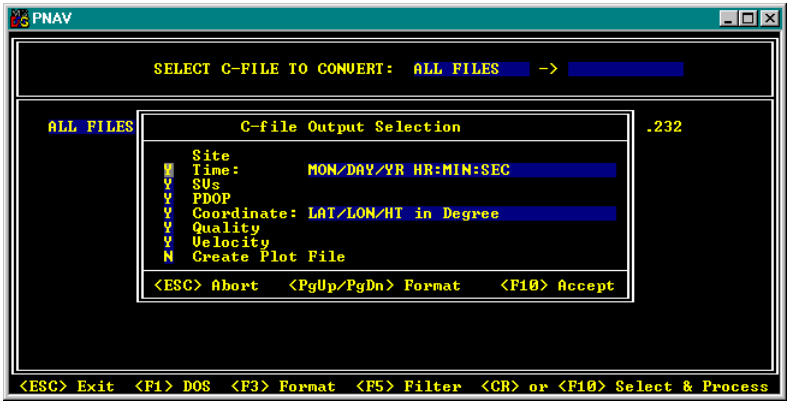

Figure 9.11: Modify NAV Solution

The **B-Files** area lists all the B-files in the current directory and the **C-Files** area lists all the C-files. By default, the **MODIFY B-FILE** area lists the first B-file (with the cursor) and the first C-file.

1. To select a different B-file to modify:
   a. Type in the desired file name, or

b. Press **<F3> Select** to move the cursor to the **B-Files** area, highlight the desired file, and press <ENTER> to return the cursor to the B-file field in the **MODIFY B-FILE** area.

2. To select a different C-file to modify the selected B-file:
   a. Type in the desired file name, or
   b. Press **<F3> Select** to move the cursor to the **C-Files** area, highlight the desired file, and press <ENTER> to return the cursor to the C-file field in the **MODIFY B-FILE** area.
3. When satisfied with your selections, press **<F10> Continue**.
4. PNAV displays a spinner until finished; the current directory then contains: a copy of the unmodified selected B-file called X*.BAK and the modified B-file. In the modified B-file:

   A special message is added to the **`rawheader`** structure:

   ```
   rawhead.spare =  "POST-PROCESSED NAV SOLUTION".
   ```

   If the C-file has a good position for a given epoch, that position replaces the original navigation solution in the **`rawnav`** structure (**`navx`**, **`navy`**, **`navz`**, **`navxdot`**, **`navydot`**, **`navzdot`**) and **`navt`** and **`navtdot`** in **`rawnav`** are zeroed out; otherwise, the navigation solution is unchanged and **`navt`** and **`navt`** in **`rawnav`** are nonzero.

In subsequent processing in the Relative Nav Mode, when PNAV finds the special message in the B-file header, it treats all epochs in the B-file with non-zero `navt` and `navt` in `rawnav` as bad epochs and ignores them.

5. When finished, press <ESC> to exit to the PNAV B-FILE UTILITY menu.

Option E - Merge B-files

COMBFILE.EXE combines all available B-files in current directory to reduce number of working B-files. It combines B-files according to time span in each B-files and the RCVR ID in the S-file.

COMBFILE.EXE is an example.

- a DOS prompt
- PNAVFILE.EXE selections
- PNAV main menu / E) PNAV UTILITY / B) B-FILE UTILITY / E) MERGE B-FILES

The original B-files will be backed up to X-files.

It is advisable to backup the original raw data files before running this program to prevent any lost of original raw data.

The COMBFILE.LOG file shows how the B-files were combined. The following COMBFILE.LOG is an example:

```
       Found the following 9 B-files in this directory:
 Name           type       start    end      interval
 B_ASHA94.131   L1CP_L2P   322270   323210   10.0
 B0002C94.131   L1CP_L2P   324320   324940   10.0
 B0003B94.131   L1CP_L2P   323440   324020   10.0
 B0003C94.131   L1CP_L2P   324260   324920   10.0
 B0004B94.131   L1CP_L2P   323420   324020   10.0
 B0005A94.131   L1CP_L2P   322670   323220   10.0
 B0005B94.131   L1CP_L2P   323290   324020   10.0
 B0006A94.131   L1CP_L2P   322300   323220   10.0
 B0006C94.131   L1CP_L2P   324280   324940   10.0
Creating file B_ASHA94.131
 ...Appending B_ASHA94.131 with file B0005B94.131:  OK
 ...Appending B_ASHA94.131 with file B0003C94.131:  OK
Creating file B0006A94.131
 ...Appending B0006A94.131 with file B0004B94.131:  OK
 ...Appending B0006A94.131 with file B0006C94.131:  OK
Creating file B0005A94.131
 ...Appending B0005A94.131 with file B0003B94.131:  OK
 ...Appending B0005A94.131 with file B0002C94.131:  OK
They have been merged into the following 3 B-files:
 Name           type       start    end      interval
 B_ASHA94.131   L1CP_L2P   322270   324920   10.0
 B0006A94.131   L1CP_L2P   322300   324940   10.0
 B0005A94.131   L1CP_L2P   322670   324940   10.0
```

It shows that 9 B-files were combined into 3 B-files

```
B_ASHA94.131 + B0005B94.131 + B0003C94.131 -> B_ASHA94.131
B0006A94.131 + B0004B94.131 + B0006C94.131 -> B0006A94.131
B0005A94.131 + B0003B94.131 + B0002C94.131 -> B0005A94.131
```

Figure 9.12: COMBFILE

The antenna parameters from each S-file will be combined into a D-file to retain the antenna parameters, site description, meteorological data, etc. For example, D_ASHA94.131 contains information from site _ASH, 0005 and 0003.

```
C 322270.000000
ZS B _ASH  0.0000 0.1737  0.0000 A_____________________________ +00 +00 00 0000
C 323210.000000
ZS E
C 323290.000000
ZS B 0005  1.8900 0.1737  0.0000 B_____________________________ +00 +00 00 0000
C 324020.000000
ZS E
C 324260.000000
ZS B 0003  2.0610 0.1737  0.0000 C_____________________________ +00 +00 00 0000
C 324920.000000
ZS E
```

Figure 9.13: Antenna Parameters

Program options

Type COMBFILE -H will display the following on-line help.

```
COMBFILE  [option]
 -h or /h display this message.
 -f or /f do not fake the last epoch of each B-file.
    By default, the site ID of the last epoch of each B-file will be changed
     to “????” for rapid static processing.
 -n or /n ignore the receiver number during the file merging.
 -s or /s check the site ID between B-files during merging.

-f by default, the site ID of last epoch of each pre-combined B-file will be
renamed as ????, if it is not already ????. This allows PNAV to handle the
data processing more smoothly.  -f will turn off this logic.

-n by default, COMBFILE.EXE checks the RCR field in the S-file for the
receiver ID. If that field is not empty, it will be used to combine B-files
with the same receiver ID into the same B-files.  -n will turn off this logic.

-s with -s option, if the site ID of the last epoch of a B-file matches the
site ID of the first epoch of another B-file, then these two B-files will be
combined.
```

Figure 9.14: |COMBFILE-H

Option C - File Filtering

In menu 5.0, select “C-FILE UTILITY” from the PNAV Utility menu.

This will bring you to a screen containing a menu of all available c-files in the current directory.

Make a file selection by moving the cursor to the desired file, press <CR> or <F10> or click the mouse. The filtered file will be named after the selected C-file with the first character being changed to ‘W’.

There are two filtering options, one is <F3> to specify the output file format, the other is <F5> to specify the Filter parameters:

<F3> Output File Format

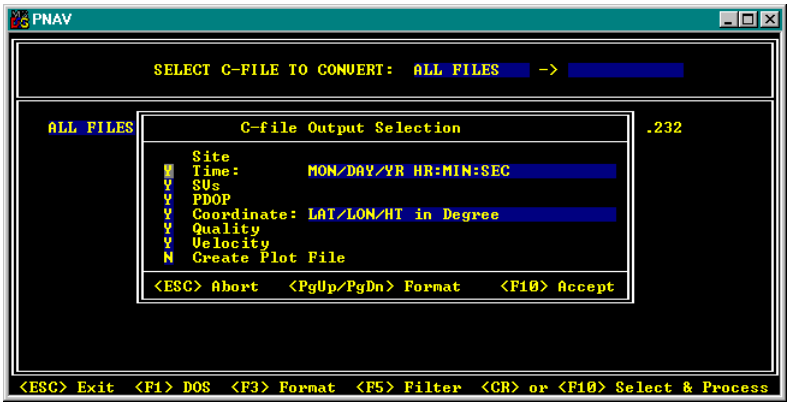

Figure 9.15: C-File Output Selection

Time can be chosen from:

Table 9.1: Time Format in C-File

Format	Example
MON/DAY/YR HR:MIN:SEC	10/04/96 15:23:12.00
GPS WEEK/SEC	873 487392

Coordinate can be chosen from:

Table 9.2: Coordinate Formats in C-File

Format	Example		
LAT/LON/HT in Degree	N 37.432423423	W 121.8543543534	-14.8130
LAT/LON/HT in Deg/Min	N 37 22.474892	W 121 59.543543	-14.813
LAT/LON/HT in Deg/Min/Sec	N 37 22 21.05436	W 121 5950.36578	-14.8130
WGS ECEF XYZ	-2689135.98577	-4303964.49021	3850320.36326

Use <PgUp> or <PgDn> keys to make the selections.

<F5> Filter Parameters

The filter looks at a selected C-file, and writes a W-file containing all the epochs that passed the filter criteria. The criteria are applied with a logical AND operator, meaning that only epochs that pass all of the filter criteria are written to the output file. Press the F5 to bring up the Filter Parameters dialog, containing the following fields:

Site ID mask

Any epochs which are not at this site are removed. Default value is ____, which lets all site names through the filter.

@___ Any epochs whose site ID first character is not '?' will be written to the new file.

?___ Any epochs whose site ID first character is '?' will be written to the new file.

Number of SVs

Any epochs with no less than this number of SVs will be written to the new file. Default value is 0.

PDOP

Any epochs with a PDOP no greater than this value will be written to the new file. Default value is 9999.99.

Std Dev

Any epochs with a position standard deviation of smaller than or equal to this value will be written to the new file. Default value is 9999.999.

Solution Type

It specifies the range of solution. For example, "0 to 0" means solution with fixed ambiguities will be written to the new file.

The following are valid inputs:

-1 predicted solution

0 Solution with fixed ambiguities

1 Solution with float ambiguities

2 Kalman filter reset

Average Static Site

There is a choice between Y (yes) and N (no). If you select Y, values are averaged for any particular non-kinematic (????) site name. For instance, all epochs with site name 0001 averaged, all with 0002 are averaged, etc. In the resulting file, this is viewed as all epochs for that site being compressed into one line. You will notice that the time tags in the file are no longer at the epoch interval of the input data files.

CAUTION
In many cases, the RMS value in the averaged site tends to be optimistic.

Option D - Deleting Temporary Files

During processing PNAV creates a number of temporary files for its own use. In previous versions, there was no option for deleting these after processing had finished. PNAV allows you to delete some or all of these files. To do this:

1. Select PNAV Utility option from the main menu.
2. Select the Delete Temp Files from the PNAV Utility menu.

You will be prompted with a list of file name templates, and to choose Yes, No or All.

- To delete files one by one, choose Yes.
- To keep files and exit this window, choose No.
- To delete all files and exit the window, choose All.

This is a convenient method of clearing up the temporary files if you have no further need for them.

Option E - About PNAV

Displays the current PNAV version number. Press any key to return to Menu 5.0.

Setup Menus

These menus allow you to:

- Edit input parameter files:
  - Run-Time/Kalman Filter Parameters file (PNAV.PMT) or Default Parameters file (PNAVPMT.DFT).
  - Site Position file (PNAV.POS - in Navigation Mode and Relative Nav Mode only).
  - Waypoint Navigation file (PNAV.WAY).
  - Rover Antenna Offset file (PNAV.PNT - in Navigation Mode and Relative Nav Mode only).
  - Simulation file (PNAVSIM.SIM).
- Change the menu display attributes (color, etc. - in the Configuration file, PNAV.CNF).
- Save any changes for use in subsequent processing sessions.

The Relative Nav Mode is not tested and not supported in this release.

Setup Menu Summary

You access Setup Menus with <Alt-?> hot-key commands. <Alt-?> means to hold the <ALT> key while pressing the second key, e.g. <Alt-A> means hold the <ALT> key and press <A>.

The following <Alt-?> Setup Menus are available via Overview Menu Option B) BATCH PROCESSING and Overview Menu Option C) DATA PROCESSING only:

<Alt-A> Attribute: edit display attributes (related to the PNAV.CNF file).

<Alt-F> File: DISPLAY, FILE, AND OUTPUT SELECTION--set output

data interval, select verbose/concise result display, turn on/off PNAV output files.

<Alt-O> Other: PROCESSING EPOCHS and MATCH SITE ID (related to the PNAVSIM.SIM file) and ROVER ANTENNA OFFSET (related to the PNAV.PNT file).

ROVER ANTENNA OFFSET applies only when processing in Navigation Mode or Relative Nav Mode; for Survey Mode, antenna height is in the LOGTIMES file and is edited via the EDIT LOGTIME screen.

<Alt-P> Position: edit Base station coordinates and antenna offsets when processing in the Navigation Mode.

This menu is not available when processing in the Survey Mode because site information is in the file called PROJFILE.KIN (edited via the EDIT PROJECT [EDIT SITE] screen) rather than in the PNAV.POS file.

<Alt-W> WayPoint (related to the PNAV.WAY file).

The following <Alt-?> SETUP MENUS are available via Overview Menu Option A) BATCH PROCESSING, Overview Menu Option B) DATA PROCESSING or Overview Menu Option D) PNAV UTILITY:

<Alt-K> Kalman: Kalman Filter System Parameters and Kalman Filter Measurement Noise Parameters (related to the PNAV.PMT and PNAVPMT.DFT files).

<Alt-R> RunTime: Run-Time Parameters (related to the PNAV.PMT and PNAVPMT.DFT files). In this Setup Menu, <F3> accesses a popup menu for more run-time parameters, and <F4> accesses a popup menu for quality assurance parameters.

Routes to Setup Menu

Setup Menus are available via Overview Option B) BATCH PROCESSING, Overview Option C) DATA PROCESSING, or Overview Option E) PNAV UTILITY.

CAUTION
To set the runtime parameters and Kalman filter parameters for BATCH PROCESSING, use Overview Menu Option E) PNAV UTILITY/MODIFY DEFAULT PARAMETERS. We do not recommend that you use the **F9 Menu** command to set these parameters in mid-processing.

(For details on the following summary procedures, see the appropriate chapter.)

Summary Procedure: Overview Menu Option C - Data Processing

The defaults in the Setup Menus are adequate for most processing. However, when processing in the Navigation Mode, be sure that the correct Base station coordinate and antenna heights have been entered.

In most of these Setup Menus, press <ESC> to abort any changes to parameter settings and return to the PROCESSING SETUP MENU screen or press <F10> to accept changes and return.

Any changes to parameter settings are effective in the current processing session when accepted via <F10>.

If you want to use any changes in subsequent processing sessions other than the current one, save them via the <Alt-F> File Setup Menu.

While in the **Alt-K**, **Alt-P**, **Alt-R**, and **Alt-W** Setup Menus, you can press the appropriate <Alt-?> combination to switch to another Setup Menu in this group without exiting to the SETUP MENU screen. PNAV automatically saves any changes made in the current Setup Menu when you switch to another Setup Menu.

CAUTION

Mid-process parameter modification is for expert use only. Until you become proficient, set the parameters when the PROCESSING SETUP MENU screen appears before processing.

From the DATA PROCESSING option, you can reach all the Setup Menus as follows:

1. Menu 3.0. PROGRAM EXECUTION MODE AND ROVER DYNAMICS.
2. Menu 3.1. PNAV DATA PROCESSING OPTIONS.
3. Preliminary processing.
4. PROCESSING SETUP MENU screen.
5. Continue processing.
6. F9 Menu, PROCESSING SETUP MENU screen, F9 Process.

Summary Procedure: Overview Menu Option E - PNAV Utility

This option allows you to modify the default values of the runtime and Kalman filter parameters for subsequent use in Batch Processing or Data Processing. In these Setup Menus, press <ESC> to abort any changes to parameter settings and return to the MODIFY DEFAULT PARAMETERS SETUP MENU screen or press <F10> to accept changes and return. From the PNAV UTILITY option, you can reach the corresponding Setup Menus as follows:

1. Option A) MODIFY DEFAULT PARAMETERS.
2. Menu 5.1.0. MODIFY DEFAULT PARAMETERS.
3. MODIFY DEFAULT PARAMETERS SETUP MENU screen

<ALT-A> Attributes Setup Menu Command

This Setup Menu allows you to change display (color and flash) attributes for the SETUP MENU screen. If you have a monochrome display, you may have to change the screen attributes in order to see the cursor.

1. To change menu attributes, press <Alt-A>; observe, typically:

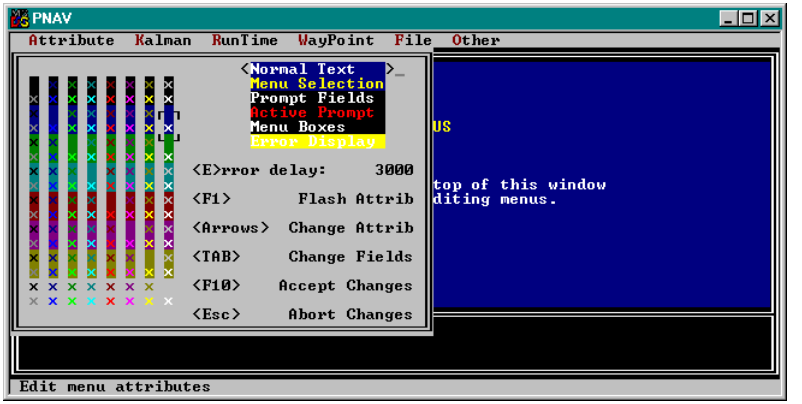

Figure 10.1: Attributes Setup Menu

2. To select a field type, press <TAB> to enclose in "<>" brackets the name of the desired field in the upper right area of the menu.
3. To change color, highlight the desired color combination in the left area.
4. Toggle flash on and off with <F1>.
5. Press <ESC> to exit the Setup Menu and abort any changes.
6. Press <F10> to exit and use any changes in the current processing session.

<ALT-F> File Setup Menu Command

This Setup Menu allows you to select:

- Verbose/concise for the default processing display in the current session,
- which parameter files to save for use in subsequent processing sessions,
- which optional output files to generate in the current session, and
- the output data interval for the output files in the current session.

Although you can save changes to the parameter settings in the PNAV.PMT file from the <Alt-F> File Setup Menu, they will not apply the next time you run PNAV.EXE without command-line options. Each time you run PNAV without options, it resets PNAV.PMT to the default parameter settings. As PNAV takes you through Menu 3.0, 3.1, preliminary processing, and the SETUP MENU screen, you must re-edit PNAV.PMT to restore the desired processing configuration. If you want to use a set of non-default parameters repeatedly, you should run PNAV with a command line option; see the *Command Line Options* chapter for details.

General Procedure

1. For output selections, press <Alt-F>; observe, typically:

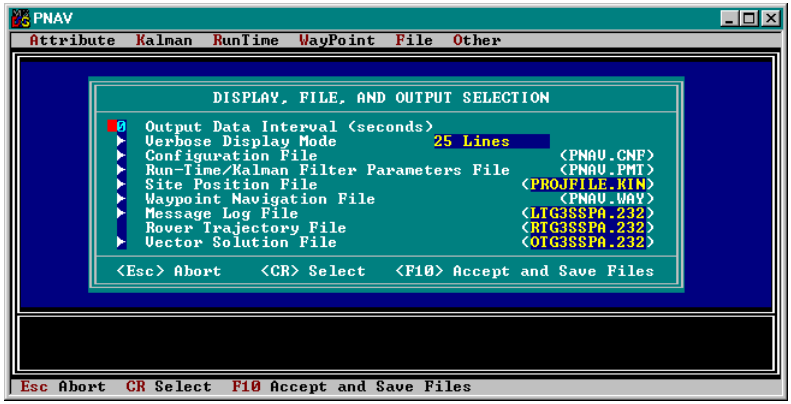

Figure 10.2: Files Setup Menu

"▶" means that the item is ON (selected for saving), while a blank means that the item is OFF (deselected from saving).

Any changes to this menu will be effective in the current processing session as soon as you press <F10>.

If you select the **Configuration File** for saving and then press <F10>, settings in this menu will be saved to the PNAV.CNF file in the current directory along with the menu attributes from the <Alt-A> Attribute Setup Menu. The next time you run PNAV, with or without options, the settings in this menu will be retrieved from the PNAV.CNF file in the current directory.

2. To toggle the **Verbose Display Mode** on and off, highlight it and press <ENTER>.
3. To select or deselect a file, highlight it and press <ENTER>.

4. To change the **Output Data Interval**, highlight it and type in the desired value.
5. Press <ESC> to exit the menu without saving any PNAV.* files.
6. Press <F10> to exit the menu and save the selected PNAV.* files.

Output Data Interval

allows you to select the interval of the data in the C, J, and R-files. An Output Data Interval of 0 seconds (default) produces output data files with the same data interval as the input files (i.e. if the data was recorded at a one-second interval, the output data will also be at a one-second interval.)

Verbose Display Mode

ON (default) selects the Verbose Result Display as the default initial display window, while OFF selects the concise Result Display. These displays are described in the corresponding sections of the *Overview Menu Option C) DATA PROCESSING* chapter. The **25 Lines** display field shows the default display mode; to toggle it to **43/50 Lines**, highlight **Verbose Display Mode**, and press <PageUp>/<Page Down>.

During data processing, you can press <F4> to toggle between the verbose and concise result display.

For details on the following files, see the chapter *Program Input and Output Data Files*.

Configuration File, Run-time/Kalman Filter Parameters File, and Waypoint Navigation File

are the PNAV input parameter files; the default for each of these files is ON.

Site Position File

P*.* is **PNAV.POS** (as shown in the example) when you are processing in Navigation Mode or Relative Nav Mode and **PROJFILE.KIN** (kinematic project file) when you are processing in Survey Mode; the default for this file is ON.

Message Log File (L-file)

is an optional output data file following the standard file-naming convention, Lxxxyyys.ddd. The L-file (default ON) is a message log file recording the data processing events and status.

Rover Trajectory File (R-file)

is an optional output data file following the standard file-naming convention, Rxxxyyys.ddd. The output R-file (default OFF) has a format which is compatible with the R-file generated by the GPPS KINSRVY program.

Vector Solution

is an optional output data file following the standard file-naming convention, Oxxxyyys.ddd. When you are processing in the Survey Mode, the O-file (default ON) provides "averaged" Rover site positions. The O-file is compatible with the output of the GPPS KINSRVY program. Selection of the O-file in Navigation Mode or Relative Nav Mode is disabled.

<ALT-K> Kalman Setup Menu Command

This Setup Menu allows you to modify Kalman filter system parameters and Kalman filter measurement noise parameters. The initial settings are from the Default Parameters file (PNAVPMT.DFT) and depend on the ROVER MOTION DYNAMICS selected via Overview Menu Option C) DATA PROCESSING or Overview Menu Option E) PNAV UTILITY. If you access this menu via DATA PROCESSING, PNAV saves any changes to the Run-Time/Kalman Filter Parameters file (PNAV.PMT) for use in the current processing session. If you access this menu via PNAV UTILITY, PNAV saves any changes to the PNAVPMT.DFT file. (The factory default values are listed with the PNAV.PMT file in the chapter *Program Input and Output Data Files*, section *Program Control Input Files*.)

CAUTION
Do not change these parameters from the factory default values unless you have a basic knowledge of Kalman filter theory and applications.

General Procedure

1. To edit Kalman filter parameters, press <Alt-K>; observe typically:

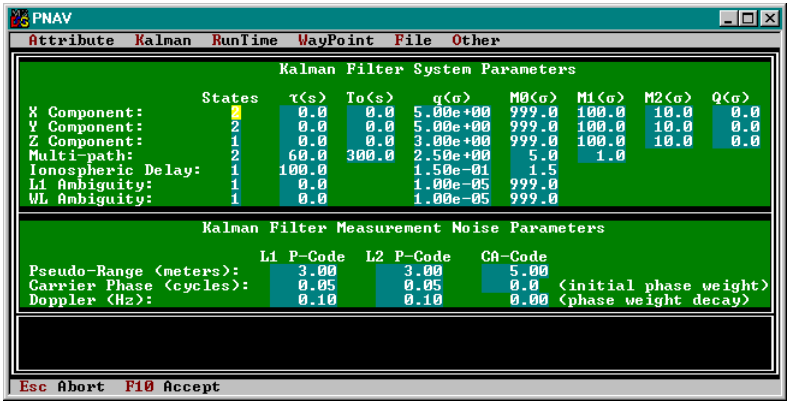

Figure 10.3: Kalman Filter Parameters

This Setup Menu comprises two sections: **Kalman Filter System Parameters** and **Kalman Filter Measurement Noise Parameters**.

2. To change a parameter field, highlight it and then type in the desired value.
3. Press <ESC> to exit the Setup Menu and abort any changes.
4. Press <F10> to exit the Setup Menu and use any changes in the current processing session.

Kalman Filter System Parameters

Column: States

is the number of states.

Column: τ(s)

is the correlation time (tau) in seconds.

Column: To(s)

is the oscillation period in seconds.

Column: q(σ)

is the process noise density (RMS value); the units depend on the state category.

Column: M0(σ),M1(σ),M2(σ)

is the initial state estimation RMS; the units depend on the state category.

Column: Q(σ)

is the additional process noise in the position state.

Each row represents a state category. In the following tabulations of recommended parameter settings, "na" (not applicable) means PNAV ignores the parameter setting.

Row: X Component, Y Component and Z Component

are the minimum set of state parameters. They consist of position/velocity/acceleration in WGS-84 XYZ coordinates, if **ENU Coordinate** in the **<Alt-R> RunTime** Setup Menu is set to **N**o; they correspond to the local geodetic ENU direction, if **ENU Coordinate** in the **<Alt-R> RunTime** Setup Menu is set to **Y**es. The proper Kalman filter parameter settings for X, Y, Z components depend on the setting of the Rover Motion Dynamics parameter in Menu 3.0 (via Overview Menu Option C) DATA PROCESSING). The default settings are:

Table 10.1: Data Processing Default Settings

Rover Motion Dynamics	States	τ(s)	To(s)	q(σ)	M0,M1,M2(σ)	Q(σ)	Remark
Static	all 1	0	0	<1.0e-3	M0=999 M1,M2=na	na	
Walking (low dynamic rover)	all 2	0	0	1.0	M0=999 M1=100 M2=na	na	
Automobile (medium dynamic rover)	all 2	0	0	1.0	M0=999 M1=100 M2=na	na	
Ship	X,Y=2 Z=1	0	0	X,Y=3.0 Z=1.0	M0=999 M1=100 M2=na	na	Set ENU Coordinate in Alt-R to 'Y'
Aircraft (high dynamic rover)	all 2	0	0	5.0	M0=999 M1=100 M2=na	na	

where:

q(σ) units are:

meters/(sec)$^{1/2}$ if **States** = 1

meters/(sec)$^{3/2}$ if **States** = 2

meters/(sec)$^{5/2}$ if **States** = 3

M0(σ) is in meters

M1(σ) is in meters/sec

M2(σ) is in meters/sec^2

Row: Multi-path

is for modeling pseudo-range multi-path when **Model Multi-path** in the <Alt-R> RunTime Setup Menu is set to Yes; PNAV ingnores the settings when Model Multi-path is set to No. Normally multi-path has periodic pattern and is larger for lower-elevation satellites. Recommended settings are:

Table 10.2: Multipath Settings

States	τ(s)	To(s)	q(σ)	M0,M1(σ)
2	100	120-300	0.1	5,5

where:

q(σ) is in meters/(sec)$^{3/2}$

M0(σ) is in meters

M1(σ) is in meters/sec

CAUTION

For expert use only. When Model Multi-path in the <Alt-R> RunTime Setup Menu is set to Yes, more RAM is required, data processing is slowed, and the solution may be robust.

This release of PNAV does not consider elevation-dependent multi-path.

Row: Ionospheric Delay

is for modeling residual double-differenced ionospheric delay when, in the <Alt-R> RunTime Setup Menu:

- Model Ionospheric Delay is set to **Y**es, or,

- **Model Ionospheric Delay** is set to **A**utomatic and the baseline length is longer than 15 kilometers.

  PNAV ignores the settings when Model Ionospheric Delay is set to **N**o. This residual ionosphere is spatially correlated. Generally its magnitude follows the 1-3 parts-per-million (ppm) rule. Recommended settings are::

Table 10.3: Ionospheric Delay Settings

States	τ(s)	To(s)	q(σ)	M0(σ)
1	100	n/a	0.15	M0=1.5

where:

q(σ) is in ppm

M0(σ) is in ppm

Row: Ambiguity

is for modeling carrier phase integer ambiguity. PNAV always displays **L1 Ambiguity** as long as it is processing carrier phase. **L2 Ambiguity** is displayed only for dual-frequency observables. **WL Ambiguity** (wide-lane) is displayed only for dual-frequency observables and then only when **Form Wide-lane Ambiguity** in the <Alt-R>. RunTime Setup Menu is set to Yes. This integer ambiguity is a constant. PNAV ignores all the ambiguity settings when Use Carrier Phase in the <Alt-R> RunTime Setup Menu is set to No. Recommended settings are::

Table 10.4: Ambiguity Settings

States	τ(s)	To(s)	q(σ)	M0(σ)
1	0.0	n/a	1.0e-5	M0 = 999

where:

q(σ) is in cycles

M0(σ) is in cycles

Kalman Filters Measurement Noise Parameters

These parameters instruct the Kalman filter to apply proper weight to different measurements.

We recommend the following parameter settings when processing data collected in a low multi-path environment:

```
                L1 P-Code   L2 P-Code    CA-Code
Pseudo-Range (meters):3.003.0030.00
Carrier Phase (cycles):0.050.050.0  (initial phase weight)
Doppler (Hz):0.100.100.00 (phase weight decay)
```

For observation with high multi-path, increase these values by a factor of 2 or 3, especially the **Pseudo-Range** noise.

In the menu, **Carrier Phase** noise and **Doppler** noise for CA-code and L1 P-code share the same entry field; i.e., editing Carrier Phase noise and Doppler noise under the **L1 P-Code** column will also edit those for CA-code. On the other hand, two entries under the **CA-Code** column are for initial weighting of carrier phase, once a cycle-slip is detected. The carrier phase noise will be amplified by the following formula, if these parameters are non-zero:

$$amplificationfactor = 1 + (initialphaseweight)(phaseweightdecay^{n \cdot sampleperiod})$$

where *n* is the number of epochs since cycle-slips occurred. This amplification factor converges to 1 if *phase_weight_decay* < 1.0. A graphical representation of this amplification factor is shown below.

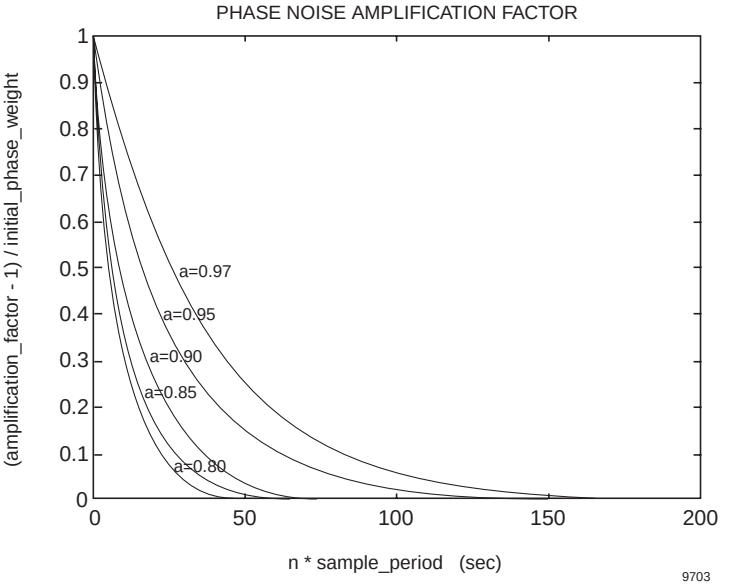

Figure 10.4: Phase Noise Amplification Factor

<ALT-O> Other Setup Menu Command

This Setup Menu allows you to:

- modify the starting and ending epoch to process,
- process only data matching specific site identifiers, and
- edit the Rover antenna offset values (for Navigation Mode and Relative Nav Mode only).

General Procedure

1. To edit other parameters, press <Alt-O>.
2. For Navigation Mode and Relative Nav Mode, observe typically:

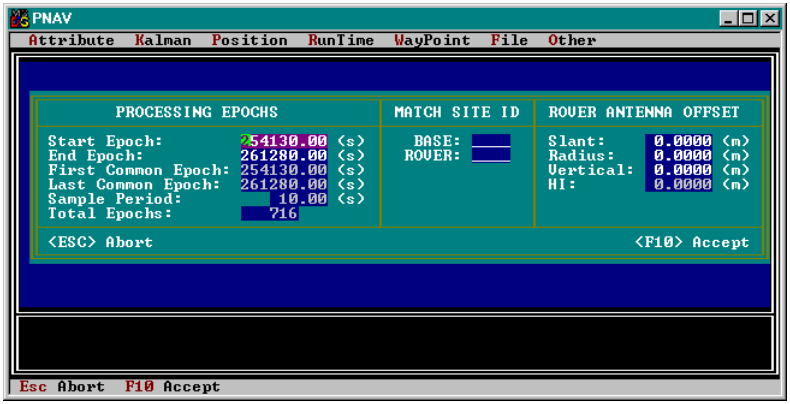

Figure 10.5: <Alt-O> Setup Menu - Navigation

3. For Survey Mode, observe typically:

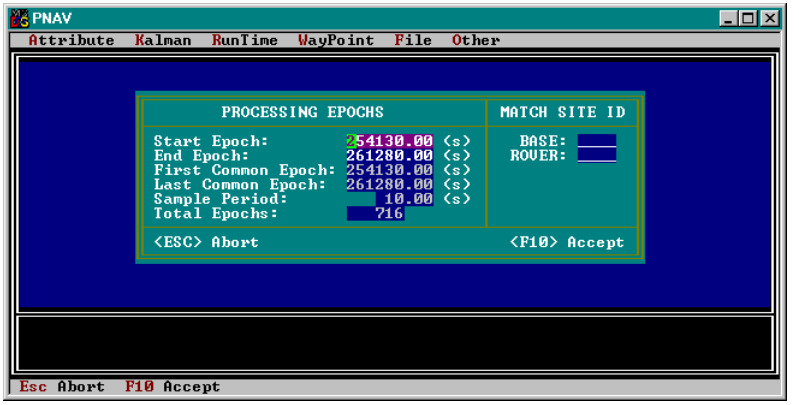

Figure 10.6: <Alt-O> Setup Menu - Survey

4. To change a parameter field, highlight it and type the desired value.
5. Press <ESC> to exit the Setup Menu and abort any changes.
6. Press <F10> to exit and use any changes in the current processing session; changes to the PROCESSING EPOCHS and MATCH SITE ID fields will be saved to the PNAVSIM.SIM file, and any changes to the ROVER ANTENNA OFFSET fields will be saved to the PNAV.PNT file.

Processing Epochs

The first two fields allow you to edit the starting and ending epoch to process (in seconds of week). The remaining fields display the available common epochs between the B-files selected to process. The default is to process all of the common data, i.e.:

- **Start Epoch** data is the same as **First Common Epoch**.
- End Epoch is the same as **Last Common Epoch**.
- **Total Epochs** is the total epochs available.
- **Sample Period** displays the data recording interval.

A legal value for the starting and/or ending epoch to process is a time tag which is within the common epoch in seconds of the week. If you enter a narrower interval, **Total Epochs** changes to display the selected epoch to process.

Match Site ID

To selectively process only data with specific site identifiers, type the desired four-character IDs in the **BASE** and/or **ROVER** fields; if "----" (the default), all data regardless of site ID are processed.

Only the data satisfying both the PROCESSING EPOCHS and MATCH SITE ID masks is processed. For example, if Start Epoch is 137000, End Epoch is 139000, and ROVER is SSSS, only the data between 137000 and 13900 matching rover site ID "SSSS" is processed.

Rover Antenna Offset

It is often important to take the Rover antenna height into account during processing. Enter the antenna offset here (in meters). Enter either the measured **SLANT HEIGHT** and the **RADIUS** of the antenna or the **VERTICAL** height of the antenna; PNAV automatically computes **HI** (height-of-instrument) from these values.

This applies to Navigation Mode and Relative Nav Mode only. For Survey Mode, edit the Rover antenna offset via the PROCESS/EDIT LOGTIME screen. When processing in Navigation Mode, PNAV will use only this value for the Rover during processing.

<ALT-P> Position Setup Menu Command

This Setup Menu is disabled if you are processing in the Survey Mode. In the Navigation Mode or Relative Nav Mode, <Alt-P> allows you to:

- Edit site and position data for the selected Base station.
- Enter a position for the Remote Base Site (_RBS).

PNAV will not begin processing until a valid Base station exists.

- Add waypoint positions to PNAV.POS that you can select as waypoints in the

PNAV does not use the _RBS site antenna offset in navigation computations if the _RBS site is different from the Base site.

General Procedure

1. To edit site positions, press <Alt-P>; observe typically:

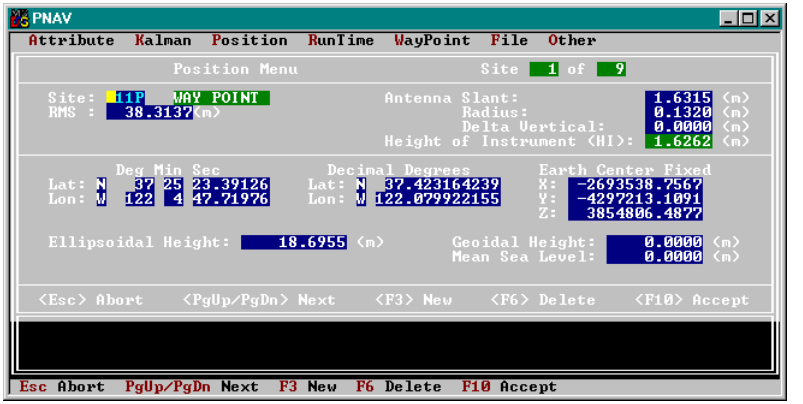

Figure 10.7: <Alt-P> Setup Menu

2. To select other sites from the PNAV.POS file, press the <PAGE UP> or <PAGE DOWN> key.
3. To create a new site and add it to the site list, press <F3>, and then type in a new name for an existing site entry.
4. To delete the displayed site from the site list, press <F6>.
5. To change a position parameter value, highlight it and type in the desired value.
6. Press <ESC> to abort any changes for the current site.
7. Press <F10> to accept any changes for the current site for use in the current processing session.

PNAV will not automatically save any changes to the PNAV.POS file; use the <Alt-F> File Setup Menu as described earlier in this chapter.

Site

This data entry field initially displays the site name of the **BASE SITE**, or the site name of each **WAY POINT**.

Sometimes a Base site may display as a waypoint. This will not affect any processing results.

Remote Base Station

If you enter a special **Site** name called "_RBS" (Remote Base Station), PNAV will compute the Rover's relative position with respect to the _RBS site which will appear on the Processing Results Screen and will be saved into the J-file. If an _RBS site does not exist in the PNAV.POS file, PNAV will use the Base station as the Remote Base Station.

If it is a site other than the Base, _RBS is supposed to be a permanent mark or some fixed station with an already-known position, so any antenna offset associated with this site is meaningless, and PNAV ignores it during processing.

Waypoints

Waypoint coordinates entered in this Setup Menu are accepted for use in the current processing session when you press <f10>. You should first enter the waypoint coordinates in this Setup Menu (or from the <f1> Edit option of the <Alt-W> Waypoint Setup Menu), and then set up your route in the <Alt-W> WayPoint Setup Menu.

RMS

represents the RMS position error of a particular site. If the Base station's position is precisely known, enter a small number (or 0.0).

If you have any previous knowledge of the sites the Rover occupied, you may enter them here with their appropriate RMS values.

Antenna Offset

Enter (in meters) either the measured slant height and the radius of the antenna or the vertical height of the antenna; PNAV automatically computes height-of-instrument from these values.

Lat/Lon

If you type anything but **N** or **S** in the first field of **Lat**itude and **W** or **E** in the first field of **Lon**gitude, PNAV will not let you leave that field until you make a valid entry. Latitude and longitude can be entered as either degrees, minutes and seconds, or as decimal degrees. If latitude, longitude, and height are not available, then a station position can also be entered as WGS-84 earth-centered, earth-fixed cartesian coordinates (XYZ).

Geoidal Height [and] Mean Sea Level

are disabled in this release.

<Alt-R> RunTime Setup Menu Command

This Setup Menu allows you to modify runtime parameters. The initial settings are from the Default Parameters file (PNAVPMT.DFT). If you access this menu via Overview Menu Option C) DATA PROCESSING, PNAV saves any changes to the Run-Time/Kalman Filter Parameters file (PNAV.PMT) for use in the current processing session. If you access this menu via Overview Menu Option E) PNAV UTILITY, PNAV saves any changes to the PNAVPMT.DFT file. (The factory default values are listed with the PNAV.PMT file in the chapter *Program Input and Output Data Files*, section *Program Control Input Files*.)

General Procedure

1. To edit run-time parameters, press <Alt-R>; observe:

Figure 10.8: <Alt-R> Setup Menu

   These parameters are automatically set to the options specified in Menu 3.0 and Menu 3.1.

2. To alter a parameter, highlight it and type in the desired setting.

Since some parameters are interrelated, PNAV will check the interrelation, and display a warning message describing the automatic effect of setting the parameter. Press any key after viewing the message, and continue editing parameters.

3. To edit more run-time parameters, press <F3> or <F4>.
4. Press <ESC> to exit the Setup Menu and abort any changes.
5. Press <F10> to exit the Setup Menu and use any changes in the current processing session.

Static Site

If the Rover remained stationary during the entire data collection period, set this parameter to **Y**es. Otherwise, set it to **N**o. If you change the setting at this level, PNAV will automatically modify, to the appropriate settings, the **Kalman Filter System Parameters** in the <Alt-K> Kalman Setup Menu and warn you with a message.

ENU Coordinate

flag specifies output format of the relative position between the Base receiver and the Rover receiver.

If the flag is **Y**es (the default), then:

- the X, Y, and Z component in the
- the relative position on the Verbose Results Display and in the J-file will be in the east, north, up (ENU) format.

If the flag is **N**o, then the relative position format will be displayed in XYZ Earth-centered Earth-fixed (ECEF) format.

Use Doppler

allows you to specify whether to use the doppler measurements during processing.

CAUTION
Using doppler measurements in PNAV processing will increase the velocity estimate accuracy. However, since doppler measurements for Sokkia receivers are averaged doppler (not instantaneous doppler), the velocity estimate for nonlinear Rover motion may not be as accurate as the RMS velocity errors (in the J-file) imply.

Use Carrier Phase

allows you to specify whether to use carrier phase during processing, or to only use the pseudo-ranges during processing. If you set this parameter to **N**o, PNAV automatically sets to **N**o certain other parameters that require carrier phase.

Use C/A Pseudo-Range

allows you to specify whether to use the C/A pseudo-range during processing. If Menu 3.1 PNAV DATA PROCESSING OPTIONS (via Overview Menu Option C) DATA PROCESSING) shows **C/A-Code Only** or **C/A-Code+Carrier** as the only Data to Process, PNAV uses C/A pseudo-range regardless of this setting.

Form LC Observable

allows you to specify whether to form the LC observables during processing. Use this option if you have dual-frequency data, and the baseline separation between the Base and the Rover exceeds 100 kilometers. If you set this parameter to **Y**es, PNAV automatically sets to **N**o the **Form Widelane Ambiguity** parameter and the **Fixing Ambiguity** parameter. You must also set the following parameters manually when **Form LC Observable** is set to **Y**.

- **Kalman Filter Measurement Noise Parameters** in the <Alt-K> Kalman Setup Menu. When Form LC Observable is Yes, PNAV treats the LC observables as if they are C/A pseudo-range and carrier phase, and therefore you must change associated C/A code parameters. Since the LC observables are usually two to three times more noisy, the measurement noise should be increased.

The recommended parameter settings are:

Pseudo-Range (meters): 30

Carrier Phase (cycles): 0.15

- **Quality Assurance Parameters** in the <Alt-R> RunTime/F4 submenu
- Increase the **Maximum Allowed Average Phase Residual** to 0.04 meters or higher.
- Increase the **Maximum Allowed Chi2 Value** to 10.

Smooth Pseudo-Range

defaults to **N**o.

This parameter is disabled in the current release; if you attempt to enter Yes, PNAV will display the following message until a key is pressed:

Flag is disabled. Will set to "N". OK

Reset Ambs on Static Site

If **N**o (the factory default), obey the setting stored in the LOGTIMES file when processing in the Survey Mode. (PNAV ignores this parameter for Navigation Mode

and Relative Nav Mode.) **Reset Ambiguities on Static Site** is the same as **RESET** in the PROCESS/EDIT LOGTIME screen, **SITE** popup. If you set the parameter **Y**es in the <Alt-R> RunTime Setup Menu, PNAV resets all ambiguities on the static site regardless of the LOGTIMES file setting.

Model Multi-path

specifies whether to model pseudo-range multi-path during processing. The default is **N**o.

CAUTION
For expert use only. When Model Multi-path is set to Yes, more RAM is required, data processing is slowed, and the solution may not be robust.

Model Ionospheric Delay

specifies whether to model ionospheric delay during processing. If **A**utomatic (the default), use the model if the baseline is 15 kilometers or more, and do not use the model if the baseline is less than 15 kilometers. If **Y**es, always use the model. If **N**o, never use it.

Model Tropospheric Delay

specifies whether to model tropospheric delay during processing. The default is **Y**es.

Form Wide-Lane Ambiguity

allows you to specify whether to form the wide-lane ambiguity during processing, and requires dual-frequency carrier phase data.

Fixing Ambiguity

allows you to specify whether to attempt to fix ambiguities during processing.

Use Unhealthy SVs

allows you to specify whether to use any unhealthy satellites in processing.

Use Pseudo-Range Every: 0.0 (seconds)

indicates that pseudo-range measurement will be processed at every epoch interval (default). Any non-zero value *x.y* means process the pseudo-range measurement every *x.y* seconds. A large pseudo-range sample interval means less processing time and less multi-path effect on the processing results, but a longer time to fix ambiguities.

Mask Angle

removes all satellites below the specified elevation from processing (default is 10 degrees).

SVs to Omit from Processing

allows you omit individual satellites from processing (default is none omitted).

SVs to Omit as References

allows you omit individual satellites from use as a reference satellite (default is none omitted).

Use Smooth Correction from B-file

allows you to specify whether to use the pseudo-range smoothing in the B-file.

PDOP Mask

Data will not be processed during periods where the PDOP exceeds the PDOP mask.

More Run-time Parameters, <F3> Command

To edit more run-time parameters, press <F3>; observe the popup submenu:

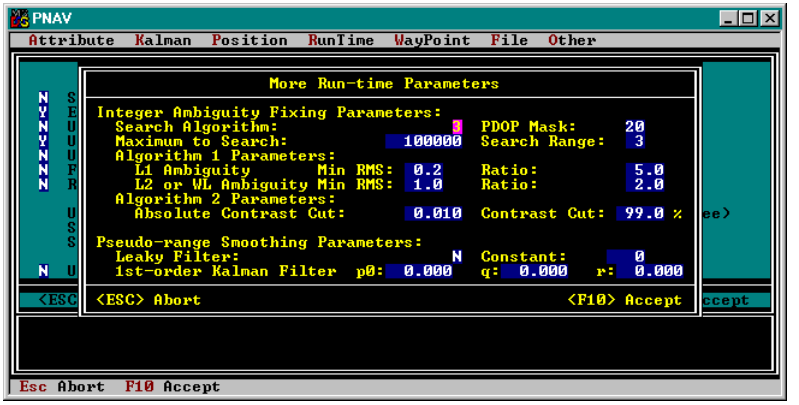

Figure 10.9: Edit Run-Time Parameters

These parameters are used to control when and how PNAV finds and fixes ambiguities.

Integer Ambiguity Fixing Parameters

These parameters affect the integer ambiguity fixing algorithm.

Search Algorithm

There are three search algorithms. Type **1**; type **2** for LC2 search and type 3 (default) for the MinQF search. If **Search Algorithm** is 2:

- when **Lowest RATIO** in the O-file is greater than 95% (by default), the solution is a fixed solution.
- when **Lowest RATIO** is 95% or less, the solution is a float solution.

Maximum to search

Maximum number of combinations to search at once; the default is **100000**.

PDOP Mask

PNAV will attempt to fix ambiguities only if the PDOP is equal to or less than the PDOP Mask.

Search Range

specifies the number of integer steps to search around the approximated solution.

Algorithm 1 Parameters

L1 Ambiguity - Min RMS

The RMS value of the ambiguity state must be under this value before PNAV will attempt to fix the ambiguities for the particular observable (**L1**). To increase the reliability of the ambiguity fixing algorithm, you may wish to lower these values. The drawback of lowering the Min RMS is that you significantly increase the time necessary to fix ambiguities.

L1 Ambiguity - Ratio

This is a cutoff value for the particular observable (**L1**) for the ratio between the Chi-square increment of the best set of ambiguity integers and that of the second best set of integers. This ratio must be greater than the number set in this parameter for the ambiguities to be fixed. To increase the reliability of the ambiguity fixing algorithm, you may wish to increase the ratio.

L2 or WL Ambiguity - Min RMS

The RMS value of the ambiguity state must be under this value before PNAV will attempt to fix the ambiguities for the particular observable (**WL or L2**). To increase the reliability of the ambiguity fixing algorithm, you may wish to lower these values.

The drawback of lowering the Min RMS is that you significantly increase the time necessary to fix ambiguities.

L2 or WL Ambiguity - Ratio

This is a cutoff value for the particular observable (**WL or L2**] for the ratio between the Chi-square increment of the best set of ambiguity integers and that of the second best set of integers. This ratio must be greater than the number set in this parameter for the ambiguities to be fixed. To increase the reliability of the ambiguity fixing algorithm, you may wish to increase the ratio.

Algorithm 2 Parameters

Absolute Contrast Cut

The absolute contrast cut-off is a measure of how well the particular integer set agrees with the float solution. If the ambiguity Absolute value is below this value, then the ambiguities will not be fixed to integers.

Contrast Cut

The contrast cut-off is a measure of the contrast between the best set of integers and the next best set. If the ambiguity Contrast is below this value, then the ambiguities will not be fixed to integers.

Algorithm 3 Parameters

Ambiguities search method 3 is an enhanced ambiguities search method over method 1 and method 2. By default, PNAV uses method 3. You can access method 3 via ALT-R/F3 screen, or “Other Run-Time Parameters” section of PNAV.PMT file.

PDOP Mask

PDOP mask to fix integer ambiguities.

Default: 20 for L1/L2

Default: 7 for L1

L1 Ambiguity Min RMS

Minimum RMS to start fix L1 ambiguities.

Default: 0.2 (for L1 only)

Ambiguity search will be initiated if the RMS in the ambiguity states are less than this value.

L1 Ambiguity Ratio

L1 ambiguities fix ratio

Default: 5.0

See below

L2 or WL Ambiguity Ratio

L2/WL ambiguity fix ratio

Default: 2.0 for L1/L2

Default: 3.0 for L1

The minimum of ambiguity fixing contrast is determined based on smaller of this value and L1 ambiguity Ratio.

Contrast Cut

Contrast cut for ambiguity search method 2.

Default: 99.0%

The ambiguity fixing contrast threshold is a function of this value. The higher the number is, the more reliable the ambiguitu fixing would be, with a trade-off of longer time to fix.

Constant

Leaky filter smoothing constant.

Default: 0

It is used to scale number of measurements. For test purpose only, suggest not change it.

Pseudo-Range Smoothing Parameters

Leaky Filter

is disabled in this release. If you attempt to enter **Y**es, PNAV will display the following message until a key is pressed:

Flag is disabled. Will set to "N". OK

Constant
1st-order Kalman Filter

are disabled in this release. If you attempt to enter a value, PNAV will display the folowing message until a key is pressed:

Parameter is not used. Will set to 0. OK

Quality Assurance Parameters, <F4> Command

To edit Quality Assurance Parameters, press <F4>; observe the popup submenu:

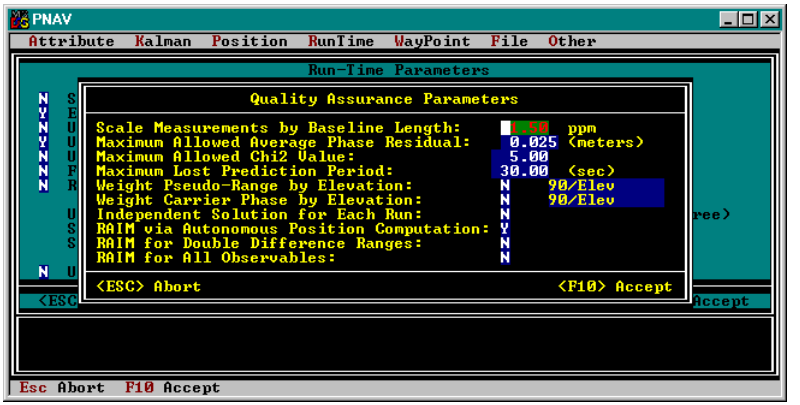

Figure 10.10: Quality Assurance Parameters

Scale Measurement by Baseline Length

allows you to scale the measurement (in ppm [parts-per-million]) based on the baseline length to accommodate the unmodeled baseline-length-dependent error, mainly unmodeled ionospheric delay. If you selected, in the

- **Y**es for **Model Ionospheric Delay**, or,
- **A**utomatic for **Model Ionospheric Delay**, and the baseline is greater than 15 kilometers,

  PNAV will ignore this parameter during processing.

Maximum Allowed Average Phase Residual

allows you to set a threshold (in meters) to detect incorrectly fixed ambiguities or unfixed cycle-slips. The formulas for computing the average phase residual and residual threshold are explained in the *Program Input and Output Data Files* chapter, *J-file* section, *Chi^2 and Averaged Carrier Phase Residual (RESID)* paragraph. If the average phase residual exceeds the residual threshold, PNAV will reset the Kalman filter or adjust the integer ambiguity and refix it to integers if possible.

When processing data in a high multi-path environment, or if the Form LC Observable run-time parameter is set to Yes, increase the Maximum Allowed Average Phase Residual value to 0.03 meter or higher. However, leave this parameter low enough that small cycle slips can be detected. Use the averaged post-fit carrier-phase residual from the J-file to adjust this parameter.

Maximum Allowed Chi2 Value

serves the same function as **Maximum Allowed Average Phase residual** in this release. To compute the Chi^2, see the chapter *Program Input and Output Data Files*.

Maximum Lost Prediction Period

allows you to specify how far ahead (in seconds) the Kalman filter should predict the position, in case the receiver tracked less than four satellites or completely lost lock (e.g. went under a bridge). This parameter is used with the Rover Motion Dynamics parameter setting in Menu 3.0. The factory default values are:

Table 10.5: Maximum Lost Prediction Period

Rover Motion Dynamics	Maximum Lost Prediction Period (sec)
Static	60
Ship	60
Walking, Automobile	30
Aircraft	15

Weight Carrier Phase by Elevation [and] Weight Carrier Phase by Elevation

allow you to down-weight the observations of satellites with low elevation angles. This decreases the effect of low-elevation satellites which usually contain the highest multi-path errors at the cost of reducing the geometric strength.

Type **Y**es to enable elevation down-weighting. Type **N**o to disable elevation down-weighting. Next to the **Y/N** fields for the two parameters are the weighting function display fields. The available weighting functions are:

- **90/Elev** for 90/elevation angle in degree, the default, and
- **1/sin(Elev)** for 1/sin (elevation angle in radius).

Both weighting functions level off at 5 degrees.

To toggle between the choices, highlight the desired parameter **Y/N** field and press <PAGE UP> or <PAGE DOWN>. The following graph shows an example of the two

weight-function curves; **90/Elev** is the top curve, and **1/sin(Elev)** is the bottom curve :

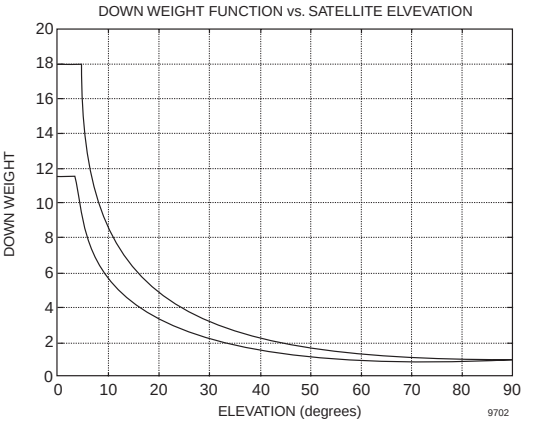

Figure 10.11: Weighting Observables by Elevation

If down-weighting is enabled, during processing, PNAV multiplies the Kalman Filter Measurement Noise Parameters (in the <Alt-K> Kalman Setup Menu) by the selected weighting function.

Set Weight Pseudo-Range by Elevation to Yes when processing data collected in a severe multi-path environment, such as a forest or urban area.

Independent Solution for Each Run

allows you to specify an independent solution for each processing run.

- If **N**o (the default), use the current KNOWNess setting in the LOGTIMES file (set via the PROCESS/EDIT LOGTIME screen) for each processing run. If the knowness is less than 2, the coordinate from the PROJFILE.KIN file will be incorporated into the position solution. This is useful for static initialization.
- If **Y**es, ignore the KNOWNess setting for all sites (except the control site, knowness 0) in the LOGTIMES file.

RAIM via autonomous position computation

Default: Y

Before processing each epoch of data, the C/A psuedo-ranges in the base B-file are used to compute the autonomous position. The psuedo-range residuals are checked, and problematic satellites will be isolated if it is able to do so (RAIM). Same process applies to the rover B-file. This epoch of data will only be used if both base B-file and rover B-file can compute autonomous position correctly.

This option is useful to detect huge psuedo-range error (> 1000 meters) possibly existed in the psuedo-range measurements.

RAIM for double difference psuedo-range

Default: N

RAIM will be performed on the doubly differenced psuedo-ranges. It detects, and isolates if possible, and psuedo-ranges errrros which is greater than 5 meters.

RAIM for All Observables

RAIM will be performed on all doubly differenced psuedo-ranges and carrier phases. It detects, and isolates if possible, any double difference psuedo-ranges errors which is greater than 5 meters, and double difference carrier phase error which is greater than a values that is specified as “maximum allowed average phase residual” (default 0.025 cm + 1.5ppm).

<Alt-W> Waypoint Setup Menu Command

Waypoint navigation is primarily for graphics display purposes; it does not affect actual position computation or output files. This Setup Menu enables you to create or change the Waypoint Navigation file (PNAV.WAY) and thereby add waypoint references to the Graphics Display Window described in the *Reference: Graphics Display Window* chapter.

This Setup Menu and the graphics display assume the Altitude position coordinate to be the height of the ground mark. To correct for the Rover antenna slant height, edit the ROVER ANTENNA OFFSET in the <Alt-O> Other Setup Menu.

General Procedure

1. To edit waypoints, press <Alt-W>; observe, typically:

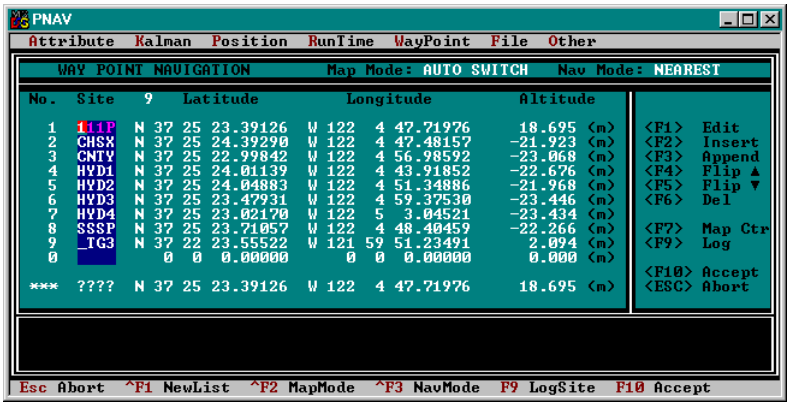

Figure 10.12: <Alt-W> Setup Menu

2. In this Setup Menu:
   - The top row lists the current **Map Mode** and Nav Mode.
   - The number of waypoints in PNAV.WAY appears to the right of the **Site** label.
   - A window lists up to ten of the waypoint names and positions contained in the PNAV.WAY file.
   - The row labeled *** displays the current position of the Rover. Before processing begins, this position is identical to the first waypoint in the list.
   - The active function keys are listed on the right side and along the bottom of the screen.
3. If the PNAV.WAY file contains more than the ten waypoints this window can accommodate, PNAV displays ? under the last site number in the window.
4. You can use the arrow keys to scroll through the list a line at a time, or press <PAGE UP> or <PAGE DOWN> to scroll a "page" at a time.
5. As you scroll down, PNAV displays ? over the first site number in the window.

Usage of the active function keys is described below.

Changing a Waypoint Name

To change the name of an existing site in the waypoint list, highlight it in the **Site** column, and type a four-character site name over the existing name.

<ESC> Abort Command: Cancel Any Changes

Press <ESC> to abort any changes and return to the SETUP MENU screen.

<F10> Accept Command: Accept Any Changes

Press <F10> to save any changes in the PNAV.WAY file, use them in the current processing session, and return to the SETUP MENU screen.

<F1> Edit Command

The Edit function is disabled in Survey Mode. (PROJFILE.KIN is edited via the PROCESS/EDIT PROJECT screen.)

To **Edit** existing positions in the PNAV.POS file (for Navigation Mode or Relative Nav Mode):

1. Highlight the desired **Site** field.
2. Press <F1> to access the <Alt-P> Position Setup Menu
3. Edit the selected site as described in the <Alt-P> *Position Setup Menu Command* section of this chapter.

In the Alt-P menu, only function keys <F10> and <ESC> are valid.

4. Press <ESC> to abort any changes and return to the <Alt-W> WayPoint Setup Menu.
5. Press <F10> to save any changes for that site and return to the <Alt-W> WayPoint Setup Menu.

<F2> Insert Command

To add a new waypoint position anywhere in the waypoint list:

1. Highlight the **Site** field before which you want to insert a waypoint.
2. Press <F2> to create a new waypoint line item and increment the site number of any subsequent waypoint lines.
3. Type in a four-character site name.
4. If the entered site name and its position already exist in the Site Position file (PNAV.POS in Navigation Mode or Relative Nav Mode) or the kinematic

Project File (PROJFILE.KIN in Survey Mode), PNAV automatically displays the position when you enter the site name.

5. If PNAV does not find the entered site, it supplies zero coordinates.

<F3> Append Command

To add a waypoint position to the end of the waypoint list:

1. Press <F3> to send the cursor to the end of the list and create a new waypoint line item and site number.
2. Type in a four-character site name.
3. If the entered site name and its position already exist in the Site Position file (PNAV.POS in Navigation Mode or Relative Nav Mode) or the kinematic Project File (PROJFILE.KIN in Survey Mode), PNAV automatically displays the position when you enter the site name.
4. If PNAV does not find the entered site, it supplies zero coordinates.

<F4> Flip G/<F5> Flip ▼<ESC> Commands

To exchange the **No.** line item order of adjacent waypoints, highlight the desired **Site** field, and press <F4> **Flip** G or <F5> **Flip** ▼.

<F6> Del Command

To Delete an existing waypoint position, highlight the desired **Site** field, and press <F6>.

<F7> Map Ctr Command

When the graphics display is in Map Mode FIXED MAP (see the **^F2 MapMode** command below), the plot will be centered (by default) around the averaged coordinate of all waypoints. To explicitly specify a map center, highlight waypoint in the **Site** column, and press <F7> to select/deselect it.

<F9> LogSite Command

During processing in Navigation Mode or Relative Nav Mode only, you can log a current Rover position as a position in the PNAV.POS file and as a waypoint in the PNAV.WAY file as follows:

1. In the PROCESSING SETUP MENU screen, press <F10> to begin processing.
2. When the Rover is at the desired point in its trajectory, in the Processing Results Screen (i.e., the Verbose or concise Result Display), press <F9> to interrupt processing and return to the PROCESSING SETUP MENU screen.

3. Press <Alt-W> to access the WayPoint Setup Menu.
4. PNAV displays, in the ******* row, the Rover Site ID and position when you interrupted processing, typically:

   ```
   ? *** _TG3  N 37 22 23.22136  W 121 59 48.29596 0.775 (m)
   Í <ESC> Abort  ?
   ```

5. Highlight the **Site** field before which you want to log a waypoint.
6. Press <F9> (LogSite) to access a modified <Alt-P> Position Setup Menu displaying the position of the desired point; observe, typically:

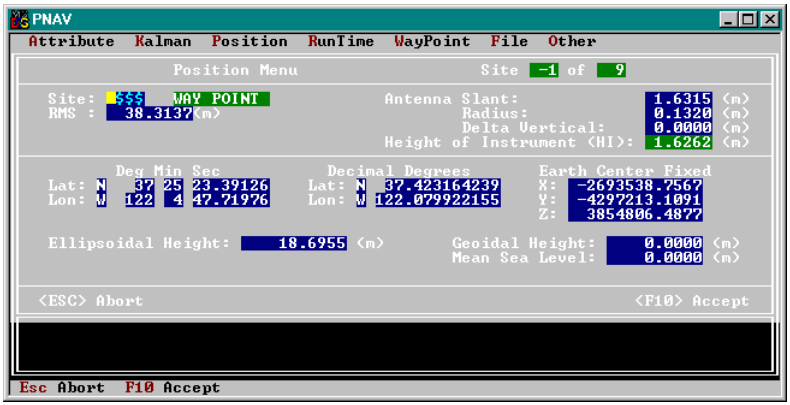

Figure 10.13: <Alt-P> Position Setup Menu

7. Change the **Site** field from **$$$$** to a valid site name other than an existing site name in the PNAV.POS file.
8. Press <F10> (Accept) to save the position to PNAV.POS and return to the WayPoint Setup Menu.
9. Press <F10> (Accept) to save the position to the PNAV.WAY file and return to the Processing Setup Menu.
10. Press <F9> to resume processing.

^F1 NewList Command

To create a new list based on the position list (the PNAV.POS file for Navigation Mode and Relative Nav Mode or PROJFILE.KIN for Survey Mode), press <CTRL-F1>.

^F2 MapMode Command

The map modes for graphics display are AUTO SWITCH (auto scaled map) and FIXED MAP (fixed area map). Press <CTRL-F2> to toggle the initial graphics display map mode between the default AUTO SWITCH and FIXED MAP.

After processing begins, <F2> toggles between these map modes in the graphics display.

AUTO SWITCH Mode

By default, the graphics display automatically zooms in and out to accommodate both the current Rover position and the waypoint navigation target (waypoint center). The waypoint center is determined by the Navigation Mode selected via the ^F3 NavMode command described below.

FIXED MAP Mode

The graphics display covers the area that includes all waypoints in the PNAV.WAY file and is kept unchanged during data processing. The map is centered around the average position of all the waypoints, unless a specific waypoint center is selected by the <F7> Map Ctr command described above.

After processing begins, the graphics display does not automatically zoom in and out; you use the <PAGE UP/DOWN> and <CTRL-PAGE UP/DOWN> keys to zoom.

^F3 NavMode Command

The Navigation Modes that specify the waypoint navigation target (waypoint center) in the AUTO SWITCH Map Mode are BASE (to Base), NEAREST (the default), and HEADING FOR. Press <CTRL-F3> to cycle among them to determine the initial Navigation Mode in the graphics display.

After processing begins, <F3> cycles among these navigation modes in the graphics display.

BASE Mode

The waypoint navigation centre (target) is always the Base station.

NEAREST Mode

The waypoint navigation center (target) is the waypoint which is closest in distance from the current Rover position.

HEADING FOR Mode

The waypoint navigation center (target) is the waypoint which is within ±45° of the current Rover position and course-over-ground vector and is closest in distance to the current Rover position.

Graphics Display Window

The graphics display window displays the calculated trajectory of the Rover as the input data is processed. It comprises a horizontal trajectory plot, a vertical offset plot, and a text information panel.

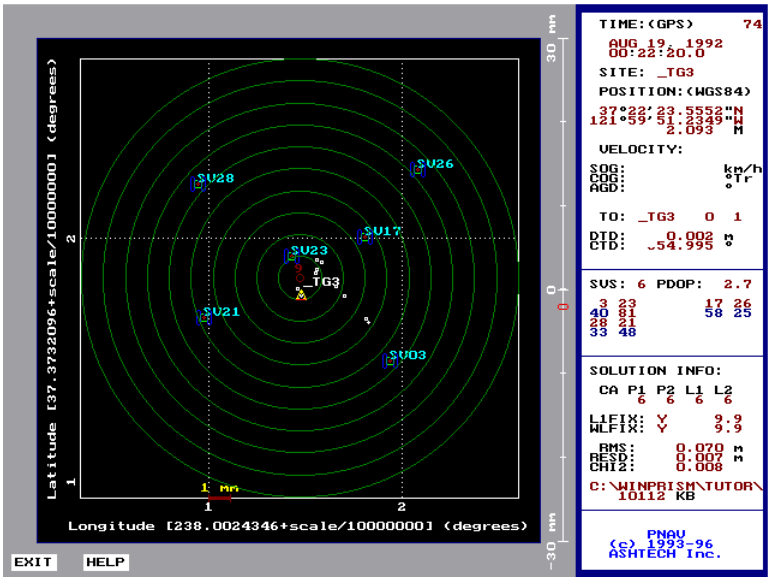

Figure 11.1: Graphic Display Window

Help Panel

Press **H** while in the graphics display window to toggle between the text information panel and the help panel.

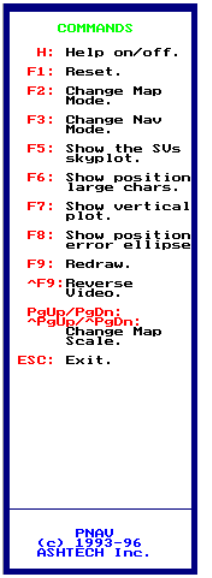

Figure 11.2: Help Panel

Graphics Window Control

The valid command keys in this display mode are:

Table 11.1: Graphics Window Function Keys

Key	Function
H:	**Help on/off.** Toggle between help panel and text information panel; default off.
F1:	**Reset.** Reset Kalman filter.
F2:	**Change Map Mode.** Toggle between Fixed Map and Auto Switch.
F3:	**Change Nav Mode.** Cycle among To Nearest, To Base, and Heading For; default To Nearest.
F5:	**Show the SVs skyplot.** Toggle ON/OFF; default off.

Table 11.1: Graphics Window Function Keys

Key	Function
F6:	**Show position in large chars.** Toggle ON/OFF; default off.
F7:	**Show vertical plot**. Toggle ON/OFF the vertical offset plot; default on.
F8:	**Show position error ellipse.** Toggle ON/OFF; default off.
F9:	**Redraw.** Redraw the whole screen.
F9:	**Reverse Video.** Switches to white background, black graphics.
PgUp/PgDn:	^PgUp/^PgDn: Change Map Scale. Zoom in and out in Fixed Map Mode.
ESC: Exit.	Exit the graphics display window and return to the verbose or concise result display.

Horizontal Trajectory Plot

This plot displays the Rover trajectory in the horizontal plane parallel to the earth's surface. The initial display scaling depends on the Map Mode setting in the <Alt-W> WayPoint Setup Menu or in the PNAV.WAY file, either automatic (Auto Switch mode) or manual (Fixed Map mode).

Rover Trajectory

The current Rover position is represented by a blinking triangle-with-happy-face. Any previous rover positions along the trajectory are represented by a square dot, solid line, or a diamond dot, depending on the map scale and the position history.

Scale Indicator

The red bar drawn along the East-West (**Longitude** - X) axis starting at the leftmost units marker, typically defines the current linear distance scale reference for the X-axis and the North-South (**Latitude** - Y) axis; in this example, all distances in all directions on the current display are proportional to the 100-meter bar.

Figure 11.3: Scale Indicator

Circular Grids

are automatically equal (or proportional) in radius to the scale indicator.

Absolute Coordinates

The **Longitude** axis itself is always calibrated in East Longitude degrees (0 to 360) and the **Latitude** axis is always North Latitude degrees (-90 to 90). You can calculate the approximate absolute coordinates of a point on the plot using the formulas on the X and Y the axial legends. In these formulas, the variable **scale** is the number you read from the axis.

The accuracy of the calculation will depend upon the scale of the plot.

More accurate absolute coordinates are displayed in the text information panel.

Reset, F1 Command

Press <F1> to reset the Kalman filter.

Change Map Mode, F2 Command

After processing begins, use the <F2> function key to toggle between the available Map Modes: Auto Switch and Fixed Map.

Auto Switch Mode

By default, the plot is automatically scaled to display, at a minimum, the Rover position currently being calculated, a reference waypoint, and the Base site if it is within the mapping area.

Scaling

The plot scale changes automatically to accommodate the Rover position and the current waypoint. The screen scales are automatically adjusted and the screen is redrawn according to the new scales, if either:

1. Current Rover position is outside the screen, or,
2. Rover position nears a new waypoint for more than two epochs.

In case 1, the new screen covers more physical area, and in case 2, the screen is zoomed in. The graphics display automatically zooms in and out to accommodate both the current Rover position and the waypoint navigation target (waypoint center).

Waypoint Center (Waypoint Target)

The plot is centered around a waypoint which is determined:

- Initially, by the Navigation Mode setting in the <Alt-W> WayPoint Setup Menu or in the PNAV.WAY file, or,
- After processing begins, by the <F3> function key command, described in the next section.

FIXED MAP Mode

If the initial Map Mode is FIXED MAP, the graphics display covers the area that includes all waypoints in the PNAV.WAY file and is kept unchanged during data processing. The map is centered around the average position of all the waypoints, unless a specific waypoint center is selected by the <F7> Map Ctr command in the <Alt-W> WayPoint Setup Menu. After processing begins, you use the <PAGE UP/DOWN> and <CTRL-PAGE UP/DOWN> keys to zoom in and out.

Change NAV Mode, F3 Command

After processing begins, use the <F3> function key to cycle among these navigation modes in the graphics display: To Nearest, To Base, and Heading For. These navigation modes are the criteria used to determine the waypoint center (waypoint target).

To Base Mode

The waypoint navigation center (target) is always the Base station.

To Nearest Mode

The waypoint navigation center (target) is the waypoint which is closest in distance to the current Rover position.

Heading For Mode

The waypoint navigation center (target) is the waypoint which is within ±45° of the current Rover position and course-over-ground vector and is closest in distance to the current Rover position.

For example:

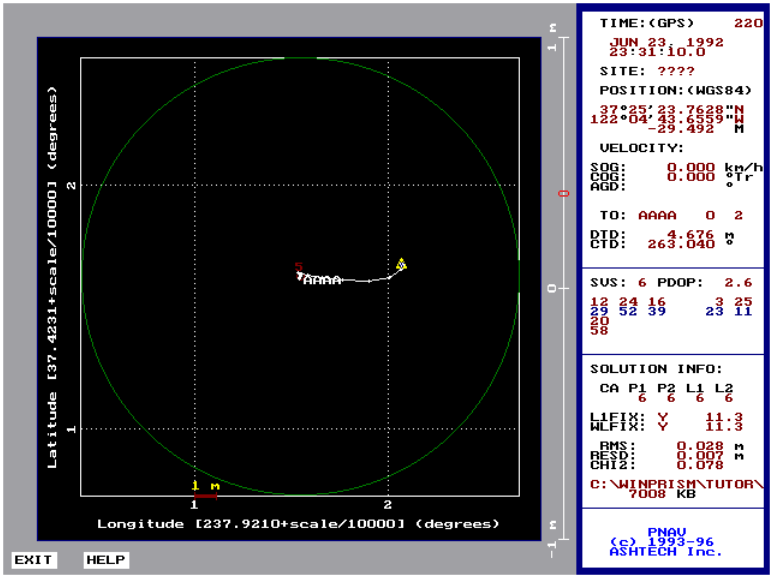

Figure 11.4: Waypoint Navigation Screen

The waypoint is identified by its site name and number in the list in the PNAV.WAY file; if the PNAV.WAY file contains no additional waypoints, the center is always the Base position. The Base site and other waypoints are also displayed if they are within the mapping area. The Base site is denoted by a different color from that of waypoints.

Show SVS Skyplot, F5 Command

Press <F5> to toggle on and off an overlay of the approximate azimuth and elevation of the satellites used in processing, typically:

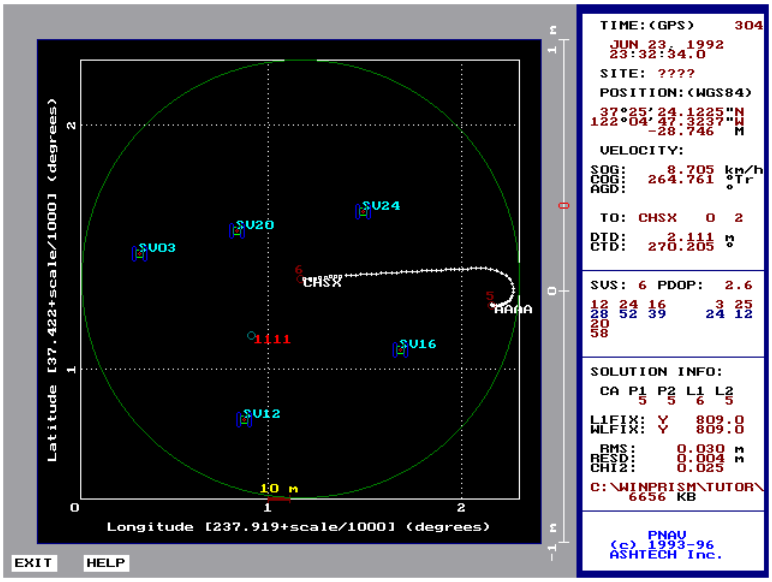

Figure 11.5: SVs Skyplot

The scales are: clockwise from North, 0 to 360 degrees for azimuth; and 0 to 90 degrees from the edge of the plot to the center for elevation.

When the skyplot symbol for a particular satellite label alternates between, typically, and, tracking was continuous during the epoch; if the symbol remains steady, tracking was lost during the epoch.

Show Position in Large Characters, F6 Command

Press <F6> to toggle on and off a text overlay on the graphical trajectory plot of the current rover position in degrees, minutes, and seconds. Observe, typically:

Figure 11.6: Show Position in Large Characters

Latitude is on the first line, longitude on the second, and ellipsoidal height on the third.

Vertical Offset Plot: Show Vertical Plot, F7 Command

This plot shows on a vertical ruler the current Rover vertical position with respect to the waypoint navigation target (center). Press <F7> to toggle this plot on and off. The scale is automatically adjusted to accommodate the current Rover position.

Show Position Error Ellipse, F8 Command

Press <F8> to toggle on and off an overlay of the horizontal error ellipse and vertical error bar on the vertical offset plot.

Text information Panel

This comprises three sections: Navigation Information, Satellite Information, and Solution Information.

Navigation Information

Table 11.2: Navigation Panel Fields

Field	Description
TIME (GPS):	[Epoch counter on the upper right corner] [Date and time of current epoch in next two lines]
SITE:	[current site name]
POSITION: (WGS84)	[current rover position]
VELOCITY: SOG:	[Speed over ground (km/hr), blank=0.0]
COG:	[Course over ground (°s from true north), blank=0]
AGD:	[Angle of descent (°s from local horizon), +=rising, blank=0]
TO:	[First four digits: current waypoint target (center) site name]
	[Fifth digit: current Map Mode]
	0 = Fixed Map
	1 = Auto Switch
	[Sixth digit: current Navigation Mode]
	0 = To Base
	1 = To Nearest
	2 = Heading For
DTD:	[3-D distance to destination (m)]
CTD:	[Course to designation (°s from true north)]

Satellite Information

Table 11.3: Satellite Panel Fields

Field	Description
SVS:	[Total number of satellites used for processing]
PDOP:	[Position dilution of precision] [Next four lines show the satellite PRN number and its corresponding elevation. The reference satellite is marked with different color.]

Solution Information

Table 11.4: Solution Panel Fields

Field	Description
CA P1 P2 L1 L2	[Number of observables in each slot at current epoch]
L1FIX:	[L1 ambiguity fix status, Y-fixed, N-not fixed]
WLFIX:	[WL ambiguity fix status, Y-fixed, N-not fixed; if **Form Wide-lane Ambiguity** is **Y**es in the <Alt-R> RunTime Setup Menu] or
L2FIX:	[L2 ambiguity fix status, Y-fixed, N-not fixed; if **Form Wide-lane Ambiguity** is **N**o]
RMS:	[RMS error of current position
RESD:	[Averaged carrier phase residual (m) at current epoch
CHI2:	[Chi^2 at current epoch] [Next two lines show the first 18 characters of the current working directory and free disk space available in KB.]

Sometimes, the text information area will be redrawn to indicate that the Kalman filter is reset.

Command Line Options

This chapter explains command line options provided by the PNAV program. Along with customized PNAV.PMT files, the command line options allow you to control PNAV execution outside the bounds of Overview Menu Option C) DATA PROCESSING Menu 3.0, Menu 3.1. and the Setup Menu commands.

CAUTION
These options are intended for experienced PNAV users only; become familiar with the previous chapters before using the command line options.

General Procedure

1. Running PNAV with command line options requires that the control input files (PNAV.PMT, PNAV.CNF, PNAV.POS [for Navigation Mode and Relative Nav Mode], PNAV.PNT, PNAVSIM.SIM, PNAV.WAY, PROJFILE.KIN [for Survey Mode]), and LOGTIMES [for Survey Mode]) already exist in the current directory.
    a. For Survey Mode, before running PNAV, create and edit the PROJFILE.KIN and LOGTIMES file via Prism/PROCESS/EDIT PROJECT and Prism/EDIT LOGTIME, respectively, or the GLOG.EXE, ELOG.EXE and ESITE.EXE programs if running from the Dos prompt.
    b. Run PNAV from the WinPrism/PROCESS/MANUAL/Kinematic screen to initially create and edit the control files using the <Alt-?> Setup Menu commands, and use <Alt-F> to create/save the parameters into appropriate files.
    c. Perform subsequent editing either inside PNAV (using the <Alt-?> Setup Menus) or by using your favorite ASCII text editor (except for the binary PNAV.CNF, PROJFILE.KIN, and LOGTIMES files). These control input files are described in the chapter *Program Input and Output Data Files*.
2. Run PNAV with appropriate command line options described below.

In the following command descriptions, the input file name *fname* is the simulation file PNAVSIM.SIM.

The Relative Nav Mode is not tested and not supported in this release.

HELP

Type **PNAV ?** to obtain the following help message:

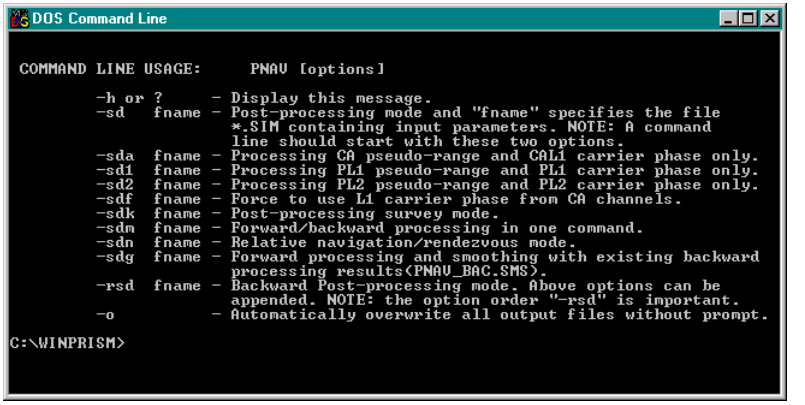

Figure 12.1: PNAV Command Line Parameters

Command Syntax

PNAV -sd[suboption]...[suboption] *fname*

forward process simulation file *fname* with suboptions

[or]

PNAV -rsd[suboption]...[suboption] *fname*

backward process simulation file *fname* with suboptions

Forward Processing, -sd Option

To forward process data (without suboptions) in the order the data was collected in the B-files, the minimum command is:

PNAV -sd *fname*

The -sd in forward processing must precede any suboptions.

Backward Processing, -rsd Option

To backward process data (without suboptions) in reverse order from the way the data was collected in the B-files, the minimum command is:

PNAV -rsd *fname*

The -rsd in backward processing must precede any suboptions.

Process CA Pseudo-Range and CAL1 Carrier Phase Only, Suboption a

Process data in C/A-code L1 slot only.

PNAV -sda *fname*

[or]

PNAV -rsda *fname*

Process PL1 Pseudo-Range and PL1 Carrier Phase Only, Suboption 1

Process data in P-code L1 slot only.

PNAV -sd1 *fname*

[or]

PNAV -rsd1 *fname*

Process PL2 Pseudo-Range and PL2 Carrier Phase Only, Suboption 2

Process data in P-code L2 slot only.

PNAV -sd2 *fname*

[or]

PNAV -rsd2 *fname*

Force to Use L1 Carrier Phase From CA Channels, Suboption f

Use L1 carrier-phase from C/A-code slot to replace L1 carrier-phase in P-code slot.

PNAV -sdf *fname*

[or]

PNAV -rsdf *fname*

Survey Mode Suboption k

Process data in Survey Mode, i.e., compute averaged position solution for static site. By default (without **k** option) PNAV processes data in Navigation Mode.

PNAV -sdk *fname*

[or]

PNAV -rsdk *fname*

Relative Navigation/Rendezvous Mode, Suboption n

PNAV -sdn *fname*

[or]

PNAV -rsdn *fname*

The Relative Nav Mode is not tested and not supported in this release.

Automatic Backward and Forward Processing

PNAV -sdm *fname*

This instructs PNAV to automatically process backwards and forwards and contains the results.

Overwrite Output Files

PNAV -o *fname*

Instructs PNAV to overwrite all output files (SUMMARY.OUT, J-file, L-file, O-file, C-file) without any prompts/user interactions.

Forward Processing and Smoothing, Suboption g

PNAV -sdg *fname*

Forward and Backward Processing Procedure

When you run PNAV through the menus, it automatically performs the forward and backward processing. However, when you run PNAV through the command line, you have the option to execute programs manually to accomplish forward/backward

processing and smoothing i.e., without using the -m option above. The procedure is summarized below for example B-files B111PA92.352 and BSSSPA92.352.

Table 12.1: Forward and Backward Processing Example

Step	Command	Files
1	PNAV-rsd day352.sim	Create PNAVBAC.SMS, PNAV_BAC.IFO, J-file, C-file by default; L-file, R-file if requested.
2	PNAV -sdg day352.sim	Create J-file, C-file by default; J*.SMS, C*.SMS files, L-file, R-file if requested.

Forward and Backward Processing Files

Two temporary files are created during the backward processing, PNAV_BAC.IFO and PNAV_BAC.SMS. PNAV_BAC.IFO stores the information for reading file PNAV_BAC.SMS in reverse direction. PNAV_BAC.IFO is a small file, PNAV_BAC.SMS is a large file. The general guideline to predict the file size for PNAV_BAC.SMS is:

$$S = [20 + n(4n+14)] * N_{epoch}$$

where *n* is total number of states in the Kalman filter. Compute *n* by adding, from the following table, the numbers in the right column that correspond to the characteristics in the left column that apply to the data to be processed.

Table 12.2: Kalman Filter States

Characteristic	# of States
Static Site	3
Moving dynamics	6
L1 carrier phase	m-1
L2 carrier phase	m-1
Model ionospheric delay	m-1
Model multi-path	2(m-1)

where *m* is number of satellites. For example, suppose we are going to process data with the following characteristics: tracks six satellites, moving dynamics, and L1 and L2 carrier phase; then:

n = 6+(6-1)+(6-1) = 16

and the file size for each epoch is:

20 + n(4n+14) = 20 + 16 * (4*16+14) = 1268 bytes

If we process 3600 epochs of data, the file size would be:

1268*3600 = 4,564,800 bytes= 4.6 Mbytes

Program Input and Output Data Files

This chapter describes in detail the general categories of input and output files used by PNAV and their naming conventions and provides definitions for the file types, listing them in alphabetic order. The categories and constituent files comprise:

Downloaded Input Files

(downloaded from the receiver via Prism/ TRANSFER/DOWNLOAD)

B-file	binary measurement file
E-file	ephemeris file
S-file	site data file
Photo-file	photogrammetry file

Prism/PROCESS Control Input Files

(created when PROCESS SURVEY TYPE KINEMATIC selected)

LOGTIMES file

PROJFILE.KIN- kinematic project file (Survey Mode)

PNAV Control Input Files (created during PNAV execution)

PNAV.CNF- configuration file

PNAV.PMT- runtime and Kalman filter parameter file

PNAV.POS- site position file (Navigation Mode and Relative Nav Mode)

PNAV.PNT- Rover antenna offset file

PNAVSIM.SIM- simulation file

PNAV.WAY- waypoint list

Output Files

J-file - Rover relative position and velocity file
C-file - Rover position in WGS-84 coordinates file
R-file - complete Rover position file
O-file - vector solution file
L-file - data processing log file
A-file - acceleration file
@-file - interpolated files for time tags from photo-file
*.SMS-file - backward processed or smoothed results file
*.FWD-file - forward processed results file
*.BWD-file - backward processed results file
Plot file - graphical plot file
SUMMARY.OUT- summary of processing results

Support Files

PNAVPMT.DFT and PNAVPMT.FAC- contain Kalman filter parameters for various dynamics

Miscellaneous Files

*.IFO B-file or backward processing information file
COMMON.NAV Common navigation file
MODE.PMT Menu 3.0 parameters
PNAVFILE.PMT PNAV file parameters
VIEWFILE.LST View file template

Download Input Files Summary and Naming Convention

This section summarizes the downloaded files used as input by PNAV and describes the naming convention. For a detailed description of each file type, see the alphabetical list later in this chapter.

Summary

The Prism/TRANSFER/DOWNLOAD function downloads the following file types from Ashtech receivers:

B - binary measurement file.

E - ephemeris file.

P - photogrammetry file or photo-file.

S - site data file.

PNAV uses as input the B-file, E-file, S-file, and possibly a photo-file. The Prism/TRANSFER/DOWNLOAD function automatically names the files according to the convention described below.

Naming Convention

The format follows the DOS file-naming rules: up to eight characters for the body of the file name, followed by a period and up to three characters for the extension. (If you do not want the default names, simply overtype them when you run Prism/TRANSFER/DOWNLOAD.) The convention is:

tnnnnsyy.ddd

where:

t	is the file type (B, E, P, S)
nnnn	is the last four-character site name entered in the receiver or overtyped when Prism/TRANSFER/DOWNLOAD runs
s	is the session character (0-9, A-Z) in chronological order (for each day).
yy	is the calendar year - 1900 (00-99).
ddd	is the day of the year (001-366) of the first record.

Examples:

B*nnnnsyy.ddd* = BHILLA89.304 = measurement data file

E*nnnnsyy.ddd* = EHILLA89.304 = ephemeris file

P*nnnnsyy.ddd* = PHILLA89.304 = photogrammetry file

These are B-, E-, and photo-files for station HILL, collected on the 304th day of 1989 (October 31st) and on the first session of that day.

In some cases a photo-file is downloaded as the file PHOTO.DAT.

Program Control Input Files Summary

This section summarizes the program control input files used by PNAV. For a detailed description of each file type, see the alphabetical list later in this chapter.

Four files control PNAV execution when processing in either Survey Mode or Navigation Mode: PNAV.CNF, PNAV.PMT, PNAVSIM.SIM, and PNAV.WAY. In Navigation Mode, PNAV also uses the files PNAV.POS and PNAV.PNT. In Survey Mode, it also uses the file PROJFILE.KIN and the LOGTIMES file. When it begins automatic execution, PNAV uses the parameter settings in the PNAV.CNF, PNAV.PNT, and PNAV.WAY files. In Navigation Mode only, it also uses the PNAV.POS and PNAV.PNT files if they exist in the current directory; otherwise it creates the files with default parameter settings. When PNAV displays the Setup Menu screen you can edit the parameters in all these files except PROJFILE.KIN and LOGTIMES using the appropriate <Alt-?> commands as described in the *Setup Menus* chapter. You can edit PROJFILE.KIN via the PROCESS/EDIT PROJECT FILE screen and LOGTIMES via the PROCESS/EDIT LOGTIME screen.

Output Files Summary and Naming Conventions

This section summarizes the files output from PNAV and describes the naming conventions. For a detailed description of each file type, see the alphabetical list later in this chapter.

Summary

PNAV processes input B-files, E-files (and possibly photo-files) to generate the following file types:

Table 13.1: PNAV Output Files

File Type	Description
C-file	ASCII file for the Rover position in WGS-84 coordinates.
C*@-file	ASCII interpolated C-file for time tags from a photo-file.
J-file	ASCII file for Rover relative position, velocity, and data processing information.
J*@-file	ASCII interpolated J-file for time tags from a photo-file.
A-file	ASCII file containing the estimated accelerations in the E,N,U frame. Only created if the state of any component in the ALT-K menu is set to 3.

Table 13.1: PNAV Output Files (continued)

File Type	Description
J*.BWD, C*.BWD, A*.BWD and R*.BWD files	contain the backward processing results when you run automatic FORWARD AND BACKWARD processing via Overview Menu Option B) BATCH PROCESSING or Option C) DATA PROCESSING.
J*.FWD, C*.FWD, A*.FWD and R*.FWD files	contain the forward processing results when you run automatic FORWARD AND BACKWARD processing via Overview Menu Option B) BATCH PROCESSING or Option C) DATA PROCESSING.
J*.SMS, C*.SMS and R*.SMS files	are equivalent to the J-file, C-file, A-file and R-file when you run both forward and smooth processing through the PNAV command-line options.
L-file	ASCII PNAV data processing message log file.
MODE.PMT file	contains saved parameters for Menu 3.0.
O-file	binary vector solution file contains baseline vector solutions, compatible with the O-file from the GPPS KINSRVY program.
Plot file	graphical plot file contains PNAV data processing results or a comparison of two J-files or C-files. It can be viewed by the PROCESS/RESULTS/RESIDUAL PLOTS function.
PNAV_BAC.SMS file	binary file contains the backward processing results for smooth processing. Its epoch index is stored in the PNAV_BAC.IFO file.
PNAVCOMP.DIF file	ASCII tabular comparison of two J-files or C-files.
PNAVFILE.PMT file	contains saved parameters used by the PNAVFILE.EXE program for Option D) PNAV UTILITY/B-FILE UTILITY.
R-file	ASCII file for the complete Rover position, compatible with the R-file from the GPPS KINSRVY program.
SUMMARY.OUT file	ASCII summary of the results of processing. When SUMMARY.OUT results from processing in the Survey Mode, it contains input control parameters, vector solutions, and statistics; from processing in the Navigation Mode or Relative Nav Mode, it contains input control parameters only.
VIEWFILE.LST file	file template for the view file (not applicable to PNAV-for-Prism) *.IFO B-file or backward processing information file which: • Contains the average coordinates from the B-file and the B-file index (used for reading data for backward processing), or, • When named PNAV_BAC.IFO, contains the epoch index from the PNAV_BAC.SMS file.

J*.SMS, C*.SMS, A*.SMS and R*.SMS are temporary files created when you run automatic FORWARD AND BACKWARD processing via Overview Menu Option B) BATCH PROCESSING or Option C) DATA PROCESSING; PNAV automatically renames these files to the standard J-file, C-file, A-file and R-file and creates the J*.BWD, C*.BWD, A*.BWD and R*.BWD backward processing results files and the J*.FWD, C*.FWD, A*.FWD and R*.FWD foreward processing results files. Forward and backward processing also generates other temporary files. For details, see the section *Forward/Backward Processing and Smoothing* in the *Command Line Options* chapter.

Naming Conventions

For J-, R-, O-, L-, A-, and Plot files, the convention is:

tbbbrrrs.ext

where:

Table 13.2: File Naming Conventions

Item	Description
t	is the file type (J, R, O, L, P, A)
bbb	is the last three characters of the four-character site name from the Base station B-file name.
rrr	the last three characters of the four-character site name from the Rover station B-file name.
s	is the session character (0-9, A-Z) in chronological order (for each day) except for the J*@-file, where it is always "@".
ext	is SMS for J*.SMS files and/or R*.SMS files
ext	is FWD for J*.FWD and/or R*.FWD files
ext	is BWD for J*.BWD and/or R*.BWD files
ext	is the day of the year (001-366) of the first record for J-, J@-, P-, R-, O-, L-files

To avoid having duplicate files with this convention, it is important that the last three characters of the four-character site name from the Base and Rover station B-file names be unique. For example, if we have five stations in a session, they should be named:

0001, 0002, 0003, 0004, 0005

rather than

1000, 2000, 3000, 4000, 5000.

For J*@-files created by Overview Menu, Option D) POST MISSION/ PHOTOGRAMMETRY, the convention is that of the J-files, except that the session character is always **@, i.e.:**

Jbbbrrr@.ddd

For C-files resulting from Overview Menu Option C) DATA PROCESSING, the convention is that of the input B-, E- and photo-files, except that the first character is C, i.e.:

Cnnnnsyy.ddd

For C-files resulting from Overview Menu Option B) BATCH PROCESSING, the convention is that of the input B-, E- and photo-files, except that the first character is

C and the extension is the last three characters of the four-character site name from the Base station B-file name.

For C*.SMS files or C*@-files created by Overview Menu, Option D) POST MISSION/PHOTOGRAMMETRY, the convention is that of the input B-, E- and photo-files, except that the first character is C and the *.day* extension is replaced by .SMS or the session is replaced by @.

A-File

During the data processing, if the “state” in any component in ALT-K menu is set to 3, a A-file will be created. This A-file contains the estimated accelerations. It has the following format

The Acc_East, Acc_North, and Acc_Up are the accelerations in east, north, and up direction. This shows a car is making a U-turn from east direction to west direction. The Acc_Up is 0.0 is because the “state” in Up component is set to 2.

```
Time      Ax        Rms_ax Ay       Rms_ay   Az      Rms_az
257506.00   -0.075   8.110     0.202    8.110    0.000    0.000
```

For example,

```
Sec of week  Acc_East          Acc_North         Acc_Up
257501.00    0.093    8.110    0.013    8.110    0.000    0.000
257502.00    0.055    8.110    0.032    8.110    0.000    0.000
257503.00    0.258    8.110    0.108    8.110    0.000    0.000
257504.00    0.150    8.110    0.170    8.110    0.000    0.000
257505.00    0.136    8.110    0.257    8.110    0.000    0.000
257506.00   -0.075    8.110    0.202    8.110    0.000    0.000
257507.00   -0.062    8.110    0.245    8.110    0.000    0.000
257508.00   -0.174    8.110    0.231    8.110    0.000    0.000
257509.00   -0.244    8.110    0.276    8.110    0.000    0.000
257510.00   -0.435    8.110    0.383    8.110    0.000    0.000
257511.00   -0.596    8.110    0.292    8.110    0.000    0.000
257512.00   -0.532    8.110   -0.370    8.110    0.000    0.000
257513.00   -0.473    8.110   -0.272    8.110    0.000    0.000
257514.00   -0.534    8.110   -0.234    8.110    0.000    0.000
257515.00   -0.301    8.110   -0.579    8.110    0.000    0.000
257516.00    0.096    8.110   -0.337    8.110    0.000    0.000
257517.00    0.162    8.110   -0.301    8.110    0.000    0.000
257518.00    0.135    8.110   -0.130    8.110    0.000    0.000
257519.00    0.113    8.110   -0.021    8.110    0.000    0.000
257520.00    0.073    8.110   -0.013    8.110    0.000    0.000
```

Figure 13.1: A-File

B-File

is a raw binary measurement file, downloaded from a receiver, containing collected pseudo-range, optional carrier-phase, and doppler measurement data. It contains computed positions for every epoch, plus health flags indicating the confidence of the measurements. You can view this file and its structure format with the Prism/TOOLS/ EDIT FILETOOL function.

C-File

is an ASCII file containing a chronological listing of time, site, number of satellites, PDOP, and position for every epoch. It is output from a receiver that is in Ranger mode 2, or from PNAV processing.

When output from PNAV, this file lists the Rover's position in WGS-84 coordinates. Each line in the ASCII C-file is a record for a single epoch. The C-file can be read directly by Ashtech post-mission analysis software products. A typical record line item is 103 characters long; the following example is for a single-record line, i.e., a continuous line beginning with **SITE** and ending with **V_UP**:

```
Ashtech, Inc. GPPS-2    Program:   PPDIFF-PNAV     Version: 2.2.34M
Fri Oct 04 14:22:59 1996    Differentially Corrected: Y
BASE: _ASH 37 22 21.05436 N  121 59 50.36578 W   -14.813  1.790 0.174  0.000
ROVR:                                                    1.890 0.174  0.000
SITE MM/DD/YY HH:MM:SS         SVs PDOP     LATITUDE       LONGITUDE        HI
      RMS   FLAG   V_EAST  V_NORTH     V_UP
0005 05/11/94 17:40:40.000000   8   1.3  N 37.37243600  W 121.99740949   -15.533
9     9.303   2     0.000    0.000    0.000
0005 05/11/94 17:40:50.000000   8   1.2  N 37.37244426  W 121.99740984   -15.412
7     5.710   1     0.000    0.000    0.000
0005 05/11/94 17:41:00.000000   8   1.2  N 37.37244218  W 121.99741080   -16.245
```

Figure 13.2: C-File Header

where:

Table 13.3: C-File Header

Item	Description
SITE	is the Rover site name.
MM/DD/YY and **HH:MM:SS**	are the date and current GPS time of the current epoch.
SVs	is the number of satellites being used in processing the current epoch.

Table 13.3: C-File Header (continued)

Item	Description
PDOP	is the position dilution of precision.
LATITUDE and **LONGITUDE**	are the geodetic coordinates of the Rover in decimal degrees. The prefix **N** is north latitude, **S** is south latitude, **E** is east longitude, and **W** is west longitude.
HI	This height plus the antenna height (in the <Alt-O> Other Setup Menu, in the PNAV.PNT file, or in the LOGTIMES file) is the ellipsoidal height of the Rover antenna phase ceter in meters.
RMS =	Equation Here • σ_E is the RMS error in the east position (m). • σ_N is the RMS error in the north position (m). • σ_U is the RMS error in the up position (m). • σ_{dX} is the RMS error in the earth-centered earth-fixed (ECEF) X-position (m). • σ_{dY} is the RMS error in the ECEF Y-position (m). • σ_{dZ} is the RMS error in the ECEF Z-position (m).
FLAG	2 -Kalman filter reset. 1 -ambiguities-free solution. 0 -ambiguities-fixed solution. -1 missing measurement data based on Kalman filter predicted solution.
V_EAST	is the eastward velocity of the Rover (m/s).
V_NORTH	is the northward velocity of the Rover (m/s).
V_UP	is the upward velocity of the Rover (m/s).

C*@-FILE

contains the Rover's WGS-84 positions, interpolated to the precise time tag of the input photogrammetry file. The format of the C*@-file is exactly that of the C-file generated during the same processing session.

Common.NAV File

is a binary file generated by the COMNAV program. COMNAV reads in each E-file (ephemeris file) that has been recorded for a given session and generates a common ephemeris file that will be used by other processing modules to compute accurate satellite positions for a given time.

E-File

is a binary file, downloaded from a receiver, containing the GPS satellite ephemeris data. It gives orbit parameters and satellite clock corrections and is used to compute the satellite's position. You can view this file with the Prism/TOOLS/EDIT FILETOOL function.

J-File

PNAV generates an ASCII J-file with the format specified by the setting of the **ENU Coordinate** parameter in the **<Alt-R>** RunTime Setup Menu: East, North, Up (ENU) or dX, dY, dZ WGS-84 Earth-centered Earth-fixed (ECEF). Both formats are relative coordinate systems with respect to the _RBS site (which may be the Base Site). This section describes these formats and discusses in detail the significance to output file analysis of the parameters RESID and Chi^2.

Each line in the J-file is a record for a single epoch. A typical record line item is 160 characters long; each of the following examples is for a single-record line, i.e., a continuous line beginning with **Time** and ending with **m/s**. The column headings are for reference only and do not appear in the listing.

East, North, Up (ENU) Format

(PNAV default: **Y** ENU Coordinate parameter). The ENU epoch format is:

```
     Time      PDOP     E       sE          N        sN       U        sU
   305221.00   1.72  931.753   0.005   5186.942   0.006   535.991   0.013

     u       su       v       sv      w       sw     RESID   Chi2   SVs  M/S
   -24.126   2.686  -58.503   2.686   0.521   2.687   0.008   3.693   6    1
```

where:

Table 13.4: J-File Fields, ENU Format

Item	Description
Time	is GPS seconds-of-week for the current epoch.
PDOP	is the position dilution of precision.
E	is the east distance from the Base or _RBS (m).
σ_E	is the RMS error in the east position (m).
N	is the north distance from the Base or _RBS (m).
σ_N	is the RMS error in the north position (m).

Table 13.4: J-File Fields, ENU Format

Item	Description
U	is the up distance from the Base or _RBS (m).
σ_U	is the RMS error in the up position (m).
u	is the east velocity of the Rover (m/s).
σ_u	is the RMS error in the east velocity (m/s).
v	is the north velocity of the Rover (m/s).
σ_v	is the RMS error in the north velocity (m/s).
w	is the up velocity of the Rover (m/s).
σ_w	is the RMS error in the up velocity (m/s).
RESID	is the averaged post-fit carrier-phase residual of the measurements (m).
Chi^2	is a "goodness-of-fit" indicator of the solution.
SVs	is the number of satellites used in data processing.
M/S	is the site flag: **1** for moving or **0** for stationary.

Earth-centered Earth-fixed (ECEF) Format

To generate a J-file in the ECEF dX,dY,dZ format, set the ENU Coordinate flag to **N** in the <Alt-R> RunTime Setup Menu. The ECEF epoch format is:

```
   Time      PDOP      dX     sdX     dY      SdY      dZ      sdZ
305221.00  1.72  145.562 0.010 321.449  0.005  334.219  0.014

  VX     sVx     VY     sVy    VZ     sVz   RESID   Chi2  SVs M/S
-12.227   1.342   -45.338   2.343   2.122   2.757   0.007
3.547   6    1
```

where:

Table 13.5: J-File Fields, ECEF Format

Item	Description
Time	is in GPS seconds-of-week for the current epoch.
PDOP	is the position dilution of precision.
d_x	is the ECEF X distance from the Base or _RBS (m).
σ_{dX}	is the RMS error in the ECEF X-position (m).
d_Y	is the ECEF Y distance from the Base or _RBS (m).

Table 13.5: J-File Fields, ECEF Format

Item	Description
σ_{dY}	is the RMS error in the ECEF Y-position (m).
$\mathbf{d_Z}$	is the ECEF Z distance from the Base or _RBS (m).
σ_{dZ}	is the RMS error in the ECEF Z-position (m).
$\mathbf{V_X}$	is the ECEF X velocity of the Rover (m/s).
σ_{Vx}	is the RMS error in the ECEF X velocity (m/s).
V_Y	is the ECEF Y velocity of the Rover (m/s).
σ_{Vy}	is the RMS error in the ECEF Y velocity (m/s).
V_Z	is the ECEF Z velocity of the Rover (m/s).
σ_{Vz}	is the RMS error in the ECEF Z velocity (m/s).
RESID	is the averaged post-fit carrier-phase residual of the measurements (m).
Chi^2	is a "goodness-of-fit" indicator of the solution.
SVs	is the number of satellites used in data processing.
M/S	is the site flag: **1** for moving or **0** for stationary.

Chi^2 and Averaged Carrier Phase Residual (RESID)

After processing each epoch of measurement data, PNAV computes a post-fit measurement residual vector δy:

δy = measurement vector - computed measurement vector

or

δy = measurement vector - modeled measurement vector

Chi^2 is a goodness-of-fit solution quality indicator.

Given the *a priori* knowledge of the measurement vector (also called Kalman measurement noise covariance R) which is formed based on the parameters from the <Alt-K> Kalman Setup Menu, the Chi^2 is defined as:

$$\text{Chi}^2 = \frac{\delta y^T R^{-1} \delta y}{n-3}$$

where *n* is the number of measurements (double-difference observables) used. This normalized Chi^2 should have a mean of 1.0 for good position fit.

For data processing with code- and carrier-phase data, only carrier-phase data is taken into account for computing Chi^2; i.e., δy is the post-fit carrier-phase residual, and *n* is the total number of double-difference carrier-phase observables.

In PNAV this Chi^2 is used for an approximate judgment of goodness-of-fit.

- **Chi^2 < 1.0**: the model fits data well; the position solution is trustable.
- **1.0 < Chi^2 < 5.0**: the model does not fit data well; the position solution is questionable.
- **Chi^2 > 5.0**: there is a huge discrepancy between the data and the model which might to due to unfixed cycle-slips or data outliers; the position solution is unacceptable.

Averaged Post-Fit Carrier-Phase Residual (RESID)

The RESID is computed as follows:

$$RESID = \sqrt{\frac{wavelength \times \sum (carrier\_phase\_residual)^2}{n_p - 3}}$$

9704

Figure 13.3: RESID computed

where:

carrier phase residual is the carrier-phase part of the post-fit measurement residual, and

n_p is the total number of carrier-phase measurements.

For Ashtech receivers, the carrier-phase measurement noise (thermal noise) is less than 0.01 cycles. Under normal multi-path conditions, the absolute carrier-phase noise is about 0.05 cycles. This corresponds to 0.01 meters (1-sigma) of averaged phase residual. Multiply this number by a factor of two to get a 2-sigma value; the resulting averaged phase residual should not exceed 0.02 meters. In addition, the unmodeled residual ionospheric delay should be added to the averaged phase residual. In summary, an empirical formula to compute the threshold of averaged carrier phase residual is:

```
RESIDthreshold = (SMBL * baseline length) + MAAPR
```

where:

SMBL is the **Scale Measurements by Baseline Length** parameter (ppm) from the <**Alt-R> RunTime** Setup Menu/<F4> **Quality Assurance** submenu

MAAPRis **Maximum Allowed Average Phase Residual** from <Alt-R>/F4

The term *SMBL* baseline length* above will be multiplied by a factor of 0.1, if the residual ionosphere is modeled because, in the <Alt-R> RunTime Setup Menu, the Model Ionospheric Delay parameter is set to Yes (for all baselines) or to Automatic (when the Baseline length is greater than 15 kilometers).

Goodness-of-fit Criteria

After establishing these two thresholds, a good data quality check is then **Chi^2 < 1.0** and **RESID < $RESID_{threshold}$**.

Any epoch's solution is considered to be good if the above criteria are met.

Besides checking the absolute values of CHI2 and RESID, check the time history of these parameters by examining the plot file. When the CHI2 or RESID ramps up when fixing the integer ambiguities and reaches the thresholds, it usually indicates the integer ambiguities are not fixed correctly. A sudden increase in the CHI2 or RESID indicates that there are small cycle slips.

J*@-File

contains the Rover's ENU positions, interpolated to the precise time tag of the input photogrammetry file. The format of the J*@-file is exactly that of the J-file generated during the same processing session except that the **Time** (current epoch) field is in GPS seconds-of-week to the nearest microsecond (Photo-file time tag). The following example is of the East, North, Up (ENU) format:

```
 Time       PDOP     E       sE         N        sN       U      sU
305221.623094 1.6 931.753  0.005  5186.942  0.006  535.991 0.013
   u      su       v      sv     w      sw    RESID   Chi2   SVs  m/s
-24.126  2.686  -58.503  2.686  0.521  2.687  0.008  3.693  6   1
```

L-File

is an ASCII Message Log file containing a time-history of what occurred while the receiver was collecting the data or while PNAV was processing the data. (These messages appeared in the Processing Results Message Log Window during processing.) When examining an L-file, look for the following terms or phrases for an indication of bad data periods and what happened during data collection or data processing:

```
Average CHI2 ... > ...
Average Residual ... > ...
No Measurement for ... seconds.
Detect small cycle-slip in L1/L2 channels.
No good reference SV has been found.
Total number of SVs is less than 4.
Detected bad carrier phase measurement.
```

```
Ashtech, Inc.      Program: PNAV     Version: [version]
------------------------------------------------------------
Fri May 21 15:25:12 1993
BASE : B1111A92.175
ROVER: B_ROVA92.175

257251.00 Initializing the reference site position
257251.00 Initializing Kalman Filter.
257251.00 Fixing L1 cycle-slip     -4053848.00 for SV#12
257251.00 Fixing WL cycle-slip      3197762.00 for SV#12
257251.00 Fixing L1 cycle-slip     -2816728.00 for SV#24
257251.00 Fixing WL cycle-slip      2151767.00 for SV#24
257251.00 Fixing L1 cycle-slip       468710.00 for SV#16
257251.00 Fixing WL cycle-slip     -3148497.00 for SV#16
257251.00 Fixing L1 cycle-slip     -1110249.00 for SV# 3
257251.00 Fixing WL cycle-slip      1077829.00 for SV# 3
257251.00 Fixing L1 cycle-slip       402987.00 for SV#25
257251.00 Fixing WL cycle-slip      -847230.00 for SV#25
Updated week number of 650 at  257252.00
257270.00 Search WL FA RESD 2.71 RATIO = 1.52 CUT:2.00
257275.00 Search WL FA RESD  3.20 RATIO = 2.02 CUT:2.00  Fixed.
257275.00 Search L1 FA RESD 5.23 RATIO =48.19 CUT:  5.00 Fixed.
257275.00 Changes in fixed L1 ambiguities:
       -4053823.00000 for SV12 in channel 00
       -2817170.00000 for SV24 in channel 01
         468215.00000 for SV16 in channel 02
       -1109976.00000 for SV03 in channel 04
         403092.00000 for SV25 in channel 05
257275.00 Changes in fixed WL ambiguities:
        -856080.00000 for SV12 in channel 00
        -665059.00000 for SV24 in channel 01
       -2679897.00000 for SV16 in channel 02
         -32360.00000 for SV03 in channel 04
        -444220.00000 for SV25 in channel 05
257528.00 Fixing WL cycle-slip -50333.00 for SV#25
257528.00 Search WL FA RESD 0.19 RATIO = 551.50 CUT:2.00
Fixed.
257528.00 Changes in fixed WL ambiguities:
         -50333.00000 for SV25 in channel 05
257540.00 Fixing L1 cycle-slip   -36354.00 for SV#25
257540.00 Fixing WL cycle-slip   -36354.00 for SV#25
257552.00 Fixing L1 cycle-slip    130978.00 for SV#25
257552.00 Fixing WL cycle-slip    130978.00 for SV#25
257570.00 Fixing WL cycle-slip    18607.00 for SV#25
257570.00 Search WL FA RESD 0.80 RATIO =118.49 CUT:2.00  Fixed.
257570.00 Search L1 FA RESD 0.06 RATIO = 16594.47 CUT:5.00
Fixed.
257570.00 Changes in fixed L1 ambiguities:
          94624.00000 for SV25 in channel 05
257570.00 Changes in fixed WL ambiguities:
         113231.00000 for SV25 in channel 05
257575.00 Fixing WL cycle-slip -682.00 for SV#25
257575.00 Search WL FA RESD 0.02 RATIO =6680.09 CUT:2.00 Fixed.
  257575.00 Changes in fixed WL ambiguities:
           -682.00000 for SV25 in channel 05
257587.00 Fixing WL cycle-slip -3005.00 for SV#25
257587.00 Search WL FA RESD 0.10 RATIO =  1088.50 CUT:2.00
Fixed.
257587.00 Changes in fixed WL ambiguities:
          -3005.00000 for SV25 in channel 05
257617.00 Fixing WL cycle-slip        -8234.00 for SV#25
257618.00 Fixing L1 cycle-slip       522782.00 for SV#25
257618.00 Fixing WL cycle-slip       522782.00 for SV#25
257618.00 Search WL FA RESD  1.77 RATIO  31.09 CUT:  2.00 Fixed.
```

```
257618.00 Search L1 FA RESD 0.19 RATIO =337.79 CUT 5.00  Fixed.
257618.00 Changes in fixed L1 ambiguities:
          25066.00000 for SV25 in channel 05
257618.00 Changes in fixed WL ambiguities:
          16832.00000 for SV25 in channel 05
257629.00 Fixing WL cycle-slip    1611.00 for SV#25
257629.00 Search WL FA RESD 0.00 RATIO = 28816.60 CUT: 2.00
Fixed.
257629.00 Changes in fixed WL ambiguities:
          1611.00000 for SV25 in channel 05
257884.00 Missing epoch in the BASE receiver
257884.00 No good reference SV has been found.
257885.00 Missing epoch in the BASE receiver
257886.00 Missing epoch in the BASE receiver

 Reached the end of Bfile #1

END OF INPUT
```

Logtimes File

is the binary Logtimes File created when you select SURVEY TYPE: KINEMATIC or PSEUDO in PROCESS. It allows you (via the PROCESS/EDIT LOGTIME [EDIT LOG] screen) to edit information regarding common time intervals between sites, to edit antenna height (kinematic only), and to decide whether to reset the ambiguities for the static site (kinematic only).

O-File

is the binary Vector Output file generated by the LINECOMP program as a result of processing static or pseudo-kinematic survey data or by PNAV from kinematic survey data (i.e. in the Survey Mode). An O-file contains, in abbreviated binary form, vector information and solution statistics, for each pair of known and unknown stations selected for processing from PROJFILE.STA, PROJFILE.PSD, or PROJFILE.KIN. It can be read by adjustment packages such as FILLNET, Geolab® or SNAP. It can be inspected via the VECTOR OUTPUT function in the PROCESS/RESULTS screen.

In the PNAV O-file, the FLOAT SOLUTION data listed is always identical to the FIXED SOLUTION data. The PNAV solution is a fixed solution if the Lowest RATIO is greater than 95 and the Sigmas in the ambiguities are all zeroes; otherwise the PNAV solution is a float solution.

The O-file contains multiple solutions for multiple baseline vectors.

The solution information for each calculated vector is preceded by a line of asterisks in the PROCESS/RESULTS/VECTOR OUTPUT display.

A PNAV kinematic O-file listing excerpt is shown below; in this case, the **Lowest Ratio** of 0.0 indicates a float solution:

```
PNAV: 2.1.00P     KINEMATIC - L1-L2              Processed:
03/02/94 12:17
PROJECT: PNAV Survey/PNAV Search    Year: 1992   Day: 231
Session: A
Start: 22:35 Span: 5 min  Start: 22:35 Span:5 min   Interval:
10.00 s
------------------------------------------------------------
-------------
KNOWN Station:   _TG3                        STATION _TG3

LAT: N 37 22 23.55522  LONG: W 121 59 51.23491  ELLIP. HT:2.094
Antenna Height:       | Met. Information:    | Operator:  PHG
  Slant:       0.000 m |  Temp:      20.0(C)  | Receiver #: 113
  Radius:      0.000 m |  Humidity:  50.0(%)  | Antenna #:  ___
   Vert Offset:  0.000 m |  Pressure: 1010.0(mb) |
Antenna Offset:          |                      |Comment:
6L_TESTING___
  North:         0.000 m |                      |
  East:        0.000 m |                  | Receiver Log ID: 00
------------------------------------------------------------
-------------
UNKNOWN Station: SSSP                        STATION SSSP
Antenna Height:       | Met. Information:    | Operator:  PHG
  Slant:       1.632 m |  Temp:      20.0(C)  | Receiver #: 108
  Radius:      0.132 m |  Humidity:  50.0(%)  | Antenna #:  109
   Vert Offset:  0.000 m |  Pressure: 1010.0(mb) |
Antenna Offset:         |                      | Comment:
6L_TESTING___
  North:         0.000 m |                      |
  East:        0.000 m |                  | Receiver Log ID: 01
------------------------------------------------------------
           FLOAT SOLUTION          |          FIXED SOLUTION
                                   |
RMS:  0.0070 m                     | RMS:  0.0070 m  Lowest
RATIO:   0.0
Conv: 0.0000 m   29 of   29 Meas Used| Conv: 0.0000 m   29 of
29 Meas Used
                                   |
LATITUDE:    N   37 25 23.71124    | LATITUDE:    N   37 25
23.71124
LONGITUDE:   W  122 04 48.40531    | LONGITUDE:   W  122 04
48.40531
ELLIP. HT:          -22.268    | ELLIP. HT:          -22.268
                                   |
delta X:         -4396.007 +/-0.707  | delta X:         -
4396.007 +/-0.707
delta Y:        6753.246 +/-0.372  | delta Y:        6753.246
+/-0.372
delta Z:        4397.576 +/-0.262  | delta Z:        4397.576
+/-0.262
                                   |
BASELINE LENGTH:      9179.863     | BASELINE LENGTH:
9179.863
                                   |
Reference SV:  3                   | Reference SV:  3
SV    Amb.   Sigma   Fit(m)  # Meas  | SV    Amb.   Sigma
Fit(m)  # Meas
20  6.642  3.310  0.000   28   | 20  6.642  3.310  0.000   28
26  8.701  1.766  0.000   28   | 26  8.701  1.766  0.000   28
16  0.790  2.652  0.000   28   | 16  0.790  2.652  0.000   28
```

```
17  -7.491   2.092   0.000     28    | 17  -7.491   2.092
0.000     28
23  -7.295   3.512   0.000     28    | 23  -7.295   3.512
0.000     28
-------------------------------------------------------------
```

Photo-File

is an ASCII descriptor file containing photogrammetric data, typically downloaded from the receiver with the name PHOTO.DAT. It contains precise time tags generated by TTL pulses sent to the "Camera In" port on the receiver. It is useful for logging events; a later analysis can correlate the logged time with a position.

Example:

```
???? 2 23:25:00.6820077
???? 2 23:27:00.6543654
???? 2 23:28:09.6546546
???? 2 23:29:00.5435437
???? 2 23:30:01.4534534
???? 2 23:31:00.5767567
???? 2 23:32:00.5647657
???? 2 23:32:59.0690044
```

The format is:

site d hh:mm:ss

where:

site	is the site name.
d	is the GPS day of the week (measured from GPS midnight Sunday 0:00:00 am).
hh	is GPS hours from midnight.
mm	is GPS minutes.
ss	is GPS seconds.

Plot File

is a graphical plot file containing PNAV data processing results or a comparison of two J-files or C-files. It can be viewed by the PROCESS/RESULTS/RESIDUAL PLOTS function.

PNAV.CNF File

is a **binary** configuration file which contains the menu attribute information and your selections from the <Alt-F> File Setup Menu.

PNAVCOMP.DIF File

contains an ASCII tabular comparison of two J-files or C-files. Each line in the file is a record for a single epoch. The data is organized into 23 columns. A typical record line item is 160 characters long; the following examples are for single-record lines. The column headings are for reference only and do not appear in the listing.

A comparison of J-files is shown below:

```
Column1          2       3        4          5         6        7
 257252.00   0.254   1.995   26.153   -0.000    0.578    0.578

Column8          9        10     11       12       13       14
1.072  1.732    23.283  -0.003    0.577    0.578   3.982

Column15       16      17      18       19       20       21
4.678  54.725   0.010  0.578    0.579    0.002    0.001

Column22           23
0.013       0.005
```

where:

Table 13.6: PNAVCOMP.DIF Format

Column	Meaning
1	GPS seconds-of-week for the current epoch
2	East position difference (meters)
3	East position RMS from file 1 (meters); zero for C-files
4	East position RMS from file 2 (meters); zero for C-files
5	East velocity difference (meters/ses)
6	East velocity RMS from file 1 (meters/sec); zero for C-files
7	East velocity RMS from file 2 (meters/sec); zero for C-files
8	North position difference (meters)
9	North position RMS from file 1 (meters); zero for C-files
10	North position RMS from file 2 (meters); zero for C-files
11	North velocity difference (meters/sec)
12	North velocity RMS from file 1 (meters/sec); zero for C-files
13	North velocity RMS from file 2 (meters/sec); zero for C-files
14	Up position difference (meters)
15	Up position RMS from file 1 (meters); zero for C-files
16	Up position RMS from file 2 (meters); zero for C-files

Table 13.6: PNAVCOMP.DIF Format (continued)

Column	Meaning
17	Up velocity difference (meters/sec)
18	Up velocity RMS from file 1 (meters/sec); zero for C-files
19	Up velocity RMS from file 2 (meters/sec); zero for C-files
20	averaged post-fit carrier-phase residual of the measurements from file 1 (meters)
21	averaged post-fit carrier-phase residual of the measurements from file 2 (meters)
22	**Chi^2** "goodness-of-fit" indicator of the measurements from file 1
23	**Chi^2** "goodness-of-fit" indicator of the measurements from file 2

In a comparison of C-files, all position RMS, velocity RMS, phase residual, and Chi^2 columns are always zero.

You may inspect PNAVCOMP.DIF via the Prism/TOOLS/RESULTS function.

PNAVCOMP.PLT File

is a binary plot file (default name PNAVCOMP.PLT) generated from Overview Menu Option C) POST MISSION/COMPARE NAV SOLUTIONS. When comparing comparing J-files, PNAVCOMP.PLT contains the following plot screens:

- East Difference (meters).
- North Difference (meters).
- Up Difference (meters).
- East Velocity Difference (meters/second).
- North Velocity Difference (meters/second).
- Up Velocity Difference (meters/second).
- Phase Residuals (comparitive-meters).
- Post-fit Chis (Chi values-dimensionless).

For comparison of C-files, PNAVCOMP.PLT omits Phase Residuals and Post-fit Chis.

You may inspect this file via the RESIDUAL PLOTS function in the PROCESS/ RESULTS screen.

PNAVPMT.DFT File

is the binary Default Parameters file (a PNAV support file) containing the default Kalman filter parameter settings for STATIC, WALKING, AUTOMOBILE, SHIP, or AIRCRAFT Rover Motion Dynamics.

PNAVPMT.FAC File

is the binary read-only Backup Factory Default Parameters file (a PNAV support file) from which PNAV can restore the factory default settings. The first time you access the MODIFY DEFAULT PARAMETERS Setup Menu Screen (via Overview Menu Option D) PNAV UTILITY copies the current contents of PNAVPMT.DFT to PNAVPMT.FAC.

PNAV.PMT File

is an ASCII file containing the Kalman filter parameters and runtime parameters used to control data processing and modified via the <Alt-?> Setup Menus. PNAV extracts the factory default settings from the PNAVPMT.DFT file. The factory default Run-Time Parameters, Other Run-Time Parameters, and Quality Assurance Parameters are basically identical for all ROVER MOTION DYNAMICS selections (via Overview Otions BATCH PROCESSING, DATA PROCESSING, or PNAV UTILITY). The Kalman Filter System Parameters factory defaults vary with the selected ROVER MOTION DYNAMICS. The Kalman Filter Measurement (Noise) Parameters factory defaults used by PNAV depend on the setting of the USE SMTHCOR parameter (via Overview Menu BATCH PROCESSING or Overview Menu DATA PROCESSING). The following sample PNAV.PMT file lists the defaults:

The explanatory bracketed phrases do not appear in the actual file.

```
Run-Time Parameters ------------------------------------------------------
N | (Y = static site, N = moving site)
Y | (Y = ENU frame,   N = XYZ frame)
N | (Y = process doppler measurements)
Y | (Y = process carrier phase measurements)
N | (Y = process C/A pseudo-ranges)
N | (Y = form LC observables)
N | (Y = model pseudo-range multi-path)
Y | (Y = apply troposphere correction)
A | (Y = model residual ionosphere)
Y | (Y = form wide-lane integer ambiguities)
N | (Y = internally smooth the pseudo-ranges)
Y | (Y = try to fix ambiguities to integers)
```

```
N | (Y = form tripple difference observables)
N | (Y = reset ambiguities before static site)
N | (Y = use smooth correction from B-files)
N | (Y = use unhealth satellites)
  0.0                  | code pseudo-range sampling period (sec)
 10                    | Mask angle
200                    | PDOP mask
 0  0  0  0  0  0  0    | SVS to omit from processing
 0  0  0  0  0  0  0    | SVS to omit as a reference
------------------------------------------------------------------------
Other Run-Time Parameters ---------------------------------------------
      3                     | integer ambiguity searching algorithm
     20                     | PDOP mask to fix integer ambiguities
      3                     | integer ambiguities search range
  100000                    | maximum combination to search
      1.0                   | minimum RMS to start fix L1 ambiguities
      1.0                   | minimum RMS to start fix L2/WL ambigui
      5.0                   | L1 ambiguities fix ratio
      2.0                   | L2/WL ambiguities fix ratio
     99.0                   | contras cut for ambiguity search method 2
      0.010                 | absolute cut for ambiguity search method2
      N                     | (Y = leaky filter to smooth pseudo-ranges
      0                     | leaky filter smoothing constant
      0.0                   | Kalman filter smoothing parameters: P0
      0.0000                | Kalman filter smoothing parameters:Q
      0.0                   | Kalman filter smoothing parameters: R
      1                     | maximum number of iterations per epoch
------------------------------------------------------------------------
Quality Assurance Parameters ------------------------------------------
      1.50                  | scale measurements by baseline length(ppm)
      0.025                 | maximum allowed average phase residual(m)
      5.00                  | maximum allowed Chi2 value
      N                     | (Y = weight pseudo-ranges by elevation)
      0                     | pseudo-range weighting function type
      N                     | (Y = weight carrier phases by elevation)
      0                     | carrier phase weighting function type
     30.0                   | maximum prediction period (sec)
      N                     | generate independent solution for each run
      Y                     |RAIM: via autonomous position computation
      Y                     |RAIM:check double difference psuedo range
      Y                     |RAIM:check all observables
------------------------------------------------------------------------
[When not use smooth correction]
Kalman Filter Measurement Parameters ----------------------------------
[L1 Pcode][L2 Pcode][CA code]
   3.00     3.00    30.00      | measurement noise in pseudo-range (meter)
[L1 Phase][L2 Phase]
   0.05     0.05     0.0       | measurement noise in carrier phase (cycle)
[L1 Doppler][L2 Doppler]
   0.10     0.10     0.00      | measurement noise in doppler (cycle/sec)
------------------------------------------------------------------------
[When use smooth correction]
Kalman Filter Measurement Parameters ----------------------------------
[L1 Pcode][L2 Pcode][CA code]
   2.00     2.00     5.00      | measurement noise in pseudo-range (meter)
[L1 Phase][L2 Phase]
   0.05     0.05     0.0       | measurement noise in carrier phase (cycle)
[L1 Doppler][L2 Doppler]
   0.10     0.10     0.00      | measurement noise in doppler (cycle/sec)
------------------------------------------------------------------------
[For STATIC ROVER MOTION DYNAMICS]
Kalman Filter System Parameters ---------------------------------------
ns   tau     To        q     m0     m1     m2      Q | parameter name
x  xxx.x  xxx.x  x.xxe+xx  xxx.x  xxx.x  xxx.x  xxx.x | parameter field
```

```
1   0.0   0.0  1.00e-03  999.0  100.0   10.0    0.0 | X component parameters
1   0.0   0.0  1.00e-03  999.0  100.0   10.0    0.0 | Y component parameters
1   0.0   0.0  1.00e-03  999.0  100.0   10.0    0.0 | Z component parameters
2  60.0 300.0  2.50e+00    5.0    1.0    0.0    0.0 | Multi-path  parameters
1 100.0        1.50e-01    1.5                     | Ionosphere   parameter
1   0.0        1.00e-05  999.0                     | L1 Ambiguity parameter
1   0.0        1.00e-05  999.0                     | L2 Ambiguity parameter
-------------------------------------------------------------------------
[For WALKING ROVER MOTION DYNAMICS]
Kalman Filter System Parameters ---------------------------------------
-----
ns   tau     To        q     m0     m1     m2      Q | parameter name
x  xxx.x  xxx.x  x.xxe+xx  xxx.x  xxx.x  xxx.x  xxx.x | parameter field
2   0.0   0.0  1.00e+00  999.0  100.0   10.0    0.0 | X component parameters
2   0.0   0.0  1.00e+00  999.0  100.0   10.0    0.0 | Y component parameters
2   0.0   0.0  1.00e+00  999.0  100.0   10.0    0.0 | Z component parameters
2  60.0 300.0  2.50e+00    5.0    1.0    0.0    0.0 | Multi-path  parameters
1 100.0        1.50e-01    1.5                     | Ionosphere   parameter
1   0.0        1.00e-05  999.0                     | L1 Ambiguity parameter
1   0.0        1.00e-05  999.0                     | L2 Ambiguity parameter
-------------------------------------------------------------------------
-----
[For AUTOMOBILE ROVER MOTION DYNAMICS]
Kalman Filter System Parameters ---------------------------------------
-----
ns   tau     To        q     m0     m1     m2      Q | parameter name
x  xxx.x  xxx.x  x.xxe+xx  xxx.x  xxx.x  xxx.x  xxx.x | parameter field
2   0.0   0.0  1.00e+00  999.0  100.0   10.0    0.0 | X component parameters
2   0.0   0.0  1.00e+00  999.0  100.0   10.0    0.0 | Y component parameters
2   0.0   0.0  1.00e+00  999.0  100.0   10.0    0.0 | Z component parameters
2  60.0 300.0  2.50e+00    5.0    1.0    0.0    0.0 | Multi-path  parameters
1 100.0        1.50e-01    1.5                     | Ionosphere   parameter
1   0.0        1.00e-05  999.0                     | L1 Ambiguity parameter
1   0.0        1.00e-05  999.0                     | L2 Ambiguity parameter
-------------------------------------------------------------------------
------
[For SHIP ROVER MOTION DYNAMICS]
Kalman Filter System Parameters ---------------------------------------
-----
ns   tau     To        q     m0     m1     m2      Q | parameter name
x  xxx.x  xxx.x  x.xxe+xx  xxx.x  xxx.x  xxx.x  xxx.x | parameter field
2   0.0   0.0  3.00e+00  999.0  100.0   10.0    0.0 | X component parameters
2   0.0   0.0  3.00e+00  999.0  100.0   10.0    0.0 | Y component parameters
1   0.0   0.0  1.00e+00  999.0  100.0   10.0    0.0 | Z component parameters
2  60.0 300.0  2.50e+00    5.0    1.0    0.0    0.0 | Multi-path  parameters
1 100.0        1.50e-01    1.5                     | Ionosphere   parameter
1   0.0        1.00e-05  999.0                     | L1 Ambiguity parameter
1   0.0        1.00e-05  999.0                     | L2 Ambiguity parameter
-------------------------------------------------------------------------
-----
[For AIRCRAFT ROVER MOTION DYNAMICS]
Kalman Filter System Parameters ---------------------------------------
-----
ns   tau     To        q     m0     m1     m2      Q | parameter name
x  xxx.x  xxx.x  x.xxe+xx  xxx.x  xxx.x  xxx.x  xxx.x | parameter field
2   0.0   0.0  5.00e+00  999.0  100.0   10.0    0.0 | X component parameters
2   0.0   0.0  5.00e+00  999.0  100.0   10.0    0.0 | Y component parameters
2   0.0   0.0  5.00e+00  999.0  100.0   10.0    0.0 | Z component parameters
2  60.0 300.0  2.50e+00    5.0    1.0    0.0    0.0 | Multi-path  parameters
1 100.0        1.50e-01    1.5                     | Ionosphere   parameter
1   0.0        1.00e-05  999.0                     | L1 Ambiguity parameter
1   0.0        1.00e-05  999.0                     | L2 Ambiguity parameter
-------------------------------------------------------------------------
-----
```

PNAV.PNT File

is an ASCII file containing information about the relationship between the Rover's positioning point and the Rover's antenna phase center. It is used for Navigation Mode only. For example:

```
Antenna Position relative to the Reference Point ------------
  xx.xxx             | (units in meters, Assuming Vertical Mounting)
    2.125               | Slant
    0.132               | Radius
   0.000              | Vertical between Slant pt. and reference pt.
-------------------------------------------------------------
```

If this file does not already exist in the current directory, PNAV creates a file with zero default values. For a Rover antenna mounted directly on a tripod or bipod, the antenna height (slant and radius) should be entered in the Antenna Position relative to the Reference Point. In this example, a slant height of 2.125 meters and a radius of 0.132 meters were entered. There is 0.000 meters of additional vertical offset.

PNAV.POS File

is the Site Position File for the Navigation Mode and Relative Nav Mode. It is an ASCII file containing the site list. At least one entry should have the correct Base station site name and coordinates. By default, the Base station is the site from which the Rover's east, north, up (ENU) vectors are determined. Another entry with a site name "**_RBS**" can be used as a reference point with which all the Rover's ENU positions will be computed. The antenna height of the Base station or _RBS site will be ignored when computing ENU position.

For example:

```
Site Information ------------------------------------------------------------
Name Slant   Radius  D_Vert       LAT            LON         ELLIP. HT.   RMS
cccc xx.xxxx xx.xxxx xx.xxxx c xx xx xx.xxxxxx c xxx xx xx.xxxxxx xxxxx.xxxx
xxx.xxxx
1111  1.5000  0.1318  0.0000  N 37 25 23.293160  W 122  4 48.308670    -
28.9220    0.0000
2222  0.0000  0.0000  0.0000  N 37 25 23.312700  W 122  4 48.122500    -
28.9330    0.0000
3333  0.0000  0.0000  0.0000  N 37 25 23.459500  W 122  4 48.146000    -
28.9890    0.0000
SSSS  0.0000  0.0000  0.0000  N 37 25 23.440300  W 122  4 48.331700    -
28.9520    0.0000
CHSX  0.0000  0.0000  0.0000  N 37 25 24.122700  W 122  4 47.408500    -
29.0810    0.0000
HYD1  0.0000  0.0000  0.0000  N 37 25 23.740870  W 122  4 43.845410    -
29.8400    0.0000
HYD3  0.0000  0.0000  0.0000  N 37 25 23.208900  W 122  4 59.302600    -
30.5790    0.0000
HYD4  1.6300  0.1318  0.0000  N 37 25 22.751360  W 122  5  2.972400    -
30.5740    0.0000
_DH1  0.0000  0.0000  0.0000  N 37 25 24.537840  W 122  5 10.826860    -
26.5110    0.0000
```

```
_TRN  0.0000  0.0000  0.0000  N 37 25 25.009610  W 122  5
17.896820    -30.4270    0.0000
------------------------------------------------------------
----
```

Ensure that the site name, the antenna height, and the coordinates for the Base station have been entered and are correct in order to get accurate WGS-84 results for the Rover.

PNAVSIM.SIM File

is an ASCII simulation file automatically generated by PNAV that describes the input data files and the common epochs to process.

Example:

```
1.00              Timing scale factor
N BSSSPA92.232    (Nav Data in Output, Y or N) BENDATA File
F BS 0 R CA       [F]ixed or [R]over Site (rrr = RCVR ID) (COMM)
Y B_TG3A92.232    (Nav Data in Output, Y or N) BENDATA File
R 01 1 R CA       [F]ixed or [R]over Site (rrr = RCVR ID) (COMM)
COMMON.NAV        COMMON.NAV File
345000            Start epoch
                  End epoch
                  Process epochs whose base site matches this ID
                  Process epochs whose rovr site matches this ID
```

In all these parameters, only the fields with bold characters are important for PNAV post-processing, other fields are reserved for future implementation.

BENDATA File

Second line and fourth line list the B-files used for post-processing as specfied in Menu 3.1. PNAV DATA PROCESSING OPTIONS.

[F]ixed or [R]over Site

Third line and fifth line specify the B-file above current line is a **F**ixed (Base) site or a **R**over site.

COMMON.NAV File

Sixth line specifies the ephemeris data (COMMON.NAV) file used for post-processing.

Start epoch and End epoch

Seventh line and eighth line list the starting epoch (second of week) or ending epoch (second of week) of post-processing as specified in the

Process epochs whose base/rovr site matches this ID

Last two lines list base and rover from the MATCH SITE ID data entry fields specified in the

PNAV.WAY

is an **ASCII** file containing a list of waypoints (sites) relating to the expected trajectory of the Rover at the time of data collection. If this file does not already exist in the current directory, PNAV extracts these waypoints from the PNAV.POS file if you are processing in the Navigation Mode or from the PROJFILE.KIN file if you are processing in the Survey Mode. PNAV uses PNAV.WAY to generate the graphics display.

Example:

```
Way Point Navigation Site List ---------------------------------
  1 1111
  2 _ROV
-------------------------------------------------------------
Navigation Mode ------------------------------------------
 0            | [0] Auto scaled map   [1] Fixed area map
 1            | [0] To Base   [1] Nearest   [2] Heading_for
              | Map center site name
-------------------------------------------------------------
```

The **Way Point Navigation Site List** area contains the site names of points the Rover will either occupy or be in the vicinity of during the time period given by a collected data set and will be shown on the graphics display during processing.

The Navigation Mode area lists current settings via the <Alt-W> WayPoint Setup Menu of the commands, **^F2 MapMode**, **^F3 NavMode**, and **<F7> Map Ctr**:

- On the first line, the Map Mode,

where:

0 AUTO SWITCH mode (Auto scaled map)

1 FIXED MAP mode (Fixed area map)

- On the second line, the Navigation Mode:

where:

0 TO BASE mode. The way point navigation target is always the Base station.

1 NEAREST mode. The way point navigation target is the site which is closest in distance from the current position.

2 HEADING FOR mode. The way point navigation target is the site which is within ±45° of the current Rover position and course-over-ground vector and is closest in distance to the current Rover position.

- On the third line, the Map Center site name when the FIXED MAP mode is selected.

Once the target is selected, the graphics display will automatically draw a map around the target. Also, the scale will automatically be determined.

PROJFILE

is a binary project file created in the PROCESS module containing site information such as site name, position, and meteorological data. It is editable via the PROCESS/ EDIT PROJECT [EDIT SITE] screen. PROJFILE.STA, PROJFILE.PSD, and PROJFILE.KIN is created when you select SURVEY TYPE: STATIC, PSEUDO, and KINEMATIC, respectively. In PNAV, PROJFILE.KIN is the Site Position File when you are processing in the Survey Mode.

R-File

The KINSRVY program and PNAV output R-files (rover trajectory files) which contain epoch-by-epoch solutions between the roving receiver and the base receiver. By default, PNAV does not create the R-file during processing because of the large amount of output data that is generated; however, you can instruct PNAV to do so in the <Alt-F> File Setup Menu. This R-file can be viewed by the PROCESS/ RESULTS/ROVER TRAJECTORY function. Each line in the R-file is a record for a single epoch. A typical record line item is 284-characters long; the following example

is for a single-record line, i.e., a continuous line beginning with 00025 and ending with 1.

```
00025 g f:24_7 r:24_4 1992-10-27 18:20: 0.000 5 s: 4 t:  2.76 ...
fxyz:    1503.041     -676.563       -3.907  ...
Af:  89.95856  Ef:  -0.20798  Df:     1648.297  ...
nf:        0.929  ef:     1648.288  uf:   -5.771 ...
Rn: 51, 5  46.99456 Rw:  114,  22  23.71757 Rh: 1201.784 ...
r:24_4   1
```

where:

Table 13.7: R-File Format

Item	Function
00025	is the epoch counter number for each entry.
g	is the position computed good/bad flag.
f:	is the Base station's site name.
r:	is the Rover's site name.
1992-10-27	is the date the GPS data was collected.
18:20:00	is the GPS time (hours:minutes:seconds).
5	is the number of satellites.
s:4	is the 1-sigma error value of the position (mm).
t:2.76	is the "trace" of the satellite geometry.
fxyz:	is the relative earth-centered earth-fixed (ECEF) xyz vector between the Base and Rover (m).
Af:	is the azimuth angle of the Rover from the Base station (deg).
Ef:	is the elevation angle of the Rover from the Base station (deg).
Df:	is the linear distance between the Base and Rover (m).
nf:	is the northing distance of the Rover from the Base station (m).
ef:	is the easting distance of the Rover from the Base station (m).
uf:	is the upping distance of the Rover from the Base station (m).
Rn:	is the "n"orth latitude of the Rover (deg, min, sec).
Rw:	is the "w"est longitude of the Rover (deg, min, sec).
Rh:	is the ellipsoidal height of the Rover (m).
r:	is the Rover's site name.
1	is a KINSRVY flag not applicable to PNAV.

SUMMARY.OUT FILE

An ASCII summary of the results of processing. When SUMMARY.OUT results from processing in the Survey Mode, it contains the main input control parameters, vector solutions, and statistics; from processing in the Navigation Mode, it contains input control parameters only. Prism copies SUMMARY.OUT to RSUMMARY.OUT. This R-file can be viewed by the PROCESS/RESULTS/ ROVER TRAJECTORY function. A typical SUMMARY.OUT file from Survey Mode processing is listed below:

```
Ashtech, Inc.    Program: PNAV     Version: 2.1.00P
------------------------------------------------------------------------
Wed Mar 02 12:23:09 1994
BASE FILE: B_TG3A92.232
ROVER FILE: BSSSPA92.232

Processing direction       : Forward
Processing mode            : SURVEY
Data sample period (sec)   :  10.00
Data type being processed  : PL1-code/PL2-code/PL2-phase/CAL1-phase/
Static site iteration      : No
Ambiguity search algorithm : PNAV search

      BASE  ROVR  LENGTH(m)  Std(m) Resid(m) Chi2  T(m) SVs DOP  Comment

R  X  Y  _TG3  SSSP    9179.969   0.015  0.006   0.019   4.8  6  2.2
R  F  N  _TG3  111P    9176.741   1.207  0.064   0.029   4.2  6  2.1
had cycle slips
R  X  Y  _TG3  SSSP    9179.967   0.015  0.004   0.015   3.3  6  2.3
R  F  Y  _TG3  HYD1    9098.151   1.044  0.004   0.012   3.0  6  3.1
R  X  Y  _TG3  CHSX    9174.679   0.022  0.006   0.018   3.0  5  3.1
R  F  Y  _TG3  HYD2    9244.300   1.376  0.004   0.007   3.0  5  3.1
R  F  Y  _TG3  HYD3    9392.156   0.984  0.004   0.010   3.0  6  1.8
R  F  Y  _TG3  HYD4    9456.484   0.937  0.005   0.015   3.0  6  1.9
R  F  Y  _TG3  CNTY    9335.642   0.951  0.014   0.012   3.0  6  1.9
R  F  Y  _TG3  SSSP    9179.849   1.007  0.003   0.004   3.0  6  1.9
R  X  Y  _TG3  HYD1    9098.012   0.016  0.003   0.007   3.0  6  1.9
R  X  Y  _TG3  CHSX    9174.648   0.017  0.007   0.026   3.0  6  1.9
R  F  Y  _TG3  HYD2    9244.166   0.908  0.002   0.003   3.0  6  1.9
R  X  Y  _TG3  HYD3    9392.009   0.017  0.005   0.023   3.0  6  1.8
R  F  Y  _TG3  HYD4    9456.524   0.927  0.003   0.006   3.0  6  1.8
R  X  Y  _TG3  CNTY    9335.862   0.017  0.004   0.009   3.0  6  1.8
R  X  Y  _TG3  SSSP    9179.952   0.013  0.009   0.056   6.2  6  1.8
R  F  Y  _TG3  SSSP    9179.822   5.446  0.000   0.000   0.3  6  1.8
------------------------------------------------------------------------
Wed Mar 02 12:31:16 1994
```

where:

The main input control parameters are **Processing direction**, **Processing mode**, **Data sample period**, **Data type being processed**, **Static site iteration**, and **Ambiguity**

search algorithm; and:

Table 13.8: SUMMARY.OUT Format

Parameters	Description
Column 1:	R means ambiguities are reset, - means ambiguities are not reset.
Column 2:	X means fixed solution, F means float solution.
Column 3:	Y means solution written to O-file, N means solution not written to O-file; if the solution is too bad, PNAV does not write it.
BASE	Base station identifier.
ROVR	Rover station identifier.
LENGTH(m)	Calculated baseline vector length in meters.
Std(m)	Standard deviation or the one-sigma RMS value of the baseline solution error (in meters).
Resid(m)	Averaged post-fit carrier-phase residual (in meters).
Chi2	Post-fit Chi^2.
T(m)	Duration of static observation (in minutes).
SVs	Average number of satellites available during the observation.
DOP	Position dilution of precision.

US Coast Guard GPS Navigation Information Service

7323 Telegraph Road, Alexandria VA 22310-3998
Tel 703-313-5900 (24-hour watch)
Fax 703-313-5920

Overview

Since February 1989, the US Coast Guard has developed the requirements and plans for the Civil GPS Service (CGS) and has begun to implement these services. The four CGS functions recognized by the Coast Guard are listed below:

- Provide a GPS Operational Advisory Broadcast (OAB)
- Process applications for civil use of GPS PPS (Precise Positioning Service)
- Provide precise GPS satellite ephemeris data
- Provide a government interface for civil GPS users

Two agencies perform these functions:

- The GPS Information Center - provides the OAB and precise ephemerides
- The PPS Program Office - processes civil applications to PPS access

The primary source of information for the OAB is the GPS control center at Falcon Air Force Base in Colorado Springs, Colorado. The OAB originates at GPSIC in Alexandria VA and is broadcast during normal working hours, 8AM to 4PM EST, Monday through Friday, except Federal holidays. An answering machine records messages after hours, and calls are returned the next working day. OAB information is updated only during normal working hours, but advisory services are accessible 24 hours, 7 days. OAB presents the following information:

- Status - Current constellation health and availability
- Outages - Recent and future satellite down time
- Almanac - Current projected orbit data for GPS coverage and visibility predictions
- Other - General GPS information and some user documentation

Satellite visibility and coverage predictions are not offered by GPSIC. These services are available from commercial sources or commercially available software.

GPSIC Voice Recording

This is a 90-second tape message which contains current satellite status and outage information. The recording is available 24 hours 7 days and can be heard by dialing 703-313-5907 (direct number). The recording is updated at least daily during normal GPSIC working hours.

WWV/WWVH Voice Broadcasts

These short-wave voice broadcasts contain current GPS status and outage information in a 45-second message. The message is broadcast at minutes 14 and 15 past each hour on WWV and at minutes 43 and 44 past the hour on WWVH. The information is updated at least daily during normal GPSIC working hours. WWV and WWVH operate at 5.0, 10.0, and 15.0 MHz.

US Coast Guard Broadcast to Mariners

GPS status, future outages, and safety advisories are transmitted on the VHF marine radio band. The information is updated weekly and whenever satellite outages occur.

GPSIC Computer Bulletin Board Service (BBS)

GPSIC operates a BBS that lists status, outage, almanac, and other GPS information. The BBS is available to any user free of charge, except for normal telephone fees. To access the BBS, the user will need a computer, a modem, and communication software. Users obtain a User ID password on line during the first session. The following information will be found useful in connecting to the GPSIC BBS.

The BBS can handle the following connections:

- 300 bps/Bell103,
- 1200 bps/Bell 212A/CCITT V.22bis,
- 2400 bps/CCITT V.22/CCITT V.22bis,
- 4800 bps/CCITT V.32,
- 9600 bps/CCITT V.32
- no MNP capability (common US specs, Supramodem 2400).

- MNP capabilities level 2,3,4,5, none (DigiCom Systems 9624).

  STANDARD BBS number703-313-5910

  USR/HST703-313-5917 (USRobotics modems only, in case of trouble with 5910)

  2400 Bell703-313-5918 (in case of trouble with 5910)

  2400 CCITT703-313-5919 (in case of trouble with 5910)

Communications parameters at all numbers:

Asynchronous No parity

8 data bits Full duplex

1 stop bit (10-bit word)

The BBS ignores the 8th bit of data, restricting the character set to the lower 128 ASCII values. The BBS also checks for ANSI graphics capability, and employs some ANSI graphics if the user's equipment can display them. All users get the same information, but non-ANSI users will not see color images.

Defense Mapping Agency ANMS

The Defense Mapping Agency's Navigation Information Network, Automated Notice to Mariners System is a computer database that contains GPS status, outage, almanac, and other information. GPSIC updates the information at least daily. The information is contained in query number 85. Users must register with DMA. To obtain a user ID and information booklet, contact:

DMA Hydrographic/Topographic Center

Attention: MCN/NAVINFONET

Washington DC 20315-0030

301-227-3296

DMA Broadcast Warnings

GPSIC provides GPS status, future outages, and safety advisories through the DMA HYDROLANT, HYDROPAC, and NAVAREA warning systems. These warnings are updated weekly and whenever satellite outages occur.

DMA Weekly Notice to Mariners

DMA publishes weekly navigation warnings and notices to mariners in a weekly publication "Notices to Mariners." This publication automatically includes active GPS status and outage information generated by both broadcast and NAVAREA warnings.

Distributed by:

Director, DMA

Combat Support Center

Attention: PMSS

Washington DC 20315-0010

NAVTEX Text Broadcast

The Coast Guard Local Notice to Mariners and DMA Broadcast Warnings also include text broadcast that contains the same information as the voice broadcasts. NAVTEX data is broadcast in English at 518 KHz from 16 transmitters worldwide. GPS status and outage information is available on NAVTEX.

Selected Bibliography

Introduction to GPS

Wells, David: *Guide to GPS Positioning*, 1987, ISBN 0-920-114-73-3

Available from Canadian GPS Associates

Box 5378, Postal Station F, Ottawa, Ontario Canada K2C 3J1

The Institute of Navigation, *Global Positioning System*, Papers published in *NAVIGATION*, vol. I. II. III. 1980, 1984, 1986.

GPS Carrier Phase Positioning

Remondi, Benjamin W., "Using the Global Positioning System (GPS) Phase Observable for Relative Geodesy: Modeling, Processing, and Results", Ph.D. Thesis, The University of Texas at Austin, 1984.

Leick, Alfred: *GPS Satellite Surveying*, 1990, ISBN 0-471-81990-5

Wiley Interscience, 605 3rd Avenue, New York NY 10158-0012

Differential GPS

Proceedings of ION GPS. International Technical Meeting of the Satellite Division of the Institute of Navigation. Annually since 1988.

Proceedings of the National Technical Meeting. Biannually by Institute of Navigation.

Proceedings of the International Geodetic Symposium on Satellite Positioning.

Proceedings of the International Symposium on Differential Satellite Navigation Systems. Annually since 1992.

Qin, Xinhua, et al: "Very Precise Differential GPS - Development Status and Test Results", *Proceedings of ION GPS-92*, Albuquerque, New Mexico, 1992.

Chou, Hsing-Tung: "An Adaptive Correction Technique for Differential Global Positioning System", Ph.D. Thesis, Stanford University, June 1991.

Kee, Changdon: "Algorithms and Implementation of Wide Area Differential GPS", *Proceedings of ION GPS-92*,Albuquerque, New Mexico, 1992.

Kalman Filtering Theory and Application

Gelb, Arthur: *Applied Optimal Estimation*, The M.I.T. Press, 1974.

Bryson, Arthur E. and **Ho, Yu-Chi**: *Applied Optimal Control*, Hemisphere Publishing Corporation, 1975.

Bierman, Gerald J.: *Factorization Methods for Discrete Sequential Estimation*, Academic Press, 1977.

Customer Support

If you have any problems or need further help, the Sokkia customer support team can be reached by telephone. Before you call, please refer to the documentation that came with your system (both receiver and software manuals). Many common problems are identified within the documentation and suggestions are offered for solving them.

- Check cables and power supplies. Many hardware problems are related to these simple problems.
- If the problem seems to be with your computer, reboot it to clear the system's RAM memory.
- If you are experiencing receiver problems and have already downloaded receiver files, reset the receiver as documented in the system commands section of the receiver manual. Note that the reset command clears receiver memory and resets operating parameters to factory default values.

  If none of these suggestions solves the problem, contact the Sokkia customer support team. Have the following information at hand:

Table C.1: Customer Support Information

Information Category	Your Actual Numbers
Receiver Model	
Receiver Serial #	
Software Version #	
Software Serial #	
Firmware Version #	
A clear, concise description of the problem	

Then contact someone on the customer support team at the following numbers:

Voice:1-800-257-2552

Voice:(913) 492-4900 - press 0 for Operator

FAX:(913) 492-0188

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