Carlson

SurvStar Manual

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Chapter 1 - Overview

Introduction

SurvStar is a complete real-time data collection system that interfaces with both total stations and GPS receivers. The program runs on the MicroFlex DAP (9500 & 9800), Husky (FS/2 & FS/3) and HP Palmtop (100 & 200), as well as any IBM compatible laptop. Due to subtle differences in screen formatting and serial communications among the DAP, HUSKY, HP and PC, there are different versions of SurvStar for each of these platforms. The first thing you should do is make sure that you have the correct version of SurvStar for the computer platform you will be using.

The SurvStar system allows you to record survey data, stakeout points, and apply real-time coordinate data to design elements such as surface models, centerlines and templates. Much of SurvStar is derived from SurvCadd, Carlson Software's inside AutoCAD program that consists of COGO-Design, DTM-Contour, Section-Profile, Hydrology and Mining. SurvStar also includes SurvCOGO which is Carlson Software's original full-featured COGO program. This manual explains the features of SurvStar and some essentials about the DAP, Husky, and HP data collectors. For additional information about the total station, GPS receiver, or hand-held computer you will be using, please refer to the equipment manufacturer's user manual.

Because most hand-held data collectors do not have disk drives or even PCMCIA card slots, transfer programs are necessary that connect the serial COM port of your PC to the serial COM port of the data collector. Once the two are connected, you can generally transfer files from one to the other as you would from one directory to another. For each data collector manufacturer, there is a different default file transfer program that will be necessary for the SurvStar installation process. These will all be discussed here in Chapter 1. Once SurvStar has been installed, you will be able to use the SurvStar File Utilities transfer program which is the same for all data collectors. This feature is covered in Chapter 3.

Husky

Before starting SurvStar, here are some things to know about the Husky.

The PAW key: the key located between the up and down arrows on the Husky keyboard.

Power Management: to bring up the power management program, hold down the PAW key and press

'H'. When changing batteries, it is sometimes necessary to go to power management and tell the Husky that the power level is at 100%. If you are using Husky rechargeable batteries, be sure to set the Authorization level to either 3 or 4. The Husky will disable charging if level 1 is set (default).

Caps Lock: to switch between caps on and off, hold down the PAW key and press 'C'.

To move the display: hold down the PAW key and press one of the arrows. The Husky actually has a full screen but only shows part of it.

To reboot the Husky: hold down the two shift keys (the two keys to the left and right of the return key) and press the On button at the same time. Hold down these keys for about three seconds. On some Husky's, using the three keys Ctrl, Alt, and Del at the same time will also reboot the computer, but this does not work with all Husky types.

Default File Transfer

The **hcom.exe** program is used to transfer files between the Husky and a computer (PC). The first step is to connect the null-modem cable from the 9-pin serial port of the computer to COM1 (top left) on the Husky. Then run HCOM from the Husky.

C:\> *HCOM*

Next, run HCOM from the computer. HCOM shows a spilt screen with the files for the computer on the left and the Husky files on the right.

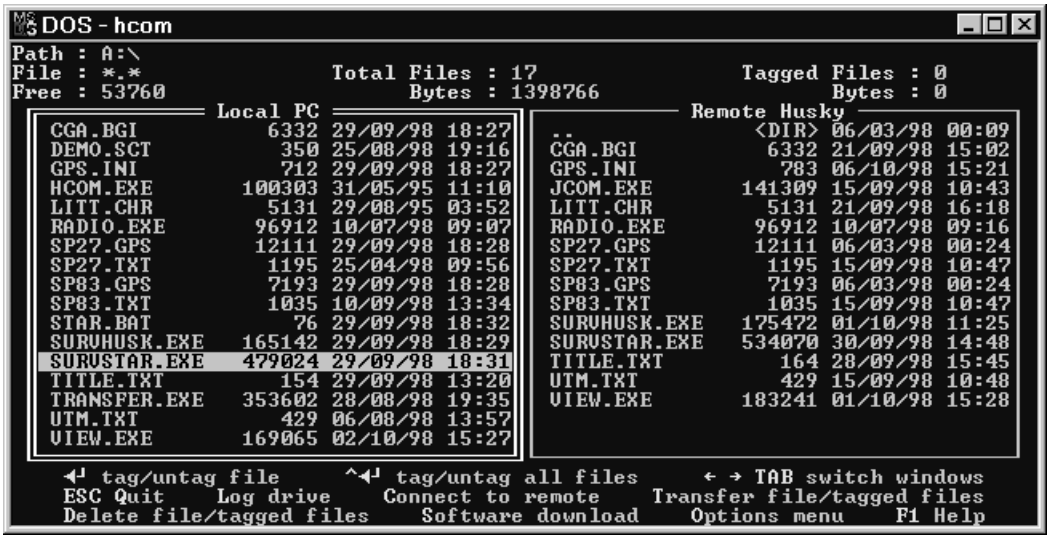


FIGURE 1.1

To transfer a file, use the arrow keys to highlight the file. Then press Enter to select the file. You may select multiple files. You may also deselect a file by highlighting the file name and pressing enter again. To start transferring the selected files, type 'T'.

The Husky has limited space for files. If a file is not needed for the current job, it can be transferred onto the computer and then deleted on the Husky. To delete a file, highlight the file and press Enter to select it. Then type 'D' to delete.

Use the left and right arrow keys to toggle from the PC to the Husky. If you are having difficulty connecting to your Husky, type "O" to check that your options are set correctly.

SurvStar Installation

The SurvStar program files need to be installed in a directory called **SURVSTAR** on the Husky. Also there needs to be a **DATA** directory on the Husky where SurvStar will store your data files. To create these directories, turn on the Husky and type the following:

```
CD \
MKDIR SURVSTAR
MKDIR DATA
```

To install the SurvStar files, start up the HCOM program as described in the last section. Next, insert the SurvStar installation disk into the computer floppy drive. Then type 'L' for Logged Drive to change the computer drive to your floppy drive, either drive A or B.

First transfer the **STAR.BAT** file by highlighting the file name on the PC side of the screen with the arrow keys and pressing Enter. When the file is selected, type 'T' to transfer. Next change to the SURVSTAR directory on the Husky by highlighting SURVSTAR and pressing Enter. Transfer **SURVSTAR.EXE**, **SURVHUSK.EXE**, **VIEW.EXE**, **GPS.INI**, **SP27.GPS**, **SP27.TXT**, **SP83.GPS**, **SP83.TXT**, **UTM.TXT**, **TITLE.TXT**, **LITT.CHR**, **SURVCOGO.HLP**, **KEYS.HLP**, **JCOM.EXE**, **RADIO.EXE** (if available) and **CGA.BGI** to the Husky. If there is not enough room for the files on the Husky, it will be necessary to free up some space by deleting unused files on the Husky.

If this is your first time running SurvStar and you wish to install the demo files, change to the **DATA** directory on the Husky. Do this by highlighting the ".." and pressing Enter. Then highlight DATA and press Enter. Transfer files **DEMO.CL**, **DEMO.GRD**, **DEMO.PRO**, **DEMO.SCT**, and **DEMO.TPL** to the Husky. For a description of what to do with these files see Page 1-11.

You will also find on the SurvStar diskette a file called **TRANSFER.EXE**. This file should be copied to your PC in either the directory where you intend to transfer files, or some other directory that is in your path (i.e. C:\Winnt35 or C:\batch).

The SurvStar files are as follows:

C:\STAR.BAT	- routine to start SurvStar
C:\SURVSTAR\SURVSTAR.EXE	- the main SurvStar program
C:\SURVSTAR\SURVHUSK.EXE	- the SurvCOGO program in SurvStar
C:\SURVSTAR\VIEW.EXE	- the View Screen program in SurvStar
C:\SURVSTAR\GPS.INI	- user settings
C:\SURVSTAR\SP83.GPS	- data tables required for state plane 83
C:\SURVSTAR\SP83.TXT	- text labels for state plane 83
C:\SURVSTAR\SP27.GPS	- data tables required for state plane 83
C:\SURVSTAR\SP27.TXT	- text labels for state plane 83
C:\SURVSTAR\UTM.TXT	- text labels for UTM datum regions
C:\SURVSTAR\TITLE.TXT	- opening screen for SurvStar
C:\SURVSTAR\LITT.CHR	- a font file
C:\SURVSTAR\SURVCOGO.HLP	- SurvCOGO help file
C:\SURVSTAR\KEYS.HLP	- SurvStar Hot Keys help file
C:\SURVSTAR\JCOM.EXE	- data collector end of file transfer utility
C:\SURVSTAR\RADIO.EXE	- channel change program for Pacific Crest radios
C:\SURVSTAR\CGA.BGI	- needed for graphics
C:\DATA\DEMO.CL	- demonstration centerline file
C:\DATA\DEMO.GRD	- demonstration grid file
C:\DATA\DEMO.PRO	- demonstration profile
C:\DATA\DEMO.SCT	- demonstration section file
C:\DATA\DEMO.TPL	- demonstration template file

MicroFlex Dap

The C drive of the Dap is generally a read-only drive (you can't modify anything in this drive) and this is where you will find the system programs that are essential to the correct operation of the Dap. Com.exe is one of these programs and is used for file transfer from the Dap to PC or Dap to Dap. Another program you will find on the C drive is **Setup.exe**. Use this program to modify the user configurable settings of your Dap.

9500

If you are using a **Dap 9500**, your setup screen will look something like the one shown in figure 1.2.

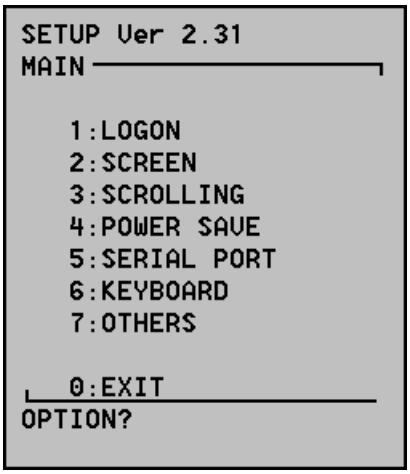


FIGURE 1.2

The most common settings that you may want to modify are option 2 (SCREEN) and option 4 (POWER SAVE).

SCREEN - Press 2 from the main setup screen to get to the screen menu. Take a look at the values set for number 4 (Backlight Timeout) and number 5 (Screen Timeout). The first is the time in seconds that the Dap will wait between key presses before it turns the backlight off. Once the backlight times out, just press any key to bring it back. Option 5 is the time in seconds that the Dap will wait between key presses before turning the screen off. Again, once the screen times out, press any key to bring it back. Enabling either of these timeout features helps to conserve battery power in the field.

POWER SAVE - Option 3 on this screen is the time in seconds that the Dap will wait before automatically shutting down. Automatic shut down will not reboot the Dap or cause you to lose any data, but could be bothersome while running the software (i.e. auto shut off could occur during stakeout or monitor). To restore power, press the "B" key.

Another important thing that you should know about your Dap 9500 is how to perform a system **reboot**. One method for doing this is to hold the three keys B-O-S all at once for about 3 seconds. Also, if you have Ctrl-Alt-Del enabled (in the Setup program, look at the Keyboard option), you can hold these three keys for approximately 3 seconds. In some 9500 models, there is also a reboot button located next to the PCMCIA slot inside the Dap. It will be a small circular button depressed from the surface; the larger rectangular button is the PCMCIA card eject button.

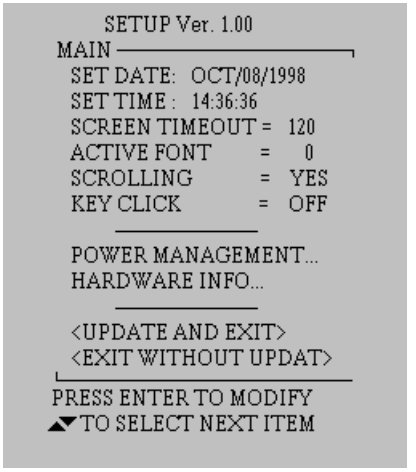


FIGURE 1.3

9800

One of the difference between the 9500 and the 9800 is the setup program. Although many of the same options are present, the program itself is quite different. The main screen for the 9800 setup program looks like the one in figure 1.3.

Use the up and down arrows to move to different editable fields. Press enter when you've highlighted a field you wish to modify. The screen timeout value is similar to that for the Dap 9500. The backlight will time out when the screen times out. To modify the automatic power shutoff, arrow down to Power Management and press enter. The first field of the next screen is the **Power Off Delay** time. This is also a good place to check your current battery status. When you have finished changing your settings, arrow key down to **Update and Exit** and press enter.

The **reboot** sequence for the Dap 9800 is F1-0-9 all at once for about 3 seconds. To toggle the caps lock on and off, press the blue key follow by the number 0 (this also works for the 9500).

Default File Transfer

All MicroFlex Dap computers come with a program called **COM.EXE** installed in the C drive. You will also find a copy of this program on your SurvStar installation disk. If you intend to use COM for file transfer, you will need to use this file on the PC end as well. The com program is also used by the SurvStar installation program. You will not be able to install SurvStar without it.

To run the com program, first connect your Dap to your PC with the provided download cable. Next run com on the Dap by typing **C:COM** at the DOS prompt. Make sure that your Com Port is set

correctly (generally you will use COM2 on the Dap). To change the Com Port, type 6, then the number of the desired Port, then 0 to return to the main menu. You can also change your baud rate by typing 4, the number that corresponds to the baud rate, then 0.

Once the Dap is set up, it's time to set up the PC for transfer. From DOS, go to the directory where the com.exe file is located. Type COM at the DOS prompt. From Windows, double click on the "com.exe" file. Check the selected Com Port. Use option 6 to change to the correct Com Port for your PC. Use option 4 to set the PC to the same baud rate that you set on the Dap.

Next, press "**2**" on the PC for **Master** mode. Within seconds, you should see the Dap go into **Slave** mode. If this does not happen, then there is a no communication between the Dap and PC. Check your download cable as well as the Com Port and baud rate settings on both the PC and Dap.

Select "**1**" to send a file from the PC to the Dap. Press "**2**" to send a file from the Dap to the PC. Then, enter the name of the file you wish to send, press enter, then type the name of the file as you want it to be received (to use the same name, press F3 and enter). When the file transfer process is complete, press "**9**" and "**0**" to exit the program.

SurvStar Installation

The SurvStar program files need to be installed in a directory called "**SURVSTAR**" on the MicroFlex. Also, there needs to be a "**DATA**" directory on the MicroFlex where SurvStar will store your data files. These directories are created by the installation program.

To install the software, insert the installation disk into the floppy disk drive on your computer or extract the survstar zip file if you have received the software via the internet. Then locate the file named **INSTALL.EXE** and begin this program. Under Windows this can be done by double-clicking on its icon. In DOS, type **A:INSTALL** at the DOS prompt.

A menu screen similar to the one shown below will appear.

```
SurvStar  Install
1 - COM Port     : 1
2 - BAUD Rate  : 38400
3 - DAP Drive    : A
4 - Install Type  : New
5 - Begin Install
Choose action (Esc-exit):
```

Option 1 is used to set the correct COM port on your computer*. Option 2 sets the baud rate at which the files will be transferred onto the DAP. If you are installing to a drive on your DAP other that "**A**" use option 3 to select the appropriate drive. If this is not the first time you have installed SurvStar on this DAP (i.e. the SURVSTAR and DATA directories already exist) use option 4 to set the install type to "**Update**". Once these options have been set, choose option 5 to begin the installation. The install program will then ask you to connect the DAP to your computer. Connect the DAP with the supplied cable and begin the COM program (as explained earlier) on the DAP. Make sure that the baud rate is set to the same value on both the DAP and the computer. When you are ready, press ENTER to begin the installation.

The install process may take as long as ten to fifteen minutes. The program will exit back to DOS when the process is complete.

The SurvStar files are as follows:

A:\STAR.BAT	- routine to start SurvStar
A:\SURVSTAR\SURVSTAR.EXE	- the main SurvStar program
A:\SURVSTAR\SURVDAP.EXE	- the SurvCOGO program in SurvStar
A:\SURVSTAR\VIEWDAP.EXE	- the View Screen program in SurvStar
A:\SURVSTAR\GPS.INI	- user settings
A:\SURVSTAR\SP83.GPS	- data tables required for state plane 83
A:\SURVSTAR\SP83.TXT	- text labels for state plane 83
A:\SURVSTAR\SP27.GPS	- data tables required for state plane 83
A:\SURVSTAR\SP27.TXT	- text labels for state plane 83
A:\SURVSTAR\UTM.TXT	- text labels for UTM datum regions
A:\SURVSTAR\TITLE.TXT	- opening screen for SurvStar
A:\SURVSTAR\LITT.CHR	- a font file
A:\SURVSTAR\SURVCOGO.HLP	- SurvCOGO help file
A:\SURVSTAR\KEYS.HLP	- SurvStar Hot Keys help file
A:\SURVSTAR\CGA.BGI	- needed for graphics
A:\DATA\CONFIG.PIK	- default configuration file for SurvCOGO
A:\DATA\DEMO.CL	- demonstration centerline file
A:\DATA\DEMO.GRD	- demonstration grid file
A:\DATA\DEMO.PRO	- demonstration profile
A:\DATA\DEMO.SCT	- demonstration section file
A:\DATA\DEMO.TPL	- demonstration template file

*Note: The COM Ports for the DAP and the PC do not necessarily have to be the same. However, the Baud rate settings must be the same.

HP Palmtop

Many of the functions of the HP Palmtop work exactly as they do on your desktop or laptop PC. For example, if you need to reboot your HP, just press the **Ctrl**, **Alt** and **Del** keys at the same time. Also, for most of the HP software programs, you can use **Alt-F** and **X** to exit, as you would on your PC.

When you are running DOS programs (such as SurvStar) on your HP, you can toggle the size of the text using the **Fn** key plus the **space bar (zoom)**. To set the **Caps Lock**, press one of the **shift** keys (the up arrow keys to the left and right of the space bar), then press the **0** key

Another thing to know before beginning SurvStar is how to exit out to DOS. Simply pressing the DOS key ("**C:>**\") will not be sufficient because substantial memory used by the System Manager will not be available to run SurvStar. To exit completely to DOS, press the "**&..**" application key. Then press Alt-A (Applications), T (Terminate All). Say yes to the dialog box. Once in DOS, you can return to the System Manager by typing 100 and enter (for HP100) or 200 and enter (for HP200).

Default File Transfer

Following is a list of steps to take to transfer files between the HP and PC using the HP program **DataComm**.

1. Select the DataComm program on the HP Palmtop.

2. Open the terminal (Windows 3.1) or hyperterminal (Windows 95) program on your PC.

3. Check that both machines are set to the same baud rate, parity, stop bits, etc. (On the HP, go to **Alt-C** for Communications and **S** for Settings).

4. Press the F10 key on the HP to open the connection (the word "connect" on the bottom right should change to "hangup").

5. On your PC select to either send or receive a file. You should be able to set the transfer protocol here. On the HP, check that you are set to the same transfer protocol by typing **Alt-F** (File), **P** (Protocol).

6. Next, on the HP, select to Receive or Send by typing **Alt-F, R** or **Alt-F, S**. Enter the name of the file you wish to receive or send and press enter.

7. Both screens will display the progress of the file transfer. When everything is complete. Press F10 on the HP to Hangup and select Disconnect on the PC. Exit both programs

by typing **Alt-F, X**.

SurvStar Installation

Before beginning the SurvStar installation, two directories **SURVSTAR** and **DATA** need to be created in the root directory of the HP. Do this by opening DOS from the System Manager and typing the following:

**CD **
MKDIR DATA
MKDIR SURVSTAR
EXIT

Next, open the DataComm program on the HP and either the terminal or hyperterminal program on the PC. Press the Connect button on the HP to establish communication with the PC. On the HP, select **Alt-F** (File) then **R** (Receive). Select the root directory (A:\ or C:\) directory, then type "star.bat" in the file to receive box. Press enter on the HP. Then go to your PC, select the file to send as "star.bat" from your set of SurvStar files and click "OK". Once this file transfer is successful, repeat the procedure for the following files. Be sure to note which directory each file belongs in.

The SurvStar files are as follows:

A:\STAR.BAT	- routine to start SurvStar
A:\SURVSTAR\SURVSTAR.EXE	- the main SurvStar program
A:\SURVSTAR\SURVDAP.EXE	- the SurvCOGO program in SurvStar
A:\SURVSTAR\VIEWDAP.EXE	- the View Screen program in SurvStar
A:\SURVSTAR\GPS.INI	- user settings
A:\SURVSTAR\SP83.GPS	- data tables required for state plane 83
A:\SURVSTAR\SP83.TXT	- text labels for state plane 83
A:\SURVSTAR\SP27.GPS	- data tables required for state plane 83
A:\SURVSTAR\SP27.TXT	- text labels for state plane 83
A:\SURVSTAR\UTM.TXT	- text labels for UTM datum regions
A:\SURVSTAR\TITLE.TXT	- opening screen for SurvStar
A:\SURVSTAR\LITT.CHR	- a font file
A:\SURVSTAR\SURVCOGO.HLP	- SurvCOGO help file
A:\SURVSTAR\KEYS.HLP	- SurvStar Hot Keys help file
A:\SURVSTAR\CGA.BGI	- needed for graphics
A:\DATA\CONFIG.PIK	- default configuration file for SurvCOGO
A:\DATA\DEMO.CL	- demonstration centerline file
A:\DATA\DEMO.GRD	- demonstration grid file

A:\DATA\DEMO.PRO	- demonstration profile
A:\DATA\DEMO.SCT	- demonstration section file
A:\DATA\DEMO.TPL	- demonstration template file

Once you have uploaded the files to the HP, press F10 to hangup the connection. Close the terminal program on the PC. On the HP, exit the DataComm program. Exit to DOS by hitting the "&.." key, the Fct-A (Applications), T (Terminate All). Say yes to the dialog box. Once in DOS, type "cd.." and enter until you get to the root directory. Now the installation is complete. You can type "star" from the Dos prompt to begin SurvStar. If you wish to return to the regular HP icon screen, exit SurvStar, then from the Dos prompt, type "100" (for an HP100) or "200" (for an HP200) and enter. You will need to exit back to Dos again whenever you wish to run SurvStar.

Using Demonstration Files in SurvStar (GPS Only)

1. Alignment: Pick an open area and do a one-point alignment at 5000,5000,1000.

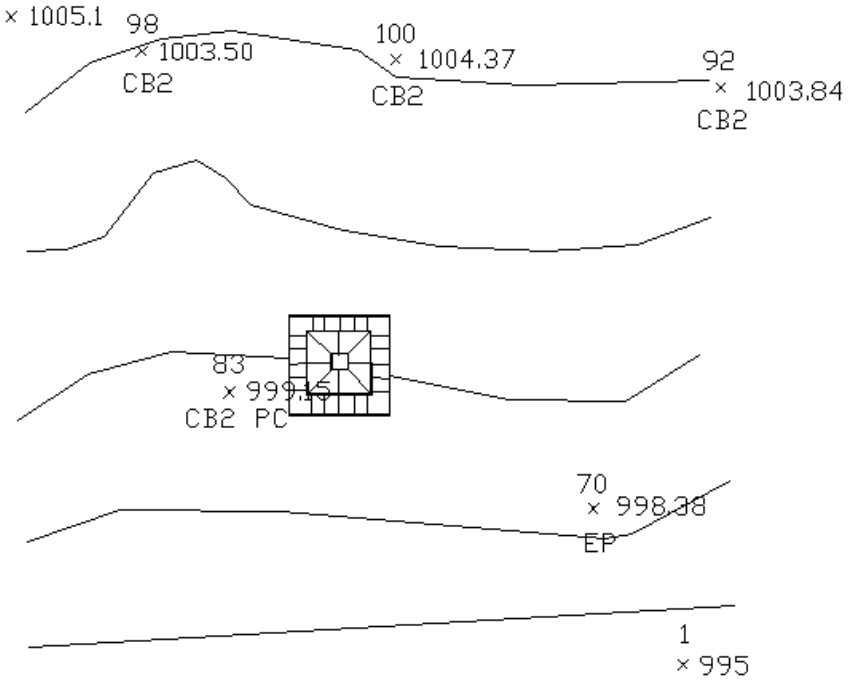


FIGURE 1.4

2. Grid-Based Stakeout: An area approximately 330 feet by 300 feet has been gridded and is stored as the file Demo.grd. This grid file slopes from approximately 995 on the south side to 1005 on the north, with a pond as shown below of dimension 50x50, sloping down in the pond interior to a low point of 990. The point 5000,5000,1000 is the lower left pond corner. You would select the option "Elevation Difference", option 1, Grid File. Using the file Demo.grd to check elevations, you would take shots moving north and east of the reference point 5000,5000,1000 to illustrate how the final surface dips to 990. The program will report cut values as you move north and east of 5000,5000 towards the center of the pond. In other areas, a cut or fill value will be reported depending on how the terrain at your site varies from the terrain shown above.

3. You can also demonstrate road-related exercises. For example, "R" for roadwork, option 3, Centerline Position, can be shown using the centerline file Demo.cl. Move south of 5000,5000 towards the centerline, and take a shot within this command. You will be given the station and offset. Alternately, go to Stakeout and find a particular station and offset. For template-based grade staking, choose Elevation Difference, option 3, Template File. You will be asked for the profile (Demo - You are not required to enter the extension for any SurvStar file!), centerline file (Demo) and template file (Demo). Press enter, leaving all other files set to "none", as they will not be used here. Then take any shot and get the exact station, offset and elevation difference. Experiment also with slope staking under Road Work menu.

Chapter 2 - Getting Started

Starting SurvStar

The SurvStar start-up program is called STAR.BAT and can be run by typing STAR at the DOS prompt. Be sure that you are in the root directory before typing STAR.

**C:/> CD **	**or**	**A:/>CD \ (for DAPs)**
C:/> STAR		**A:/>STAR**

SurvStar Registration

Each SurvStar is registered to run on one computer. Before going out into the field, you must register your copy by starting SurvStar. A registration message will appear similar to the one below:

Registration Error 7
SurvStar is not licensed
to run on this computer.
1. Register Software
2. Run in Demo Mode
Selection <2>:

Enter your selection at the prompt and follow the instructions given. If you are registering your software, the program asks for a change key. To receive the change key, call Carlson Software at 617-254-5429 or fax at 617-254-8374. If you continue to run in demo mode, you will be limited to 100 points and will not be able to utilize the Roadwork features.

Once this is done, the Main Menu will appear.

SurvStar Menu (GPS)

```
SurvStar - Carlson Software
DISK: 797492
CRD: TOPO.CRD
A  - Align Local Crds
C  - Calculator
E  - Elev Difference
F  - File Transfer
M  - GPS Monitor
P  - Store Point
O  - Job Options
R  - Road Work     (*Must be registered separately)
S  - Stakeout
SC - SurvCOGO
SU - SetUp GPS
U  - Point Utilities
X  - Exit Program
Choose action:
```

SurvStar uses a menu based system starting from this main menu. The current coordinate file (CRD file) is shown at the top of the screen. The DISK value is the amount of free space (in bytes) remaining for storing job data. Because the functionality of total stations and GPS equipment is so different, there are some features that are available only for one and not for the other. If you are missing certain functions in your main menu (such as Align Local Crds), go to the Setup menu and check that you are set to the correct equipment type.

SurvStar Menu (Total Stations)

```
SurvStar - Carlson Software                    DEMO.CRD
DISK:  1161728
C  - Calculator                  O  - Job Options
E  - Elev  Difference            SU - SetUp
F  - File  Transfer              SC - SurvCOGO
R  - Road Work                   S  - Stakeout
U  - Point Utilities             X  - Exit program
P  - Store  Point                Choose action:
```

The number in the DISK field is the amount (in bytes) of free space available on your computer for

storing data. The word in the top right corner is the name of the current coordinate file. This is the file that will store all points collected in this session. To change the current coordinate file, use the General Options menu. Select an item from the Main Menu by typing the letter(s) to the left of the item you want and pressing enter.

If you do not see the Roadwork option in your main menu screen, then the Roadworking Module has not yet been registered to run on your data collector. To register Roadwork on your machine, type "R" and enter at the "Choose action:" prompt. You will see an error registration message similar to the one on page 2-1. Follow the instructions from the **SurvStar Registration** section to register your Roadworking Module.

I**f you are using GPS equipment, set the correct grid system (state plane or UTM)!** Don't just start working, because you will be in Alabama, East Zone by default! Go to O for Job Options, then 1 for General Options, then item 1, zone. You can set it to any U.S. state plane zone, either 27 or 83, or you can select from a complete list of international UTM zones.

NovAtel GPS Users: Beginning with Release 1.5 of SurvStar, the program no longer does a "soft" reset of the receivers at startup. In the past, this would reset the receivers to a standard working mode. With the new NovAtel firmware and greater flexibility to set the receivers to specific working conditions, we no longer override the receiver configuration with the "soft" reset at startup. We assume that the user has set up the receivers correctly using command sequences entered directly into the receivers or through connection to a PC. The soft reset also had the effect of losing "lock", requiring a wait of 2-3 minutes to regain lock. Now if your receivers are locked in, you can exit SurvStar on the DAP and start up again, gaining lock immediately. If you experience any communication difficulty and are not concerned about overriding existing receiver settings, you can still do a hard reset to factory defaults by selecting Setup GPS at the Main Menu, then option 8, Solution Reset (see page 4-12).

Hot Keys

Starting with Release version 1.6 of SurvStar, you will have the ability to access "hot keys" from any "**Choice (Esc-Exit):**" prompt or the "**Choose Action:**" prompt in the Main Menu. These hot keys will allow you to jump directly to any feature in SurvStar without the need for navigating through several layers of menu screens. The complete list of hot keys is available at anytime on your data collector by pressing "**H**" and enter at either of the prompts mentioned above. There is also a complete listing in Appendix I of this manual. Keep in mind that due to the differences between GPS and Total Station equipment, not all features are available for both types of instruments. Also, for GPS equipment types, you may hot key items from the setup menu by typing **"SU"** plus the item number. For example, **"SU2"** for setup item 2.

Chapter 3 - General Features

Calculator (C)

1. Numerical Expression
2. Lat/Long to State Plane 83
3. State Plane 83 to Lat/Long
Choice (ESC-Exit):

Numerical Expression - This option calculates the results of a user entered expression. For example, to convert an instrument height from feet to meters,

Enter expression: 6.25/3.28
Result: 1.90549

Lat/Long to State Plane 83 - This method converts latitude/longitude coordinates into state plane 83 northing/easting coordinates. The latitude and longitude are entered in degrees, minutes and seconds in the format of dd.mmss. Decimal seconds can be included as dd.mmssss. The state plane zone to use is defined under the Job Options menu.

State Plane 83 to Lat/Long- This method converts state plane 83 northing/easting coordinates into latitude/longitude coordinates. The state plane zone to use is defined under the Job Options menu.

Point Utilities (U)

Select choice "U" from the Main Menu to enter the Point Utilities menu. All features listed in this menu use the current coordinate file. To select a different coordinate file, use the General Options menu. From the point utilities menu, type in the number that corresponds to your choice and press enter. You may also jump directly to any of these options from this menu or the Main Menu by using the letters in parenthesis following each option. List Points (L), View Points (V), Inverse (I), Read Text File (RT) and Write Text File (WT) are all "hot" keys when entered from the Main Menu. For example, L with Enter from the Main Menu will go directly to the List Points command, even though the actual prompt for List Points appears only within Point Utilities.

Point Utilities
1. List Points (L)
2. View Points (V)
3. Inverse (I)
4. Read Text File (RT)
5. Write Text File (WT)
6. Edit GIS Notes (GIS)
7. Process GPS Raw File (RAW) (*Available with GPS only)
Choice (Esc-Exit):

Exit this menu by pressing Esc or typing "X" and Enter. A full description of each of these options follows.

List Points (L)

This command displays the point number, northing, easting, elevation and description for points in the current coordinate file. Point Notes can also be listed. At the "**Range of points to list:**" prompt, you can press Enter to list all the points or enter the point numbers to list with a dash to specify a range and a comma to specify individual points. For example, 1-5,12,15 would list points 1,2,3,4,5,12,15. Only six points are shown at a time in order to fit on the Husky screen.

PtNo.	North(y)	East(x)	Elev(z)	Desc
1	5000.00	5000.00	110.00	
2	4986.09	5010.25	113.03	GD
3	4974.77	5015.79	111.98	GD
4	4960.27	5019.02	110.42	GD
5	4965.92	5030.42	110.57	GD
6	4985.40	5010.39	113.34	2

X-Exit,Enter-More:

Press Enter to continue to the next six points, or "X" and Enter to return to the Main Menu.

View Points (V)

Application: To view points on the screen and to screen-verify linear areas.

Features: There are three methods of screen viewing:

(1) Zoom all (all points are centered)
(2) Zoom point (a specific point is centered)

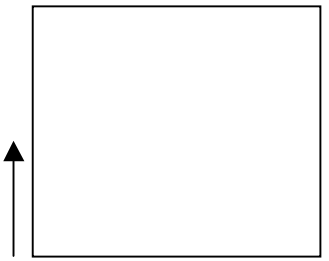
(3) Enter lower left coordinates

Plotting is due north up the screen. Once plotted, points can be shifted up, down, left and right by "frame factors" where a 0.5 frame shift to the left would move all points leftward half the width of the frame.

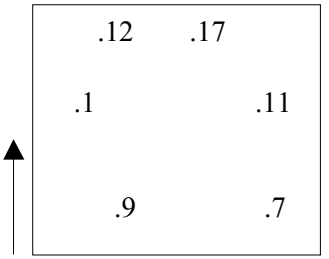
Procedure: Press V at the main menu or 2 at the Point Utilities menu. The program will go into "graphics" mode and show the following menu:

<A>ZOOM ALL (B) ZOOM PT
(B) ENTER LOWER COORDS? A (A is the default, so you can press Enter to Zoom All.)

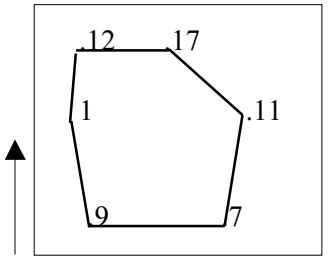
A blank screen window will appear with a north arrow for orientation as shown below:



MAX SCALE: 62.6758
DESIRED SCALE:? 70 (Choose a scale larger than that recommended in order to see all points. The scale represents roughly the scale of the points to fit on the actual screen of the data collector itself.)
PLOT PT. NUMBERS <Y>/N? Y (or Enter)



DRAW LINES (Y/<N>)? Y



STARTING POINT? 9
NEXT PT (0-END)? 1
NEXT PT (0-END)? 12
NEXT PT (0-END)? 17
NEXT PT (0-END)? 11
NEXT PT (0-END)? 7
NEXT PT (0-END)? 9 A closed loop leads automatically to area calculation:
AREA: 110130.2 S.F. 2.528 ACRES ENTER?
NEXT PT (0-END)? 0
DRAW LINES (Y/<N>)? Enter

(M) MAIN MENU (B) BEGIN
(T) TRANSLATE? Option T permits translation according to a "frame factor", such as 0.5 for half the distance of a frame, either vertically or horizontally.

Both options "Zoom Pt" and "Enter Lower Coords", require that the user select a scale. To obtain a zoom effect on point 9, for example, within the Zoom Pt option, a scale of 20 might be entered, as opposed to 70.

Inverse (I)

Application: To obtain the bearing/azimuth and distance from one point to another. This is done by direct inversing from point to point, whereby the program moves from the first point to the second point and holds the backsight for possible angle turning (total station applications).

Procedure: Press I for Inverse at the main menu or 3 in the Point Utilities menu. At the "Point Number" prompt, enter the number of your first occupied point. At the next prompt, enter the point number desired and the program prints the bearing and distance to the new point from the point you had just occupied. Printouts will be in the form specified in the "Inverse Type" setting under the General Options screen (see Chapters 4 and 5). Also, an inverse scale factor can be applied to convert GPS collected grid

distances to ground distances. See the section on General Options in Chapter 4 for more information on inverse settings.

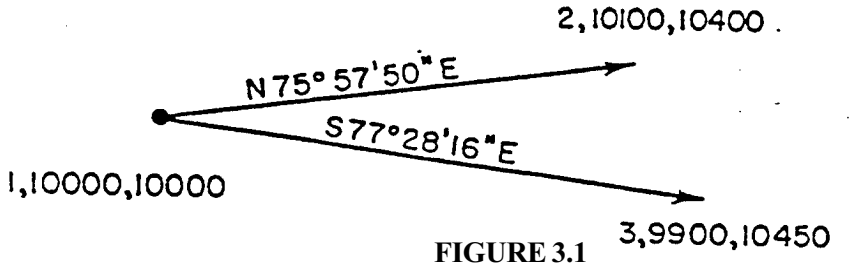


FIGURE 3.1

In the example above, we want to compute the bearings from l to 2 and from l to 3. Using the Inverse Routine, we begin by pressing I. We are prompted:

Point Number: 1

Pt: 10000.0000 10000.0000 100.0

Point Number: 2

Pt: 10100.0000 10400.0000 101.5

N 75 DEG 57 MIN 50 SEC E
H_Dist: 412.31

Point Number: 1

Pt: 10000.0000 10000.0000 100.0

S 75 DEG 57 MIN 50 SEC W
H_Dist: 412.31

Point Number: 3

Pt: 9900.0000 10450.0000

S 77 DEG 28 MIN 16 SEC E
H_Dist: 460.98

Read Text File (RT)

Application: For reading in ASCII files of coordinates to SurvStar from third-party software.

Procedure: Select menu option "RT" or 4. Assume you have an ASCII file that looks like the following:

JONES.DAT
Project 74-5
May 22, 1997
1, 5000, 5000, 988.7
2, 4781.5, 9128.23, 1023.45
"
"
"

Prompting is answered as follows:

Read Text File

Full Name of Text File: JONES.DAT

Number of Header Lines to Ignore <0>: 2 (Project 74-5 and May 22, 1997)

File Preview:
1,5000,5000,988.7 (Shows you first point entry to remind you of the file format)

1. P,Y,X,Z,D (P = Point Number, Y = Northing, X = Easting, Z = Elevation, D = Description)
2. P Y X Z D
3. P,Y,X,Z
4. P Y X Z
5. X,Y,Z
6. Other

File Format: 3 (Point Number, Northing, Easting, Elevation)

Offset to Point Numbers <0>: Enter (If you entered a number here (i.e. 100), that number will be added to each point number read. For example, point 1 in the text file will become point 101 in the coordinate file.)

Overwrite existing points (Y/<N>)? Enter (If the program encounters a point number in the text

file that matches an already existing point in the CRD file, the program will either overwrite the old point or assign the point values from the text file to the next available point number in the coordinate file. The default is to assign new point numbers and preserve all existing data.)

After all this information has been entered, the program will read in values from the text file and insert them into the current coordinate file. As this is done, the point numbers only will be displayed in the screen to keep you aprised of the status. When the process is complete, you will see the message, "Done reading file JONES.DAT." At this point, press enter to return to the Point Utilities menu.

Consider another "generic" ASCII file having the form:

```
SMITH.TXT
4950.23   10147.19  18   427.91       space
4970.18   10107.23  18   426.52       separators
5017.33   10214.98  17   430.03
   x            y          code   elev.
            "
            "
```

In this case, answer prompts as follows:

```
Full Name of Text File:  SMITH.TXT

Number of Header Lines to Ignore <0>: Enter

File Preview:
4950.23   10147.19  18   427.91

1. P,Y,X,Z,D
2. P Y X Z D
3. P,Y,X,Z
4. P Y X Z
5. X,Y,Z
6. Other
File Format: 6
```

Enter Format: X Y D Z (Here, because the file format does not match any of the 5 basic formats, we need to enter the file format manually using any combination of **P**, **X**, **Y**, **Z**, **D**, **space** and **comma**.)

Offset to Point Numbers <0>: 20

Write Text File (WT)

Application: To write out an ASCII file (with ".TXT" extension) of coordinates for use by third-party software.

Procedure: Select menu option "WT" or 5. The program prompts as follows:

Write Text File

Format Options:
1. PT#, N, E, Z, TEXT
2. PT# N E Z TEXT

Choice <1>: Enter (Choices are either comma or space deliminated. The default is comma deliminated.)

Range of points to write <All>: Enter (Here you may enter a range of points from the current coordinate file to write to a text file. This prompt is answered exactly as it would be in the List Points routine (see page 3-2). Press enter to select all points.)

Name for New Text File: GREEN (This will output a file named GREEN.TXT to the default data directory. Note that you should not try to type a file extension. The program will automatically add that for you.)

As the program writes the text file, the number of the current point will be displayed to the screen. This is just to keep you aware of the progress. When the process is complete, the message "Done writing GREEN.txt" will appear. At this point, press enter to return to the Point Utilities menu.

Edit GIS Notes (GIS)

Application: To review and edit previously stored point notes and GIS data.

Procedure: Enter "GIS" from the main menu or 6 from the Point Utilities menu. Choose whether to review points **1. By Point Range** or **2. By GIS Field & Value**.

If you choose to review by point range, at the **Range of Points:** prompt, enter a point range in the same manner that you would for the List Points (L) function. Otherwise, at the **Field Name:** prompt type in a field name from the GIS file. (For more information on the GIS files, see chapter 4). You will then be prompted for a value. If you are looking for a point (or points) with a specific value in the

specified field, enter that value here. Otherwise, simply press enter and all point with that field name, no matter what the value, will be called up.

For example, if you were standing at a manhole marked 5346 and you wanted to edit the GIS data for that manhole, you could select option 2 (edit by GIS field and value). At the first prompt, you would enter "MH#", because this is the field name for manhole number in your GIS file. Then at the next prompt, you would enter "5346", because you are only concerned now with manhole 5346. The screen display will look like this:

PT: 46 N: 5000.00 E: 5000.00 Elv: 100.00
Location:
=> 704 Houser Street
Manhole Number:
=> 5346
Manhole Depth (Feet):
=>24.678

ESC PgDn PgUp Nxt Prv

Use the arrow keys to highlight the field you wish to modify. Fields which are defined by equations can be highlighted, but can not be modified by the user. The program will calculate and update these fields automatically.

Use the PgUp and PgDn (F1 and F2) feature to scroll through all the GIS and Note data for this point. If your query brought up more than one point, use the Nxt and Prv (F3 and F4) features to go forward or backward through the list of points. To exit this function, use the ESC key or scroll to the end of the point list and press Nxt. Once you exit, all changes to GIS and Point Notes will be saved. For more information on recording GIS data, see chapter 4.

Process GPS Raw File (RAW)

When collecting GPS position data, SurvStar also creates a GPS raw file. This file is stored in the Data directory of your data collector. The name of the file will be the same as the name of your coordinate file, but with a *.raw* extension. All points stored by reading from the GPS will be stored in this file. **Points entered through option 5 of the Point Store Menu (Enter & Edit Coords), or through SurvCogo functions such as sideshot and traverse, will not be stored in the raw file.**

The existence of a raw file allows for corrections to alignment and state plane zone after the actual GPS work is done. To make these corrections, first go to the Alignment Options Menu and ensure that you are set to the proper state plane. Then go to the Alignment function and enter the correct

alignment values. Save this alignment to a file. From the main menu, go to the Point **U**tilities Menu and enter option 7 (Process GPS Raw File). Select the name of the raw file to process. Use the up, down, left, and right arrows to toggle between the filenames listed. Press Enter to accept the highlighted choice. The default will be the raw file associated with the current coordinate file.

Next, select the file for output where the newly processed coordinates will be stored. Select from an existing or new coordinate file. Caution: if you select an existing file, it will be overwritten! Next, select the type of coordinate file you would like to create. You may choose from 1. Latitude/ Longitude, 2. State Plane, or 3. Local Alignment. If you select Latitude/Longitude or State Plane, there is nothing else you need to do. The program will tell you when the output file is ready.

If you selected to apply a local alignment to your raw file, you will next be asked to select the correct alignment file. Once the alignment file has been read, press enter to begin processing the raw file. You will see the point numbers of the processed coordinates appear on screen. When everything is complete, you will get the message: "Done. Press Enter." After you press enter, you will be returned to the Point Utilities Menu. Press Esc to get back to the Main Menu. If you want to resume work with your new coordinate file, don't forget to go to the Job Options Menu and open the new file.

The purpose of this raw file process routine is twofold: (1) If you failed to heed the warning to check your state plane zone (Chapter 2, Getting Started), you may have been working in the wrong state or the wrong country altogether. You need to set the correct zone, redo the alignment and then re-process the raw data. (2) If you did an initial GPS alignment, but in the course of the work you picked up one or more additional, quality alignment points or rejected some earlier alignment points, you can re-calculate all your work by the Process GPS Raw File command.

File Utilities (F)

1. File Transfer (FT)
2. File Manager (FM)
Choice (Esc-Exit):

From the File Utilities menu, you can choose either File Transfer or File Manager. Both of these functions are described below.

File Transfer (FT)

Included on the SurvStar diskette are two files, **jcom.exe** and **transfer.exe**. The jcom.exe file should be placed on your data collector in the SurvStar directory (See Chapter 1). The transfer.exe

file should be moved to your PC in either the directory where you intend to put downloaded data files, or in your path (i.e. c:\Winnt35 or c:\batch), where it can be accessed from any directory.

Transfer.exe (from Carlson Software) This program can be run from inside SurvStar and is handy way to download data files to your PC without exiting the data collection program. Also, this program can be run from inside Carlson Software's **SurvCADD** and **Carlson Survey** software packages.

To begin file transfer, go to the File Utilities section from the main menu of SurvStar. You will see a screen that looks similar to the one below:

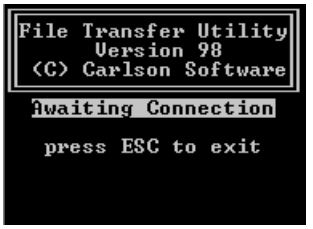


FIGURE 3.2

If you are not currently a SurvCADD or Carlson Survey user, you may choose to run the transfer program on your PC from the DOS prompt (by typing "transfer" and enter) or by double-clicking

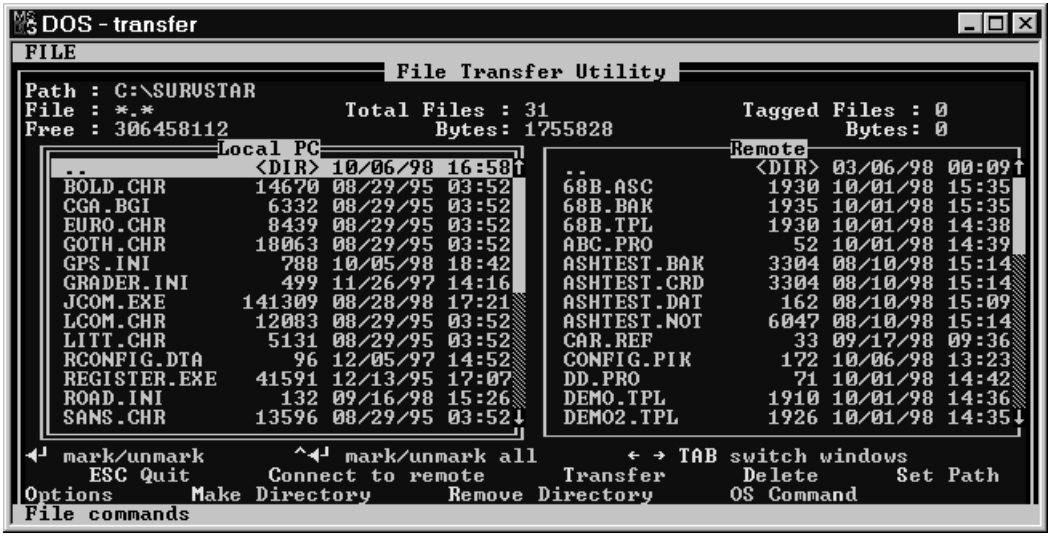


FIGURE 3.3

on the transfer.exe file in Windows. You will see a screen similar to the one shown in figure 3.3.

From SurvCADD, open the **Cogo & Design Menu**, then click on **Misc\Data Collectors**. From Carlson Survey, pull down the **COGO** menu and select **Data Collectors**. Select **SurvStar** from the popup box that appears. If you do not see a screen similar to the one shown in figure 3.4 or figure 3.5, you may have an older version of SurvCADD or Carlson Software. If this is the case, please call our technical support line (phone number is printed on the first page of this manual) for

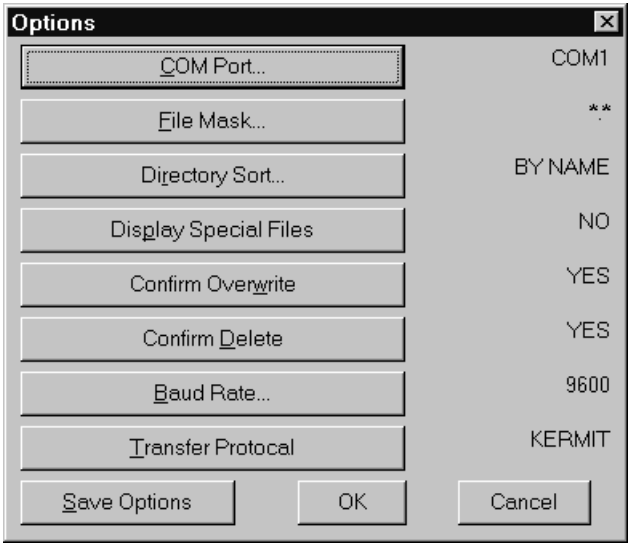


FIGURE 3.4

an update, or email **support@carlsonsw.com**.

From this first popup window, make sure that all of your communication and transfer settings are correct. Especially check that your COM Port is set correctly, as this is the most critical and most often incorrect setting. If you plan to transfer large files, you may wish to increase the baud rate setting for faster transfer. SurvStar will automatically adjust on the data collector end and reconnect at the new baud rate. Be sure to click **Save Options** before going on so that all settings are remembered the next time and you can bypass this options screen. Also, keep in mind that you can always bring this window back and modify your settings later by clicking the **Options** button from the **File Transfer Utility** screen that appears in figure 3.5.

As with the DOS version of the transfer program, this screen displays files from your local PC directory on the left and files from your data collector on the right. If you wish to change the directory of either system, click the **Set Path** button. Select **Local PC** or **Remote**, then type in the path name of the desired directory. Click **OK**. You may also choose to make a new directory or

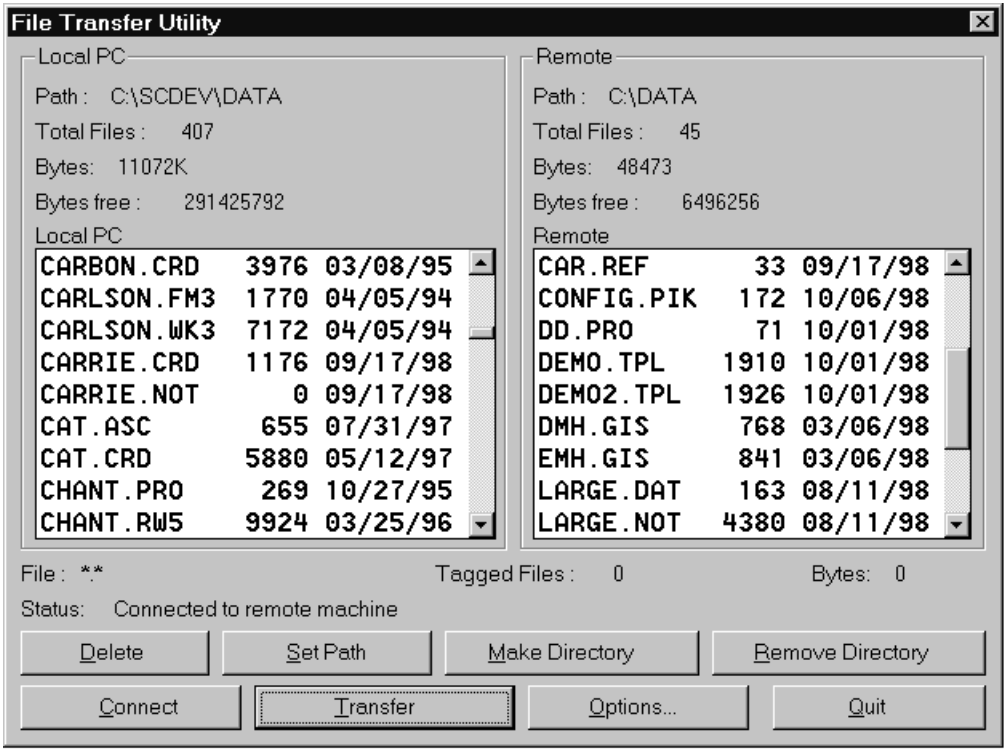


FIGURE 3.5

delete an existing directory from either computer by using the **Make Directory** and **Remove Directory** buttons. Click on the file you wish to transfer and you will see it highlighted in the screen. You may select multiple files at once by holding the **Ctrl** key and clicking on additional file names. Once you have highlighted your files, simply click the **Transfer** button to copy them from one machine to the other. Once the transfer is complete, the window shown in figure 3.6 will appear. If you do not get this message, the transfer was not successful. Check all your cables, COM Port settings and available Disk Space (displayed on the File Transfer Utility screen).

FIGURE 3.6

You may also choose to **Delete** highlighted files. To avoid accidental deletion of files, ensure that the **Confirm Delete** prompt is set to **YES**. Finally, when you have finished your file transfer session, click Quit to return to the SurvCADD or Carlson Survey program. If you plan to use the coordinate file you just downloaded, don't forget to use the **Set CooRDinate File** function under the **Points** or **Pnts** menu.

File Manager (FM)

```
    File                Size
1.  02261999.CRD        1160
2.  02261999.DAT        163
3.  02261999.NOT        5238
4.  02261999.RAW        528

1784523 bytes free
ESC:Exit    F1:More     F2:Del
```

The File Manager function in SurvStar can be used to list and delete files from the Data directory. Press enter, F1, or 'M' to scroll through the list of files. The amount a free memory available will be displayed. Be sure not to allow your free space to fall below 1000 bytes! If you need to free space, delete old project files that you will no longer be needing. Press F2 or 'D' for delete. Then enter the number that corresponds to the file you wish to delete. You will be prompted to confirm the deletion by pressing 'Y'. If you do not wish to delete this file, press 'N'.

Chapter 4 - Data Collection - GPS

Options (O)

Enter "O" from the Main Menu to access the various Options Menus associated with GPS data collection. The Esc key (function ESC on DAP) will Exit from any of the following menus.

1. General Options Menu

1. **State Plane 83 Zone - MA Mainland** — *Essential to configure*
2. **Coordinate File - park.crd**
3. **Unit mode - US Feet**
4. **RMS Tolerance - 1.00** — *Causes beep if RMS exceeds this range*
4. **CEP/SEP Tolerance - 1.00** — **If GPS type is NovAtel*
5. **Store Fixed Only - ON**
6. **GPS Com Port - COM1**
7. **Inverse Display - Bearing**
8. **Inverse Scale Factor - 1.00000** — **New Feature*
9. **Elevation Type - Spheroid (Ellipsoid)** — **If GPS type is NovAtel*
10. **Font Size - Small** — ****For Microflex only***

Choice (Esc-Exit):

2. Alignment Options Menu

1. **Transformation - Rigid Body - NoScale** — *Applies to Multi-point alignment*
2. **One Pt Align Azimuth - Grid**
3. **Project Scale Factor: 1.00000000**
4. **Auto Load Last Alignment - No**
5. **Two Pt Align Method - Fit & Rotate**

Choice (Esc-Exit):

3. Point Store Options Menu

Menu Page 1

1. **Backup Crd File in Store Pts - OFF** — *Will Slow Down Operation*
2. **Beep for Store Point - OFF** — *If ON, will beep with every point*
3. **New CRD File Format - Numeric** — *SurvCOGO uses only numeric*
4. **Point Notes - OFF** — *Will use substantial disk space*
5. **Point Data in Notes - OFF**
6. **RMS in Point Notes - OFF** — *Uses substantial disk space*
6. **CEP/SEP in Point Notes - OFF** — **If GPS type is NovA-tel*
7. **Rod Ht in Point Notes - OFF**

Choice (Esc-Exit,Enter-More):

Menu Page 2

8. **Time/Date in Point Notes - OFF**
9. **Store GIS Data with Points - OFF** — *User-defined GIS data storage*
10. **GIS File - NONE**
11. **Prompt Rod Height - No**
12. **Code File - NONE**
13. **Trigger External Device** — *For Use with Earth Radar*
14. **External Device Port - COM2**

Choice (Esc-Exit,Enter-More):

4. Stakeout Options Menu

1. **Display RMS in Stakeout - OFF**
1. **Display CEP in Stakeout - OFF** — **If GPS type is NovA-tel*
2. **Draw Trail in Stakeout - OFF** — *Nice option to "bull's-eye" for staking*
3. **Separate Stakeout CRD File - No**
4. **Stakeout Report - No**
5. **Stakeout Tolerance: 10.000**
6. **Num Readings for Average: 10**

Choice (Esc-Exit):

5. Laser Gun Options Menu

1. **Type: ATLANTA** — *ATLANTA or IMPULSE*
2. **Laser Alignment Azimuth: 0.00**
3. **Laser COM Port - COM2**

Choice (Esc-Exit):

6. Rod Height - 0.000

Needed if Rod Height changes

-General Options Menu (GO)-

State Plane Zone - SurvStar reads the LAT/LONG from the GPS receiver which is then converted to the state plane zone that is specified here. The state plane zone can be in either 27 or 83.

Coordinate File - The coordinate file is a binary file that contains point number, northing, easting, elevation and descriptions. Descriptions can have up to 32 characters. One coordinate file is active at a time and SurvStar routines such as Store Point will automatically use the active coordinate file. The main menu screen shows the name of the current coordinate file. You will be given the option to create a new coordinate file or select from a list of existing coordinate files located in the DATA directory.

Unit mode - The unit mode can be set to either metric, US feet or international feet. For conversion factors, see Appendix D.

RMS Tolerance - The RMS values, reported from GPS receivers, measure the confidence interval that the point is within + or - the RMS value. If the unit mode is metric, then the RMS values are in meters. Otherwise the RMS values are in feet. When the sum of the horizontal and vertical RMS values is greater than the tolerance, SurvStar will give a beep as a warning.

CEP/SEP Tolerance - NovAtel GPS receivers report CEP (circular error probability) and SEP (spherical error probability) values. CEP is a function of the standard deviation of the latitude and the standard deviation of the latitude. SEP is a function of the standard deviations of the latitude, longitude and elevation. Look for CEP and SEP values similar to those for HRMS and VRMS of previous versions. Consider any mention of RMS in this manual to pertain to CEP if you are a NovAtel user.

Store Fixed Only - This provides a secondary check to the RMS and CEP/SEP Tolerance setting. Even if the position calculation is within RMS tolerance, it may still be a float solution. Turning this setting on will cause SurvStar to reject any non-fixed solutions.

GPS COM Port - This is the COM port number for connection from the computer to the GPS receiver. The default is port 1 which is the upper left port on the Husky. On the MircoFlex(DAP), this COM port should be set to port 2.

Inverse Display - This setting applies to the way results will be displayed in the inverse function of the Point Utilities menu. Possible values are *Bearing*, *North Azimuth*, and *South Azimuth*.

Inverse Scale Factor - This value will be applied to inverse distances in the Inverse function. This is useful for storing coordinates on the grid and inversing distances on the ground.

Elevation Type (NovAtel only) - The possible values for this feature are "Ellipsoid (Spheroid)" and "MSL" - Mean Sea Level. All elevations (Monitor GPS, Store Point, Setup Base Station, etc) will be entered and recorded based on the elevation type specified here.

Font Size (Microflex only) - This can be set to either "Small" or "Large". Small is font size 0 and Large is font size 2. When you toggle this setting, you should notice your font size change instantly on the screen. If the font does not chang properly, exit SurvStar and set the font from DOS using the Microflex Setup program. Then return to SurvStar and make sure the setting of this feature matches the actual font that is being used by your system.

-Alignment Options Menu (AO)-

Transformation - The transformation in the Align Local Coordinates command can either be by plane similarity or rigid body methods. Both methods use a best-fit least squares transformation. The difference is that the rigid body method does a transformation with a translation and rotation and without a scale. The plane similarity does a rotation, translation and scale. This option only applies when two or more points are used in Align Local Coordinates.

One Pt Align Azimuth - This option applies to the rotation when using one point in Align Local Coordinates. For this alignment method, the state plane coordinate is translated to the local coordinate. Then the rotation can use either the state plane grid or the geodetic as north. No scale is applied in this transformation. The state plane and geodetic true north diverge slightly in the east and west edges of the state plane zone. This option allows you to choose which north to use.

Project Scale Factor - After converting the LAT/LONG from the GPS to the state plane coordinates and applying the Align Local Coordinates, the Project Scale Factor is applied as the final adjustment to the coordinates. This adjustment is used on the X,Y and not the Z. The Project Scale Factor is applied by dividing the distance between the coordinate and a base point by the Project Scale Factor. The coordinate is then set by starting from the base point and moving in the direction to the coordinate for the adjusted distance. The base point is the first point in Align Local Coordinates. If there are no points specified in Align Local Coordinates, then 0,0 is used as base point. The Project Scale Factor can be entered directly or calculated using the grid factor and elevation for the current position. When using the current position, the program will read the LAT/LONG from the GPS receiver. The scale factor is then calculated as: (State Plane Grid Factor - (Elevation/Earth Radius)).

Auto Load Last Alignment - This option will automatically load the last Align Local Coordinates setup. Otherwise you need to run Align Local Coordinates and choose Load. In order to use this

option, the base GPS receiver must be in exactly the same location using the same Lat, Long and elevation.

Two Point Align Method - This option applies only to two point alignments. Possible values are *Fit & Rotate* and *Rotate Only*. Fit & Rotate (the default) will use the second alignment point for rotation, translation, and scale (depending on the value set for *Transformation*). The Rotate Only option will use the second point of a two point alignment for rotation only.

-Point Store Options Menu (PO)-

Backup CRD file in Store Points - This option will create a backup of the current coordinate file when you enter the Store Points command. The backup file name has the same name as the coordinate file with a .bak extension. For example, the JOB5.CRD file would have a backup name of JOB5.BAK.

Beep for Store Point - This option will make a double beep to indicate when a point is stored in the coordinate file.

New CRD File Format - Point numbers can have either numeric or alphanumeric format. This option determines the point number format for when a new coordinate file is created. Alphanumeric point numbers consist of nine or less digits and letters (i.e. point number 7A). With numeric point numbers, the point is stored in the coordinate file at a fixed position set by the point number. This means that the size of the coordinate file is determined by the highest point number. For example, point number 500 will be stored in position 500 and if point 500 is the only point in the file, the file size will still be 500 points long and positions 1-499 will be unused. Each point takes 56 bytes to store. So if there are 300,000 bytes free on the computer, you can have a coordinate file with over 5000 points. The amount of free bytes on the computer is shown in the main menu. Besides allowing point numbers with letters, alphanumeric points also store efficiently without fixed file positions and can handle high point numbers such as 501101. The disadvantage to alphanumeric points is that SurvCOGO is designed for numeric points and only a few essential SurvCOGO routines are available for alphanumeric points.

Point Notes - Point Notes are additional descriptions that can be stored with a point. A regular point consists of a point number, northing, easting, elevation and 32 character description. These points are stored in a .CRD file. Point Notes are a way to add an unlimited number of lines of text to a point number. With Point Notes ON in the Store Point command, the program will prompt for notes after collecting a point. The notes are stored in a file that uses the name of the coordinate file with a .NOT extension. For example, a coordinate file called JOB5.CRD would have a note file called JOB5.NOT.

Point Data in Point Notes - When storing a point, this option will store the point number, northing,

easting, elevation and description in the point notes as well. This may be used as a backup or reference to coordinate data as it was originally stored.

RMS (or CEP/SEP) in Point Notes - When storing a point, this option will store the horizontal and vertical RMS values in the note field for the point. This offers a good check on the quality of the shot.

Rod Ht in Point Notes - When storing a point, this option will store the rod height value in the note field for the point.

Time/Date in Point Notes - This option will store the time and date that the point was stored in the note file. SurvStar will read the time from your data collector.

Store GIS Data with Points - When storing a point, this option will prompt for and store additional descriptions for user-defined fields in the note field for the point. The fields to store are defined in a .GIS file which contains a field definition on each line. The definition line has the field name, prompt and default value separated by commas. If the field is a choice of options, the definition line also has each choice separated by commas. If the field's value is to be calculated automatically by an equation, the equation takes the place of the default value. The field's value is calculated automatically once the point is stored or edited. For example, consider the following GIS file to store information for manholes:

```
LOC,Location, ,
MH#,Manhole Number, ,
MH Depth(Ft),Manhole Depth (Feet), ,
MEAS Down,Measure Down,$EQN=$ELV-MH Depth(Ft),
SIZE,Ring Size,24,
MATERIAL,Ring Material, ,
INVERT,MH Invert (Excellent/Good/Fair/Poor/Bad), ,Excellent,Good,Fair,Poor,Bad
LEAKS,Manhole Leaks (Yes/No),No,Yes,No
GPM,Approximate GPM, ,
BY,Reviewed By, ,
```

The first line defines a field called LOC and will prompt the user with **'Location:'**. The SIZE definition is an example of a default value of 24. When at the **'Ring Size <24>:'** prompt, the user can just press Enter to use this default value of 24. The INVERT definition is an example of a choice between Excellent, Good, Fair, Poor and Bad. At this prompt the user only has to type in the first character of any of these choices. The MEAS Down definition is an example of an equation. The key letters "$EQN=" must appear at the very beginning of the default section to signal that this field is an equation. Then the equation is entered using field names to represent their values or key words to represent northing, easting, or elevation point values. The key words are as follows: $NOR =

Northing, $EAS = Easting, $ELV = Elevation. The equation is calculated from left to right (normal order of precedence is ignored), and regular numerical values may also be used. The user will not see this prompt the first time the point is being stored, but it will be displayed and updated whenever GIS data is edited through SurvStar. Note: If there is no default or equation for a field, there must be exactly one space between the two commas that define the default area.

GIS File - This is the File where the GIS field definitions are found. When you select this option, you will have two choices. (1) Enter the name of the file - Enter a filename (up to eight characters), without extension, where the GIS format is stored. (2) Automatic by Point Description. When entering GIS information, SurvStar will look for a file having a ".gis" extension and filename matching the first eight characters of the current point description. For example, if a point's description is "MH", the file "MH.GIS" will be used for that point.

Prompt Rod Height - This option will bring up a prompt to enter the rod height before storing points. Otherwise the current rod height will be used automatically. The current rod height can be set in the Options command item 6 or in the Store Point menu (P from the main menu, followed by choice 14).

Code File - Code files are tagged with an ".fld" extension and stored in the DATA directory. They contain a series of predefined point descriptions in the form of abbreviations followed by explanations. Code files can be created using SurvCadd's Field to Finish module. See Appendix C for a sample code file.

Trigger External Device - If you will be using an external device, such as earth radar (eg. sounding devices for marine applications), that requires a trigger from the serial port, turn this feature on. The device will only be triggered during the *Auto Points at Interval by Time* Point Store function. Do Not use this feature for lasers. See Laser Gun Options on the following page.

External Device Port - This is the COM port of your data collector from which the trigger for the external device will be sent.

Note: The **Store Latitude/Longitude** and **Store State Plane** features are no longer available due to the existence of the GPS raw file. Latitude and Longitude values for all GPS collected points will be stored in the raw file automatically. To create a file of State Plane values for your GPS collected points, go to the Process GPS Raw File function and select "State Plane" at the "Type of File to Create" prompt. For a file consisting of Latitude and Longitude coordinates for your points, select the "Latitude/Longitude" option at this prompt.

-Stakeout Options Menu (SO)-

Display RMS (or CEP) in Stakeout - This option will show the RMS value within the bull's eye

stakeout screen. The only disadvantage to having this option active is that it slows down the stakeout position update.

Draw Trail in Stakeout - As you approach the target in the center of the bull's eye, this option will draw a trail following your stakeout path.

Separate StakeOut CRD File - This is an option to use a second coordinate file to store the staked points in the Stakeout routine.

StakeOut Report - This option will create a stakeout report in the Stakeout routine.

StakeOut Tolerance - This value is used in the Stakeout routine as the distance tolerance. When storing the staked point, the program will beep and display a warning if the staked point is further than this tolerance from the target point.

Num Readings for Average - This option allows you to take an average reading at the end of the stakeout routine instead of just a single shot. If you still wish to use only a single shot, set this value to 1. Otherwise, when you exit the Stakeout bull's eye screen, SurvStar will read from the GPS as many times as you have specified here and take an average of all shots for the final stakeout position.

-Laser Gun Options Menu (LO)-

Type - Select the correct type of Laser Gun you are using. Current options are the Laser Atlanta and the Impulse Laser (IP200 format or CR400 format). If using an impulse laser, it is suggested to use the IP200 format (9600 baud rate). See the equipment user manual for instructions on selecting a communication format.

Laser Alignment Azimuth - This value is the rotation between the GPS coordinate system and the laser gun. The laser is used to calculate the azimuth and offset in the Offset Point Entry mode of the Store Point command. The rotation difference is determined by entering an occupied point and a reference point and then setting up on the occupied point and measuring the azimuth to the reference point with the laser. The difference between the laser azimuth and the calculated azimuth is the alignment azimuth.

Laser COM Port - This is the COM port number for connection from the computer to the laser gun. The default is port 2 which is the upper right port on the Husky.

Rod Height (RH) - This value is the height of the rover antenna above the measured point. This value is subtracted from the GPS coordinate to calculate the elevation of the point.

Align Local Coordinates (A)

SurvStar reads a LAT/LONG position from the GPS receiver which is converted to a state plane coordinate. Using local coordinate points and their corresponding GPS position, Align Local Coordinates applies a transformation to convert the state plane coordinate to the local. SurvStar can operate in three different modes depending on the Align Local Coordinate settings:

- No alignment
- One point alignment
- Two or more point alignment

Without Align Local Coordinates set, SurvStar will operate with no alignment which directly uses the state plane coordinates. In order for the coordinates to be the true state plane coordinates in this alignment mode, the GPS base receiver must be set up over a known point and the true Lat/Long for the point must be entered in the base as the base position. Otherwise, if the base is set over an arbitrary point, then the coordinates will not be true state plane.

In one point alignment mode, one pair of GPS and local coordinates is specified in Align Local Coordinates. The differences between the GPS and local northing, easting and elevation for these points are used as the translation distances in the transformation. The rotation will use either the state plane grid or the geodetic as north. The rotation type is specified in the Alignment Options menu. No scale is applied in this transformation.

One point alignment is useful for data collection on a new site. In this case you can set the GPS base receiver up anywhere convenient. Then position the rover over the first point and run Align Local Coordinates. Add this one alignment point by reading the GPS point and entering a local coordinate like 5000,5000,100. Now the local coordinate system is set around this first point at 5000,5000,100.

A two or more point alignment is used to align to an existing local coordinate system. At least two pairs of local and GPS coordinates must be entered. Two pairs of points is sufficient to define the translation, rotation and scale for the transformation. If more than two points are entered, the program will find a least squares best fit transformation and will report the “residuals”.

For entering the local coordinate, you can either enter the northing, easting and elevation or specify a point number. To enter the GPS position that matches this local coordinate, you can either set up the rover over the local point and read the GPS receiver or enter the GPS LAT/LONG for that point. In order to use the LAT/LONG, you must set up the base over a known point and enter the correct LAT/LONG at the base. Reading the position from the GPS receiver does not have this restriction which allows you to set up the base at any point.

Use the hot key "A" to enter the Align Local Coordinates feature. You will first be presented with the values you have selected for pertinent alignment settings. At the prompt, simply press enter if all settings are as they should be, or type 'N' and enter to jump to the Job Options menu where you can modify any incorrect settings. Once you exit the Job Options menu, you will continue with the Align Local Coordinates process.

The next screen displays a list of the points used for the alignment. To Add a new alignment point, type A or F1. To remove a point, highlight the point using the up and down arrow keys and then press D or F3. If you have entered a local coordinate or description value that is incorrect, you may type E or F3 to edit these values *(*New Feature)*. This will not modify any points you have already stored, but you can use the Process GPS Raw File option (hotkey 'RAW') under the Point Utilities menu to reprocess the previously stored points with the new alignment.

Press M or F4 to toggle the bottom menu for more options. Use Load (L) to recall a previously stored alignment file. Be very careful to ensure that your current base configuration is exactly as it was when the alignment was stored. Because the alignment links local coordinates to GPS coordinates, if the latitude and longitude value at your base changes for any reason whatsoever, you must also change your alignment file. The View option switches between showing the local coordinates and the corresponding GPS LAT/LONG coordinates. The On/Off option allows you to switch whether the highlighted point is used for the horizontal and/or vertical alignment. The H column represents horizontal control and the V column vertical control. For example, you may wish to use 2 points for horizontal alignment and one for vertical (YN).

In the local points view, the HRes column shows the horizontal residual and the VRes column shows the vertical residual. The residual is the difference between the actual point and the point calculated using the alignment transformation. In GPS points view, the HRMS and VRMS columns show the horizontal and vertical RMS values when that point was recorded.

Northing Easting Elev HRes VRes HV Description
5000.00 5000.00 993.50 0.0 0.0 YY MH #4
5324.52 4739.43 970.23 0.0 0.0 YY MH #5
ESC:Exit F1:Add F2:Del F3:Edit F4:Menu

Local coordinates view.

Lat Long Elev HRes VRes HV Description

GPS coordinates view.

41.153943 83.031243 992.87 0.03 0.04 YY
MH #4
41.150232 83.034811 970.42 0.03 0.03 YY
MH #5
ESC:Exit F1:Load F2:View F3:On F4:Menu

To start a new local coordinate system, enter one pair of local and GPS coordinates. SurvStar will then do a translation but not a rotation or scale. North for the GPS coordinates will be the same north for the local coordinates.

In addition to the northing and easting transformation, SurvStar will also translate the elevation from the GPS system to the local. The elevation difference between the two systems is modeled by a best-fit plane.

When SurvStar starts, there is no alignment data and the system is in state plane coordinates. To recall a previously entered alignment, use the Load option in the Align Local Coordinates menu. You will be prompted to enter the filename of the alignment you wish to load. Alignment files are stored in the DATA directory with ".dat" extensions.

Load alignment is only valid if the base receiver setup has not changed since the alignment points were recorded. If you had to exit SurvStar or turn off the Husky while in the field, then when you restart SurvStar you can run Load Alignment. In order to use an alignment when returning to a site, you must set up the base receiver in the same position and enter the same LAT/LONG coordinates for the base.

When you exit the Align Local Coordinates menu, the program will ask you if you want to save the changes. Say yes to apply these alignment points to your GPS session and save them to a file for future reference. If you loaded points from a file, they will be saved to the same file. Otherwise, enter a filename at the prompt.

Typical Alignment Scenarios

Scenario: New site. In this case, there are no established coordinates on the site.
Alignment: Choose a point on site and do a one point alignment. For the local alignment point, enter the coordinates that you would like to use (ie 5000,5000,100). The One Pt Align Azimuth option chooses between using true north (geodetic) or state plane north (grid). To use real world ground distances, set the Project Scale Factor. Otherwise the default scale factor of 1.0 will collect points on state plane distances.

Scenario: One known state plane coordinate and you want to work in the state plane

coordinate system.
Alignment: Do a one point alignment on this known state plane point. Set the One Point Align Azimuth to Grid and set the scale factor to 1.0.

Scenario: Multiple known control points.
Alignment: Choose two or more control points to align to. It is best to use control points around the perimeter of the site. Use as many control points as are available or enough to envelope the site. Set the Transformation to Plane Similarity to fit the GPS points onto the control points. Set the Project Scale Factor to 1.0. After making the alignment, stake out another control point (ideally one the is not used in the alignment) to make sure the alignment is good.

Setup (SU)

This screen controls several of the GPS receiver settings. A more detailed explanation of these settings can be found in the GPS receiver documentation. The options that are available in this menu depend on the type of GPS receiver.

NovAtel

GPS Control

1. **Equip Type - NovAtel**
2. **Satellite Position**
3. **Elevation Cutoff - 10.0**
4. **Configure Base Station** ***If Base is the Station Type**
4. **Select Base Station ID** ***If Rover is the Station Type**
5. **Station Type - ROVER**
6. **Mode - RTCA**
7. **Base Rate - 1**
8. **Send Command to Receiver**
9. **Receiver Reset (Full Initialize)**
10. **Solution Reset (Soft Reboot)**
11. **Dynamics - Kinematic**
12. **Set Radio Channel**
13. **Check Comm. Status**
14. **PC Card Utilities** ***for DL Logpak receiver only**

Choice (Esc-Exit):

Equip Type - If the correct equipment type is not displayed here, press one. Then select from a list of equipment types.

Satellite Position - Use this feature to view the position of satellites in the sky. Press F1 once in the Satellite View screen to toggle the view. Possible views are Satellite Geometry Only, Satellite Geometry with PRN value, and Text Mode. You may also jump to this same satellite view screen from the Monitor GPS window.

Elevation Mask/Cutoff - This sets the satellite elevation mask angle. Satellites that are below this angle from the horizon are not included in processing the position.

Configure Base Station - This routine sets up the base GPS receiver for real-time differential operation by entering the latitude, longitude and elevation of the base. The base position can be either entered manually, read from the GPS receiver, or read from a file. Once the base position is entered, the base station will transmit differential corrections over radio modem. Before returning to the setup menu, the program will ask you if you want to save these settings to the receiver. It is recommended that you only answer yes if this is a permanent base station. Saving the settings to the receiver will cause it to always begin outputting the same latitude and longitude corrections automatically once it's powered on. The program will also ask you if you want to save the settings to a file. Answering yes to this prompt will store a file with the current latitude, longitude (in decimal degrees) and height. These base station files are stored with a ".ref" extension and can be used whenever you wish to set a base station over this same point.

Select Base Station ID - The rover by default will accept base station corrections from any base receiver that is transmitting on the same radio frequency. If you are working in an area where more that one base station may be sending corrections on the same frequency, you can choose to have your rover only listen to one particular base station. Use this option to specify the name of the base station ID you enter at the time of Base Station Configuration.

Station Type - This value will be either ROVER or BASE. If you do not exit SurvStar before moving from base to rover or vice versa, be sure to change this setting.

Mode - Choose RTCA, RTCM, or CMR. If you are using your own NovAtel base station, you will be using RTCA. If you are using a Coast Guard beacon as your base, set to RTCM. If you are using a Trimble base station with your NovAtel rover, select CMR.

Base Rate - The is the rate at which the base station will output information to the radio port. Possible values are 1 second or 2 seconds.

Send Command to Receiver - This routine allows you to send a command to the GPS receiver. If you need to set or read a feature on the GPS receiver that is not in the SurvStar Setup command, then you can use this routine to send the command. Any response from the receiver will be displayed. Please refer to the GPS receiver documentation for descriptions of these additional receiver commands.

Receiver Reset (Full Initialize) - This command sends the FRESET command to the NovAtel receiver. This command is the equivalent of a hard reset (turning off and turning on the receiver). It may take the NovAtel a few minutes to find all satellites again and solve for ambiguities.

Solution Reset (soft Reboot) - This command sends the CRESET command to the NovAtel receiver. This will cause the receiver to resolve its position. It may take the NovAtel a few minutes to fix again.

Dynamics - Possible values here are **Kinematic** and **Static**. Static should only be used if your unit is on a tripod or some other non-moving mounting surface. Reading the NovAtel in static mode will take a second or two longer than reading in kinematic mode. Any movement of the GPS antenna while in static mode could cause the CEP values to rise suddenly and the position data to vary. Kinematic mode is the default and it is suggested that you use this mode for all real-time surveys.

Set Radio Channel - This feature is valid only if you are using Pacific Crest radio modems with your NovAtel GPS equipment. Whether you intend to change radio channels in the field or not, your radios should be programmed to Transparent mode (the default) before using them with NovAtel receivers (Note: This has changed from version 1.43) For a full explanation of how to use this feature, see Appendix B.

Check Comm. Status - Use this command at the rover monitor the number of correct or incorrect RTCA, RTCM, or CMR message have been received from the base station. If you have trouble attained or keeping a fix solution, use this feature to help trouble shoot where the problem lies.

PC Card Utilities - You now have the ability to log static data to the PC card inside the DL without leaving SurvStar. To use this new feature do the following:

a. First, you must have a PC card inserted into the PC slot of the DL receiver itself. For a list of supported PCMCIA cards, please contact NovAtel customer support (the SanDisk 15MB Compact Flash Card is one that is supported).
b. Once in SurvStar, go to the Setup Menu (SU) and look for option 14, “PC Card Utilities”. If this option does not appear, then the DL receiver was not detected at start-up. Exit the Setup menu and come in again.
c. Once in option 14, you will need to set up at least one "Log Group". Log Groups

are stored in the memory of the DL receiver itself and establish raw file parameters such as data rate and antenna height. Type "1" and enter to get into the Group Editor.

d. Create a new log group by hitting the F2 key. Enter a name for the new group, then enter data rate, elevation cutoff, satellite minimum and antenna height by typing in these values and using the up and down arrow keys to move between fields.
e. Once you have set this data, press the F3 key to save the new group to the DL. It is very important to save any changes, as they will not automatically be saved when exiting this feature.
f. Hit Escape to exit the Group Editor. You will be prompted to beginning logging. Select Yes or No.
g. If you say No here, you can also beginning logging from option 2 on the previous screen.
h. While logging data, you will see your current PDOP, HDOP and other pertinent statistics displayed on the screen. Watch for the Project duration clock to increment to confirm that data is being logged to the card.
i. To collect a point, you must mark it as a site. Do this with the F1 key.
j. To finish logging data, press escape. You may choose to continue logging in the background as you return to real-time differential data collection. However, be sure to return to option 14 of the Setup menu to end logging and close the file before powering off the receiver. If the receiver loses power before closing the file, the file will be corrupt or deleted.
k. Depending on the size of your PC Card, you may find yourself running out of room to log new files. Use the File Manager feature from the PC Card Utilities menu to list and delete files and also to check the amount of disk space remaining on your PC Card.

Ashtech

GPS Control

1. **Equip Type - Ashtech**
2. **Multipath - Medium**
3. **Dynamics - Walking**
4. **Elevation Mask - 5**
5. **Solution Reset (Full Initialize)**

6. **Satellite Position**
7. **Fast CPD - OFF**
8. **Record Interval - 1.0**
9. **Site Name - ????**
10. **Ambiguity Fixing Parameter - 4**
11. **Reset Sensor Memory**
12. **Send Command to Receiver**
13. **Station Type - ROVER**
14. **Configure Base Station**
15. **Save Settings to Receiver**
16. **Ashtech Type - Z12 or Sensor**
17. **Ashtech Data Port - B**
18. **Ashtech Radio Port - A**
19. **Set Radio Channel (Pacific Crest)** (Husky Only)

Choice (Esc-Exit):

Equip Type - If the correct equipment type is not displayed here, press one. Then select from a list of equipment types.

Multipath - This specifies the interference level of the environment.

Dynamics - This specifies the dynamics mode which determine the tolerance to movement and accuracy. The modes that allow for more movement have slightly higher solution RMS values. While moving with the rover, the option should be set to Walking. Quasistatic mode can be used when the rover satellite dish in set on a tripod.

Elevation Mask - This sets the satellite elevation mask angle. Satellites that are below this angle from the horizon are not included in processing the position.

Solution Reset (Full Initialize) - This forces the Ashtech to resolve the position.

Satellite Position - This option shows a sky plot of the satellite positions. The locked number is the number of satellites being used in the position solution. The available number is the number of satellites being tracked. If there is a number of available satellites but the locked number is zero, then the rover is not processing the fixed position. In this case make sure that the base is sending the phase differential and that the radio connection is working.

Fast CPD - This option toggles between off and on. With Fast CPD **on**, the Ashtech system will solve the position more quickly and the system is less likely to lose lock when temporarily interrupted by an obstruction. With Fast CPD **on**, the solution is more accurate with a lower RMS. This setting is relevant for the **rover** only.

Record Interval - This is the Ashtech recording interval in seconds. This is equivalent to the INTVL setting on the Z12 Screen 4.

Site Name - This sets the site name. On the Z12, it is displayed in screen 9.

Ambiguity Fixing Parameter - This option controls the confidence system locked on to the correct position. At a lower confidence interval the system solves much faster. This setting is a number that ranges from 1 to 5 where 1 is the fastest with low confidence and 5 is the slowest with high confidence. At mode 1 the confidence interval is 97.6%. At the default of mode 4, the reliability is 99.9%. If the system incorrectly solves the position, then the position error will be much greater than the reported RMS value.

Reset Sensor Memory - This command will reset the receiver memory, reinitialize the communications ports and reset the modem. Saved settings on the receiver will be returned to their default values.

Send Command to Receiver - This routine allows you to send a command to the GPS receiver. If you need to set or read a feature on the GPS receiver that is not in the SurvStar Setup command, then you can use this routine to send the command. Any response from the receiver will be displayed. Please refer to the GPS receiver documentation for descriptions of these additional receiver commands.

Station Type - This value will be either ROVER or BASE. If you do not exit SurvStar before moving from base to rover or vice versa, be sure to change this setting.

Configure Base Station - This routine sets up the base GPS receiver for real-time differential operation by entering the latitude, longitude and elevation of the base. The base position can be either entered manually, read from the GPS receiver, or read from a file. Once the base position is entered, the base will transmit the differential corrections over the radio. Before returning to the setup menu, the program will ask you if you want to save the settings to a file. Answering yes to this prompt will store a file with the current latitude, longitude, and height. These base station files are stored with a ".ref" extension and can be used whenever you wish to set a base station over this same point.

Save Settings to Receiver - Saves the current configuration to receiver memory. Saved values can be overridden by choosing **Reset Sensor Memory**.

Ashtech Type - Select either **"Z12 or Sensor"**, **"Z-Surveyor"**, **"GG24"**, or **"Z-Surveyor FX"**. Use the "Z-Surveyor FX" Ashtech type for any Z-Family receiver with firmware release UB00 or later. Use the "Z-Surveyor" Ashtech type for previous firmware releases.

Ashtech Data Port - This is the port on the Ashtech where the data collector is connected.

Ashtech Radio Port - This is the port on the Ashtech where the radio is connected.

Set Radio Channel (Pacific Crest) - This feature is available on Husky data collectors only and the file "radio.exe" must be present in the SurvStar directory. To run this feature, connect the Pacific Crest radio to the Husky (you must be able to power the radio and connect it to the Husky at the same time). Enter the Com Port of the Husky that you are using. Disconnect the power from the radio and press enter. Reconnect the power and wait for SurvStar to establish connection with the radio. You will see your current channel setting on the screen. Enter the channel you wish to set and press enter. It is recommended that you answer Yes to the prompt "Program Radio (<Y>/N)?"

Leica

GPS Control
1. **Equip Type - Leica**
2. **Leica Type - MC1000 or 500 Series**
3. **Satellite View**
4. **Send Command to Receiver**
5. **Station Type - Rover or Base** ****For the 500 Series only***
6. **Mode - Leica Prop.** ****For the 500 Series only***

Choice (Esc-Exit):

Equip Type - If the correct equipment type is not displayed here, press one. Then select from a list of equipment types.

Leica Type - Currently, SurvStar works with the Leica MC1000 and the Leica 500 Series receivers.

Satellite View - Use this feature to view the position of satellites in the sky. Press F1 once in the Satellite View screen to toggle the view. Possible views are Satellite Geometry Only, Satellite Geometry with PRN value, and Text Mode. While in Text Mode, stars (*) are used to denoted which satellites are actually used in the posiotion calculation. You may also jump to this same satellite view screen from the Monitor GPS window.

Send Command to Receiver - This routine allows you to send a command to the GPS receiver. If you need to set or read a feature on the GPS receiver that is not in the SurvStar Setup command, then you can use this routine to send the command. Any response from the receiver will be displayed. Please refer to the GPS receiver documentation for descriptions of these additional receiver com-

mands.

Station Type - This value will be either ROVER or BASE. If you do not exit SurvStar before moving from base to rover or vice versa, be sure to change this setting.

Mode - This indicates the type of message that will be passed via radio modem from the Base to the Rover. There are three options: Leica Prop., RTCM, and CMR. If you are going from one Leica instrument to another, you should use the Leica Prop. format. If you are using a Coast Guard Beacon as a base station, you will need to use the RTCM format. CMR is generally used if you are mixing Leica GPS equipment with equipment from other GPS manufacturers (i.e. Trimble or NovAtel). Whichever setting you do use, it is vital that the Base and Rover are set to the same format.

Trimble (1)

The Trimble (1) equipment type is used for direct request and response interaction with the Receiver. Use the Trimble (2) equipment type if you are using cycle outputs such as NMEA-GGK or Pos Type 2.

GPS Control
1. **Equip Type - Trimble (Direct)**
2. **Receiver Series - 4000**
3. **Satellite Position**
4. **Reset Receiver**
5. **Battery Remaining**
6. **Simulate Keyboard Press**
7. **Power Off**
8. **Setup Base Station** (*Available for 7400 Series only)

Choice (Esc-Exit):

Equip Type - If the correct equipment type is not displayed here, press one. Then select from a list of equipment types.

Receiver Series - Possible values are 4000 and 7400.

Satellite Position - Use this feature to view the position of satellites in the sky. Press F1 once in the Satellite View screen to toggle the view. Possible views are Satellite Geometry Only, Satellite Geometry with PRN value, and Text Mode. You may also jump to this same satellite view screen from the Monitor GPS window.

Reset Receiver - On the 7400, this function will restore factory defaults. On the 4000, you can either Re-Solve Position, Factory Restart, Clear All RAM, Power Cycle, or Re-Solve with Power Cycle.

Battery Remaining - This will tell you the percentage of battery life remaining.

Simulate Keyboard Press - From this function you can simulate several of the more commonly used keys from the Trimble face.

Power Off - This function will turn off the Trimble receiver.

Setup Base Station - For the 7400 receiver, this feature will go through all of the key presses necessary to begin output of base station corrections. The program will prompt you to output either RTCM or CMR and will also ask which port of the Trimble to send corrections to.

Trimble (2)

GPS Control
1. Equip Type - Trimble (Cycle)
2. Message Type - Pos Type 2
3. Send Command to Receiver
Choice (Esc-Exit):

Equip Type - If the correct equipment type is not displayed here, press one. Then select from a list of equipment types.

Message Type - Possible values are **Pos Type 2** or **NMEA-GGK**.

Send Command to Receiver - This routine allows you to send a command to the GPS receiver. If you need to set or read a feature on the GPS receiver that is not in the SurvStar Setup command, then you can use this routine to send the command. Any response from the receiver will be displayed. Please refer to the GPS receiver documentation for descriptions of these additional receiver commands.

GPS Monitor (M)

This screen reads the position and solution information from the GPS receiver.

LAT: 41.15325718
LONG: 83.03497385
NORTH: 5000.00
EAST: 5000.00
ELEV: 993.50
HRMS: 0.038 (or CEP)
VRMS: 0.040 (or SEP)
FIXED SAT: 6
PDOP: 2.0 HDOP: 1.8 VDOP: 2.1
Latency: 1.0 (or Link: 100%)

Press Enter or X to exit
F1 for Satellite View

LAT/LONG - This is the latitude and longitude of the position shown in degrees, minutes, seconds and decimal seconds as dd.mmssssss. For example, 83.03497385 is 83 degrees, 3 minutes and 49.7385 seconds.

NORTH/EAST/ELEV - This is the local coordinate if a local alignment is defined. Otherwise this is the state plane coordinate.

HRMS - This is the horizontal root mean squared position error.

VRMS - This is the vertical root mean squared position error.

CEP - This is the Circular Error Probability.

SEP - This is the Spherical Error Probability.

SAT - The number of satellites used in the computation. With the NovAtel GPS system, two numbers will be displayed here. The first is the number of satellites used for the differential position, the second is the number of satellites visible by the receiver unit.

LATENCY - (NovAtel, Trimble Direct, and Leica 500 Series Only) - This value is the time in seconds from the last calculated position with base corrections. Look for values to be around 1.0 and 2.0.

LINK (Ashtech Only)- This displays the percentage to data messages successfully transferring between the base and rover.

You may exit the monitor screen by pressing X, enter, or Esc. You may also jump to the Satellite view screen by pressing F1.

Store Point (P)

This command stores a point number, northing, easting, elevation and description in a coordinate file. The coordinate file is a binary file with a .crd extension. One coordinate file is active at a time. To change the current coordinate file, go to the Job Options menu.

-Point Methods-
1. Standard
2. Auto Pts at Interval
3. Offset Point Entry
4. Average Point
5. Enter & Edit Coords
6. Monitor GPS
-Options-
7. Notes OFF
8. RMS (or CEP) OFF
9. Beep OFF
10. GIS OFF
11. Store RodHt OFF
12. Point Data OFF
13. Time/Date OFF
14. RodHt: 6.470
X to Exit
Choose Method <1>:

There are six modes for storing points:

Standard (SP) - This option brings you to a menu similar to the one shown below:

Point : 25
Northing : 0.0000
Easting : 0.0000
Elevation : 0.0000
DESC: _
HRMS = 0.000
VRMS = 0.000

ESC F1:MON F2:CODE F3:READ F4:STORE R&S

The point number defaults to the highest number in the coordinate file plus one. Use the up and down arrow keys to highlight the point number and enter a different point number if you wish. The cursor starts out in the Description field. You may enter a description for the new point either manually or by picking from a predefined code list (use the CODE option). When you have finished entering a description, press the return key and the READ option is highlighted. Press enter again to read the GPS position data. The Northing, Easting, and Elevation fields are filled in automatically. Horizontal and vertical RMS values are also displayed. If the RMS values are below the preset RMS tolerance, STORE is highlighted. One more enter key and the point is stored. If the RMS values are higher than the tolerance, READ remains highlighted and you may continue to read the GPS position until satisfactory RMS values are reached. After the point is stored, the cursor moves back up the description field and the point number, northing, easting, and elevation values are reset. Continue this process until you have finished storing points, then press ESC to return back to the Point Store menu.

If you feel confident in your RMS or CEP values and your description will not be changing frequently, you may opt to use the R&S (Read and Store) option. Use the arrow keys to highlight the R&S spot on the screen. Press enter once and SurvStar will read the GPS and store the point all in one step. You may also use the F1 key to jump to the monitor screen at any time.

Auto Points at Interval (AP) - This method stores a point whenever the distance or time from the previous point exceeds the user-specified interval. The program will prompt you: **"Interval Type (<Distance>/Time)?"** Type 'D' and Enter or simply enter to use a distance interval. The program will then prompt you for an interval value. After entering the distance interval to use, an offset value (if any), and the description to assign each point, the program will prompt you for the point number at which to start storing points. The default is the highest point in the file plus one. From whatever point number you choose to start at, SurvStar will begin storing at the first unused point number. Also, if SurvStar encounters a point that already exists, the program will skip to the next free point.

Next, SurvStar begins to continuously read the GPS receiver. As each point is read, the coordinates and the distance from the last point are shown. When a point is stored, the point number and distance are displayed. In practice, the actual distance between stored points will be greater than the distance interval. For example, if the distance interval is 10 and the current distance is 8.9, then no point is stored. Then you keep moving and the next distance is 11.4 which will store a point. When you have finished storing a set of points, press Enter, "X", or Esc to stop the auto storing process. The program will then prompt you for another description. If you wish to continue storing points at this interval value with a different description, enter that description now and press enter to begin storing points. If you wish to exit this routine and return to the Point Store menu, leave the description blank and press Enter, or press Esc.

For time interval point storing, press 'T' and Enter at the first prompt. Continue the process as described above. The time interval you specify will be in seconds. After reading and storing the first point, SurvStar will wait for the interval time to pass, then read and store again. For both interval methods, if the combined RMS (or CEP) values of the position read are above the tolerance set in Job Options, the point will not be stored.

Also, you may jump to either Monitor or Standard Point Store at any time by pressing F1 or F2 respectively. When you exit either Monitor or Standard Point Store, you will resume Auto Point Store exactly where you left off. Any points that you stored during your Standard Point Store session will not be overwritten.

Offset Point Entry (OP) - This option can be used in areas of limited satellite communication such as high walls or under a tree. This allows you to setup the rover in a clear area and read the coordinate. The point that is actually stored is offset from the rover position. The offset direction can be entered as left, right or azimuth. The left and right offset is relative to the rover position at the previous read. Next the offset distance is entered followed by the elevation difference between the rover position and the offset point.

Average Point (AVG) - With this method, the program reads the position several times and stores the average. First enter a point number. Then set up the rover over the desired point and press Enter to begin reading the GPS receiver. Remain at the same point while the program continuously reads the GPS receiver. As each point is read, the coordinates are displayed. To stop collecting data, type 'X' or press Enter. Then the number of samples and average coordinates are displayed along with the minimum, maximum and standard deviation. This averaged coordinate can then be stored.

Enter & Edit Coords (EC) - This method allows you to type in the northing, easting and elevation. Once you have entered these values, you can toggle the highlighted number from positive to negative by pressing the "-" key (Shift+K on the HUSKY, FCT+¬ on the DAP 9500). *Point* ***numbers*** **cannot** be negative. You may also use this function to edit the coordinates and/or description of any previously stored point. To edit the Notes or GIS data of previously stored points, go to Point Utilities\Edit GIS Notes.

Monitor GPS (MP) - This method displays the Monitor GPS screen which shows the current coordinates, RMS values, number of satellites and DOP values. When these values are good (i.e. the RMS values are solved), press Enter to store the point.

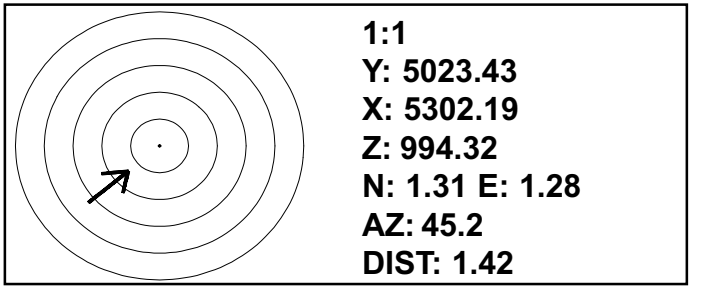
There are seven options for storing points. These options are explained further in the Options section. Default on/off settings for the options can be saved in the Setup command.

Notes - Notes are descriptions in addition to the standard 32 character that can be stored with the

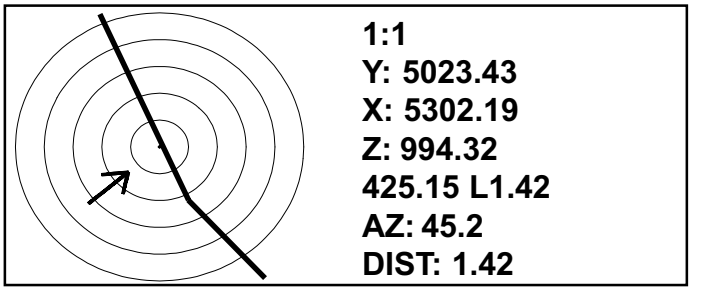
point. An unlimited number of notes can be entered one line at a time.

RMS (or CEP) - This option stores the horizontal and vertical RMS (or CEP) values in the note field.

Beep - This option makes a double beep when the point is stored to the coordinate file.



Point Stakeout



Centerline Stakeout

GIS - This option stores additional descriptions for user-defined fields.

Store RodHt - This option stores the current rod height in the note field for the point.

Point Data - This option stores the point number, northing, easting, elevation and description in the note file.

Time/Date - This option stores the time and date as read from your computer system for each point in the note file.

Rod Height - You may modify the height of your rover rod here.

StakeOut (S)

Stakeout allows you to locate a coordinate out in the field. A bull's eye locator shows your current position as an arrow and the target point as the center of the bull's eye. The direction of the arrow is relative to your previous position. The distance each of the five circles represent depends on your distance from the target point. The different scales are 1, 10, 100 and 1000. For example, at 10 scale each circle represents 10 units. So the first circle is 10 units away, the second is 20 units away, up to the fifth circle at 50 units. The scale will be set automatically based on your distance to the target point.

To the right of the bull's eye (or below on the DAP), the scale is shown at the top followed by your current position (X,Y, and Z). Next, the **N:** value is the amount to move north to reach the target and the **E:** value is the amount to move east. The **DIST:** value is the distance from the current position to the target and **AZ:** is the azimuth. If the rover loses communication with the base or the satellites, the current position stops updating and **No Position Data** is displayed at the top.

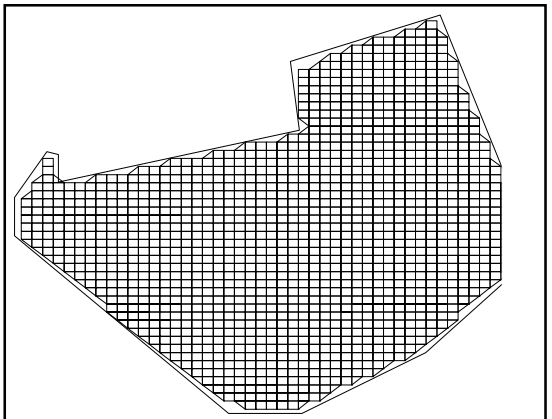
When you have reached the target, press Enter to exit the stakeout. The rover position is read one more time and the distance and azimuth are reported. There is an option to store this position in the coordinate file. If you are staking out by point number you will also be asked if you would like to stake out the next point in the coordinate file. At this prompt you may answer 'Y' to stake out the point in brackets, enter a point number to stake out, or 'N' to end the stake out session. In this method, once you reach the last point in the file, stakeout will end automatically and you will be returned to the main menu.

In addition to the bull's eye view, there is also a text view that shows the distance and azimuth in large letters. The advantage of the text view is that it is easier to read. To toggle between the views, press the 'V' (for View) key.

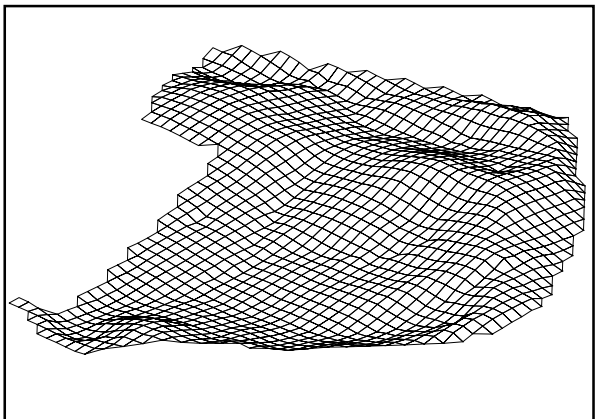
There are five methods for specifying the target point. The first option is to enter the target northing, easting and elevation directly (SE). If you are not calculating elevations, then you don't need to enter a target elevation. The second method is to read the target coordinates from the coordinate file by entering the point number (SPN). Before beginning the stakeout, the program shows the coordinate and description for the entered point number. The third method is to enter a station and offset which calculates the target coordinates using a centerline file (SSO). A centerline file can be created in SurvCadd or in SurvStar under the 4th option of the Roadwork menu. At the offset entry, a skew pipe end point, for example, can be entered as offset 40 30, which means offset 40 and 30 degrees right of perpendicular. Offset 50 -30 would be offset 50 and -30 degrees left of perpendicular.

The fourth method is stakeout by centerline (SCL) which finds nearest point on the centerline to your current position. This point on the centerline becomes the target point. The centerline is drawn across the bull's eye with the target point of the centerline being at the center. Instead of showing the North and East values, the program shows the station, offset, and whether your current position is left or right of the centerline.

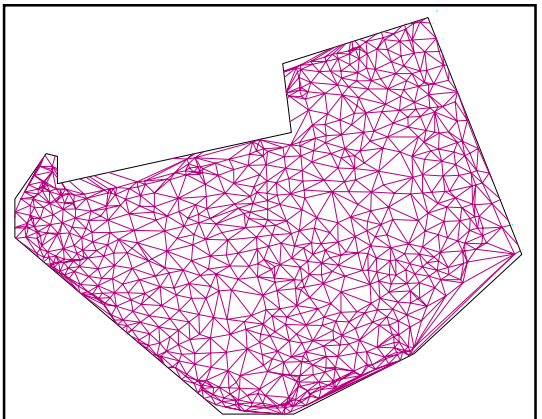
The fifth method is similar to centerline stakeout, except you do not need an actual centerline file. This method is called **"Point on Line"** (SLN) and it allows you to stake to a line formed between two points. You may specify these two points by either entering the coordinates, or choosing two points from your coordinate file. During stakeout, an 'R' or 'L' after the distance specifies your position



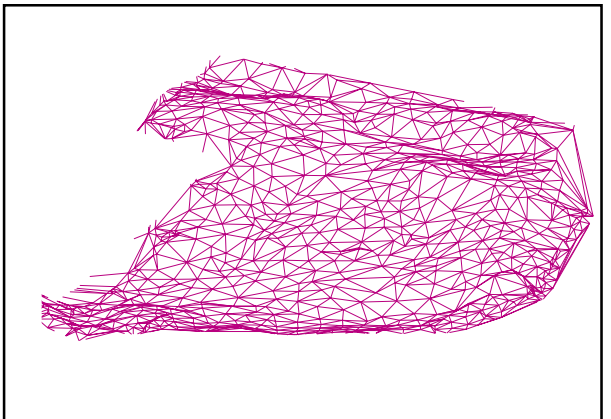
Grid file in plan view



Grid file in 3D view



Triangulation file in plan view



Triangulation file in 3D view

right or left of the line. This assumes your back is to the first point entered and you are facing the second point. A CUT or FILL measurement is also given. This assumes that the target line is a straight line from the first to the second point in all directions.

There are several options in stakeout. The Report option generates a report text file of the stake points. The report file is named after the current coordinate file using a .TXT file extension. The report contains the following:

Target Point# Northing Easting Elevation Distance RMS PDOP Comment

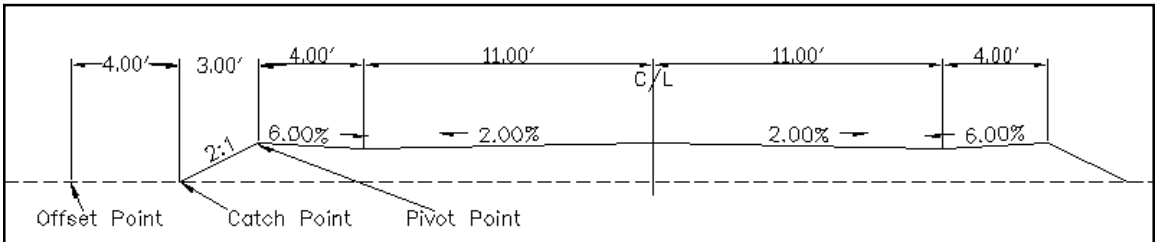
The Laser option does stakeout by reading the Atlanta Laser Gun or the Impulse Laser Gun (configure under the Laser Options menu). The RMS option displays the RMS on the screen during stakeout. The Trail option is used to draw a trail of where you have been while approaching the target.

Elevation Difference (E)

This command reports the elevation difference between a point and a surface model. A negative elevation difference represents cut and a positive elevation difference is fill. The surface model can be defined by a grid file, triangulation file or template design files. The point can be the rover GPS position, entered coordinates or a point number from the current coordinate file. SurvStar calculates the elevation at that position on the surface model and compares this surface model elevation with the point to report the elevation difference. There is an option to store the point to the coordinate file with the elevation difference as the point description. A vertical offset can also be entered to be added to the surface model.

The grid file is a rectangular mesh with elevations at each corner as shown below. The grid file has a **".grd"** extension and can be created in SurvCadd. The triangulation file represents a triangulation mesh as shown below. This file has an **".flt"** extension and can be created in SurvCadd or Softdesk. The maximum number of points in the triangulation file is 500, less if the coordinates are state plane.

The template design files include the centerline alignment (.cl file), vertical profile (.pro file) and



Example template with slope stake points.

template file (.tpl file). Superelevation (.sup file) and template transition (.tpt file) can optionally be applied. Using the rover coordinate, SurvStar calculates the station and offset for the coordinate. Then the road design is calculated at that station and the template elevation is computed for the offset. The road design files can be created in SurvCadd or with SurvStar (under the Roadwork menu).

Roadwork (R)

Go to the Roadwork menu for any of the following options:

1. **Slope Staking**
2. **Cutsheet Stakeout**
3. **Centerline Position**
4. **Centerline Design**
5. **Centerline View**
6. **Profile Design**
7. **Profile View**
8. **Profile Edit**
9. **Template Design**
10. **Template View**
11. **Template Edit**
12. **Template Insert**

Slope Staking (SL)

Slope Staking is located in the Roadwork menu. This command guides you to the catch point where the cut/fill slope intersects the existing ground. Coordinates from the GPS receiver are used to model the existing ground. There are three methods for defining the cut/fill slopes:

Design Files
Section File
User Entry

Design files include a centerline file (.cl), profile file (.pro) and template file (.tpl). The centerline defines the horizontal alignment, the profile defines the vertical alignment and the template defines the cross slopes and cut/fill slopes. Superelevation (.sup) and template transitions (.tpt) files can also be used. Using the design files, any station along the centerline can be slope staked. The road design files can be created in SurvCadd and uploaded onto the data collector. The template, centerline and profile files can also be made in SurvStar under the Roadwork menu.

Section files (.sct) can be used instead of design files when the road is too complicated to model using design files. For example, if the road contains special ditches at various offsets and varying lane

widths, then it may be easier to enter a final section file than to define the template and template transitions. A section file consists of offset-elevation points at different stations. At a minimum, each station should contain the pivot point offset-elevations. The slope staking routine will start the cut/fill slope from the furthest offset point in the section. For example, when staking the right side, the right most offset will be used as the pivot point. The section file can optionally contain additional offsets such as centerline and edge of pavement. The program can then report the horizontal and vertical distances from the catch point to these additional offsets. The section pivot offsets can also be assigned a description which the program reports before starting the slope staking. For example, a pivot offset could be "2:1 from flat bottom ditch" which is reported to the operator. When using section files, a centerline file is also required to establish the horizontal alignment. Any station along the centerline can be slope staked because the program will interpolate between entered section stations. Sections files can be created in SurvCadd by commands like Input-Edit Section File and Digitize Sections for creating sections from plans.

User entry is the most simple method for design files since this method only requires a centerline file. With this method, the program prompts for the cut/fill slopes and the pivot offset and elevation. The program finds this offset-elevation for the stake station along the centerline and begins the cut/fill slope from this point.

Slope staking starts with a list of the design files. Use the arrow keys to select the files. Press Enter when you are done specifying the files. The Centerline file is required for all methods. The Profile and Template are required for the design file method. Superelevation and Template Transition are optional for the design file method. For the section file method, the Final Section file is required and the Template is optional to define the cut/fill slopes.

Slope Staking Files
Centerline : DEMO.CL
Profile : DEMO.PRO
Template : DEMO.TPL
Superelv : None
Tpl Trans : None
Final Sect : None

After specifying your design files, the program prompts for options. Use the arrow keys to select an option to change and press Enter when done specifying the options. The Report File option stores to the specified text file the catch point offset-elevation and the horizontal and vertical distances from the catch point to the pivot point. The Vertical offset option allows you to adjust the profile. The Template report ID is the template point description for calculating the horizontal and elevation difference from the catch point to the template. Each template grade has a description. For example, in the sample template shown in the Template Design section, the template elevation difference point could

be SHD. Then at the end of the routine when the catch point is found, the horizontal and elevation difference from the catch point to template point, SHD, is reported. The C/F Ratio Prompt option makes the program prompt for the cut and fill slopes for each slope stake. The Store ground points option stores points to the current coordinate file (.crd) as the program reads existing ground data from the GPS while locating the catch point.

Report File :
Vertical offset : 0.000
Template report ID : CENTER
C/F Ratio Prompt : No
Store ground points : No

The next step is to locate the station to stakeout. The program begins to read GPS position and report the station and offset. This station-offset display updates in real-time as you move. When the desired station is reached, press Enter and the program begins the slope staking at this station as the stakeout station. The side to stakeout is determined by the initial offset. If the first offset is left of the centerline then the left template slope is used. Likewise the right template slope is used when the first offset is right of the centerline.

North : 5000.000
East : 5000.000
Elev : 1000.000
Station: 60.00
Offset : 28.53 LEFT

For the design file method, the centerline elevation at the stakeout station is calculated using the design profile and then the template is applied to calculate the pivot point. For the section file method, the pivot offset is interpolated from the section file. For example, if the stakeout station is 75 with offset right and the section file has offset-elevation of 18.0 right, 100.0 elevation at station 50 and has 20 right, 102.0 elevation at station 100, then the pivot offset for station 75 would be 19.0 right, 101.0 elevation. The program reports this interpolated pivot offset before continuing. For the user entry method, the program will prompt at this point for the pivot offset, pivot elevation and cut/fill slopes.

The existing surface to tie into is defined by the elevations from the GPS coordinates. The point where the cut or fill slope from the template intersects the existing ground is called the catch point. As each GPS coordinate is read, an existing surface cross section is built and the catch point is calculated. The program displays, in real-time as you move, the northing-easting and station-offset-elevation of your current position and the northing-easting and station-offset-elevation of the catch point. The distance from the current position to the catch point is reported as the offset difference (**Offset Diff:**). Next to the number is either "**IN**" or "**OUT**". The OUT means you should move out from the

centerline. The IN means that the catch point is closer to the centerline. Based on this offset difference, you move perpendicular to the centerline either towards or away from the centerline to reach a new offset from the centerline while maintaining approximately the same station. Be sure to check the current station, which is reported on the third line in case you have moved away from the stakeout station.

```
Current: 5000.0,5000.0
Station        Offset        Elev
60.00          28.53         1000.0
Catch: 4994.1,4985.6
Station        Offset        Elev
60.00          18.00         994.94
Offset Diff: 10.53 IN
```

When the catch point is located, press Enter to end the slope staking. The program reports that catch point offset-elevation and the horizontal and vertical distances from the catch point to the pivot point and the Template Report ID point.

```
Station       : 60.00
Catch Offset  : 18.00
Catch Elev    : 999.94
Catch to Pivot SH
H: 3.00 V: 1.50 FILL
Catch to CENTER
H: 18.00 V: 1.78 FILL
```

Next there is an option to store the catch point to the current coordinate file. Then there is an option to locate an offset point. The program prompts for the station and offset of the offset point to stakeout. The offset to stake can be entered as a distance from the catch point.

```
Locate offset point (<Y>/N)?  Y
Station <60.0>:  Press Enter
CL-offset/<Delta Distance>: 4.0
```

To locate the offset point, the bull's eye stakeout is used. After the offset point is reached, the program reports the offset point station-offset-elevation and the horizontal and vertical distances from the offset point to the catch point and from the catch point through the template points.

Cutsheet Stakeout (CS)

This command does a bull's eye stakeout of points. The horizontal (x,y) point position comes from a user-specified station and offset along a centerline file (.cl). The elevation of the stakeout point is calculated for the station and offset using the road design files which include a profile file (.pro) and template file (.tpl). Superelevation (.sup) and template transition files (.tpt) can optionally be used. A final section file can be used instead of the design files as explained in the Slope Staking command.

Cutsheet Stakeout starts with a list of files as shown below. Use the arrow keys to select the files and press Enter when done.

Cutsheet Files
Centerline : DEMO.CL
Profile : DEMO.PRO
Template : DEMO.TPL
Superelv : None
Tpl Trans : None
Final Sect : None

Next the program prompts for a Vertical Offset. For example, if you want to stakeout a subgrade that is one foot lower, then enter -1.0 for the Vertical Offset. Then you enter the Station, Design Offset and Stake Offset. The Design Offset is where the stake point elevation is calculated. The Stake Offset is where the stake point horizontal position (x,y) is positioned. This applies, for example, to staking the back of a curb, where the Design Offset is -12, but the stake offset is -17 (5' behind the back of curb, with the elevation reference to the actual back of curb design elevation).

After these inputs, the stake point is determined and the program brings up the bull's eye stakeout screen to guide you to the point. When you reach the point, press Enter to finish the stakeout. The program will then report the cut/fill and horizontal offset from the current position to the stake point.

Centerline Position (CP)

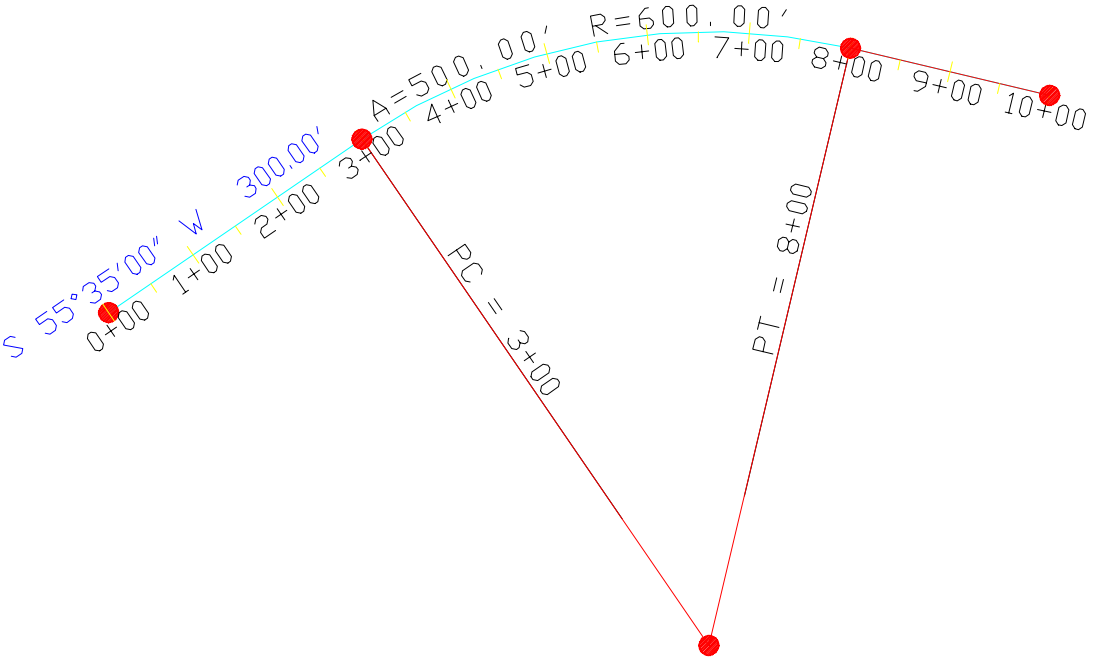
This command calculates the station and offset of a point relative to a centerline. The centerline is stored in a **".cl"** file which can be created in SurvCadd or with the 4th option (Enter Centerline) in the Roadwork menu. The point coordinates can be entered directly, specified by a point number in the current coordinate file, or read from the GPS receiver. There is an option to store the point with the station and offset recorded automatically in the point description. Before calculating the offset value, the program will prompt you for a **"Description Prefix:"**. This prefix will be added to the beginning of the new point descriptions. To exit Centerline Position, just press Enter after leaving the point or

northing blank, or press ‘X’ when prompted to read GPS equipment.

Centerline Design (CL)

Application: To enter centerlines for calculation of stations and offsets and for stakeout. Centerlines are one of three required elements in template-based stakeout, the others being the profile and template itself.

Procedure: Select option 4, or when in SurvCOGO type **SN**. Centerline entry within SurvCOGO requires that point numbers have been established for all PC’s, PT’s and PI’s of the centerline, as well as for radius points. For point-to-point centerlines (no curves), just enter the point numbers in sequence. For centerlines with simple curves, enter all PC’s as PC8 where 8 is the point number for the PC. For spirals, enter SP8 where 8 is the point number for the PI of the spiral.



CENTERLINE STATIONING

USE PC7 TO BEGIN CURVE AT POINT 7

STARTING STATION? 0 (in our example, but it could be 1500 or any other value)
STARTING POINT? 1
NEXT PT, 0 TO END? PC2
RADIUS #? 3
CURVE LEFT OR RIGHT (L OR <R>)? Enter
PT OF TANGENCY? 4
Curve data is then displayed.
NEXT PT, 0 TO END? 5
NEXT PT, 0 TO END? 0

(1) PRINT CENTERLINE FILE
(2) STORE FILE TO DISK
(0) RETURN TO MENU
? 2
FILE NAME? ROADWAY (do not enter an extension—".CL" will be used automatically)

(1) PRINT CENTERLINE FILE
(2) STORE FILE TO DISK
(0) RETURN TO MENU
? 1

PT.# STATION DESCRIPTION
1 0 POINT ON LINE
2 300 POINT OF CURVATURE
3 RADIUS PT 47.4447 DELTA ANGLE (DD.MMSS)
4 800 POINT OF TANGENCY
5 1000 POINT ON LINE

This centerline file can then be recalled within centerline-based stakeout routines for both GPS and total station field work. The centerline file is an ASCII file which can be reviewed in a text editor.

Centerline View (CV)

This command allows you to verify that a centerline file is correct by viewing the file or viewing a graphics plot.

Profile Design (PD)

Application: To create road profiles and generic profiles (eg. ditches) to stake in the field or to use in

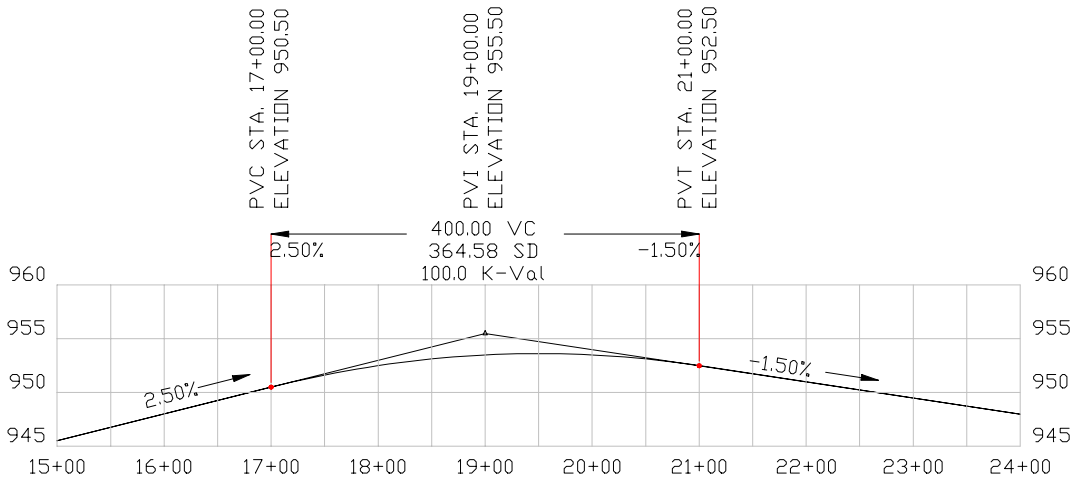
conjunction with template and centerlines for slope staking, grade staking and grade control.

Procedure: Select menu item 5, or when in SurvCOGO type **VC** (it stands for "vertical curve", a component of road profiles, in contrast to "horizontal curve"). A menu appears:

PROFILE CALCULATIONS

(1) MAKE ROAD PROFILE
(2) RECALL ROAD PROFILE
(3) MAKE GENERIC PROFILE
(4) RECALL GENERIC PROFILE
(0) END

Consider the simple road profile shown here:



This profile would be entered by selecting option 1, MAKE ROAD PROFILE. Prompting follows:

BEGINNING STATION? 1500
ELEV. OF 1ST STATION? 945
<1> KNOWN PI ELEVATION
(2) KNOWN % GRADE
(<1> OR 2)? Enter (it is typically more accurate to base profiles on the PI elevation).

STATION OF NEXT PI? 1900
ELEVATION OF NEXT PI? 955.5
LENGTH OF VERTICAL CURVE

(0 IF THIS IS END STATION, U TO UNDO)? 400 (note the vertical curve length is entered after the PI elevation)

STATION OF NEXT PI? 2400
ELEVATION OF NEXT PI? 948.0
LENGTH OF VERTICAL CURVE
(0 IF THIS IS END STATION, U TO UNDO)? 0 (to end!)
STORE PROFILE TO DISK (<Y>/N)? Enter

PROFILE NAME (RETURN-END)? ROAD
This leads to another menu that is handy for calculation:
SELECT FROM THE FOLLOWING MENU:
(0) CALCULATE INTERVAL ELEVATIONS
(1) CALCULATE SPECIFIC ELEVATIONS
(2) CALCULATE HIGH/LOW POINTS
(3) CALCULATE SUBGRADE ELEVATIONS
(4) RETURN TO PROFILE MENU
(0) MAIN MENU? 2

STATION? (0 TO END)? 1872.3
18+72.3 953.24
STATION? (0 TO END)? 2015
20+15 953.4
STATION? (0 TO END)? 0

The same calculation menu appears. Select 3 for the high and low points.
19+54.55 953.59
Now select 5 to return to the local profile menu (as opposed to the main COGO menu). If 2 is selected for RECALL ROAD PROFILE, the same 5-option sub-menu appears as above. The RECALL ROAD PROFILE menu is entered automatically after completing MAKE ROAD PROFILE.

The same pattern holds true for option 3, MAKE GENERIC PROFILE. This routine differs from MAKE ROAD PROFILE by not asking for a length of vertical curve. It will also report the percent grade to each newly entered PI station and elevation. It leads to the calculation menu after the generic profile is entered, as does the command RECALL GENERIC PROFILE.

Profiles in SurvCOGO (and SurvCadd) are ASCII files that store with a ".PRO" extension as in ROAD.PRO. They take the form:

Station, Elevation, Length of Vertical Curve

For example, our road profile appears as follows in a text editor:

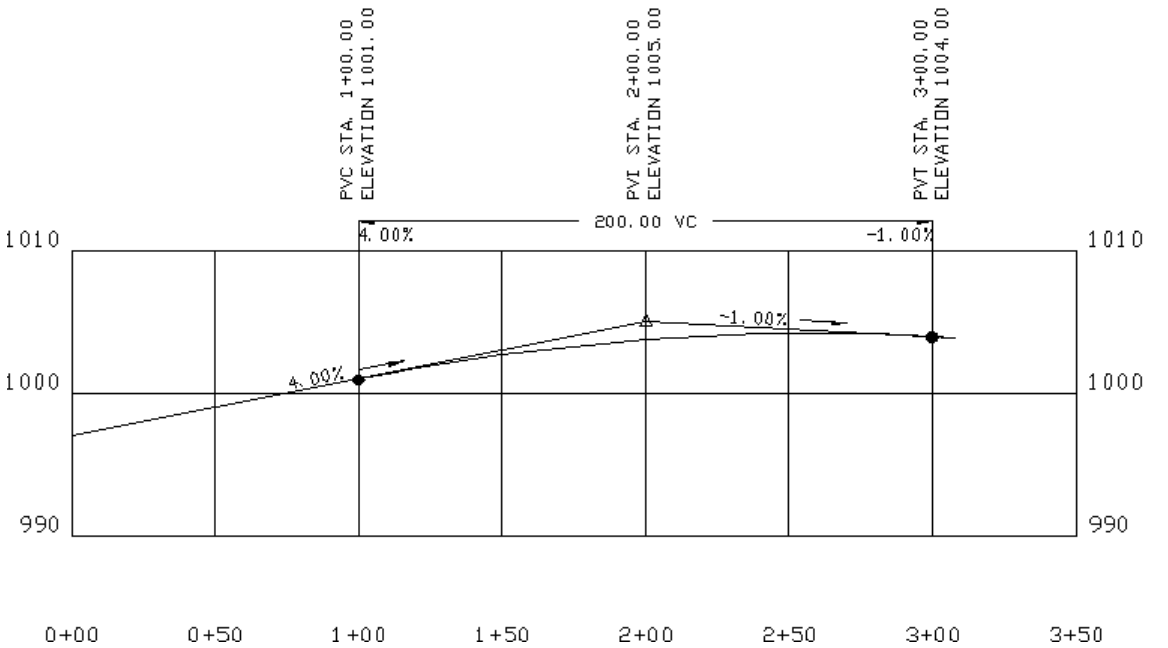
1500, 945, 0
1900, 955.5, 400
2400, 948, 0
0, 0, 0

A user could enter such a profile in a text editor and then download it to the data subdirectory on the DAP or Husky or other controller.

Profile View (PV)

This command allows you to verify that a profile file is correct by viewing the file or viewing a graphics plot.

Profile Input-Edit (PE)



This command edits the station, elevation and vertical curve data in a profile file. The profile data is displayed in a spreadsheet editor. The columns show the station, elevation, vertical curve left, vertical curve right and vertical curve total. Use the arrow keys to highlight an entry to edit. When the field is highlighted, you can type in the new number. To end the routine, type the ESC key. The program will then ask if you want to save the changes.

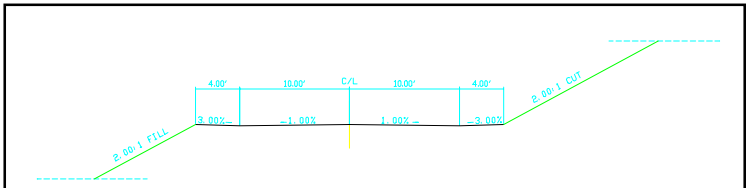
	STATION	ELEV	V-L	V-R	VTOTAL
PVI	0	997	0	0	0
PVI	200	1005	100	100	200
PVI	308	1003.92	0	0	0

Template Design (TD)

This command is a very simple template design. Much more detailed templates can be created in SurvCadd but this command allows you to create a template in the field. The template is stored in a **".tpl"** file. The program prompts for a series of grades starting from the centerline. For each grade you enter a horizontal distance, percent slope and description. The description is used by Slope Staking. After entering the last grade at the edge of the road, press Enter at the grade distance prompt to end the grade entry. The left and right side grades are the same. Then you enter the cut and fill slope ratios.

Template file to Write: RD
Left side same as right (<Yes>/No)? Press Enter.
Say No to have a non-symmetrical template.

Grade Distance (Enter to End): 10



Example template created by Enter Template

Grade Percent Slope: -1
Grade Description: EP
Grade Distance (Enter to End): 4
Grade Percent Slope: 3
Grade Description: SHD
Grade Distance (Enter to End): Press Enter
Cut Slope Ratio: 2
Fill Slope Ratio: 2

Template View (TV)

This command allows you to verify that a template file is correct by viewing the file or viewing a graphics plot.

Template Edit (TE)

This command edits the template file data in a spreadsheet editor. There are two spreadsheets. The first shows the template left and right side grades. The columns show the grade ID, horizontal distance and slope. Use the arrow keys to highlight an entry to edit. When the field is highlighted, you can type in the new number. To move to the next spreadsheet, type the ESC key.

SURFACE LEFT			SURFACE RIGHT		
ID	SLOPE	HDIST	HDIST	SLOPE	ID
EP	-2	10	10	-2	EP
SH	4	6	6	4	SH

The second spreadsheet shows the cut and fill slopes. To end the routine, type the ESC key and the program will then ask if you want to save the changes.

OUTSLOPE LEFT			OUTSLOPE RIGHT		
ID	RATIO	DIST	DIST	RATIO	ID
FILL	3	0	0	3	FILL
CUT	3	0	0	3	CUT

The “Dist” (depth) of 0 indicates that the slope ratios apply in all depth of fill/cut conditions.

Template Insert (TI)

This command creates a new template file that is interpolated between two existing templates. For example, consider a changing lane width. A template at station 100 could have EP width of 12' and a template at station 300 could have EP width 24'. This command would allow you to create a template at station 200, and the program will calculate EP width of 18'.

First the program prompts for the first existing template and station. Then you enter the second existing template and station. Next you enter the template file name to create and the station to interpolate.

Chapter 5 - Total Station Data Collection

Setup (SU)

Choose SU for SetUp from the Main Menu. This leads to a menu that utilizes the up/down and left/right arrow keys. It appears below:

```
  N  5100.0000    E  5100.0000       EL  1000.0000
  Occupy Point:  20
  Backsight Point:
>Backsight Azimuth:  BS PT NOT FND!
  Instrument Height:  0.00
  Target Height:  0.00
>Equipment:  Nikon
  ESC
```

The ">" symbols indicate items that permit left and right arrows to toggle through options. Pressing Enter while **ESC** is highlighted, or pressing **ESC** itself, will exit to the Main Menu, saving all changes made. To select an equipment type, use the up arrow to highlight the Equipment field and then use the right or left arrows to scroll through the various options. When the desired option appears, press the ESC function key or arrow down to ESC on the window display and press Enter.

Before taking a shot, use this menu to specify your current occupy point and backsight point or azimuth. Entering a backsight point will calculate and display the backsight azimuth and bearing automatically. Highlight the Azimuth field and use your right or left arrow keys to toggle the display. You may also highlight the Instrument Height and Target Height fields to enter these values. Choose ESC to exit the SetUp menu and save the current values.

Job Options (O)

Use the job options menu to configure SurvStar for your particular project needs. Once you exit this menu, all settings will be saved and recalled automatically every time you run SurvStar. The options to be set are as follows:

1. Coordinate File - The coordinate file is a binary file that contains point number, northing, easting, elevation and descriptions. Descriptions can have up to 32 characters. One coordinate file is active at a time and SurvStar routines such as Store Point will automatically use the active

coordinate file. The main menu screen shows the name of the current coordinate file. You will be given the option to create a new coordinate file or select from a list of existing coordinate files located in the DATA directory.

2. Backup CRD file in Store Points - This option will create a backup of the current coordinate file when you enter the Store Points command. The backup file name has the same name as the coordinate file with a .bak extension. For example, the JOB5.CRD file would have a backup name of JOB5.BAK.

3. Unit mode - The unit mode can be set to either metric, US feet or international feet.

4. Total Station COM Port - This is the COM port number for connection from the computer to the total station equipment. The default is COM port 1, which is the upper left port on the Husky. If you are using a DAP, you will most likely use COM 2, which is located on the upper right-hand side of the DAP.

5. Point Notes - Point Notes are additional descriptions that can be stored with a point. A regular point consists of a point number, northing, easting, elevation and 32 character description. These points are stored in a .CRD file. Coordinate file notes are a way to add an unlimited number of lines of text to a point number. With Point Notes ON in the Store Point command, the program will prompt for point notes after collecting a point. The notes are stored in a file that uses the name of the coordinate file with a .NOT extension. For example, a coordinate file called JOB5.CRD would have a note file called JOB5.NOT.

6. Beep for Store Point - This option will make a double beep to indicate when a point is stored in the coordinate file.

7. New CRD File Format - Point numbers can have either numeric or alphanumeric format. This option determines the point number format for when a new coordinate file is created. Alphanumeric point numbers consist of nine or less digits and letters (i.e. point number 7A). With numeric point numbers, the point is stored in the coordinate file at a fixed position set by the point number. This means that the size of the coordinate file is determined by the highest point number. For example, point number 500 will be stored in position 500 and if point 500 is the only point in the file, the file size will still be 500 points long and positions 1-499 will be unused. Each point takes 56 bytes to store. So if there are 300,000 bytes free on the computer, you can have a coordinate file with over 5000 points. The amount of free bytes on the computer is shown in the main menu. Besides allowing point numbers with letters, alphanumeric points also store efficiently without fixed positions and can handle high point numbers such as 501101. The disadvantage to alphanumeric points is that SurvCOGO is designed for numeric points and only a few essential SurvCOGO routines are available for alphanumeric points.

8. Store GIS Data with Points - When storing a point, this option will prompt for and store additional descriptions for user-defined fields in the note field for the point. The fields to store are defined in a .GIS file which contains a field definition on each line. The definition line has the field name, prompt and default value separated by commas. If the field is a choice of options, the definition line also has each choice separated by commas. If the field's value is to be calculated automatically by an equation, the equation takes the place of the default value. The field's value is calculated automatically once the point is stored or edited. For example, consider the following GIS file to store information for manholes:

LOC,Location, ,
MH#,Manhole Number, ,
MH Depth(Ft),Manhole Depth (Feet), ,
MEAS Down,Measure Down,$EQN=$ELV-MH Depth(Ft),
SIZE,Ring Size,24,
MATERIAL,Ring Material, ,
INVERT,MH Invert (Excellent/Good/Fair/Poor/Bad), ,Excellent,Good,Fair,Poor,Bad
LEAKS,Manhole Leaks (Yes/No),No,Yes,No
GPM,Approximate GPM, ,
BY,Reviewed By, ,

The first line defines a field called LOC and will prompt the user with **'Location:'**. The SIZE definition is an example of a default value of 24. When at the **'Ring Size <24>:'** prompt, the user can just press Enter to use this default value of 24. The INVERT definition is an example of a choice between Excellent, Good, Fair, Poor and Bad. At this prompt the user only has to type in the first character of any of these choices. The MEAS Down definition is an example of an equation. The key letters "$EQN=" must appear at the very beginning of the default section to signal that this field is an equation. Then the equation is entered using field names to represent their values or key words to represent northing, easting, or elevation point values. The key words are as follows: **$NOR** = Northing, **$EAS** = Easting, **$ELV** = Elevation. The equation is calculated from left to right (normal order of precedence is ignored), and regular numerical values may also be used. The user will not see this prompt the first time the point is being stored, but it will be displayed and updated whenever GIS data is edited through SurvStar. Note: If there is no default or equation for a field, there must be exactly one space between the two commas that define the default area.

9. GIS File - This is the File where the GIS field definitions are found. When you select this option, you will have two choices. (1) Enter the name of the file - Enter a filename (up to eight characters), without extension, where the GIS format is stored. (2) Automatic by Point Description. When entering GIS information, SurvStar will look for a file having a ".gis" extension and filename matching the first eight characters of the current point description. For example, if a point's description is "MH", the file "MH.GIS" will be used for that point.

10. Point Data in Point Notes - When storing a point, this option will store the point number, northing, easting, elevation and description in the point notes as well. This may be used as a backup or reference to coordinate data as it was originally stored.

11. Separate StakeOut CRD File - This is an option to use a second coordinate file to store the staked points in the Stakeout routine.

12. StakeOut Report - This option will create a stakeout report in the Stakeout routine.

13. StakeOut Tolerance - This value is used in the Stakeout routine as the distance tolerance. When storing the staked point, the program will beep and display a warning if the staked point is further than this tolerance from the target point.

14. Code File - Code files are tagged with a ".fld" extension. They contain a series of predefined point descriptions in the form of abbreviations followed by explanations. Code files may be generated with the Field-To-Finish module of SurvCADD or manual with any text editor. See Appendix C for more information on Code file format.

15. Inverse Display - This setting applies to the way results will be displayed in the inverse function of the Point Utilities menu. Possible values are *Bearing*, *North Azimuth*, and *South Azimuth*.

For some types of total stations there are additional option items which pertain to data collection with that manufacturer only. These items are as follows:

For Nikon Total Stations...
16. Vertical Angle - Select which vertical angle type the Nikon is set to: Zenith, Horizon, or Compass

17. Horizontal Angle - Select which horizontal angle type the Nikon is set to: Right or Left

For Geodimeter Total Stations...
16. Unit Type - There are two possible values for this field: *RPU* and *Station*. If you are connecting to the black box (Geodat) remote control unit, select RPU. When connecting directly to the total station itself, use the Station type.

Equipment Setup

Before taking and recording shots, it is necessary to connect the data collector to the total station. Also, with some instrument types, additional setup is required. The following sections deal with

proper procedure for setting up the equipment before taking shots.

Nikon

With the Nikon total station, it is very important to ensure that the baud rate is set properly. To do this with a DTM-400 series, use the FNC key and choose 5 for "Set". Next press 6 for "Others". Press the ENT key twice to scroll past the first two options. When you reach the Baud Rate menu, press 4 for "9600". Then press ENT two times to go back to the main screen.

Also with the Nikon total station, you should make sure that the instrument and the data collector are set to the same units of measure. On a DTM-400 series total station, press the FNC key and then 5 for "Set". Then press 1 for "Angle". Select Zenith, Horizon or Compass and make sure the same setting is displayed in the SurvStar Options menu under item 14 (see previous page). Press ENT twice to get back to the "Set" menu. Select 5 for "Unit". Press 1 to measure angles in degrees. Next, select the proper distance unit for measure. Make sure this is the same setting that is displayed in the SurvStar Options menu under item 3 (see page 5-2).

Geodimeter

When running SurvStar with a Geodimeter robotic total station, you may connect either to the RPU (the "Black Box") or directly to the station itself. The following explains the setup procedure for each of these cases.

When connected to the RPU:
Before taking any shots, set up the equipment and establish radio connection between the station and the remote unit. On the RPU, run Menu 4, option 1 (Select device), then 2 (Serial). Answer the prompts as follows:

Serial ON? - YES
COM=1.8.0.9600
Table no=0
REG. key? - YES

Set the Geodimeter in tracking mode with the TRK button on the RPU. From the Husky, select which type of shot (TRV, SS, etc) and the following screen should appear:

Shooting the Gun...
Press Enter to Escape.

At this point, use the REG key on the RPU to collect the shot data, or press enter on the Husky to cancel.

When connected to the Station:
Connect the Husky directly to the Geodimeter total station (use the same port as the battery). After powering on the unit, it should not be necessary to modify any of the settings. But if you should happen to experience communication problems between the Geodimeter and the Husky, run Menu 4, Option 1(Select device), 2 (Serial), and answer the prompts as follows:

Serial ON? - YES
COM=1.8.0.9600
Table no=0
REG. key? - NO
Slave? - NO

Once this is done, the total station will go into tracking mode automatically once you enter the point store menu on the Husky. The SurvStar program will also trigger the gun and retrieve data automatically, so no other key presses are necessary at the total station.

Topcon

There is a setting on the Topcon total stations that may improve communication between the instrument and the data collector. This setting is optional and may need to be undone if you plan to connect to other data collectors such as the Topcon Data Collector FC-1/2 or Data Entry Keyboard DK-5. Because of the differences in interface from one total station to the other, the method for changing this setting varies with each machine. Below are a few examples using different Topcon total stations. If the instrument you are using is not listed here, please refer to the Topcon User's Guide.

The Topcon 300 Series:

1) Turn on the power switch while pressing the S.A/T.P key. After showing all segments for approx. 2 seconds, the title of the selecting mode 1 will be shown. ("SELECT 1")
2) Show the selecting mode 3 by pressing the ↵ key twice. ("SELECT 3")
3) Set the selecting mode 3 by pressing the ANG% key.
4) The data previously set is shown with the most right digit (digit No. 1) blinking.

   SELECT 3
   00000000

5) Let the digit No. 2 blink by pressing the HOLD key. Set "1" for the digit by pressing the ↵ key.

SELECT 3
00000010

6) Press the ANG% key.

SELECT 3

7) Turn off the power.

The Topcon 200 Series:

1) Turn the power switch on while pressing the “F2” key.
2) Press the “F3” key to select the “OTHERS SET” menu.
3) Press the “F4” key (beneath the “P¯”) to scroll to the second menu screen (2/2).
4) Press the “F3” key for CR,LF.
5) Press “F1” (ON) then “F4” (ENTER).
6) Turn the power switch off.

The Topcon ET-2:

1) Turn on the power switch while pressing the meter/feet selector switch continuously until the buzzer sounds stop.
2) After indicating the software version number as “FAC 10.10”, the ET-2 will display nothing but the meter/feet and the degree/grad unit already set and will wait for the next key operation.
3) Operate the (V/H) switch and the ET-2 will display “00000000” while flashing the 1st digit (right), if it is not changed before.
4) Move the flashing position to the 2nd digit. A flashing position can be shifted each time by operating the (V/H) switch.
5) Operate the (REC) switch, the 2nd digit will be changed into “1”.
6) Operate the (F) switch. The ET-2 will again display nothing but the meter/feet and the degree/grad unit, which indicates the necessary setting is complete.
7) Turn off the power.

Again, this setting is not necessary, but it may prevent possible communications errors from occurring.

Zeiss

Before beginning data collection with the Zeiss total station, it is important to ensure that the communication parameters are correctly set on the instrument. For the Elta 4, these parameters cannot be changed, so no extra setting up is required. For both the Elta 50 and the RL, communi-

cations parameters must be set to 9600 baud rate, No Parity, 8 Data Bits and 1 Stop Bit. To change this setting on the Elta 50, hold down the ON key and press the MENU button. Scroll down to the "Setting Interface" option and press "Yes". Scroll down to "Parity", press the "MOD" key until "NONE" is displayed. Scroll down to "Baud Rate" and press the "MOD" key until "9600" is displayed. Once this is done, press "ESC" to exit back to the main menu and save changes.

Leica TCA1100

To verify the communication settings of your Leica total station, press the F3 key for "System Configuration" from the Main Menu. (Press the ESC key on the instrument to get back to the Main Menu screen, if you are not there already). Next, press 3 for GSI communication parameters. Here, make sure that your instrument is set to "9600" Baud Rate, "No" Parity, "CR LF" teminator, and "8" Data Bits. Press the "CONT" button to accept these settings.

After setting up and leveling your Leica total station, press the F6 key from the Main Menu screen to enter the Measurement Mode. If you have the proper cable connecting your data collector to your Leica instrument, your setup is complete and you may continue storing data or staking points.

Point Store (with Equipment or Manual Entry)

Traverse shots and Side shots can be taken by using option P, **Store Point**, from the Main Menu. When configured to Manual or any total station, the following screen (Screen 1) will appear, which the user can arrow key through and fill out as shown:

```
  OC:  20              FS:  21
  BS:  1
>BS Azimuth:  225.0000
  Instrument Height:  5.1
  Target Height:  4.7

  Occupy Pt  : 21
  Northing   : 5100.0000
  Easting    : 5100.0000
  Elevation  : 1000.0000
  Desc       : START
  ESC  TR  SS  IN  PT  BS  OS  CL
```

Whenever a backsight point is entered, the backsight azimuth is calculated. Alternately, a backsight

azimuth can be entered and the backsight point left blank. The user can then traverse forward with TR, sideshot with SS, inverse to the next point with IN, or simply enter and review point data with option PT. There are also the options to check the backsight point (BS), store a point with an offset method (OS), or record a closed horizon shot (CL). These options are activated by highlighting them and pressing Enter or by entering T, S, I, P, B, O, or C respectively.

Function Keys

You may also use the function keys (F1, F2,...) which correspond to each option. For each data collector, the function keys may differ slightly.

The function menu for the DAP 9500 looks like this:

TRV | SS | INV | PT
BSCK | OSET | CLZ |

For Traverse, use Fct+B or Fct+1. For SideShot, Fct+C or Fct+2. Inverse with Fct+D or Fct+3. Activate the Point Menu with Fct+E or Fct+4. For Backsight Check, use Fct+H or Fct+5. Offset with Fct+I or Fct+6. Go to Close Horizon with Fct+J or Fct+7. You may also use Fct+A or Fct+ESC to escape back to the main menu.

The function menus for the DAP 9800 look like this:

First menu: **TRV SS INV PT ®**

While this menu is displayed, use F1 to Traverse, F2 to Take a SideShot, F3 to Inverse or F4 to go to the Point Menu. To scroll to the next menu screen, use the F5 key.

Second menu: **BSCK OSET CLOS ®**

While this menu is displayed, use F1 to do a Backsight Check, F2 to collect an Offset point or F3 to Close Horizon and F5 to scroll back to the first menu screen.

The function menus for the HUSKY look like this:

First menu: **ESC | F1=TRV | F2=SS | F3=INV | F4=PT | End=MORE**
Second menu: **ESC | F1=BSCK | F2=OSET | F3=CLHZ | Home=MORE**

These menus show you how the function keys are used. To scroll from one menu to the other, use the keys Home and End which is done by Shift+Right Arrow or Shift+Left Arrow.

The function menu for the HP Palmtop looks like this:

ESC TR SS IN PT BS OS CL

Use the ESC button to escape back to the main menu, the F1 key to Traverse and the F2 key to take a SideShot. For Inverse use F3 and to go to the Point Menu, use F4. Do a Backsight Check with F5, take an Offset shot with F6 and a Closed Horizon with F7.

Taking a Shot

From the data collector, select which type of shot (TRV, SS, etc.) and the following screen should appear:

Shooting the Gun...

The SurvStar program will trigger the gun and retrieve data automatically, so no other key presses are necessary at the total station†. Once the traverse or side shot is complete, a menu appears (Screen 2) similar to the one shown below:

Occupy Point: 2
>Angle Right: 135.11 (right arrow key toggles through azimuth, angle left, etc.)
>Slope Distance: 200.3 (right arrow key toggles through horizontal distance)
>Zenith Angle: 88.5123 (right arrow key toggles through vertical angle, elev. diff., etc.)
HI: 5.10 HT: 4.70
Foresight Point: 3
Desc: fence
ESC CODE ACCEPT

After manually entering "fence" and pressing Enter, the program defaults to ACCEPT, and a second Enter stores the data. Then the user is returned to the **Store Point** screen (Screen 1). The program cycles from Screen 1 to Screen 2 as shots are taken manually or with the total station. However, the user does have the option to enter the **Inverse**, **Point**, **Backsight Check, Offset,** or **Closed Horizon** screens from Screen 1.

† If using a Geodimeter RPU, please see page 5-5.

Inverse

The **Inverse** Screen appears as follows:

```
  PT  TO  PT: 1  3
  Bearing:  N 05°03'14" E
>Horizontal Distance:  274.65
  Elev Diff:  4.3046
  Occupy Point:  3
  Backsight Point:  1
  ESC
```

(entered as 1 "space" 3 or as 1 Enter, 3 Enter)

(right arrow toggles to slope distance)

The first point entered will be your backsight point, the next point will be your occupy point. When you escape back to the point store menu, these point values will be defaulted as your occupy and backsight points for the next traverse or sideshot.

Point

The **Point** screen appears as follows:

```
  Point      : 21
  Northing   : 5300.2586
  Easting    : 5100.6408
  Elevation  : 1004.4200
  DESC:  fence
  ESC  UP  DOWN  CODE  STORE
```

The user can arrow key up and down through all items in the **Point** screen and alter any item. It is a convenient location to alter descriptions. You can even call up "wordy" descriptions from a stored table of codes, where 17 might translate to "fence post" upon download. The UP and DOWN options allow for review of adjacent points. You can also enter new points by highlighting the "Point: " field and entering in a new point number, then arrow down through the fields and enter appropriate values. Once you have entered values for Northing, Easting, or Elevation, you can toggle the highlighted number from positive to negative by pressing the "-" key (Shift+K on the HUSKY, FCT+¬ on the DAP 9500). Point ***numbers*** can ***not*** be negative. Don't forget to STORE any new or modified points before exiting this menu. SurvStar will not save these changes automatically and will not prompt you when you exit.

Backsight Check

The **Backsight Check** screen appears as follows:

N 5100.0000 E 5100.0000 EL 1000.0000
Backsight Point: 1
Occupy Point: 20
Horizontal Angle: 225.0000
>Slope Distance: 12.254 (right arrow toggles through horizontal distance)
>Vertical Angle: 5.1425 (right arrow toggles through vertical angle, elev. diff., etc.)
DIFF: N -0.8226 E 0.0610 EL 0.0124
ESC ZEROHz

Before entering this menu, SurvStar will take a sideshot with the total station and display the horizontal angle, slope distance, etc. SurvStar will also calculate the difference in Northing, Easting, and Elevation between the Backsight point and the current target point. Use the ZEROHz option from this menu to set the horizontal angle on the gun to zero.

Offset

The **Offset** menu appear as follows:

Point Offset
1. Distance\Angle
2. Plus\Minus
Enter Choice:

The first option will take two separate shots, the first to record slope distance, and the second to record angle measurements. Use this option to record difficult shots by first aiming at a prism held at the same distance and height from the gun as the target, and then turning the gun towards the target to record (without the prism) horizontal and vertical angles. You will be prompted to hit "Enter" when ready before each shot.

The second option will prompt you first for a horizontal distance (either positive or negative) between the prism and the target point. Once you hit enter, the program will proceed to take a shot and then apply this horizontal offset value to the slope distance using the measured vertical and horizontal angles.

Closed Horizon

The **Closed Horizon** option will take a series of 4 shots: Foresight Direct, Foresight Reverse, Backsight Direct, Backsight Reverse. You will be prompted to hit enter before each shot. Information about these shots will be stored in the raw file (*.rw5).

Stakeout (S)

When you enter the Stakeout Option, you will see the following menu:

-Stakeout Methods-
1. Enter Coordinates
2. By Point Number
3. Enter Station-Offset
-Options-
4. Report - No

Select one of the three stakeout methods. Next, will appear a screen similar to the one below:

N 5024.2378 E 5022.1533 EL 25.432
OC Point: 1
BS Point: 2
>Backsight Azimuth: 303.4451
Instrument Hgt: 4.753
Target Hgt: 6.254
ESC:Exit F1:Stakeout

There are three methods for staking out a point. The first option is to enter the target northing, easting and elevation directly. If you are not calculating elevations, then you don't need to enter a target elevation. Use the right, left, up and down arrow keys to select Northing, Easting, Elevation, etc.. Fill in the appropriate values. Be sure to set a backsight point or backsight azimuth before continuing the stakeout process. Once all the values are set, press F1 to begin staking out this point.

The program calculates the azimuth direction to which you should aim your total station. This is displayed on the next screen. Highlight the "Angle Right" field, then use the left and right arrow keys to toggle to Azimuth. After turning the gun† to the desired angle and setting up your prism, press F1 to take a shot. Your current distance (zero before the first shot), current coordinates, and

† Geodimeter robotic total stations will turn to the target azimuth automatically.

angle error will be updated. Note the current distance of the prism, and the distance you should move the prism in or out (towards or away from you). When you have set the prism, press F1 again to shoot the gun. You may continue to move and shoot until you reach a point that is acceptable. At that point, arrow key right to **ACCEPT** and press enter (or use the F2 key). A summary of the stakeout will be displayed and you will be given the option to store this point. You are then returned to the setup screen where you can enter new coordinates to continue and stake out another point. You may end stakeout by pressing the ESC key.

The second method of stakeout is exactly like the first, except that the target coordinates are read from the coordinate file by entering the point number. Use the arrow keys to highlight the "Stake Point:" field. Enter the point number here, then verify that your occupy point, backsight point, instrument height and target height are set properly. Press F1 to begin the stakeout. When you are done staking out this point, you will be prompted to stakeout the next point in the file. Press ESC to exit the stakeout routine. Stakeout will end automatically after the highest point in the file has been staked.

The third method is to enter a station and offset which calculates the target coordinates using a centerline file. A centerline file can be created in SurvCadd or in SurvStar under the 4th option of the Roadwork menu. Once you have entered a station and offset, stakeout will continue similar to the two previous methods. At the end, you will be given the opportunity to enter another station and offset. To end the stakeout routine, press ESC.

When the report option is set to **YES**, the software generates a report text file of the stake points. The report file is named after the current coordinate file using a **".txt"** file extension. The report contains the following:

Target Point# Northing Easting Elevation Distance RMS PDOP Comment

Elevation Difference (E)

This command reports the elevation difference between a point and a surface model. A negative elevation difference represents cut and a positive elevation difference is fill. The surface model can be defined by a grid file, triangulation file or template design files (select which type at the first prompt). The point can be entered as coordinates, a point number from the current coordinate file, or read from the total station. SurvStar calculates the elevation at that position on the surface model and compares this surface model elevation with the point to report the elevation difference. There is an option to store the point to the coordinate file with the elevation difference as the point description. A vertical offset can also be entered to be added to the surface model.

The grid file is a rectangular mesh with elevations at each corner (shown on pg 4-20). The grid file has a **".grd"** extension and can be created in SurvCadd. The triangulation file represents a triangulation mesh (also shown on pg 4-20). This file has an **".flt"** extension and can be created in SurvCadd or Softdesk. The maximum number of points in the triangulation file is 500.

The template design files include the centerline (.cl file), vertical profile (.pro file) and template file (.tpl file). Superelevation (.sup file) and template transition (.tpt file) can optionally be applied. Using the entered or read coordinate, SurvStar calculates the station and offset for the coordinate. Then the road design is calculated at that station and the template elevation is computed for the offset. The road design files can be created in SurvCadd or with SurvStar (under the Roadwork menu).

Roadwork (R)

Go to the Roadwork menu for any of the five following options:

1. **Centerline Position**
2. **Slope Staking**
3. **Enter Template**
4. **Enter Centerline**
5. **Enter Profile**

Centerline Position

This command calculates the station and offset of a point relative to a centerline. The centerline is stored in a **".cl"** file which can be created in SurvCadd or with the 4th option (Enter Centerline) in the Roadwork menu. The point coordinates can be entered directly, specified by a point number in the current coordinate file, or read from the total station. You will be given an option to store the point with the station and offset recorded automatically in the point description. Before calculating the offset value, the program will prompt you for a **"Description Prefix:"**. This prefix will be added to the beginning of the new point descriptions. To exit Centerline Position, just press enter after leaving the point or northing blank, or press 'X' when prompted to read the total station equipment.

Slope Staking

Slope Staking is also located in the Roadwork menu. This command uses coordinates read from the total station to model the existing ground and then applies a design template, centerline and profile to calculate where the cut or fill slope intersects the existing ground. Superelevation and template

transitions can also be used. The road design files can be created in SurvCadd and uploaded onto the data collector. The template, centerline and profile files can also be made in SurvStar under the Roadwork menu.

After specifying your road design files, the program prompts for the **"Template elev difference point"**. This is the template point description for calculating the elevation difference from the catch point to the template. Each template grade has a description. For example, in the sample template shown on pages 4-23 and 4-24, the template elevation difference point could be SHD. Then at the end of the routine when the catch point is found, the elevation difference from the catch point to template point, SHD, is reported.

The next step is to locate the station to stakeout. When you have reached a point along the centerline, press Enter to read the total station which reports this current station and offset. If this station is unacceptable, you can move to a new position and read the total station again to find another station. When the desired station is reached, the program begins the slope staking at this station as the stakeout station. The side to stakeout is determined by the initial offset. If the first offset is left of the centerline then the left template slope is used. Likewise the right template slope is used when the first offset is right of the centerline.

The centerline elevation at the stakeout station is calculated using the design profile and then the template is applied. The existing surface to tie into is defined by the elevations from the total station coordinates. The point where the cut or fill slope from the template intersects the existing ground is called the catch point. As each coordinate is read, an existing surface cross section is built and the catch point is calculated. The distance from the current position to the catch point is reported as the distance difference (**DIST DIFF:**). The elevation difference from the current position to the catch point is also reported. A positive distance difference means that the catch point is at a greater offset from the centerline than the current position and you should move out from the centerline. A negative distance difference shows that the catch point is closer to the centerline. Based on this distance difference, you move perpendicular to the centerline either towards or away from the centerline to reach a new offset while maintaining approximately the same station. When you reach the new position, press Enter to read the total station which adds another offset-elevation point to the existing surface cross-section and recalculates the catch point and distance difference. The current station is also reported next to the stakeout station in case you have moved away from the stakeout station.

When the catch point is located, press 'X' to end the slope staking. Next there is an option to locate an offset point. The program reports the station and offset of the catch point and then prompts for the station and offset of the point to stakeout. To locate the offset point, the standard total station stakeout routine is used (see page 5-11).

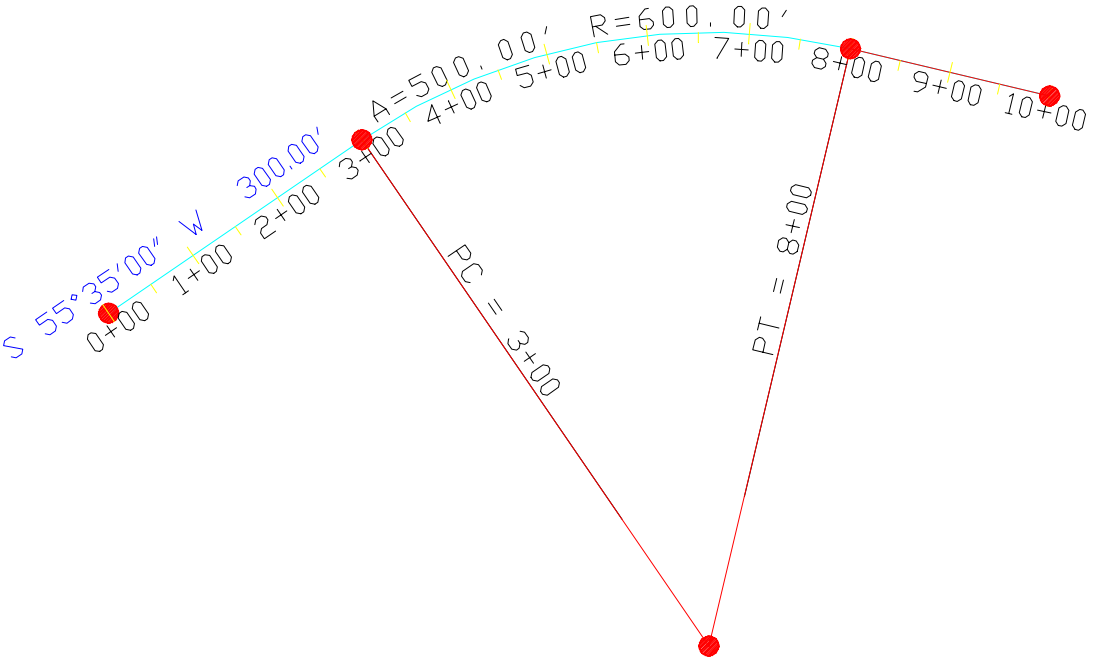
Enter Template

This command is a very simple template design. Much more detailed templates can be created in SurvCadd but this command allows you to create a template in the field. One you start the Enter Template routine, the program will prompt you for a template filename. The template is stored in a **".tpl"** file. You may select an existing filename or enter a new one. Do not enter a file extension, SurvStar will add this automatically. The next prompt determines if the left side of the template will be the same as the right. In the following example, the left and right side grades are the same. The program will then prompt for a series of grades starting from the centerline. If the sides are non-symmetrical, the left side will be filled out first. For each grade you enter a horizontal distance, percent slope and description. The description is used by Slope Staking. After entering the last grade at the edge of the road, press Enter at the grade distance prompt to end the grade entry or begin right side grade entry if sides are non-symmetrical. Finally, enter the cut and fill slope ratios.

Template file to Write: RD
Left side same as right (<Yes>/No)? Press Enter.
Say No to have a non-symmetrical template.

Grade Distance (Enter to End): 10
Grade Percent Slope: -1
Grade Description: EP
Grade Distance (Enter to End): 4
Grade Percent Slope: 3
Grade Description: SHD
Grade Distance (Enter to End): Press Enter
Cut Slope Ratio: 2
Fill Slope Ratio: 2

Enter Centerline



Application: To enter centerlines for calculation of stations and offsets and for stakeout. Centerlines are one of three required elements in template-based stakeout, the others being the profile and template itself.

Procedure: Select option 4, or when in SurvCOGO type **SN**. Centerline entry within SurvStar requires that point numbers have been established for all PC's, PT's and PI's of the centerline, as well as for radius points. (SurvStar will not permit entry of spiral curves. Any centerline, including centerlines with spirals, can be made within SurvCadd and downloaded into the data collector for use in stakeout.)

CENTERLINE STATIONING

USE PC7 TO BEGIN CURVE AT POINT 7

STARTING STATION? 0 (in our example, but it could be 1500 or any other value)

STARTING POINT? 1
NEXT PT, 0 TO END? PC2
RADIUS #? 3
CURVE LEFT OR RIGHT (L OR <R>)? Enter
PT OF TANGENCY? 4
Curve data is then displayed.
NEXT PT, 0 TO END? 5
NEXT PT, 0 TO END? 0

(1) PRINT CENTERLINE FILE
(2) STORE FILE TO DISK
(0) RETURN TO MENU
? 2
FILE NAME? ROADWAY (do not enter an extension—".CL" will be used automatically)

(1) PRINT CENTERLINE FILE
(2) STORE FILE TO DISK
(0) RETURN TO MENU
? 1

PT.# STATION DESCRIPTION
1 0 POINT ON LINE
2 300 POINT OF CURVATURE
3 RADIUS PT 47.4447 DELTA ANGLE (DD.MMSS)
4 800 POINT OF TANGENCY
5 1000 POINT ON LINE

This centerline file can then be recalled within centerline-based stakeout routines for both GPS and total station field work. The centerline file is an ASCII file which can be reviewed in a text editor.

Enter Profile

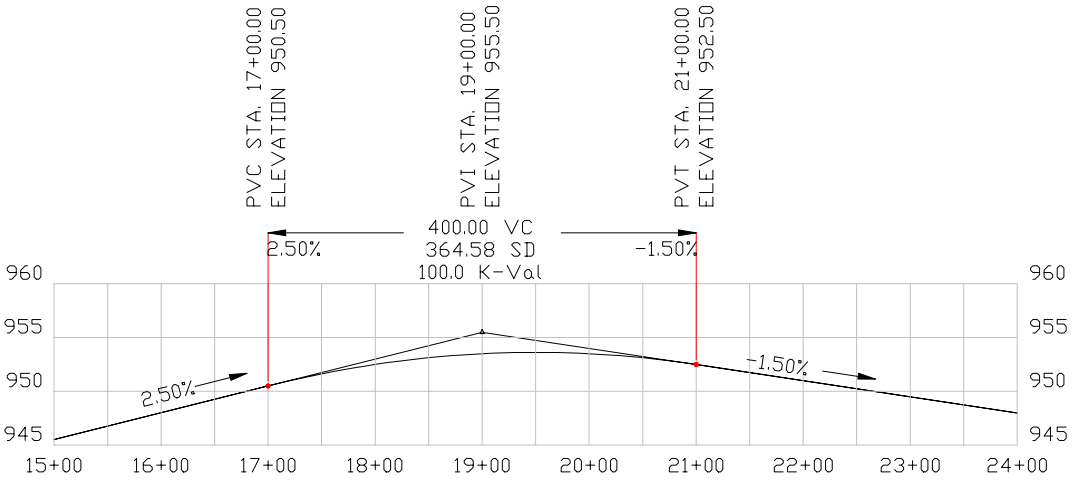
Application: To create road profiles and generic profiles (eg. ditches) to stake in the field or to use in conjunction with template and centerlines for slope staking, grade staking and grade control.

Procedure: Select menu item 5, or when in SurvCOGO type **VC** (it stands for "vertical curve", a component of road profiles, in contrast to "horizontal curve"). A menu appears:

PROFILE CALCULATIONS

(1) MAKE ROAD PROFILE
(2) RECALL ROAD PROFILE
(3) MAKE GENERIC PROFILE
(4) RECALL GENERIC PROFILE
(0) END

Consider the simple road profile shown below:



This profile would be entered by selecting option 1, MAKE ROAD PROFILE. Prompting follows:

BEGINNING STATION? 1500
ELEV. OF 1ST STATION? 945
<1> KNOWN PI ELEVATION
(2) KNOWN % GRADE
(<1> OR 2)? Enter (it is typically more accurate to base profile on the PI elevation).

STATION OF NEXT PI? 1900
ELEVATION OF NEXT PI? 955.5
LENGTH OF VERTICAL CURVE
(0 IF THIS IS END STATION, U TO UNDO)? 400 (note the vertical curve length is entered after the PI elevation)

STATION OF NEXT PI? 2400
ELEVATION OF NEXT PI? 948.0

LENGTH OF VERTICAL CURVE
(0 IF THIS IS END STATION, U TO UNDO)? 0 (to end!)
STORE PROFILE TO DISK (<Y>/N)? Enter

PROFILE NAME (RETURN-END)? ROAD
This leads to another menu that is handy for calculation:
SELECT FROM THE FOLLOWING MENU:
(0) CALCULATE INTERVAL ELEVATIONS
(1) CALCULATE SPECIFIC ELEVATIONS
(2) CALCULATE HIGH/LOW POINTS
(3) CALCULATE SUBGRADE ELEVATIONS
(4) RETURN TO PROFILE MENU
(0) MAIN MENU? 2

STATION? (0 TO END)? 1872.3
18+72.3 953.24
STATION? (0 TO END)? 2015
20+15 953.4
STATION? (0 TO END)? 0

The same calculation menu appears. Select 3 for the high and low points.
19+54.55 953.59
Now select 5 to return to the local profile menu (as opposed to the main COGO menu). If 2 is selected for RECALL ROAD PROFILE, the same 5-option sub-menu appears as above. The RECALL ROAD PROFILE menu is entered automatically after completing MADE ROAD PROFILE.

The same pattern holds true for option 3, MAKE GENERIC PROFILE. This routine differs from MAKE ROAD PROFILE by not asking for a length of vertical curve. It will also report the percent grade to each newly entered PI station and elevation. It leads to the calculation menu after the generic profile is entered, as does the command RECALL GENERIC PROFILE.

Profiles in SurvCOGO (and SurvCadd) are ASCII files that store with a "**.pro**" extension as in ROAD.PRO. They take the form:

Station, Elevation, Length of Vertical Curve

For example, our road profile appears as follows in a text editor:

1500, 945, 0
1900, 955.5, 400

2400, 948, 0
0, 0, 0

A user could enter such a profile in a text editor and then download it to the DATA subdirectory on the DAP, Husky or other controller.

Chapter 6 - SURVCOGO

Applications

The SurvCOGO program offers complete field Cogo including coordinate entry, traverse and sideshot, radial stakeout, all major intersect routines, centerline entry and stationing, profile entry and stationing, inverse with area, horizontal curves, offset to a line and coordinate transformation. Also included are ASCII file importing and exporting and a variety of routines to translate, delete, renumber and revise coordinates. SurvCOGO also includes attractive screen viewing of coordinates with the ability to graphically connect points with lines and check areas. SurvCOGO enables manual entry of field notes, and offers an alternative to manual entry within the Data Collection routine (covered in chapters 4 and 5).

The Menu

SurvStar on the DAP

—SURVSTAR COGO—-	
ENTER & ASSIGN	E
TRAVERSE	T
INVERSE	I
SIDESHOT	SS
RADIAL STAKEOUT	RS
FILE ADJUSTMENT	FA
CONFIGURATION	CF
LIST COORDS	L
CRD TRANSFORM	CT
VIEW SCREEN	VS
INVERSE W/ AREA	IA
BRG.-BRG. INT.	BB
BRG.-DIST. INT.	BD
DIST.-DIST. INT.	DD
OFFSET TO A LINE.	OF
HORIZ. CURVE	HC
EXIT TO SurvStar	X

SurvStar on the Husky

ENTER & ASSIGN	E	LIST COORDS	L
TRAVERSE	T	CRD. TRANSFORM	CT
INVERSE.	I	BB INTERSECT	BB
SIDESHOT	SS	BD INTERSECT	BD
RADIAL STAKEOUT	RS	DD INTERSECT	DD
FILE ADJUSTMENT	FA	LINE OFFSET	OF
CONFIGURATION	CF	INVERSE W/AREA	IA
EXIT TO SurvStar	X	?	

Note: On the DAP, you can scroll left and right on the screen (useful when listing points) by doing blue arrow, left arrow for left and blue arrow right arrow for right.

The user may enter both upper case and small case selections. All entries should be followed by Enter or Carriage Return (the "Yes" key on the Husky and the lower right larger key on the DAP 9500). All reference to the main COGO menu hereafter shall indicate the above menus. SurvCOGO is "command-driven". The user can transfer instantly from one routine to another without going through the menu. For example, from within I for inverse, the user can enter T for traverse and switch to the traverse routine. The main menu can be recovered by entering M.

Configuration (CF)

Much of the prompting and computation within SurvCOGO responds to the settings within Configuration, menu item CF. Even the paths of the program and data are set within CF. The program accesses and alters an ASCII file called CONFIG.PIK within the Configuration program. This file can also be revised by any text editor. There are 29 configuration items within Config.pik. A typical configuration on the DAP, for example, is as follows:

TABLE 6.1

ITEM	STATUS	CONFIGURATION
(1)	IBME	Computer (IBME displays 640x480 graphics)
(2)	HPLJ	Printer (use EP for printouts to EPSON)
(3)	A:	Data Drive (A: for DAP, C: for Husky)
(4)	\DATA\	Place data in data directory
(5)	A:	Program Drive (A: for DAP, C: for Husky)
(6)	\SURVSTAR\	Program Subdirectory
(7)	C	<C>arlson
(8)	1	Scale Factor (Change to 16.5 to enter poles, for example)
(9)	1/Y	Tab Pt/Skip (Tab for Point number, Y for line skip)
(10)	1	Tab Northing
(11)	13	Tab Easting
(12)	2	Tab Elevation (on 2nd line for Dap, 1st line for Husky)
(13)	5	Tab Bearing
(14)	7	Tab Degrees
(15)	17	Tab Dash (Dash occurs with item 18 set to Y)
(16)	17	Tab Distance
(17)	N	Extra Decimal Y/N (distances to 3 decimals, bearings to 1)
(18)	N	Deg, Min, Sec Y/N (display the word "degrees", etc.)
(19)	1/9600	Plotter Port/Baud (not applicable to data collectors)
(20)	FZ	Feet and Zenith mode (M-400/metric, m-360/metric, V-vertical)
(21)	ABC	Angle Code Mode (AR-angle right, AZI-azimuth)

(22)	80C	80 column printer (versus 132C for 132 column printer)
(23)	Y	Description Text (you can configure text off with N)
(24)	BR	Bearing Print Mode (AZ for north azimuth, SAZ for south azimuth)
(25)	1/9600	Com Port/Baud (for communication, irrelevant on DAP/Husky)
(26)	15	Foreground Color (15 is bright white, 7 is normal white)
(27)	1	Background Color (1 is blue—no effect on monochrome screen)
(28)	1	Border Color (1 is blue—no effect on monochrome screen)
(29)	0	Earth Curvature/Refraction (0-Off, 1-On), applies to traverse/ss

It should be noted that SurvCOGO can be transferred to a PC, where typing ON at the menu initiates printer output. When working from a PC, items 9 through 18 become critical for setting the style of the printout. Here are two PC-based printout styles governed by configuration items 9 through 18

TABLE 6.2

ENGLISH - 1 LINE CONFIGURATION

ITEM	STATUS	CONFIGURATION
(1)	IBME	COMPUTER
(2)	EP	PRINTER
(3)	C:	DATA DRIVE
(4)	\SDATA\	DATA SUBDIRECTORY
(5)	C:	PROGRAM DRIVE
(6)	PROGRAM	SUBDIRECTORY
(7)	C	<C>ARLSON
(8)	1	GRID SCALE/SEA LEVEL FACTOR
(9)	5	TAB FOR PT #/LINE SKIP FOR PT## (IE. 6/Y)
(10)	36	TAB FOR NORTHING UNITS
(11)	48	TAB FOR EASTING UNITS
(12)	61	TAB FOR ELEVATION UNITS
(13)	10	TAB FOR BEARING QUADRANT
(14)	13	TAB FOR DEGREE UNITS
(15)	24	TAB FOR DASH, IF ANY
(16)	25	TAB FOR DASH, DISTANCE
(17)	N	EXTRA PRECISION PRINTOUTS (Y OR N)
(18)	N	DESCRIPTION TEXT, IE. DEG,MIN,SEC, (Y / N)
(19)	1/9600	PLOTTER PORT/BAUD RATE
(20)	FZ	FEET/METERS-VERTICAL,ZENITH

E&A	1			5000.0000	5000.0000	1000.00	BENCHMARK
TRAV	2	SW 54 21 00	294.00	4828.6450	4761.0947	986.15	IRON PIN

TABLE 6.3

ENGLISH - 2 LINE CONFIGURATION

ITEM	STATUS	CONFIGURATION
(1)	IBME	COMPUTER
(2)	EP	PRINTER
(3)	C:	DATA DRIVE
(4)	\SDATA\	DATA SUBDIRECTORY
(5)	C:	PROGRAM DRIVE
(6)		PROGRAM SUBDIRECTORY
(7)	C	<C>ARLSON
(8)	1	GRID SCALE/SEA LEVEL FACTOR
(9)	6/y	TAB FOR PT #/LINE SKIP FOR PT # (IE. 6/Y)
(10)	15	TAB FOR NORTHING UNITS
(11)	29	TAB FOR EASTING UNITS
(12)	43	TAB FOR ELEVATION UNITS
(13)	8	TAB FOR BEARING QUADRANT
(14)	13	TAB FOR DEGREE UNITS
(15)	37	TAB FOR DASH, IF ANY
(16)	39	TAB FOR DISTANCE
(17)	Y	EXTRA PRECISION PRINTOUTS (Y)
(18)	Y	DESCRIPTIVE TEXT, IE. DEG,MIN,SEC (Y / N)
(19)	1/9600	PLOTTER PORT/BAUD RATE
(20)	FZ	FEET/METERS - VERTICAL, ZENITH

E&A	1	5000.0000	5000.0000	1000.000	BENCHMARK
TRAV	NW	19 DEG 34 MIN 51.0 SEC — 295.173 FEET			
	131	5278.1028	4901.0768	987.555	SET UP #2

TABLE 6.4

METRIC - 1 LINE CONFIGURATION

ITEM	STATUS	CONFIGURATION
(1)	IBME	COMPUTER
(2)	EP	PRINTER
(3)	C:	DATA DRIVE

(4)	\SDATA\	DATA SUBDIRECTORY
(5)	C:	PROGRAM DRIVE
(6)		PROGRAM SUBDIRECTORY
(7)	C	<C>ARLSON
(8)	1	GRID SCALE/SEA LEVEL FACTOR
(9)	5	TAB FOR PT#/LINE SKIP FOR PT#(IE. 6/Y)
(10)	31	TAB FOR NORTHING UNITS
(11)	43	TAB FOR EASTING UNITS
(12)	56	TAB FOR ELEVATION UNITS
(13)	10	TAB FOR BEARING QUADRANT
(14)	13	TAB FOR DE = UNITS
(15)	20	TAB FOR DASH, IF ANY
(16)	21	TAB FOR DISTANCE
(17)	N	EXTRA PRECISION PRINTOUTS (Y OR N)
(18)	N	DESCRIPTIVE TEXT, IE. DEG,MIN,SEC (Y / N)
(19)	1/9600	PLOTTER PORT/BAUD RATE
(20)	MZ	FEET/METERS - VERTICAL, ZENITH

E&A	247			4983.4151	5013.2955	57.345	SET UP NO. 1
TRAV	248	AZ 391.2495	241.269	5222.4090	4980.2367	63.618	IRON PIN
SS	249	AZ 241.8907	139.317	5112.1802	4895.0372	58.484	FENCE POST

Discussion of Configuration Usage:

Item 8: GRID SCALE/SEA LEVEL FACTOR: All distances entered in traverse or sideshot will be multiplied by the factor in config item 8. Normally, place a 1 in item 8. State plane coordinates are such that a distance measured in the field up the central meridian at sea level will calculate a new state plane coordinate without adjustment. However, if you measure up the meridian but are at an altitude above sea level, the measured distance will be greater than the "state plane" distance because of the greater earth radius at that altitude. Similarly, if you are surveying at a substantial offset to the central meridian, measured distances must be adjusted to correspond to state plane distances. If you are working with state plane coordinates and are traversing locally from a monument in an area of fairly uniform elevation, state plane coordinates can be maintained by combining the elevation factor and meridian offset factor into one number, such as .99897. All distances traversed or sideshot will then be multiplied by this number. Use a factor of 1 when doing calculation work based on previously computed field coordinates. Since Coordinate Transformation can be used to move field coordinates on State Plane Coordinates, the user may choose to do all field work with config item 8 set for 1.

One surprising application of item 8 is that it can be used to enter poles and chains directly. To work in chains (66 feet), enter 66 for item 8. To work in poles, enter 16.5 for item 8. Any positive, nonzero entry is acceptable.

Item 18: DESCRIPTIVE TEXT, IE. DEG,MIN,SEC (Y OR N): If N is entered, bearings and distances print out as numbers only. For example, for 360 circle work (see config item 20), bearings would print out as shown in Table 6.2. It is very difficult to configure for both 1-line format and descriptive text. Descriptions will certainly not fit on the line with such a format. In any metric system configuration, METERS will substitute for FEET. In the 400 circle metric configuration, all bearings will print as azimuths and will take the form ###.#### as in 387.9146.

Item 20: FEET/METERS – VERTICAL/ZENITH: This configuration item has two purposes. First, it distinguishes full Metric, partial Metric and English unit operation. Secondly, it controls the type of vertical angle used in field measurement. A typical entry would be FZ representing English unit operation and use of the zenith angle.

Considering first the units of measurement, there are three acceptable characters in the first position of config item 20. These are:

F – Angles are in the form of degrees, minutes and seconds using a 360 degree "circle". Distances are in feet. Areas are in square feet and acres. Scaling for screen plotting purposes takes the form inches per feet, as in 1"=200'.

m – Distances are in meters (or "units"). Areas are in square units and "cuerdas". The horizontal circle is the same as in English (360, divided into degrees, minutes, seconds). All scaling is in units per unit, as in 1:3000. This is a partial metric configuration that applies, in particular, to Puerto Rico. It applies also to Canada, with the exception of the area printout in "cuerdas".

M – Full metric configuration. All distances are metric. Area is in square meters and hectares. Horizontal angles and vertical angles are based on the 400 circle (grads). A due south field shot would have an azimuth of 200. Angles are metric, so that an azimuth of 195.9828 is 0.9828 of the way from 195 grads to 196 grads. A zenith angle of 100 is a horizontal reading, with 98 looking up and 102 looking down. All scaling is units per unit.

The final letter in config item 20 controls the "vertical" angle. There are three types of vertical angles:

1. Zenith Angle where 0 is straight up and 180 (or 200 in grads) is straight down.
2. Vertical Angle where 0 is horizontal, 90 (or 100 grads) is straight up and 270 (or 300 grads) is straight down. This is rarely seen in modern total stations.
3. Nadir Angle where 0 is straight down and 180 (200 in grads) is straight up.

The program currently recognizes zenith and vertical angles. The letter Z as in FZ sets zenith and V as in FV sets vertical. Nadir angles can be entered as zenith angles, except they should be entered as negatives for elevation work.

ITEM 21: ANGLE CODE MODE: This item sets the prompting in Traverse and Sideshot routines. The three setting are:

ABC – Full angle/bearing code prompting, allowing the user to mix quadrant-based traversing with azimuths, angles to the right, etc., as identified by the angle code.

AZI – Eliminates the angle/bearing code prompt and assumes all bearing entries are in azimuth. Reduces prompting when working in azimuths.

AR – Eliminates the angle/bearing code prompt and assumes all angle entries are angles to the right.

The setting in config item 21 determines the default condition in daily program use. The default entry can be altered, however, by entering ABC, AZI or AR from within the COGO routines. When running the program, the user can switch from one mode to the other at will.

ITEM 24: BEARING PRINTOUT MODE: Bearings can print out in quadrant format (eg. NE, SE, SW, NW) or in azimuth format (AZ or SAZ). If set to BR, bearing format will be used. If set to AZ, north azimuth format will be used. If set to SAZ, the south azimuth format will be used. If config item 20 is set to MZ or MV, the 400 circle (grads) is used to represent angles and azimuth printout mode is set automatically, regardless of the item 24 configuration.

ITEM 29: CURVATURE OF EARTH FACTOR (0-off, 1-on): If set off (0), this item has no effects. If set to 1, then elevations are adjusted in traverse, sideshot (both in COGO and ADVANCED TRAVERSE) based on the curvature of the earth and the distance of the field shot. The factor has a dramatic effect on long shots. If a shot is taken for a distance of 1000 feet, for example, the shot has gone straight while the sea level plane of the earth has curved away beneath it. Figure 6.1 depicts this in exaggerated form.

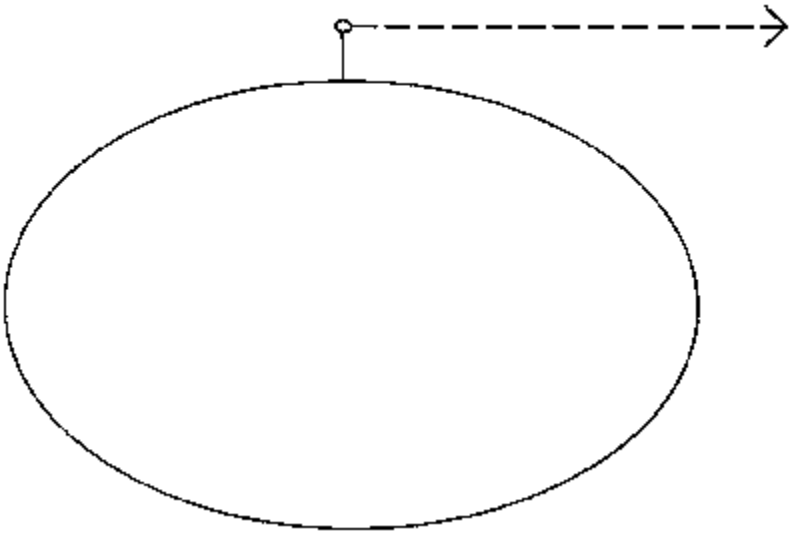


FIGURE 6.1

If a horizontal reading is taken, the shot has actually gone uphill because of curvature of the earth. The effect is negligible in short distances but increases exponentially as distance increases. For a horizontal shot of 1000 feet, the displacement is .02. For a horizontal shot of 3000 feet, the displacement is .19. If configured for metric distances, the displacement would increase by approximately a 3.28 factor (the number of feet per meter). With config item 29 set to 1, the effect of earth curvature is applied to the carrying of elevations

Enter & Assign (E)

Application: Enter & Assign is the most basic COGO routine. It is used for entering point numbers with north and east coordinates. Elevations are always prompted (press Enter to skip), but text is optional depending on whether "text on" (TON) or "text off" (TOFF) is set. Point numbers from 1 to 32,000 can be entered. When entering point numbers in sequence, Return can be pressed for default point numbering. Coordinates are stored to 17 significant figures.

When a point number is entered, the program "moves" to it. Thus if point 1 is entered with coordinates N 5000 and E 5000, the program will traverse, sideshot or inverse from coordinate 5000,5000 if those routines are entered next.

Procedure: Enter E. Prompting is as follows:

ENTER & ASSIGN (E)

POINT NUMBER <1>? 1 (or Enter – the default response is always within the <> brackets)
INPUT NORTH? 5000
EASTING? 5000
ELEVATION? 1291.23
DESCRIPTION? 1" IRON PIN (if text mode is on)

POINT NUMBER <2>? 2 (or Enter)
INPUT NORTH? 5127.23
EASTING? 4981.35
ELEVATION? 1285.03
DESCRIPTION? FENCE POST

POINT NUMBER?

You will continue to be prompted for point numbers until you enter M for the main menu or the command for another routine, such as I for Inverse or T for Traverse. If you enter another command, you will go directly to that menu item. This is what is meant by a command-driven program. The initial prompts of most COGO routines permit direct transfer to another menu item. Within Enter & Assign, the POINT NUMBER? prompt is the transfer prompt.

If point number 1 has already been stored and you attempt to enter it again, it will re-prompt:

POINT NUMBER <3>? 1
POINT NUMBER <3>?

Point number 3 is the next available point. You must re-enter 1 to force the program to accept point one as long as "point protect" (the default condition) is on. You can turn off point protect by going to File Adjustment (FA) item 6. This toggles off and on point protect.

Traverse (T)

Application: To traverse from one point to another, used when entering field notes, deed calls or when creating new points for subdivision, lot and tract surveys.

Features: The direction of the traverse can be defined by a quadrant bearing (ie. NE 10 deg 15 min), an azimuth, an angle left or right measured from a backsight, and a deflection left or right. Directions can also be point-defined. Azimuths can be entered in both the 360 and 400 degree circle (Metric). Distances can be point-defined or entered directly. Distances may also be entered with

any of the math operators (+,-,/,X) where X stands for multiplication. The form would be 47.65X4 or 1292.875/3.

The traverse operation allows for automatic point numbering. Points along a line at even distance can be created with one traverse operation. In 3-D files, and when requested, with 2-D files, zenith/ vertical angle prompting is provided. Modes can be set to activate target height and instrument height prompting, as well as prompting for the vertical difference of the field shot. Elevations can be carried from setup to setup.

A traverse from point 1 to point 2 causes the program to, in effect, "move" to point 2, holding the call from 1 to 2 as a backsight for sideshots or the next traverse leg.

As with Enter & Assign, the program will prompt for a description if Text mode is on (see the part below on additional Traverse coding options).

Procedure: Press T for Traverse. The program will first prompt for **"ANGLE/ BEARING CODE?"**. The coding system, now almost a convention with COGO programs, is shown below:

TRAVERSE CODES

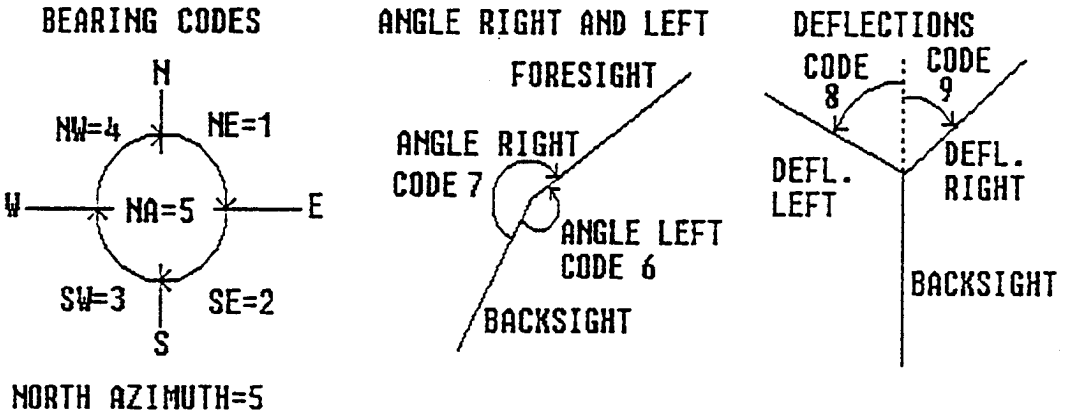


FIGURE 6.2

There are four basic prompts within the Traverse routine:

ANGLE/BEARING CODE? (ie. 1 through 9 as shown above)

ANGLE/BEARING? (entered in **DD.MMSS** or in decimal format for grads)
DISTANCE?
POINT NUMBER?

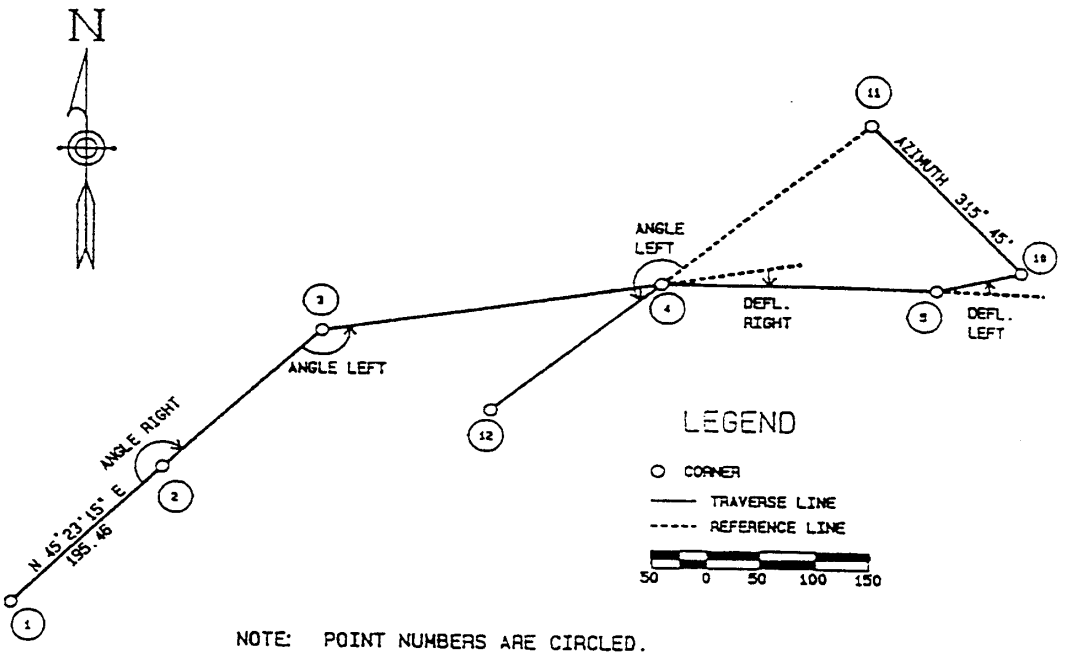


FIGURE 6.3

Suppose we wish to enter the traverse shown in Figure 6.3
Example Entries (beginning with Enter & Assign):

At the main menu prompt, press E.

?E

ENTER & ASSIGN

POINT NUMBER <1>? 1
INPUT NORTHING? 5000

EASTING? 5000
ELEVATION? 0
DESCRIPTION? GR

Resulting Printout:

E&A
POINT: 1
5000.0000 5000.0000
0.00 GR (this second line displays elevation and description)

POINT NUMBER <2>? TOFF (try this to turn off text)
POINT NUMBER <2>? T (transfers directly to traverse)

TRAVERSE ROUTINE

ANGLE CODE <>? 1 (represents northeast)
ANGLE/BEARING <>
? 45.2315
DISTANCE? 195.46
POINT NUMBER <2>? 2

Resulting Printout:

TRV NE 45 23 15 195.46
TO POINT: 2
5136.2732 5139.1427

ANGLE CODE <1>? 7 (represents angle to the right)
ANGLE/BEARING <45.2315>
? 180.3 (180 deg. 30 min. Trailing zeros can be omitted.)
DISTANCE? 200.02
POINT NUMBER <3>? 3

Resulting Printout:

TRV NE 45 53 15 200.02
TO POINT: 3
5276.5010 5282.7519

ANGLE CODE <7>? 6

ANGLE/BEARING <180.3>
? 145.1517
DISTANCE? 307.24
POINT NUMBER <4>? Enter for 4

Resulting Printout:

TRV NE 80 37 58 307.24
TO POINT: 4
5326.5079 5585.8950

ANGLE CODE <6>? 9
ANGLE/BEARING <145.1517>
? 10
DISTANCE? 251.72
POINT NUMBER <5>? Enter for 5

Resulting Printout:

TRV SE 89 22 02 251.72
TO POINT: 5
5323.7279 5837.5997

ANGLE CODE <9>? 8
ANGLE/BEARING <10>
? 15.27
DISTANCE? 82.15
POINT NUMBER <6>? 10

Resulting Printout:

TRV NE 75 10 58 82.15
TO POINT: 10
5344.7367 5917.0179

ANGLE CODE <8>? 5
ANGLE/BEARING <15.27>
? 315.45
DISTANCE? 200
POINT NUMBER <11>? Enter

Resulting Printout:

TRV NW 44 15 00 200.00
TO POINT: 11
5487.9970 5777.4598

ANGLE CODE <5>? I (Again, instant transfer, here to Inverse.)

INVERSE

POINT? 4 (We move to point 4 from point 11. The backsight to 11 is held.)

POINT? T (Again, the command-driven program transfers to Traverse.)

TRAVERSE ROUTINE

ANGLE CODE <I>? 6
ANGLE/BEARING <315.45>
? 180
DISTANCE? 200
POINT NUMBER <12>? 12

Resulting Printout:

TRV SW 49 52 09 200.00
TO POINT: 12
5197.6007 5432.9802

The traverse conducted above would plot as shown in Figure 6.3. Though Inverse is covered in a later section, it simply means "go to". When you traverse or inverse from one point to another, the backsight is automatically held, so that you can turn horizontal angles left and right or deflection angles left and right from the backsight. As an example, when traversing from 2 to 3, the program moves to 3 and backsights 2. If an angle to the right is then turned, the program calculates the resulting bearing by adding the angle right to the backsight azimuth. In this way, bearings are carried forward from backsight to foresight.

If a mistake is made during entry, just make use of Inverse to go from the last good "backsight" to the last good "setup". Then continue to Traverse.

In the example traverse above, we never returned to the main COGO menu. This is because we entered menu options at initial prompts within one routine to transfer to another routine. For this reason, we refer to the COGO program as "command-driven". "I", "T" and "E" (as well as all other menu items) act as "hot" keys. In both Enter & Assign and Inverse, the prompt, "POINT NUMBER?" can be used to transfer to another routine. Within Traverse, the first two prompts can both be used to transfer. Thus when asked for ANGLE CODE? or ANGLE/BEARING?, the user can enter E and go to Enter & Assign. However, when asked for DISTANCE?, the entry E would be taken as a 0 distance. It is only the initial, repetitive prompts within each routine that allow transfer to another menu item. Entering M at the transfer prompts returns the user to the main COGO menu.

Both the output and the prompting within the Traverse Routine are subject to change based on program configuration and certain modes set by the user. Let's review the configurations and modes that would determine the above screen-only output.

Active Modes/Configuration for Above Printout and Prompts

(1) Configuration item 17 is set to N for normal printouts (2-decimal place distances and no decimal place on the seconds)
(2) Configuration item 20 is set for feet (eg. FZ).
(3) Configuration item 21 is set for ABC, activating the Angle Code prompt.
(4) Configuration item 24 is set for BR, which gives printouts in bearing form.
(5) TOFF was entered to eliminate the text prompting

Zenith angle prompting is obtained by going to File Adjustment (FA), sub-item D, to go from the default 2-D mode to 3-D, which carries elevations. Alternately, if a 2-D traverse is involved but zenith angles are used, do FA item D again to go back to 2-D and choose the zenith prompt option.

As an example of a completely different format, consider a 400 circle (metric) traverse, strictly in azimuth, with the zenith angle used to reduce slope distances to horizontal distances. We begin by selecting CF for configuration and change config item 20 to MZ, config item 21 to AZI (no angle code prompt, all azimuth) and config item 24 to AZ for azimuth printouts. As a last step, we choose FA, item D, convert to 3-D, then select it again, convert to 2-D and ask for the zenith prompt.

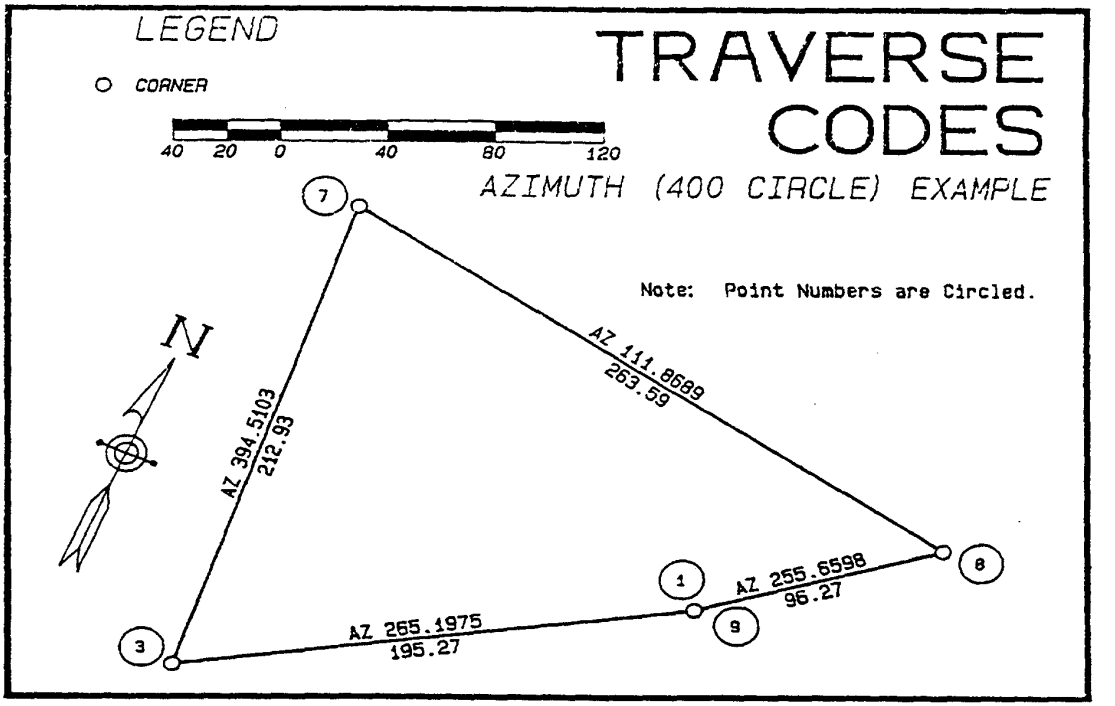


FIGURE 6.4

Starting with Enter & Assign, questions and printouts for the above example would be as follows:

?E

ENTER & ASSIGN

POINT NUMBER <1>? 1
INPUT NORTH? 5000
EASTING? 5000
ELEVATION? 0

Printout:

E&A
POINT: 1
5000.0000 5000.0000
0.0000

POINT NUMBER <2>? T

TRAVERSE ROUTINE

ANGLE/BEARING <>
? 265.1975
DISTANCE? 195.45
ZENITH ANGLE? 102.7145
POINT NUMBER? 3

Printout:

TRV AZ265.1975 195.272 (the distance always goes to 3 decimals in metric)
TO POINT: 3
4898.4875 4833.1872

ANGLE/BEARING <265.1975>
? 394.5103
DISTANCE? 214.475 (Enter as many decimal places as desired.)
ZENITH ANGLE? 92.3516
POINT NUMBER <4>? 7

Printout:

TRV AZ394.5103 212.929
TO POINT: 7
5110.6253 4814.8487

ANGLE/BEARING <394.5103>
? 111.8689
DISTANCE? 263.585
ZENITH ANGLE? Enter (Defaults to 100 Grads, or 90 Degrees)
POINT NUMBER <8>? Enter (Defaults to the next point, 8)

Printout:

TRV AZ111.8689 263.585
TO POINT: 8
5061.7677 5073.8660

ANGLE/BEARING <111.8689>
? 255.6598
DISTANCE? 96.3
ZENITH ANGLE? 98.4587
POINT NUMBER <9>? Enter

Printout:

TRV AZ255.6598 96.272
TO POINT: 9
5000.63 5000.0163

We note that in the above traverse, the calculated distance is the slope distance reduced by the effect of the zenith angle. We also note that the survey was started by menu item E, Enter & Assign. If the starting point already exists, we can also simply inverse to it to get started. The typical procedure for starting an angle-right traverse is to enter or inverse to the backsight point and traverse to the setup itself. For an azimuth-based traverse, the starting point may be the setup itself.

If a beep is heard when a point number is entered, that indicates that "point-protect" is active, and the point number entered already has coordinates. If Enter is pressed, the next available point in increasing order will be used. Point-protect is automatically on when the program is started. It is cancelled using File Adjustment, item 6.

Additional Traverse Coding Options:

(1) Pressing Enter to the ANGLE CODE prompt will default to the previous entry, once inside the Traverse routine. After pressing T for Traverse, you must enter a valid code when asked. After that first entry, Enter will default to the previous entry.
(2) Pressing L or R to the ANGLE CODE prompt will traverse 90 degrees to the left or right heading forward (100 degrees left or right with 400 circle). No ANGLE/BEARING prompt will appear. This offers a quick way to "traverse" around a building or any figure with many right-angle corners.
(3) Point-defined bearings can be entered at the ANGLE CODE prompt by entering two point numbers separated by a decimal place. Referring to Figure 6.3, if an entry of 10*5 was made at the prompt ANGLE CODE?, the program would use the bearing defined by 10 to 5, or S 75 deg 10 min 58 sec W. The user need not occupy any of the bearing-defining points. One application for point-defined bearings is shown in Figure 6.5. Given a choice, use points that are the furthest apart when defining a direction. You may sacrifice accuracy when using points that are, say, 0.001 feet apart.

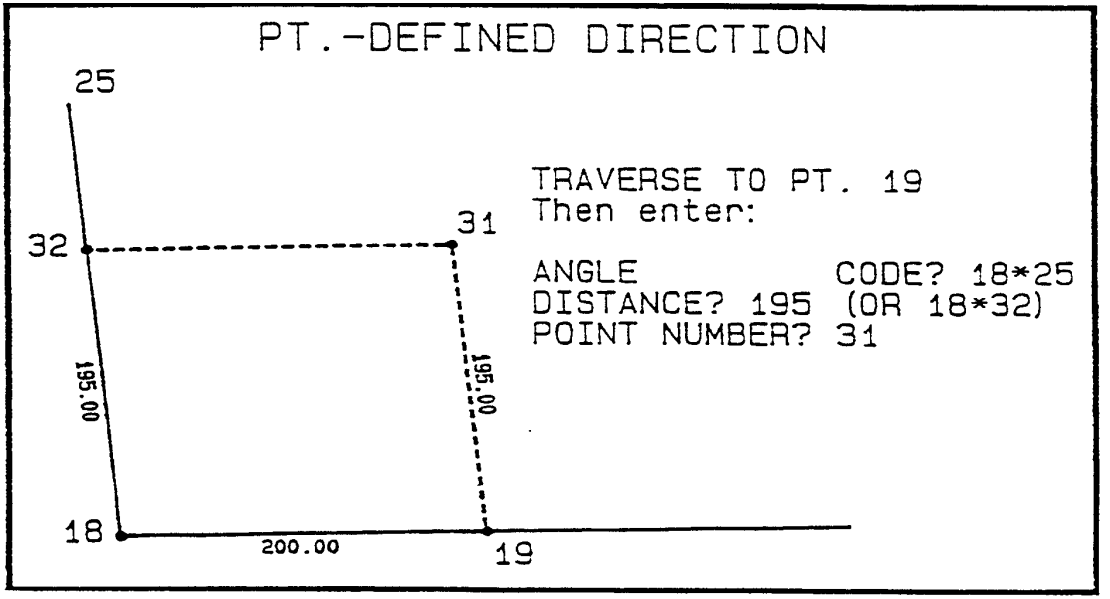


FIGURE 6.5

(4) Arithmetic operators "+" and "-" can be used with bearing entries in either azimuth mode or as a supplement to point-defined entries. Thus the user can enter a bearing of 175.23+90 in azimuth mode. Alternately, a bearing of 10*5+90 can be entered which would add 90 degrees to the azimuth defined by 10 to 5. The added bearing can include minutes and seconds, as in 10*5+30.4507.

(5) Point-defined distances can be entered using the two points separated by a '*'. Thus if the distance from point 61 to 68 is 1031.37 and you wish to traverse that same distance, at the prompt DISTANCE? enter 61*58.

(6) Distance entries can include the arithmetic operators, "+", "-", "X", and "/". If you wish to divide 2041.75 in four parts, you can traverse a distance of 2041.75/4. This is particularly useful in section division world (mid-western and western states). Do not use more than one operator per line. The entry 59.47X3 is valid. The entry 99+71.21/ 5 is not valid.

(7) Use configuration item 8 to multiply distances by any factor. If an area is, say, 5000 feet above sea level and it is desired to keep traverse work close to state plane coordinates, a scale factor can be entered for config item 8 such as .99867. All distance entries in traverse or sideshot mode will then be multiplied by this factor. Be sure the factor is 1 for normal traverse and COGO work. One unexpected application is for entry of deed calls in 'poles' (16.5 feet) or chains (66 feet). Place 16.5 in config item 8 by going to menu item CF. Then deeds can be entered directly in poles. Links can be converted to poles by multiplying by 4 and then entering them as the decimal place. For example, 17 poles 11 links can be entered as 17.44 poles.

(8) Lines can be extended by entering point numbers in the form 8-12, which would create points 8, 9, 10, 11 and 12 using the same bearing and distance entered from the occupied point to point 8. For example, if you are on point 5 and traverse NE 15 deg 100 feet to point 7, answer the prompt, POINT NUMBER? with 7-10 to traverse another 100 feet to 8, another 100 feet to 9 and another 100 feet to 10. You will then be occupying 10 and backsighting 5. The effect of this entry is shown in Figure 6.6.

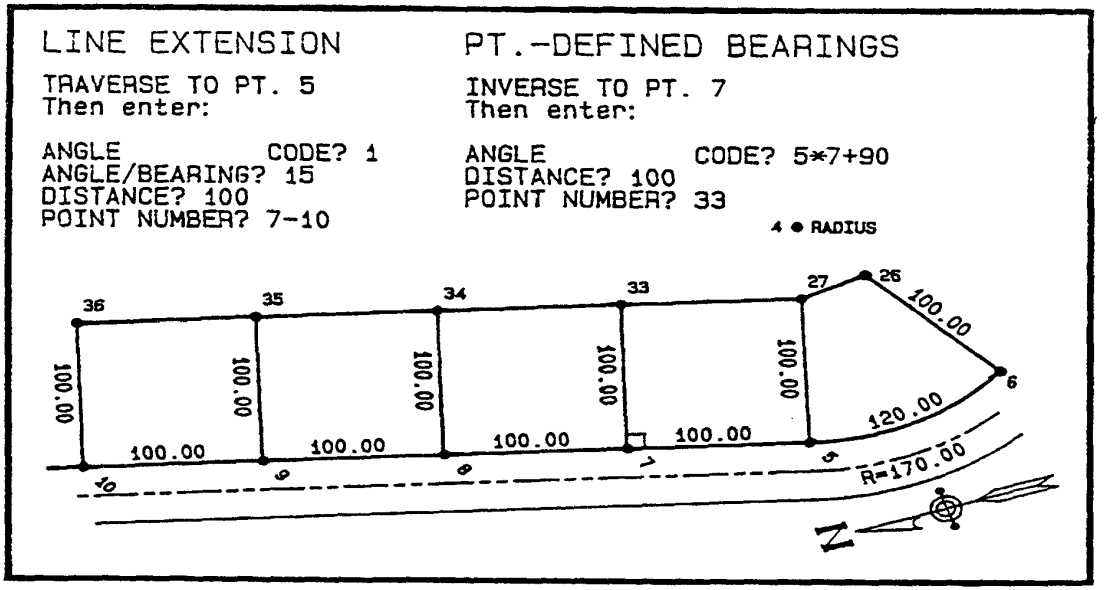


FIGURE 6.6

(9) Though configuration items 21 and 24 can set angle code prompting and bearing or azimuth printout, these can be changed by direct entry within the COGO routine. The values set in configuration will always be the default values. Accepted entries from the main COGO menu are as follows:

(a) AR - sets angle-right mode, eliminating the ANGLE/BEARING CODE prompt. All angle/bearing entries would be considered angles to the right.

(b) AZ - sets azimuth mode, eliminating the ANGLE/BEARING CODE prompt. All angle/bearing entries are taken as azimuths.

(c) ABC - restores ANGLE/BEARING CODE prompting.

(d) BR - sets printouts in bearing form (ie. SE 45 15 07).

(e) AZ - sets printouts in azimuth form (ie. AZ 134 44 53).

(10) Enter TON to activate text prompting within the Traverse Routine. Prompting will then appear as:

ANGLES CODE?
ANGLE/BEARING?
DISTANCE?
ZENITH ANGLE?
POINT NUMBER?
DESCRIPTION?

(11) Change configuration item 20 to FV, MV or mV to obtain vertical angle prompting instead of zenith angle prompting. The vertical angle can then be used to reduce slope distances or carry elevations. The vertical angle reads 0 degrees horizontally, with 2 degrees being uphill, for example, and 355 degrees being downhill. Prompting would appear as:

ANGLES CODE?
ANGLE/BEARING?
DISTANCE?
VERT. ANGLE?
POINT NUMBER?

(12) Enter HI to activate the HI mode of carrying elevations. Methods of carrying elevations are covered later, but prompting in zenith angle mode would appear as follows:

ANGLES CODE?
ANGLE/BEARING?
DISTANCE?
ZENITH ANGLE?
HGT. OF INSTR.? (entered in feet or meters with Metric configuration)
HGT. OF TARGET? (entered in feet or meters)
POINT NUMBER?

(13) Enter HIV to activate the "vertical difference" method of carrying elevations. Prompting appears as:

ANGLE CODE?
ANGLE/BEARING?
DISTANCE?

HGT. OF INSTR.?
HGT. OF TARGET?
VERT. DIF.?
POINT NUMBER?

These elevation modes are in addition to the default mode of traversing in a 3-D file:

ANGLES CODE?
ANGLE/BEARING?
DISTANCE?
ZENITH ANGLE?
PRISM (+-)?
POINT NUMBER?

SideShot (SS)

Application: To enter any number of field shots taken from one setup. To calculate coordinates radiating from one point.
Features: Sideshots require the same input as in the Traverse Routine. In Sideshot mode, the program calculates foresights without moving from the setup. The backsight is held and does not have to be reentered with each new sideshot.

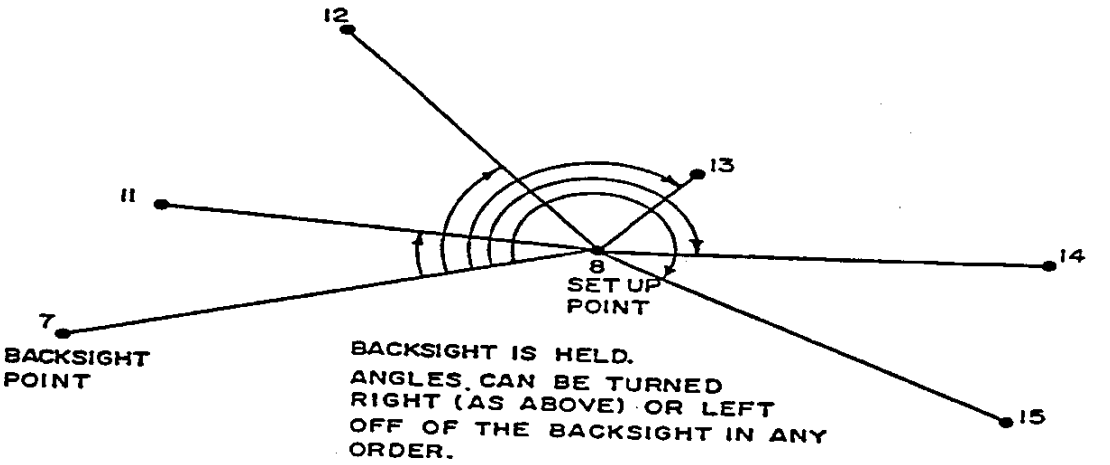


FIGURE 6.7

Procedure: Press SS for sideshot. In field surveying, it is generally desirable to have as few setups as possible. Therefore, most surveys consists of a large number of sideshots and a more limited number of traverse legs. Sideshots are usually taken in angle-right mode or azimuth mode. In angle-right mode the procedure is to inverse or traverse from backsight to setup, and then to press SS. In azimuth mode the user simply 'gets on' the setups either by inverse or traverse, the backsight being irrelevant. In either case, the sideshots are entered one after another, with no re-entry of the setup, backsight or the SS code itself. Consider the angle-right example shown as Figure 6.7

Table 6.5

(1)	IBME	COMPUTER'
(2)	HPLJ	PRINTER
(3)	C:	DATA DRIVE
(4)	\SDATA\	DATA SUBDIRECTORY
(5)	C:	PROGRAM DRIVE
(6)		PROGRAM SUBDIRECTORY
(7)	C	<C>ARLSON
(8)	1	GRID SCALE/SEA T=VEL FACTOR
(9)	5/N	TAB FOR PT #/IINE SHIP FOR PT # (IE. 6/Y)
(10)	34	TAB FOR NORTHING UNITS
(11)	46	TAB FOR HASTING UNITS
(12)	50	TAB FOR ELEVATION UNITS
(13)	11	TAB FOR DEARING QUADRANT
(14)	14	TAB FOR DEGREE UNITS
(15)	24	TAB FOR DASH, IF ANY
(16)	25	TAB FOR DISTANCE
(17)	N	EXTRA PRECISION PRINTOUTS (Y OR N)
(18)	N	DESCRIPTIVE TEXT, IE. DEG,MIN,SEC (Y OR N)
(19)	1/9600	PLOTTER PORT/BAUD RATE
(20)	FV	FEET/METES – VERTICAL, ZENITH

We will enter the field notes for the above example using vertical angles and text mode. Transits and certain European instruments use the vertical angle, where 0 degrees is horizontal and 358 degrees, for example, is downhill, 2 degrees being uphill. The printouts that follow were obtained by the configuration shown in Table 6.5, designed for a PC.

Entries beginning at main COGO menu:

?TEXT (to set Text mode)
?E

ENTER & ASSIGN

POINT NUMBER? 7
INPUT NORTHING? 10342.12
EASTING? 9768.25
DESCRIPTION? HUB #1

Printout:

E&A 7 10342.1200 9768.2500 HUB #1

POINT NUMBER? T

TRAVERSE ROUTINE

ANGLE/BEARING CODE? 1
ANGLE/BEARING? 76.34
DISTANCE? 201.5
VERT. ANGLE? RETURN (RETURN defaults to 0)
POINT NUMBER? RETURN
DESCRIPTION? HUB #2

Printout

TRAV 8 NE 76 34 00 201.5 10388.9312 9964.2372 HUB #2

ANGLE/BEARING CODE? SS

SIDESHOTS

ANGLE/BEARING CODE? 7
ANGLE/BEARING? 21.0424
DISTANCE? 168.91
VERT. ANGLE? 358.1401
POINT NUMBER? 11
DESCRIPTION? 1/2" IRON PIN

Printout:

SS 11 NW 82 21 36 168.83 10411.3769 9796.9061 1/2" IRON PIN

ANGLE/BEARING CODE? RETURN (defaults to 7, previous entry)
ANGLE/BEARING? 74.152 (Trailing 0 in 20 seconds can be omitted.)
DISTANCE? 189.71
VERT. ANGLE? 1.2355
POINT NUMBER? RETURN (defaults to next point, 12)
DESCRIPTION? 1/2" IRON PIN

Printout

SS 12 NW 29 10 40 189.65 10554.S198 9871.7771 1/2" IRON PIN

ANGLE/BEARING CODE? RETURN
ANGLE/BEARING? 131.5747
DISTANCE? 43.78
VERT. ANGLE? 352.41
POINT NUMBER? RETURN
DESCRIPTION? CONCRETE MON.

Printout

SS 13 NE 28 31 47 43.42 10427.0818 9984.9769 CONCRETE MON.

ANGLE/BEARING CODE? RETURN
ANGLE/BEARING? 198.2411
DISTANCE? 157.44
VERT. ANGLE? RETURN
POINT NUMBER? RETURN
DESCRIPTION? 1/2" IRON PIN

Printout

SS 14 SE 85 02 49 157.44 10375.3379 10121.0893 1/2" IRON PIN

ANGLE/BEARING CODE? RETURN
ANGLE/BEARING? 234.05
DISTANCE? 170
VERT. ANGLE? 352.04
POINT NUMBER? RETURN

DESCRIPTION? FENCE POST

Printout

SS 15 SE 49 21 00 168.37 10279.2469 10091.9823 FENCE POST

Lot Calculations: Sideshot and Traverse are not only used for field note entry but also for design work such as the calculation of lot corners. In the example of Figure 6.8, it is desired to calculate points 30 through 34, with the radius point 20 and perimeter points 21 to 29 already known. This would be a perfect application of point-defined sideshots. We will assume that the goal is to locate points 30 to 34 radially from the radius point to the appropriate outer boundary point. The user then simply inverses to the radius point and calculates all cul-de-sac corner points by point-defined sideshots.

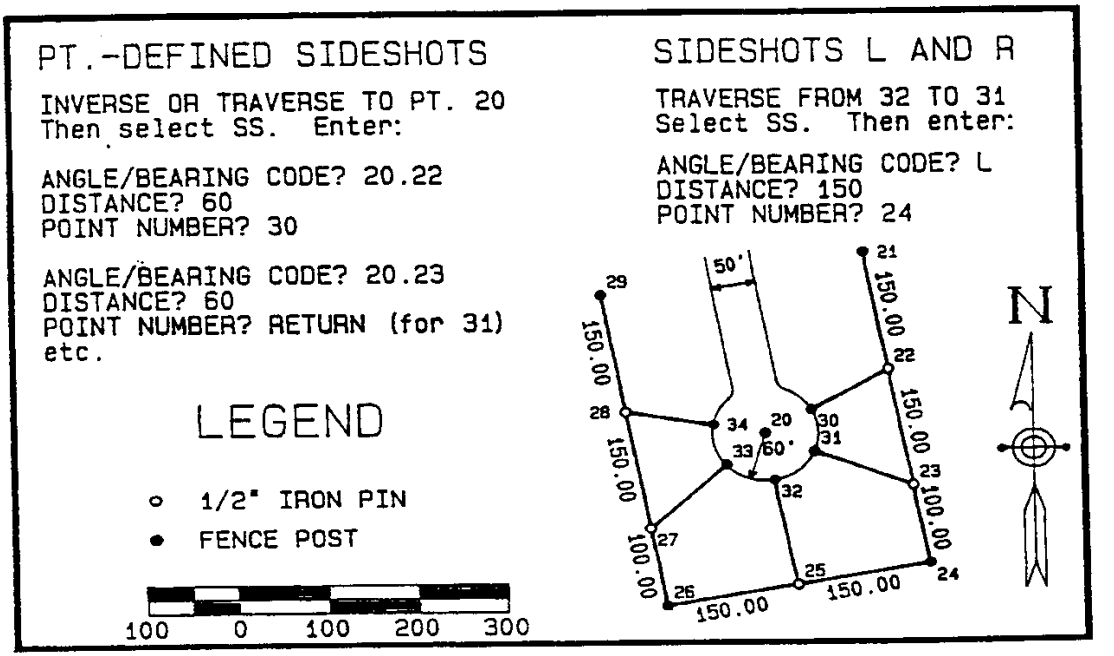


FIGURE 6.8

Dummy Points: When entering traverse and sideshot notes or when doing lot and boundary calculations, you may catch yourself entering a wrong distance or direction prior to point number entry. In such cases, enter 0 for the point number and no new point will be created.

Elevation Work: When field work is conducted for contour mapping purposes, it is not uncommon to collect 300 or 400 sideshots based on only 1 or 2 setups. The use of the traverse and sideshot routines for purposes of carrying elevations is discussed in the next section.

Carrying Elevations

There are four methods of carrying elevations using the main COGO program. These methods are as follows:

(1) From the backsight forward, based on the zenith/vertical angle. (Default method).
(2) From the setup forward, based on the heights of instrument and target and the zenith/vertical angle. (HI method).
(3) From the setup forward, based on the heights of instrument and target and the vertical difference from instrument to target (HIV method).

Method 1 (Prism +-): Carrying Elevations from the Backsight. Refer to Figure 6.9. The theory behind Method 1 is that the zenith/vertical angle, combined with the slope distance, determines the vertical difference of all backsight and foresight shots. If the prism pole height is not changed, entry of the backsight shot will transfer the backsight elevation forward to the setup. Entry of the foresight shot information will transfer the elevation from the setup to the foresight. The setup simply acts as a pivot point. If the prism pole height changes on a certain foresight, entry of the amount of change (prism +-) will allow for calculation of the foresight elevation. Furthermore, if the prism height is set to equal the height of the instrument, then even the setup elevation as calculated by the initial backsight to setup traverse will be correct.

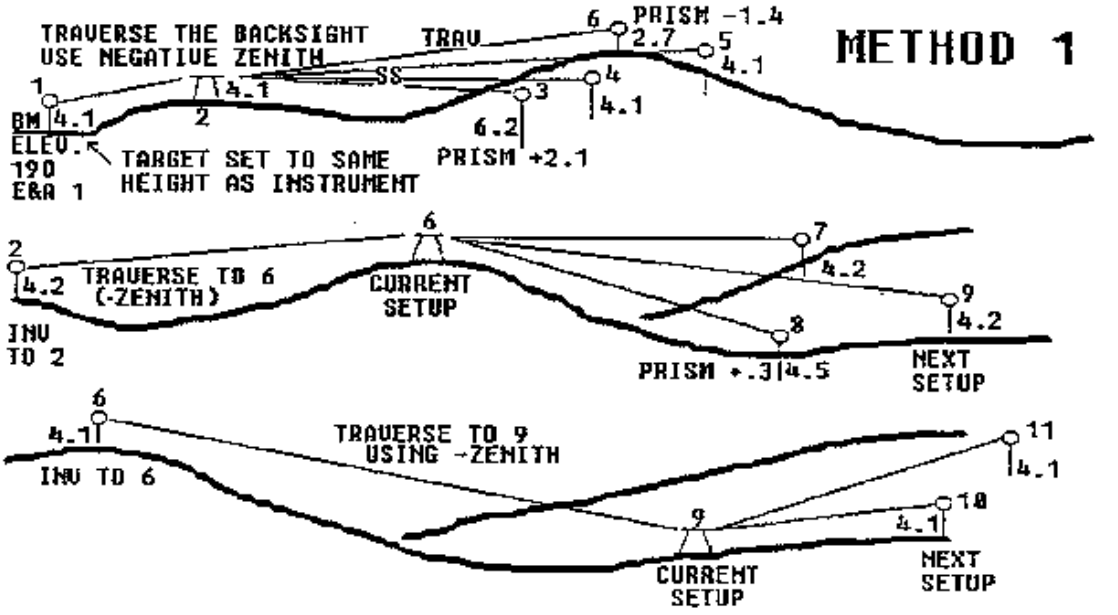


FIGURE 6.9

Three consecutive setups are shown in Figure 6.9. Method 1 has three major characteristics. First, elevations are transferred forward from the backsight, using the backsight zenith entered as a negative. Second, foresight elevations are correct, if the backsight elevations are correct. Third, setup elevations are correct only if the target is set to the height of the instrument. We note that after the first setup, all backsight points are previous foresight points and therefore correct. However, the first setup (point 2) is not a foresight but will be the backsight for the second setup at 6. Thus, the key to Method 1 is to be sure that the target is set to the height of the instrument at the first setup. Then the first setup elevation (at point 2) will be correctly calculated, and the second setup will correctly transfer the elevations forward. Note that all foresight zeniths are normally entered as positive values.

After the first setup, it is not essential that target height equal instrument height. This is because the user can inverse to the backsight point (such as point 6, which was previously a foresight with correct elevation), and then traverse the known bearing to the setup (ie. point 9) using the negative of the zenith angle read from setup to backsight. The setup is then given a "dummy" point number, foresight shots are entered, and the original point number for the current setup becomes the next backsight. The field notes for the above traverse might appear as shown in Table 6.6.

TABLE 6.6

Set Up	BS	FS	Hor. Angle	Distance	Zenith	Prism+/-
2	1	-	304.3500(az)	102.78	93.4611	
2	1	3	251.4409	175.11	94.5400	2.1
2	1	4	208.1455	198.52	89.5944	
2	1	5	175.1315	245.08	87.5100	
2	1	6	157.2842	204.61	85.0500	-1.4
6	2	0	0.0000	204.72	95.1430	
6	2	7	175.0355	185.14	90.0241	
6	2	9	198.5608	284.51	93.5507	
6	2	8	214.5100	168.51	97.4100	0.3
9	6	0	0.0000	284.50	86.0415	
9	6	11	145.0600	142.51	82.3509	
9	6	10	171.5146	103.41	87.5200	

We will assume that after the initial azimuth was taken, the instrument was set to 0 sitting at point 2 facing point 1 and angles were turned to the right. The above traverse might be entered as follows:

?E

ENTER & ASSIGN

POINT NUMBER? 1
INPUT NORTHING? 5000
EASTING? 5000
ELEVATIONS? 190

Printout:

E&A 1 5000.0000 5000.0000 190.00

POINT NUMBER? T

TRAVERSE ROUTINE

ANGLE/BEARING CODE? 5
ANGLE/BEARING? 124.35
DISTANCE? 102.78
ZENITH ANGLE? -93.4611 (backsight zenith, entered negative)
PRISM (+-)? RETURN

POINT NUMBER? RETURN

Printout:

TRAV 2 SE 55 25 00 102.56 4941.7878 5084.4359 196.76

ANGLE/BEARING CODE? SS

SIDESHOT

ANGLE/BEARING CODE? 7
ANGLE/BEARING? 251.4409
DISTANCE? 175.11
ZENITH ANGLE? 94.54
PRISM (+-)? 2.1 (plus sign not required for positive entries)
POINT NUMBER? 3

Printout:

SS 3 SW 16 19 09 174.47 4774.3470 5035.4119 179.70

ANGLE/BEARING CODE? RETURN (defaults to 7 after first SS entry)
ANGLE/BEARING? 208.1455
DISTANCE? 198.515
ZENITH ANGLE? 89.5944
PRISM (+-)? RETURN
POINT NUMBER? RETURN

Printout:

SS 4 SE 27 10 05 198.52 4765.1748 5175.0782 196.77

ANGLE/BEARING CODE? RETURN
ANGLE/BEARING? 175.1315
DISTANCE? 245.08
ZENITH ANGLE? 87.51
PRISM (+-)? RETURN
POINT NUMBER? RETURN

Printout:

SS 5 SE 60 11 45 244.91 4820.0597 5296.9493 205.95

ANGLE/BEARING CODE? T (Point 6 can be sideshot for same effect.)

TRAVERSE ROUTINE

ANGLE/BEARING CODE? 7
ANGLE/BEARING? 157.2842
DISTANCE? 204.61
ZENITH ANGLE? 85.05
PRISM (+-)? -1.4
POINT NUMBER? RETURN

Printout:

TRAV 6 SE 77 56 18 203.86 4899.1890 5283.7925 215.69

ANGLE/BEARING CODE? I (We must return to the backsight point.)

INVERSE

POINT? 2

Printout:

INV 2 NW 77 56 18 203.86 4941.7878 5084.4359 196.76

POINT? T

TRAVERSE ROUTINE

ANGLE/BEARING CODE? 2*6
DISTANCE? 204.72
ZENITH ANGLE? -95.143 (use minus zenith when traversing backsight.)
PRISM (+-)? RETURN
POINT NUMBER? 90 (use dummy point number so point 6 is unaffected.)

Printout:

TRAV 90 SE 77 56 18 203.86 4899.1875 5283.7991 215.46

ANGLE/BEARING CODE? SS

SIDESHOTS

ANGLE/BEARING CODE? 7
ANGLE/BEARING? 175.0355
DISTANCE? 185.14
ZENITH ANGLE? 90.0241
PRISM (+-)? RETURN
POINT NUMBER? 7

Printout:

SS 7 SE 82 52 23 185.14 4876.2175 5467.5086 215.315

ANGLE/BEARING CODE? RETURN
ANGLE/BEARING? 198.5608
DISTANCE? 284.51
ZENITH ANGLE? 93.5507
PRISM (+-)? RETURN
POINT NUMBER? 9

Printout:

SS 9 SE 59 00 10 283.84 4753.0083 5527.1087 196.02

ANGLE/BEARING CODE? RETURN
ANGLE/BEARING? 214.51
DISTANCE? 168.51
ZENITH ANGLE? 97.41
PRISM (+-)? .3
POINT NUMBER? 8

Printout:

SS 8 SE 43 05 18 167.00 4777.2292 5397.8790 192.63

ANGLE/BEARING CODE? I

INVERSE

POINT? 6

Printout:

INV 6 NW 77 08 14 0.01 4899.1890 5283.7925 215.69

POINT? T

TRAVERSE ROUTINE

ANGLE/BEARING CODE? 6.9
DISTANCE? 284.5
ZENITH ANGLE? -86.0415
PRISM (+-)? RETURN
POINT NUMBER? 91 (Use dummy point not to duplicate point 9.)

Printout:

TRAV 91 SE 59 00 12 283.83 4753.0186 5527.0915 196.199

ANGLE/BEARING CODE? SS

SIDESHOTS

ANGLE/BEARING CODE? 7
ANGLE/BEARING? 145.06
DISTANCE? 142.51
ZENITH ANGLE? 82.3509
PRISM (+-)? RETURN
POINT NUMBER? 11

Printout:

SS 11 NE 86 05 48 141.32 4762.6386 5668.0822 214.589

ANGLE/BEARING CODE? 7

ANGLE/BEARING? 171.5146
DISTANCE? 103.41
ZENITH ANGLE? 87.52
PRISM (+-)? RETURN
POINT NUMBER? 10

Printout:

SS 10 SE 67 08 26 103.34 4712.8743 5622.3144 200.028

The traverse and sideshot entries are shown in Table 6.7

Table 6.7

FROM SET UP	BS	FS	TO CODE	ANGLE BRG	ANGLE/ DIST	ANGLE	SLOPE DIST	ZENITH N	HORIZ. E	ELEV
1	0	2	5	124.3500	102.78	-93.4611	102.56	4941.7878	5084.4359	196.757
2	1	3	7	251.4409	175.11	94.5400	174.47	4774.3470	5035.4119	79.250
2	1	4	7	208.1455	198.52	89.5944	198.51	4765.1748	5175.0782	196.773
2	1	5	7	175.1315	245.08	87.5100	244.91	4820.0597	5296.9493	205.952
2	1	6	7	15?.2862	204.61	85.0500	203.86	4899.1890	5283.7925	215.694
2	6	90	2.6	0.0000	204.72	-95.1430	203.86	4899.1875	5283.7991	215.460
90	2	7	7	175,0355	185.14	90.0241	185.14	4876.2175	5467.5086	215.315
90	2	9	7	198.5608	284.51	93.5507	283.84	4753.0083	5527.1087	196.517
90	2	8	7	214.5100	168.51	97.4100	167.00	4777.2292	5397.8790	192.630
6	90	91	6.9	0.0000	284.50	-86.0415	283.83	4753.0186	5527.0915	196.199
91	6	11	7	145.0600	142.51	82.3509	141.32	4762.6386	5668.0822	214.589
91	6	10	7	171.5146	103.41	87.5200	103.34	4712.8743	5622.3144	200.028

In elevation work, care should be taken not to enter T for Traverse when Sideshot is intended. It is not recommended to press T until all the sideshots from the given setup are taken. If Method l is used for carrying elevations, there is in fact no need to enter any traverse except the backsight traverse using the negative zenith angle.

Though Method l is somewhat complex, it actually involves the least prompting and is ideally suited to one or two setup radial-type topo surveys. If the prism is set to the height of the instrument at

each setup, entry is simplified further since there is no need to traverse backsights once the initial backsight is entered. The user simply traverses the first backsight using the negative zenith, then enters all subsequent notes as if they were 2-D. Only the prism (+-) question distinguishes the 3-D entry from normal 2-D entry. The prism (+-) question can be eliminated by entering POFF. It can be reactivated by entering PON.

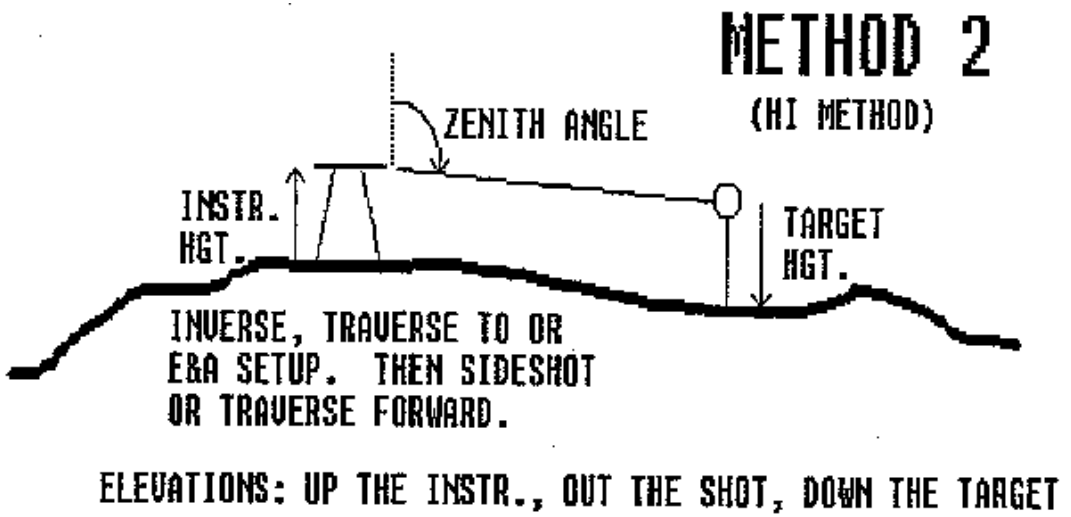


FIGURE 6.10

Method 2 (HI): Carrying Elevations forward from the Setup using vertical/zenith angle and instrument and target heights. This method is what most surveyors are accustomed to. With the elevation of the setup known, elevations are transferred to foresights by going up the instrument height, out the shot and down the target. Method 2 therefore requires known instrument and target heights, known setup elevation and recorded zenith/vertical angle. Method 2 is activated by pressing HI at the main COGO menu. Pressing M cancels the HI mode. Figure 6.10 illustrates the use of the HI method.

The procedure is to first press HI. Then "get on" the setup, establishing the backsight by inverse or traverse if angle rights are to be used. Then prompting will appear as follows:

ANGLE/BEARING CODE? 7
ANGLE/BEARING? 145.0614
DISTANCE? 195.45
ZENITH ANGLE? 93.1455
HGT. OF INSTR.? 5.1
HGT. OF TARGET? 4.5

POINT NUMBER? 41

After the first sideshot, the program will not prompt again for instrument height at that particular setup. When prompted for target height, RETURN will recall the previous target height, whether it was entered at the current setup or previous setup. When prompted for instrument height, RETURN will recall the previous instrument height.

The HI method can be combined with the default (prism pole +-) method. For example, the user can backsight a known benchmark using Method l, transferring the elevation forward to the next setup. Then when the instrument is moved to that setup, the HI method can be employed. An extra setup at the original backsight was therefore avoided.

Method 3 (HIV): Carrying Elevations forward from the Setup based on instrument and target heights and the vertical difference of the shot. Many of the latest total station instruments will measure the vertical difference of the shot automatically, or will report the vertical difference at the press of a button. The instrument person can record these vertical differences and carry elevations. This is called the HIV method. Figure 6.11 illustrates the principles involved.

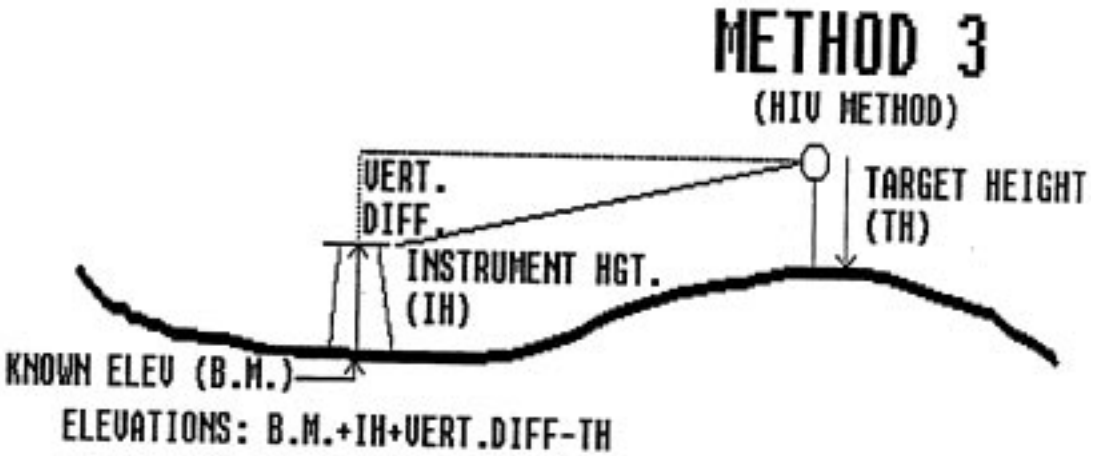


FIGURE 6.11

Press HIV at the main COGO menu to activate the HIV method. Pressing M and returning to the menu cancels the HIV method. As with the HI method, the setup elevation must be known. Elevations are transferred forward whether in sideshot or traverse mode. The program prompts for instrument height, target height and vertical difference. After the first sideshot, the instrument height is known and will not be re-prompted until the user moves to the next setup. If RETURN is pressed for

instrument heights and target heights, the previous respective entries will be recalled. Again, you would first press HIV and then "get on" the setup, inversing or traversing the backsight if angles off of the backsight are to be turned. A typical entry for the above example, whether in traverse or sideshot, might appear as follows:

ANGLE/BEARING CODE? 5
ANGLE/BEARING? 171.4405
DISTANCE? 295.41
HGT. OF INSTR.? 1.45
HGT. OF TARGET? 1.31
VERT. DIF.? 2.73
POINT NUMBER? 50

This might represent a metric system entry. Instrument heights and target heights are entered in the units of measurement, whether feet or meters.

The HIV method can also be used like method 1 to transfer elevations forward from the backsight. Consider the example shown in Figure 6.12.

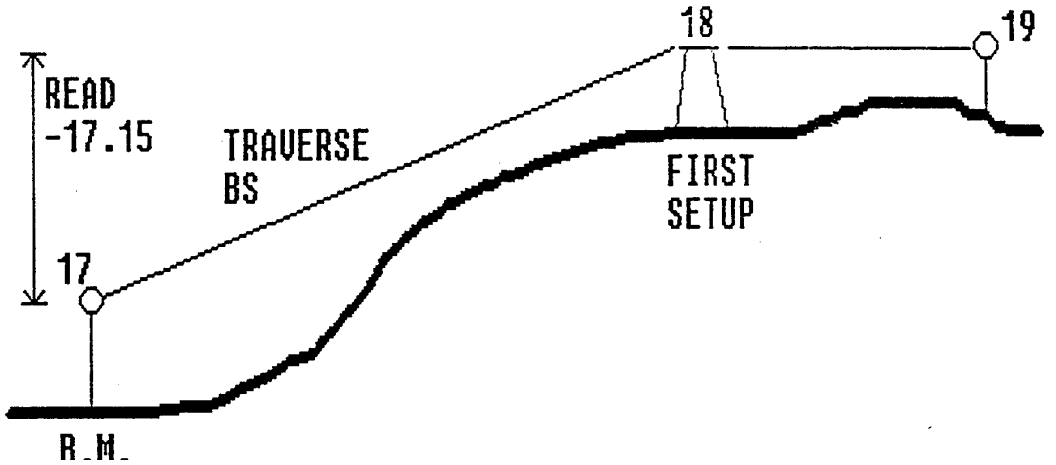


Figure 6.12

Though you set up on point 18 and read a -17.15 vertical difference to point 17, you can choose to enter & assign or inverse to 17, and then traverse to 18. When traversing, reverse all entries. Enter the instrument height as the target height and vice versa. Enter the vertical difference as 17.

15. Then enter subsequent foresights in normal fashion. You can think of the various elevation prompts as tools to be used in any manner desired.

Horizontal Curves (HC)

Application: The Horizontal Curve routine is used for calculating existing curves from plan view data and for designing curves for roads, subdivision streets and adjoining property lines.

Features: Horizontal curves are calculated by 5 distinct methods. The option is provided to calculate station points along the curve for stakeout purposes. The program will print the curve data after calculation. Horizontal curve options 1 and 2 require that you move to the PC within the traverse or inverse routines, entering the PC point in the form PC7 for PC at point 7. Horizontal curve options 3 to 5 may be entered by pressing menu item HC. Horizontal curve option 4 can be activated either by pressing HC or by using the PC prefix for the PC point number, after traverse or inverse. Curve option 5 will additionally calculate offset points to the PC and PT, such as begin curve and end curve points on the right-of-way, parallel to centerline. The 5 horizontal curve options are shown in Figure 6.13.

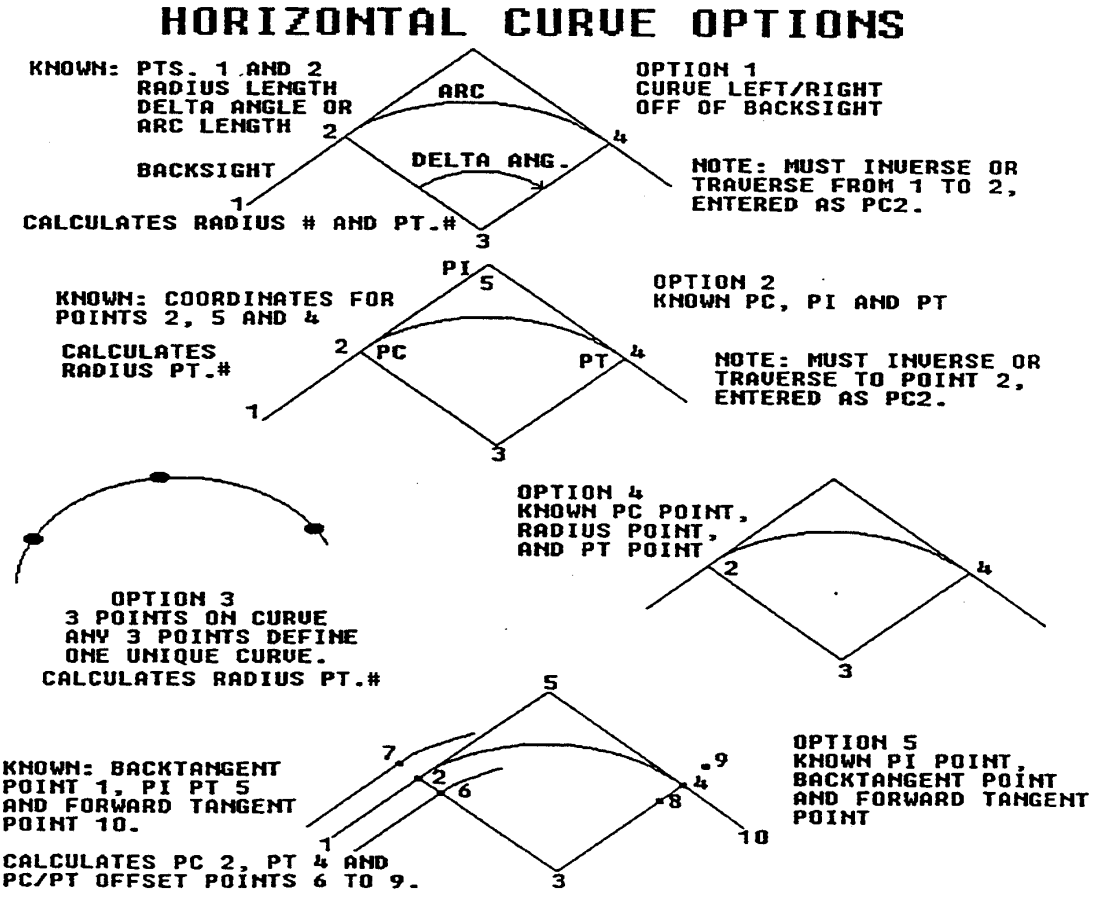


FIGURE 6.13

Horizontal Curve option 1: This option requires that you inverse or traverse along the tangent to the curve, prior to laying in the curve by direction of curve (left/right) radius length and either delta angle or arc length. The direction of curve is the direction you would walk if going from the PC to the PT. A curve to the right is a clockwise curve and left is counterclockwise.

Consider the plan view of a road shown in Figure 6.14. It is desired to stakeout the centerline at 50-foot intervals and to stakeout a catch basin with a stake 4 feet back of curb. All the information given is shown. This is a perfect application of horizontal curve option 1. To set the curve in, traverse from station 10+00 to the PC at 12+12.46. Use the PC prefix (for point of curvature) when naming the point number. Then specify the radius length, the direction of the curve (left or right) and the intersection or delta angle. The program will calculate the radius point and point of tangency (PT) and then ask if you want to calculate station points along the curve. Stations are calculated

individually, by even increment from the PC, or by even station number (ie. 12+25, 12+50, 12+75) at any interval (ie. 25). We will follow through the calculation process in the example below:

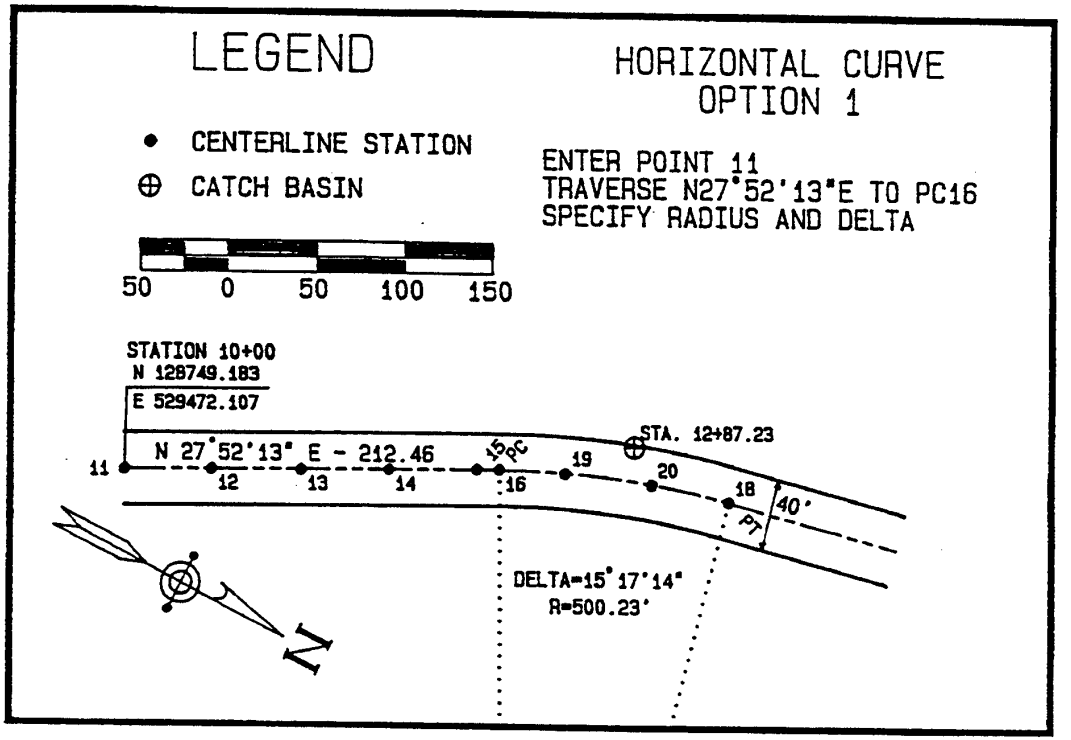


FIGURE 6.14

?E

ENTER & ASSIGN

POINT NUMBER? 11
INPUT NORTHING? 128749.183
EASTING? 529472.107

Printout:

E&A 11 128749.183 529472.1070

POINT NUMBER? T

TRAVERSE ROUTINE

ANGLE/BEARING CODE? 4
ANGLE/BEARING? 27.5213
DISTANCE? 50
POINT NUMBER? 12-15

Printout:

TRAV 12	**NW 27 52 13**	**50.00**
128793.3834	**529448.7334**	
TRAV 13	**NW 27 52 13**	**100.00**
128837.5838	**529425.3599**	
TRAV 14	**NW 27 52 13**	**150.00**
128881.7843	**529401.9863**	
TRAV 15	**NW 27 52 13**	**200.00**
128925.9847	**529378.6127**	

ANGLE/BEARING CODE? 11*15
DISTANCE? 12.46
POINT NUMBER? PC16 (The PC prefix is required for HC options 1 and 2)

Printout:

TRAV 16 NW 27 52 13 12.46 128936.9994 529372.7880 PT. OF CURVATURE

SELECT CURVE DERIVATION OPTION:

(1) KNOWN RADIUS AND DELTA ANGLE
(2) KNOWN PI AND PT
(3) KNOWN 3 POINTS ON CURVE
(4) KNOWN PC # AND RADIUS #
(5) KNOWN PI AND TANGENTS
Note: The above horizontal curve menu appears based on entry of the PC prefix.

1, 2, 4 FOR AREA, 2, 4 FOR COMPOUND CURVES (for area calculations)

?1 (option 1 is selected)
CURVE LEFT OR RIGHT (L OR <R>)? R

RADIUS LENGTH? 500.23
RADIUS POINT? 17

Printout:

TRAV 17 NE 62 07 47 500.23 129170.8426 529814.9955 RADIUS PT.

DELTA ANGLE (IDD.MMSS) OR ARC (A##.##)? 115.1714
(Note that I is used as prefix for delta (intersection) angle entries. If the arc length is used to define the curve A is entered as the prefix, as in A133.47.

PT. OF TANGENCY (PT#)? 18

Printout:

TRAV 18 SW 77 25 01 500.23 129061.8651 529326.7804 PT. OF TANGENCY

DO YOU WANT STATION COORDS. ALONG CURVE (Y/<N>)? Y

SELECT FROM THE OPTIONS BELOW:

<A> STA. INCREMENT FROM PC
<B> EVEN STA. IE. 25, 50, 100
<C> SPECIFIED STATION
<D> CONTINUE

(A brief explanation: If the PC is 1212.46, option A would calculate stations at an even increment. If the interval entered is 50, option A would calculate 1262.46, 1312.46, etc. Option B finds the even station itself. So if an interval of 50 is entered in option B, it would calculate 1250, 1300, etc. Option C simply calculates the coordinates for any specific station desired. The user will be asked to assign point numbers to the calculated stations.)

? B
STATION OF PC? 1212.46

STA. INTERVAL (25,50,100)? 50
POINT NUMBER? 19

Printout:

STA 19 SW 66 25 46 500.23 128970.8115 529356.5005 STATION 12+50

POINT NUMBER? 20

Printout:

STA 20 SW 72 09 22 500.23 129017.5598 5293388291 STATION 13+0

SELECT FROM THE OPTIONS BELOW: (Program returns to stationing menu)

<A> STA. INCREMENT FROM PC
<B> EVER STA. IE. 25, 50, 100
<C> SPECIFIED STATION
<D> CONTINUE

?C
STATION #? 1287.23 (Note: PC station will be requested first if not already entered)
POINT NUMBER? 24

Printout:

STA 24 SW 70 41 37 500.23 129005.4567 529342.8964 STATION 12+87.2

SELECT FROM OPTION BELOW: (Stationing menu, A through D)
? D

RADIUS= 500.23 DEGREE OF CURVE= 11 DEG 27 MIN 14 SEC
TANGENT= 67.13 INTERSECTION ANGLE= 15 DEG 17 MIN 14 SEC
ARC LENGTH= 133.47 CHORD LENGTH= 133.07
PC STA. 1212.46 PT STA. 1345.92

MENU ITEM? I

INVERSE

POINT? 17 (We omit the printout here.)

POINT? T

TRAVERSE ROUTINE

ANGLE/BEARING CODE? 17*24

DISTANCE? 500.23+24 (Note: radius + offset distance)
POINT NUMBER? 25

Printout:

TRAV 25 SW 70 41 37 524.23 128997.5219 529320.2461

One common characteristic of horizontal curve options 1,2,4 and 5 is that the radius point number is either known or calculated. In each of these routines, the program ends by "internally" inversing from radius point to the point of tangency, leaving the user ready to traverse forward from the PT. Another common feature of these four options is that they all offer the opportunity to calculate "stations" along the curve, as above.

Horizontal Curve Option 2: This option requires that point numbers have been previously calculated for the PC, PI and PT of the curve. Like option 1, it must be entered by inversing or traversing to the PC, using the PC prefix. If menu item HC is entered and option 1 or 2 is selected, the program will advise "USE PC PREFIX" and return to the main COGO menu. The program will not ask for the direction of the curve (L or R) in option 2. It will assume that the intersection angle is less than 180 degrees.

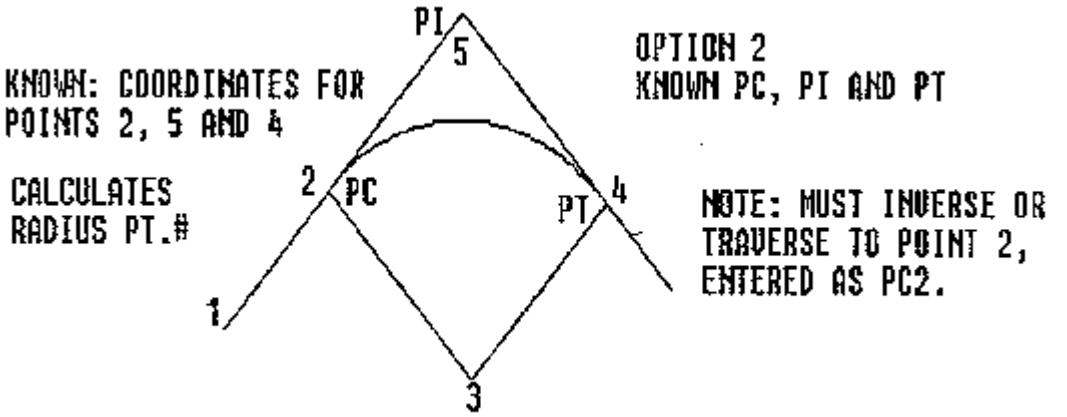


FIGURE 6.15

Referring to the example in Figure 6.15, the entry procedure begins by traversing or inversing to point 2. As opposed to option 1, there is no need to inverse along the tangent. Enter point 2 as

PC2. Select horizontal curve option 2. Then simply enter the PI point number and PT point number, as prompted. If the tangent lengths are not equal to within .02 (as measured from PC to PI and PI to PT), then the program will print, for example, TANGENT LENGTHS NOT EQUAL BY 1.27. The user will then be returned to the main menu. If the tangent lengths are within tolerance, the program will ask for the radius point number, calculate the radius coordinates, and then offer the option to calculate station coordinates. The routine concludes by printing the curve data.

Horizontal Curve Option 3: The 3-point on curve routine is useful for determining best fit curves from field data. Three points determine a unique curve by the intersection of their perpendicular bisectors.

Procedure: Press HC. This obtains the horizontal curve menu. Then select option 3. Prompting is as follows:

FIRST POINT? 5
SECOND POINT? 2
THIRD POINT? 3

Printout:

HC 2 5070.7107 5070.7107
INTERSECT PT.=RADIUS PT.
PT# OF INTERSECT PT.? 9
HC 9 SE 71 00 00 166.89 5016.3766 5228.5086
HC 3 SE 19 00 00 166.89 4858.5786 5282.8427

FIRST POINT? (M for menu or continue in HC option 3)

Horizontal Curve Option 4: This routine is similar to option 2. It requires entry of the PC point number, the radius point number and any of the following: the PT point number, delta angle, arc length or tangent length. These need to be calculated previously (ie. using curve options 1,2,3 or 5). Horizontal curve option 4 is most used when calculating areas around lots and figures (see the section on Inverse with Area).

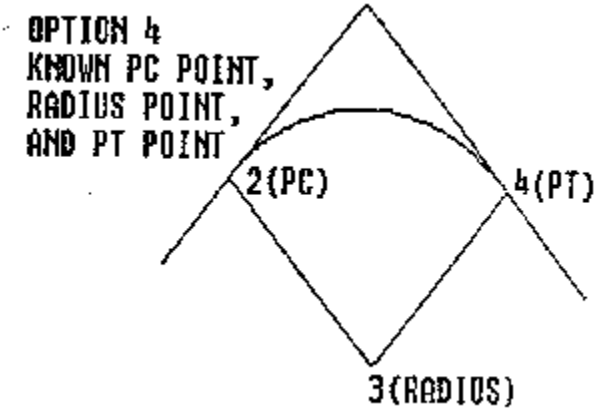


FIGURE 6.16

Option 4 can be entered using the PC prefix or by selecting menu item HC, option 4. In the latter case, the program will prompt:

PC (START) OF CURVE? 2
RADIUS #? 3
CURVE LEFT OR RIGHT (L OR <R>)? R
PT # (I-DELTA, A-ARC, T-TANGENT)? 4

The program then asks whether to calculate station coordinates, and then prints curve data. If the radii from 2 to 3 and from 3 to 4 differ beyond the acceptable tolerance of 0.02, the program will display, RADII NOT EQUAL BY 4.51, or whatever difference exists. If the radii are within tolerance, the radius from the PC to the radius point governs the calculation. If the PT # is entered, the program calculates the curve data. If any of the other options are selected, the program will calculate the new point. For example, a delta angle would be entered as I14.53 for 14 degrees and 53 minutes (or 14.53 grads). A tangent of 117.51 would be entered as T117.51.

Horizontal Curve Option 5: Option 5 is used to calculate the PC and PT when the tangent lines are known. This option is sometimes referred to as "inscribing the curve". The user knows the tangent lines and therefore the delta angle. The curve is then inscribed or laid in based on either the radius length, tangent length or arc length. The inscribed curve will always have a delta angle less than 180 degrees (or less than 200 using the 400 circle).

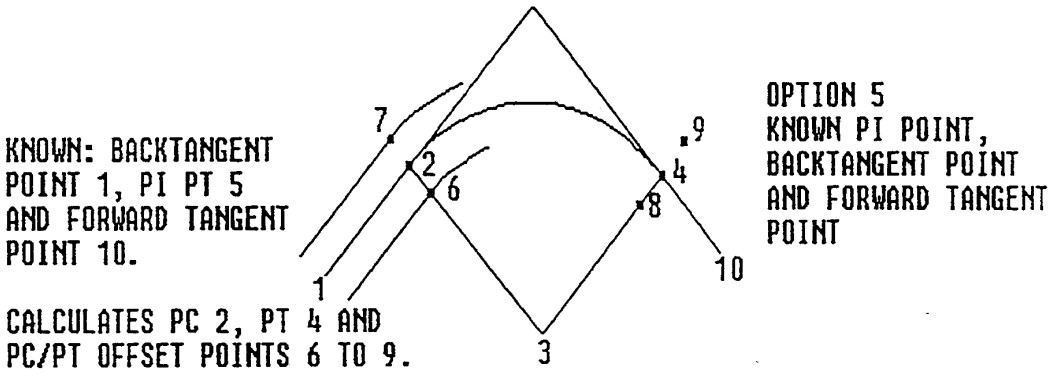


FIGURE 6.17

Press **HC** and select option 5. Referring to Figure 6.17, the prompting would appear as follows:

PT. ON BACK-TANGENT? 1
PT. OF INTERSECTION (PI#)? 5
PT. ON FORWARD TANGENT?10
RADIUS OF CURVE (PRECEDE WITH A FOR ARC OR T FOR TANGENT)?
200 PC
PT.#? 2

Printout:

HC5 2 5105.1988 5105.1988 PT. OF CURVATURE

PT PT.#? 4

Printout:

HC5 4 5162.2865 5270.9940 PT. OF TANGENCY
INTERSECT PT.=RADIUS PT.
PT. # OF INTERSECT PT.? 3

Printout:

BB 4 SE 45 00 00 200.00 4963.7774 5246.6199 RADIUS PT.
BB 20 NE 7 00 00 200.00 5162.2865 5270.9940 PT. OF TANGENCY

ROADWAY WIDTH (0 TO CONT.)? 20 (Enter 0 if you do not wish to calculate 6-9).
START PT.#? 6 (The 4 offset points 6-9 will be calculated without point protect).

Printout:

PC	**L**	**6**	**5112.2698**	**5098.1277**
PC	**R**	**7**	**5098.1277**	**5112.2698**
PT	**L**	**8**	**5172.2120**	**5272.2127**
PT	**R**	**9**	**5152.3611**	**5269.7753**

DO YOU WANT STATION COORDS. ALONG CURVE (Y/<N>)? **N**

RADIUS= 200 **DEGREE OF CURVE= 28 DEG 38 MIN 52 SEC**
TANGENT= 97.55 **INTERSECTION ANGLE= 52 DEG 0 MIN 0 SEC**
ARC LENGTH= 181.51 **CHORD LENGTH= 175.35**

Horizontal curve option 5 is very useful for subdivision design or road design in general. Working from a subdivision sketch plan, for example, you would first establish the tangents or "straightaways" of the roads.

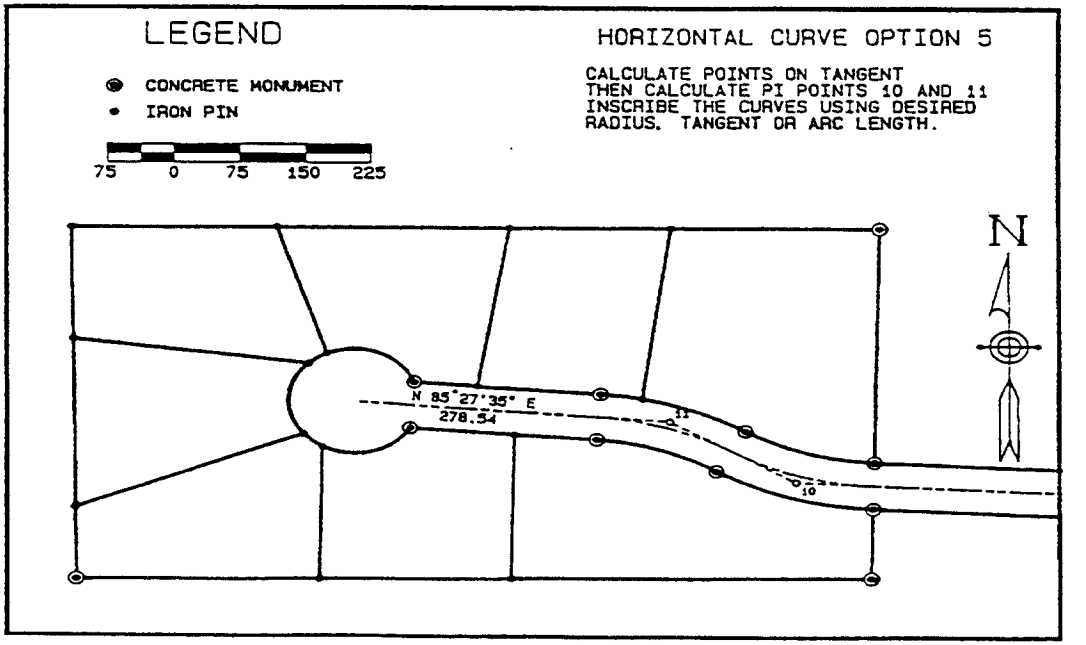


FIGURE 6.18

After at least 2 points are calculated on each tangent line, intersect the tangents to determine the PI or point of intersection. Then inscribe each of the curves using HC option 5, based on either desired radius or tangent length. Select appropriate roadway width and calculate all right-of-way offset points at the same time. Reverse and compound curves can be inscribed by making the sum of the tangent lengths equal to the inversed distance between the PI points.

Inverse and SideShot Inverse (I)

Application: To obtain the bearing/azimuth and distance from one point to another. To establish a backsight from which to turn angles to the right, angles to the left and deflection angles. To establish a tangent bearing from which to enter a curve to the left or right using horizontal curve option 1.

Features: There are two types of inversing: (l) Direct inversing from point to point, whereby the program moves from the first point to the second point and holds the backsight for possible angle turning. (2) Sideshot inversing in which the program remains on the first point, and subsequent points are inversed from the first point, with bearings and distances displayed.

Procedure: Press I for Inverse at the main COGO menu or any first prompt in the major COGO routines. Enter the point number desired and the program prints the bearing and distance to the new point from the point you had just occupied. If configuration item 24 is set to BR, printouts will be in bearing form. If item 24 is set to AZ, printouts will be in the form of azimuths (360 or 400 circle).

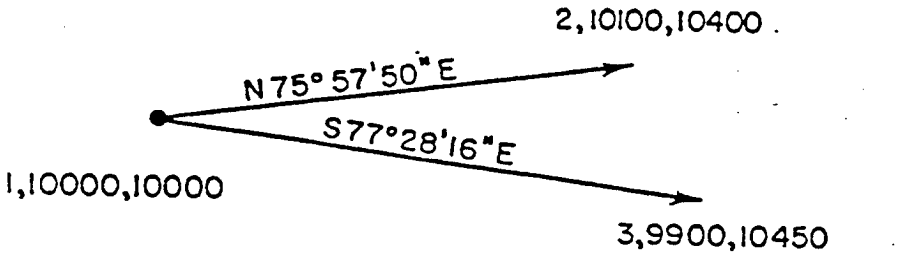


FIGURE 6.19

In the example above, we want to compute the bearings from l to 2 and from l to 3. Using the Inverse Routine, we begin by pressing I. We are prompted:

POINT? 1
POINT? 2
POINT? 1
POINT? 3
POINT? SS (This would transfer to the sideshot routine holding the backsight l to 3).

The printout for the above entries (with config item 6 set to 6/Y and 18 set to Y), might appear as follows:

INV NW 82 DEG 15 MIN 47 SEC -- 192.71 FEET
1 10000.0000 10000.0000
INV NE 75 DEG 57 MIN 50 SEC -- 412.31 FEET
2 10100.0000 10400.0000
INV SE 77 DEG 57 MIN 50 SEC -- 412.31 FEET
1 10000.0000 10000.0000
INV SE 77 DEG 28 MIN 16 SEC -- 460.98 FEET
3 9900.0000 10450.0000

Note that we obtained an "odd" bearing to l of NW 82 15 47. This is the bearing from the point we previously occupied to 1. If you want to avoid the printing of that bearing to dress up the appearance of the final printout, inverse to l by using menu item IA, INVERSE WITH AREA. IA prints the starting coordinate only. Then switch to menu item I for Inverse.

Sideshot Inverse: The goal of the above example was to obtain the bearing and distance from l to 2 and from l to 3. Using inverse, an extra step was involved inversing back from 2 to 1. This can be avoided by use of Sideshot Inverse. This is a "hidden" command. To enter Sideshot Inverse, first inverse to the base point, in this case point 1. Then press SI. Prompting is as follows:

SIDESHOT INVERSE
POINT? 2
POINT? 3

Printouts are shown below:

SI NE 75 DEG 57 MIN 50 SEC -- 412.31 FEET
2 10100.0000 10400.0000
SI SE 77 DEG 28 MIN 16 SEC -- 460.98 FEET
3 9900.0000 10450.0000

Inverse with Area (IA)

Application: To obtain the area within closed figures.

Features: Areas are computed around figures with any number of sides and simple curves, including compound and reverse curves. If config item 20 begins with F for English units, areas are printed in square feet and acres. If config item 20 begins with M for Metric units, areas are printed in square meters and hectares. If config item 20 begins with m for the Puerto Rican configuration, areas are printed in square meters and cuerdas. If the closed figure does not include curves and the points are numbered sequentially, the area can be computed with one entry, namely the starting point and ending point separated by a dash.

Procedure: Press IA. Enter the starting point number. The starting point number can be anywhere on the figure. In figures with curves, proceed clockwise. In figures without curves, the direction of inversing does not matter.

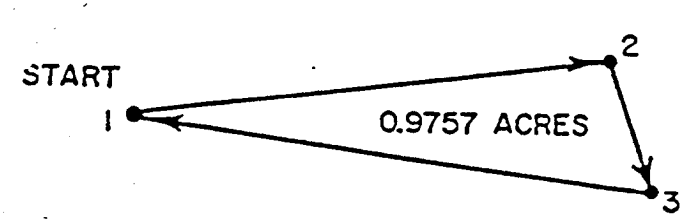


FIGURE 6.20

The area for the above 3-sided figure can be computed by either of the following methods:

INVERSE

STARTING POINT? 1
POINT #? 2
POINT x? 3
POINT #? 1

STARTING POINT? 1-3

The printout will be the same regardless of which method is used:

```
 1       10000.0000     10000.0000
INVA   NE 75 DEG 57 MIN 50 SEC -- 412.31 FEET
 2       10100.0000     10400.0000
```

INVA SE 14 DEG 02 MIN 11 SEC -- 206.16 FEET
3 9900.0000 10450.0000
INVA SW 77 DEG 28 MIN 16 SEC -- 460.98 FEET
1 10000.0000 10000.0000

AREA = 42500 S.F. 0.9756658 ACRES

The sequential method of entering (ie. 1-,) applies especially to deed checking, where point numbers are entered sequentially. It should also be pointed out that a wayward entry will have no effect on area if you immediately inverse back to the last point. Thus if point 1,2,3 and then 6 were entered by mistake, enter 3 next and then continue to 1. The first prompt (STARTING POINT?) is not a "transfer" prompt. After the first prompt, the POINT # question allows transfer to any other menu item prior to completing an area calculation.

For lots and tracts that include curves, go clockwise around the perimeter. Figure 6.21 is an enlargement of Figure 6.18 and shows two lots for which we will calculate area

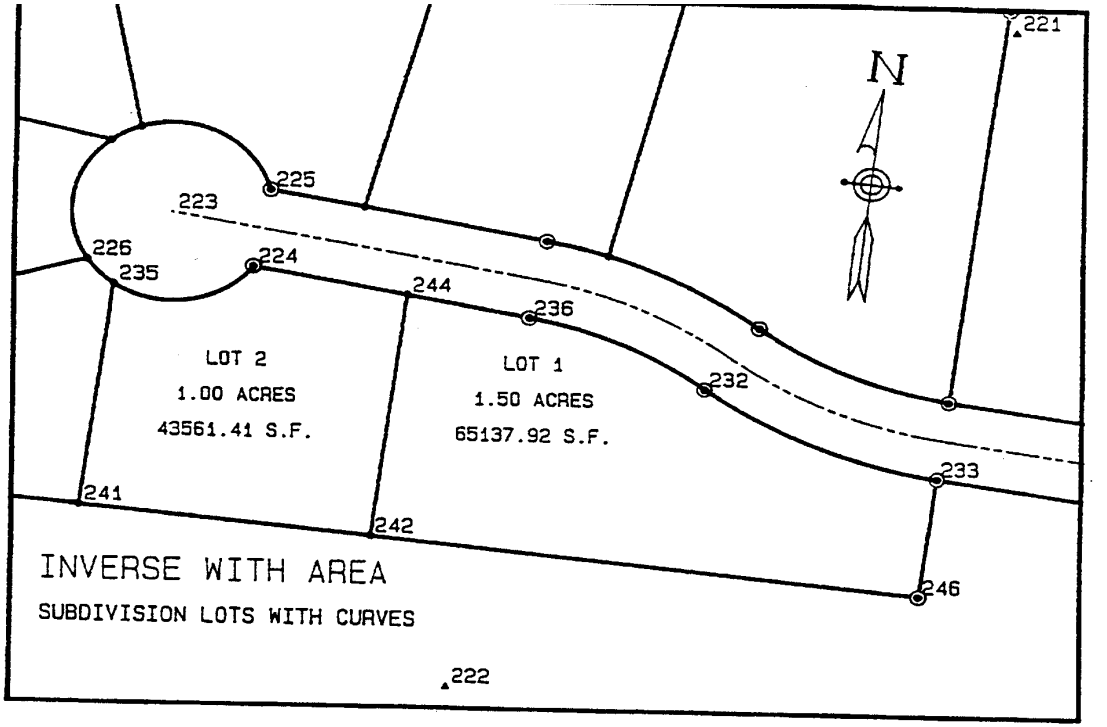


FIGURE 6.21

The procedure is to utilize horizontal curve option 4. Options 1 and 2 can also be used, but option

1 requires that curves are "approached" along the tangent, and option 2 requires that the curve "PI" points be known. For purposes of keyboard entry, the beginning of the curve segment is referred to as the PC and the end of the segment as the PT. These points may be different from the PC and PT of the entire curve.

We will enter LOT 2 first as follows:

?IA

INVERSE WITH AREA

STARTING POINT? 241 (We could start at 235 by entering PC235)

Printout:

INVA 241 1137.4945 864.4806

POINT? PC235

Printout:

INVA 235 NE 01 11 00 188.63 1326.0806 868.3760

SELECT CURVE DERIVATION OPTION:

(1) KNOWN RADIUS AND DELTA ANGLE
(2) KNOWN PI AND PT
(3) KNOWN 3 POINTS ON CURVE
(4) KNOWN PC' AND RADIUS
(5) KNOWN PI AND TANGENTS

1, 2, 4 FOR AREA, 2, 4 FOR COMPOUND CURVES
?4
RADIUS #? 223
CURVE LEFT OR RIGHT (L OR <R>)? L
PT. OF TANGENCY (PT#)? 224 (Note: In area mode, other options not provided.)
RETURN FOR FAST AREA, OR ELSE ANY KEY? RETURN
(Note: Usually press RETURN. Slow area is used only when the property crosses back through the segment area above the chord, as explained below.)

Printout:

RADIUS= 75 DEGREE OF CURVE= 76 DEG 23 MIN 39 SEC
TANGENT= 72.95 INTERSECTION ANGLE= 88 DEG 24 MIN 41 SEC
ARC LENGTH= 115.73 CHORD LENGTH= 104.59

POINT? 244

Printout:

INVA 244 SE 85 27 35 118.00 1344.0735 1086.9561

POINT? 242

Printout:

INVA 242 SW 01 11 00 205.68 1138.4425 1082.7086

POINT? 241

Printout:

INVA 241 SW 89 45 04 218.23 1137.4945 864.4806

AREA: 43561.42 S.F. 1.000033 ACRES

LOT l will also be entered as an example. We note first that the lot contains a reverse curve at point 232. The key to computing areas when reverse or compound curves are involved is to enter the PT point using the PC prefix. This cycles the program right back into curve calculation. Alternately, you can conclude with 232 as the PT point using no prefix, and then re-enter point 232 as PC232 (in effect inversing no distance). We will go through the example, displaying only the final area printout.

?IA

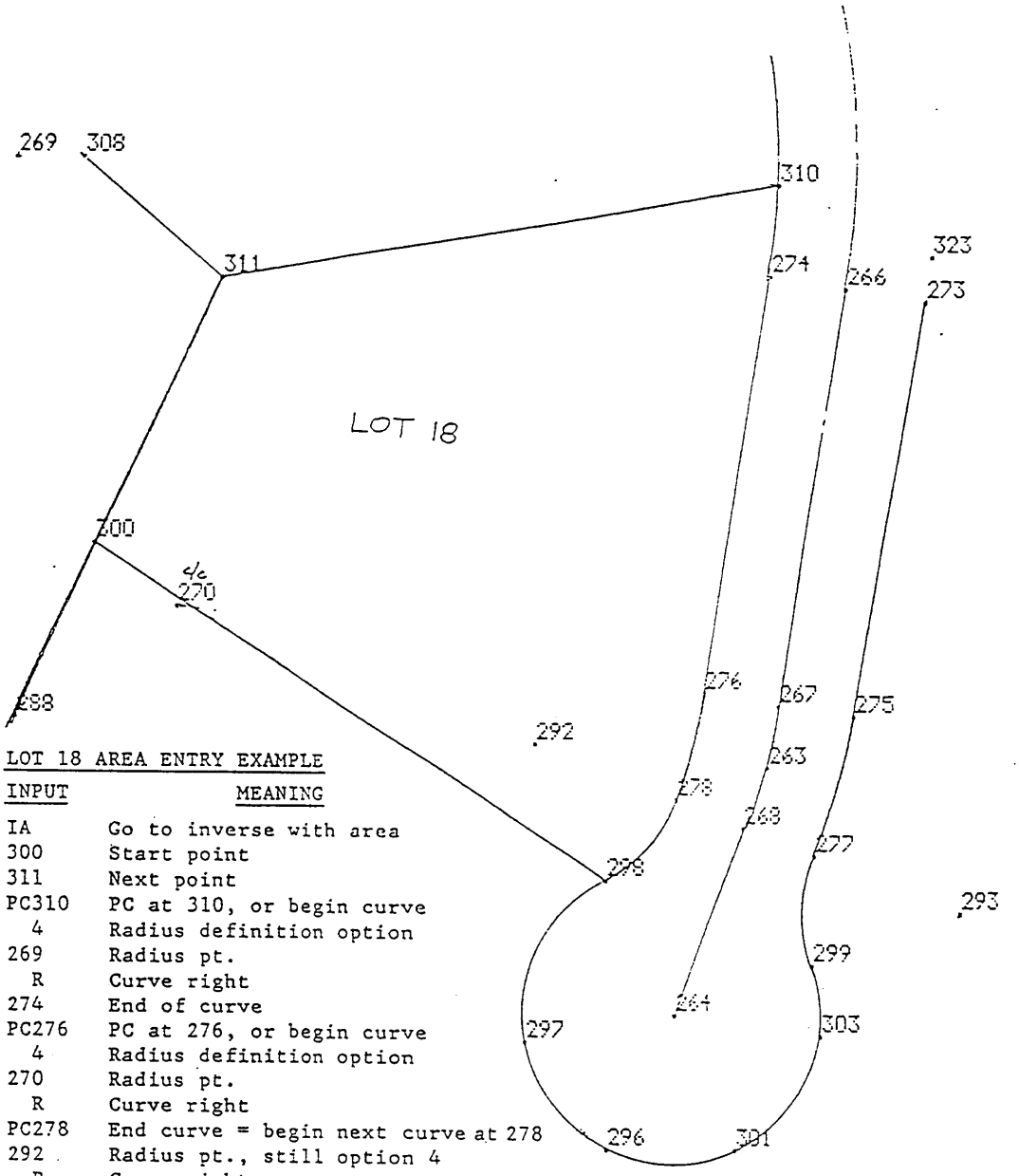
INVERSE WITH AREA

STARTING POINT? 244
POINT? PC236
SELECT CURVE DERIVATION OPTION:

?4
RADIUS #? 222
CURVE LEFT OR RIGHT (L OR <R>)? R
PT. OF TANGENCY? PC232
(First set of curve data is printed)
RADIUS #? 221
CURVE LEFT OR RIGHT (L OR <R>)? L
PT. OF TANGENCY (PT#)? 233
RETURN FOR FAST AREA, OR ELSE ANY KEY? RETURN
POINT? 246
POINT? 242
POINT? 244

AREA: 65137.98 S.F.1.495362 ACRES

Figure 6.22 shows still another example set of entries for areas involving curves. In this case, a compound curve is involved at point 278. Again, the area is inversed in a clockwise direction. Figure 6.22 also illustrates how printer plots can be used for sketching and overlay drafting. Referring to Figure 6.22, if you start at the end of a curve (such as point 298) when you conclude at 298 as the PT. OF TANGENCY, you will be prompted **POINT?** Enter 298 again to obtain the area printout. For this reason it is not recommended to begin at the end of a curve.



LOT 18 AREA ENTRY EXAMPLE

INPUT	MEANING
IA	Go to inverse with area
300	Start point
311	Next point
PC310	PC at 310, or begin curve
4	Radius definition option
269	Radius pt.
R	Curve right
274	End of curve
PC276	PC at 276, or begin curve
4	Radius definition option
270	Radius pt.
R	Curve right
PC278	End curve = begin next curve at 278
292	Radius pt., still option 4
R	Curve right
298	End curve
300	End point = begin point

Area = 0.7419 acres.

FIGURE 6.22

File Adjustment (FA)

The File Adjustment menu presents the following range of applications:

(1) INSERT PTS. FROM ANOTHER FILE
(2) CHANGE NO. OF PTS.
(3) RENUMBER POINTS
(4) ELIMINATE POINTS
(5) ADJUST ELEVATIONS
(6) POINT PROTECT
(7) NEW FILE
(8) DELETE FILE
(D) 2D< — >3D
(E) EDM VERTICAL OFFSET
(T) TRANSLATION
(A) ASSIGN ELEVATIONS
(X) ASSIGN DESCRIPTIONS
(M) MAIN MENU

Features: Each one of the above menu items will be discussed in order.

(1) INSERT PTS. FROM ANOTHER FILE: Often it is desired to bring in coordinates from another ".CRD" file, such as control points or points for stakeout. This routine will prompt:
FILE NAME? TOPO2 (for example)
RANGE OF POINTS TO INSERT? 4-7
The program will then insert these points from TOPO2 into the current file. If point protect is on and these points already have coordinates, the program will prompt:
PT. NO. 3 IS USED. OVERWRITE <Y>/N?
If the user enters N, then it will ask: PT. TO USE? 20 (an unused point should be entered)

(2) CHANGE NO. OF PTS.: SurvCOGO coordinate files are binary files that grow in proportion to the highest point number. If there are only 20 points in a file, but the highest point number is 20000, then the file is sized for 20000 points. This leads to fast recall, but can also lead to large file size. If the user wants to reduce the file size, it may be a good idea to first do Renumber Points within File Adjustment (which can reduce and condense the file), then follow with Change No. of Pts. to lower the highest point number. The prompt is:
MAX. NUMBER OF POINTS? 20

(3) RENUMBER POINTS: This command is useful for making a second set of identical points starting at a higher point number or lower point number. It is also useful for condensing a file

and removing unused points. You must turn off point protect if you wish to renumber over used coordinates. In a file of 15 points, where 3 through 5 are not used and 14 is not used, the file could be reduced to 11 total points by answering prompting as follows:
RANGE OF POINTS TO RENUMBER (EG. 2-9, 4 ONLY=4)? 1-15
STARTING POINT NUMBER FOR RENUMBERING? 1
CONDENSE (Y/<N>)? Y
Then you would use FA item 2 above to set the maximum file size to 11.

(4) ELIMINATE POINTS: This routine will prompt:
RANGE OF POINTS TO BE SET TO 0? 2-6
One range at a time is deleted and the user is returned to the File Adjustment menu.

(5) ADJUST ELEVATIONS: This routine is useful for adjusting up or down the elevations of individual 3D points or ranges of 3D points. This allows the user to conduct 3D field topo work by first assuming elevations, and then when a tie is made to a known benchmark, adjusting the set of field shots by the difference between the benchmark and the calculated elevation. Prompting:
CHANGE IN ELEV.
(- TO DECREASE, * TO MULTIPLY)? -3.71
RANGE OF POINTS TO BE ADJUSTED? 1-11

(6) POINT PROTECT: Selecting option 6 toggles point protect on and off. Since the main COGO program starts up the point protect defaulting to "on", the first time File Adjustment Option 6 is selected, point protect is turned off. The second time it is entered, point protect is turned on, etc. Point protect causes a "beep" sound whenever a new coordinate value is entered for a point number with current nonzero coordinates. If the point number is re-entered, the old coordinate values are overridden by the new values. If Enter is pressed after the beep is heard, the program searches upward for the next free, zero-coordinate point number. When point protect is on, it applies to virtually all COGO routines, from Traverse to Right-Of-Way Offsets. A few routines will automatically override point protect. These include Coordinate Transformation (when renumbering the transformed points) and Stationing.

(7) NEW FILE: This will do a directory of existing .CRD files and allow the user to load another.

(8) DELETE FILE: This routine first does a directory of all existing files on the data directory. It then prompts:
SELECT FILE (0 FOR MENU)? TEMP1
EXTENSION? TXT
This would delete file TEMP1.TXT. To delete all files ending in TXT, you would enter:
SELECT FILE (0 FOR MENU)? *

EXTENSION? TXT The * acts as a wildcard exactly as in DOS. Do not delete CONFIG.PIK, which may reside in the data directory!

(D) 2D<—>3D: When in 3D, the program will prompt for zenith angles and calculate elevations in traverse and sideshot. Enter & Assign will always prompt for elevations. When converting from 3D to 2D, the user has the option to select the zenith angle prompt, to reduce slope distances to horizontal distances.

(E) EDM VERTICAL OFFSET: This feature is designed for improved elevation calculation when a top-mounted distance meter is placed over the theodolite. Since the theodolite measures the vertical angle, the angle of the distance meter shot will differ from the recorded vertical/zenith angle. Entry of an EDM offset (such as 0.35) will take this difference into account in carrying elevations.

(T) TRANSLATION: Translations of coordinates can be conducted by point number or by direct entry. If you wanted to shift all points from 3 to 11 by a translation defined by the vector from point 1 to point 2, you would respond as follows:
BY PT.# (Y/<N>)? Y
1ST PT.? 1
2nd PT.? 2
ADJUST ALL COORDINATES (Y/<N>)? N
RANGE OF POINTS TO BE TRANSFORMED
(EG. FOR 3-5, ENTER 3-5, FOR 4 ONLY ENTER 4)? 3-11

STARTING PT. # FOR RELOCATED POINTS: <ENTER IS SAME>? Enter

(A) ASSIGN ELEVATIONS: One point at a time, the user can assign a new elevation to the point.
PT. # (0 IF NO MORE)? 9
ELEVATION? 945.35
Use item (5) above to force a range of points to elevation 0, by using *0 as the operator.

(X) ASSIGN DESCRIPTIONS: This routine is often used to add a new description to not just a single point but to a range of points. Prompting is as follows:
POINT NO. (0 TO END, 2-4 FOR TEXT ON 2 TO 4)? 3-5
NOTE? FENCE
File Adjustment item X will also activate text mode automatically.

List Coordinates (L)

Application: To print the used and unused coordinates in a file.

Features: There are two print/display options: (1) print the used coordinates (those with nonzero values) and (2) print the unused coordinates. The coordinate printout displays northing and easting. If the file is 3-D, elevations are displayed. If unused coordinates are printed, the ranges of points with zero coordinates are displayed, minimizing screen space and printout volume. In text mode, descriptions are also displayed.

Procedure: Press **L** to display coordinates. The program prompts:

PRINT ENTIRE FILE (Y/<N>)?

If N or RETURN is entered, the program will ask:

RANGE OF PTS. TO BE PRINTED (IE. 3 TO 5 = 3-5 AND 4 ONLY = 4)? 5-10(two numbers separated by a dash or a comma)

The coordinate data is then displayed. If the printer is on and printer status is “ON”, coordinate data is printed. Coordinates with 0 value are skipped in the printout. On the DAP you will need to "blue arrow", "right arrow" to scroll right to see the full printout, since it is a one line printout of northing, easting, elevation and text. Use "blue arrow", "left arrow" to scroll back.

MORE POINT (Y/<N>)? RETURN (or Y for another range)

If all coordinates have been printed or RETURN is pressed, the user is returned to the main COGO menu.

Press **LU** to display/print all unused coordinates. If a file has been created and points 3 to 7 and 15 to 17 have been assigned coordinates, the unused coordinate printout will take the form:

UNUSED POINTS
1-2
8-14

The user is then returned to the main COGO menu.

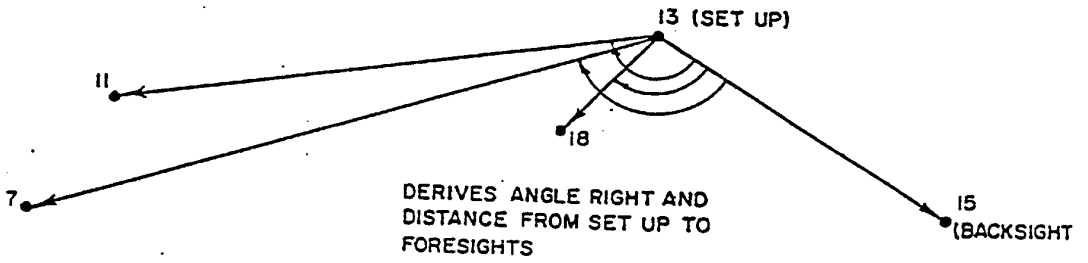
Radial Stakeout (RS)

Application: To calculate the angle-right (or azimuth!) and distance from a setup and backsight to any number of foresights. The printouts obtained are useful for staking out points in the field.

Features: A setup point and backsight point are entered, followed by any individual or set of foresights. Groups of foresights can be entered in the form 5-10 for foresights 5 through 10. The printout obtained skips a line after every 5 foresights for improved readability. With printout mode set for one line format (config item 6), stakeout data is compact and easy to read for use in field work.
Procedure: Press RS. The program first prompts:

AZIMUTH (A), ANGLE RIGHT (R) OR BOTH (B)?

RETURN defaults to angle right. The program then prompts for setup and backsight, followed by foresights. If azimuth mode is selected, printouts are essentially no different than sideshot inverse in azimuth printout mode, since backsights do not effect output. Figure 6.23 illustrates a typical Radial



Stakeout situation

FIGURE 6.23

Assuming Angle-Right mode is selected, prompting appears as follows:

SET UP POINT? 13
BACKSIGHT POINT? 15

FORESIGHT POINT #? 18
FORESIGHT POINT #? 7
FORESIGHT POINT #? 11
FORESIGHT POINT #? 20-25 (This would stakeout 20, 21, 22, 23, 24 and 25)

FORESIGHT POINT #? M (or any other menu item)

In the Radial Stakeout routine, both the SET UP POINT? question and the FORESIGHT POINT #? question are transfer prompts, accepting the entry of any other menu command. Assuming that point 13 has coordinates N 10424.793, E 9988.4095 and 15 has coordinates N 10308.557, E 10112.9396, the printout for the first three entries in one-line format appears next:

RADIAL STAKE-OUT

SET UP AT 13
BACKSIGHT 15

FORESIGHTS

RS 18 AR 95 DEG 35 MIN 26 SEC -- 40.53 FEET 10398.0000 9958.0000
RS 7 AR 116 DEG 23 MIN 28 SEC -- 235.17 FEET 10342.1200 9768.2500
RS 11 AR 132 DEG 57 MIN 56 SEC -- 191.97 FEET 10411.3769 9796.9061

Radial Stakeout can be used to determine point-to-point angles. For example, if you wanted the acute angle formed by 7 to 13 to 18, just call 13 the setup, 18 the backsight and foresight point 7. Radial stakeout can be used to stakeout curves from any setup or backsight. Conventional curve stakeout is to set up on the PC and turn deflection angles from the PI. Distances are chained from station to station around the curve. To use Radial Stakeout, set up on the PC, backsight the PI and turn angles right to the calculated station points. This simulates the "deflection angles" and provides "long chord" distances to the target points. To obtain the short chord, simply inverse from one curve station point to the next and include that inversed distance on the printout given to the field crew. Figure 6.24 outlines this procedure.

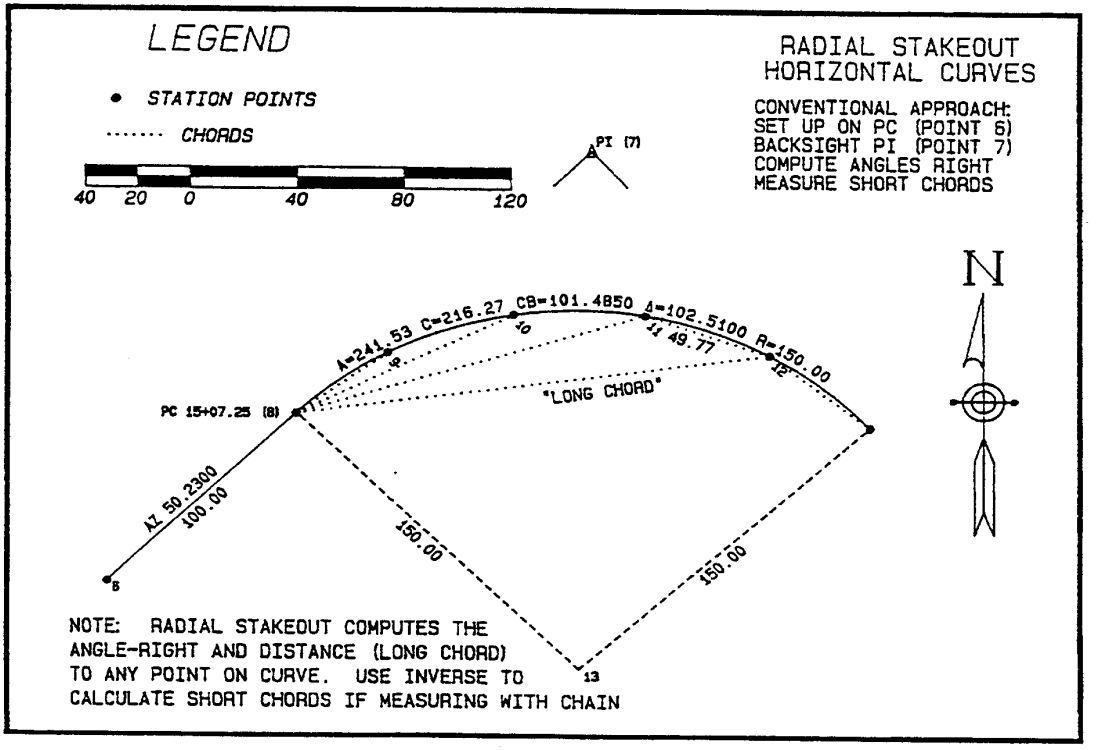


FIGURE 6.24

We will create the above layout using the 400 circle configuration (config item 20 set to MZ and config item 24 set to AZ).

? **E**

ENTER & ASSIGN

POINT NUMBER? 6
INPUT NORTHING? 5000
EASTING? 5000

POINT NUMBER? T

TRAVERSE ROUTINE

ANGLE/BEARING CODE? 5
ANGLE/BEARING? 50.23
DISTANCE? 100

POINT NUMBER? PC8

Printout:

TRAV 8 AZ 50.2300 100.00 5070.4548 5070.9657 PT. OF CURVATURE

SELECT CURVE DERIVATION OPTION:

(1) KNOWN RADIUS AND DELTA ANGLE
(2) KNOWN PI AND PT
(3) KNOWN 3 PTS. ON CURVE
(4) KNOWN PC' AND RADIUS
(5) KNOWN PI AND TANGENTS

1,2,4 FOR AREA, 2,4 FOR COMPOUND CURVES

?1
CURVE LEFT OR RIGHT (L OR <R>)? RETURN
RADIUS LENGTH? 150
RADIUS POINT? 13

Printout:

TRAV 13 AZ 150.2300 150.00 4964.0062 5176.6478 RADIUS PT.

DELTA ANGLE (IDD.MMSS) OR ARC (A##.##)? 1102.51
PT. OF TANGENCY (PT#)? 14

Printout

TRAV 14 AZ 52.7400 150.00 5065.4104 5287.1793 PT. OF TANGENCY

DO YOU WANT STATION COORDS. ALONG CURVE (Y/<N>)? Y

SELECT FROM OPTIONS BELOW:

<A> STA. INCREMENT FROM PC
<B> EVEN STA. IE. 25, 50, 100
<C> SPECIFIED STATION
<D> CONTINUE

?B
STATION OF PC? 1507.25
STA. INTERVAL (25, 50, 100)? 50
POINT NUMBER? 9
POINT NUMBER? 10
POINT NUMBER? 11
POINT NUMBER? 12

Printout

STA 9 AZ 368.3735 150.00 5095.8739 5105.1572 STATION 15+50
STA 10 AZ 389.5939 150.00 5112.0068 5152.2380 STATION 16+00
STA 11 AZ 10.8146 150.00 5111.8471 5202.0067 STATION 16+50
STA 12 AZ 32.0353 150.00 5095.4122 5248.9836 STATION 17+00

SELECT FROM OPTIONS BELOW:

<A> STA. INCREMENT FROM PC
<B> EVEN STA. IE. 25, 50, 100
<C> SPECIFIED STATION
<D> CONTINUE
?D

RADIUS= 150
TANGENT= 156.03
DELTA= 102.5100
ARC LENGTH=
268.37 CHORD
LENGTH= 233.98
PC STA. 1507.25 PT STA. 1775.62

MENU ITEM? IA

INVERSE WITH AREA

STARTING POINT? 10
POINT? 11

Printout:

INVA 11 AZ 100.2042 49.77 5111.8471 5202.0067
(Note: Distance is typical short chord length.)

STARTING POINT? 12
POINT? 14

Printout:
INVA 14 AZ 142.3900 48.57 5065.4104 5287.1793

POINT? RS

RADIAL STAKEOUT

AZIMUTH (A), ANGLE RIGHT (R) OR BOTH (B)? B

SET UP POINT #? 8
BACKSIGHT POINT #? 7
FORESIGHT POINT #? 9-12

Printout:

RS	**9**	**AR 9.0718**	**42.61**	**5095.8739**	**5105.1572**
RS	**9**	**AZ 59.3018**	**42.61**	**5095.8739**	**5105.1572**
RS	**10**	**AR 19.6820**	**91.28**	**5112.0068**	**5152.2380**
RS	**10**	**AZ 69.9120**	**91.28**	**5112.0068**	**5152.2380**
RS	**11**	**AR 30.2923**	**137.42**	**5111.8471**	**5202.0067**
RS	**11**	**AZ 80.5223**	**137.42**	**5111.8471**	**5202.0067**
RS	**12**	**AR 40.9026**	**179.76**	**5095.4122**	**5248.9836**
RS	**12**	**AZ 91.1326**	**179.76**	**5095.4122**	**5248.9836**

This completes all necessary calculations. The distances above are the long chords from the PC. The distance to point 9 is also the first "short chord". The typical short chords are 49.77 as inversed above. The final, odd short chord from 12 to 14 is 48.57. All printouts using the 400 circle are set for azimuth by config item 24, with radial stakeout (AR mode) being the only exception.

Bearing-Bearing Intersect (BB)

Application: Intersecting two lines at a single point.

Features: The Bearing-Bearing Intersect routine will calculate the intersect of two lines. It will also

allow the user to define a parallel offset line from the base line and to calculate its intersect with another line or offset line

Procedure: Press BB. The routine requests base points for 2 lines which, unless parallel, will intersect at only one point. Consider the example of Figure 6.25.

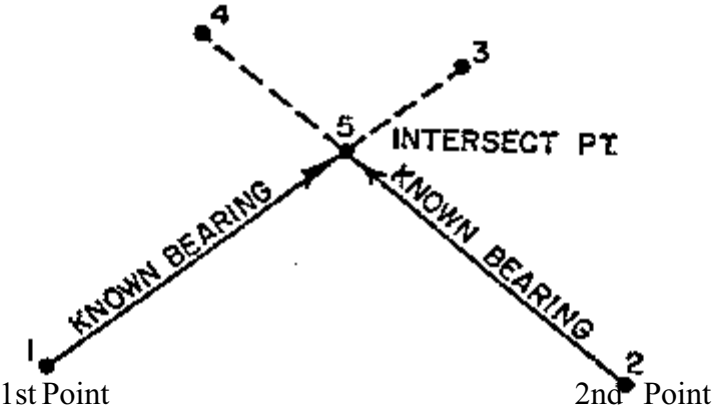


FIGURE 6.25

The sequence of inputting is given below:

BEARING-BEARING INTERSECT

INPUT BASE PT. # 1
? 1
BEARING OR PT-DEFINED DIRECTION (<B> OR P)? P
BEARING-DEFINING PT. # FOR LINE 1
?3 Alternate: QUADRANT? 1
BEARING? 46.27

INPUT BASE PT. # 2
?2
BEARING OR PT-DEFINED DIRECTION (<B> OR P)? P
BEARING-DEFINING PT. # FOR LINE 2
?4 Alternate: QUADRANT? 4
BEARING? 40.2513

Note that a line can be defined by a point and a bearing or simply by two points. Once the intersection is computed, the program requests the intersection point # and prints the calls from base point #1

to intersect point to base point #2. An example of the printout is shown next:

```
E&A   1                  9900.0000          9900.0000
E&A   2                  9906.0000          10300.0000
TRAV  4      NW 40 DEG 25 MIN 13 SEC -- 400.00 FEET 10210.5236 10040.6442
INV   1      SW 24 DEG 22 MIN 01 SEC -- 340.89 FEET  9900.0000 9900.0000
TRAV  3      NE 46 DEG 27 MIN 00 SEC -- 350.00 FEET 10141.1456 10153.6707
```

(Note: The entries above set up the data for the example.)

```
BB    1                  9900.0000          9900.0000
BB    5 NE 46 DEG 27 MIN 00 SEC -- 308.88 FEET   10112.8107   10123.8641
BB    2 SE 40 DEG 25 MIN 13 SEC -- 271.65 FEET    9906.0000   10300.0000
```

Another variation is shown in Figure 6.26. In this case point 1 is still the base point, but the direction used is defined by 6 to 3. In other words, the point-defining direction can be two other distinctly separate points.

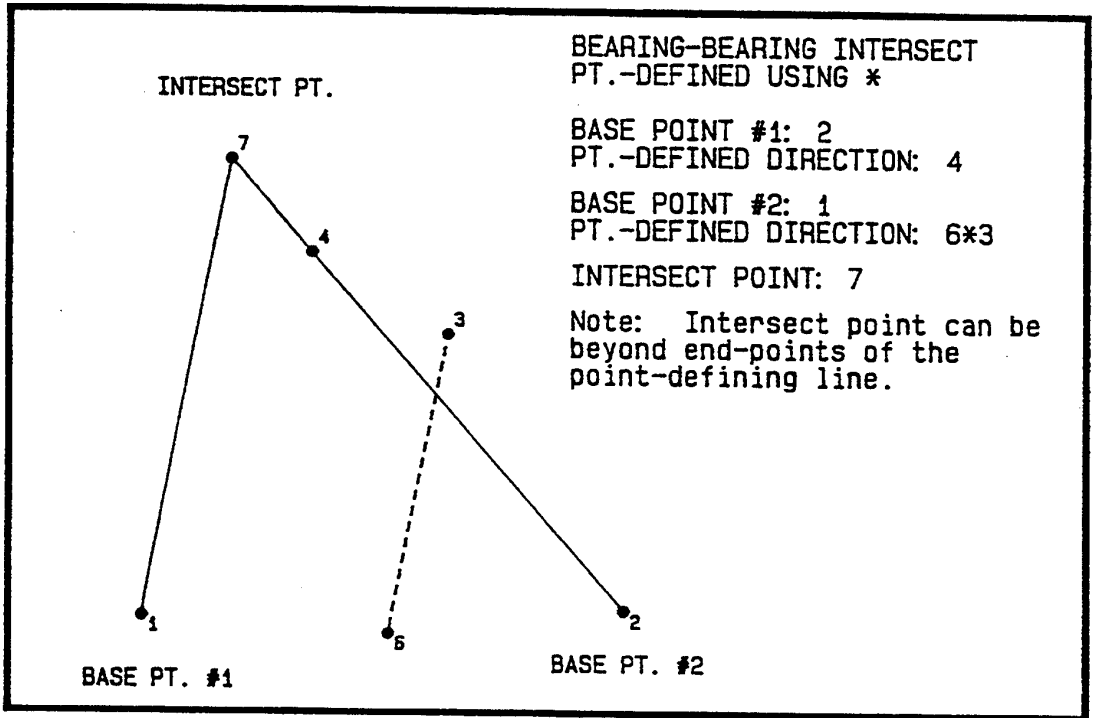


FIGURE 6.26

The input procedure for Figure 6.26 would be as follows:

INPUT BASE PT. #1
? 2
BEARING OR PT-DEFINED DIRECTION (<B> OR P)? P
BEARING-DEFINING PT. # FOR LINE 1? 4
INPUT BASE PT. #2
? 1
BEARING OR PT-DEFINED DIRECTION (<B> OR P)? P
BEARING-DEFINING PT. # FOR LINE 2? 6*3

PT. # OF INTERSECT POINT? 7

The coordinates for 7 are then printed, along with the inversed bearings from 2 to 7 to 1. Note that the INPUT BASE PT question is the transfer question in BB. Enter any other menu item and the program will transfer to it.

Point-defined directions involving the * can also include an added or subtracted angle entered in the form DD.MMSS or ###.#### in the 400 circle. Thus, an entry such as 14*17+45.15 would add 45 degrees and 15 minutes to the azimuth defined by 14 to 17. Figure 6.27 illustrates this form of reference bearing.

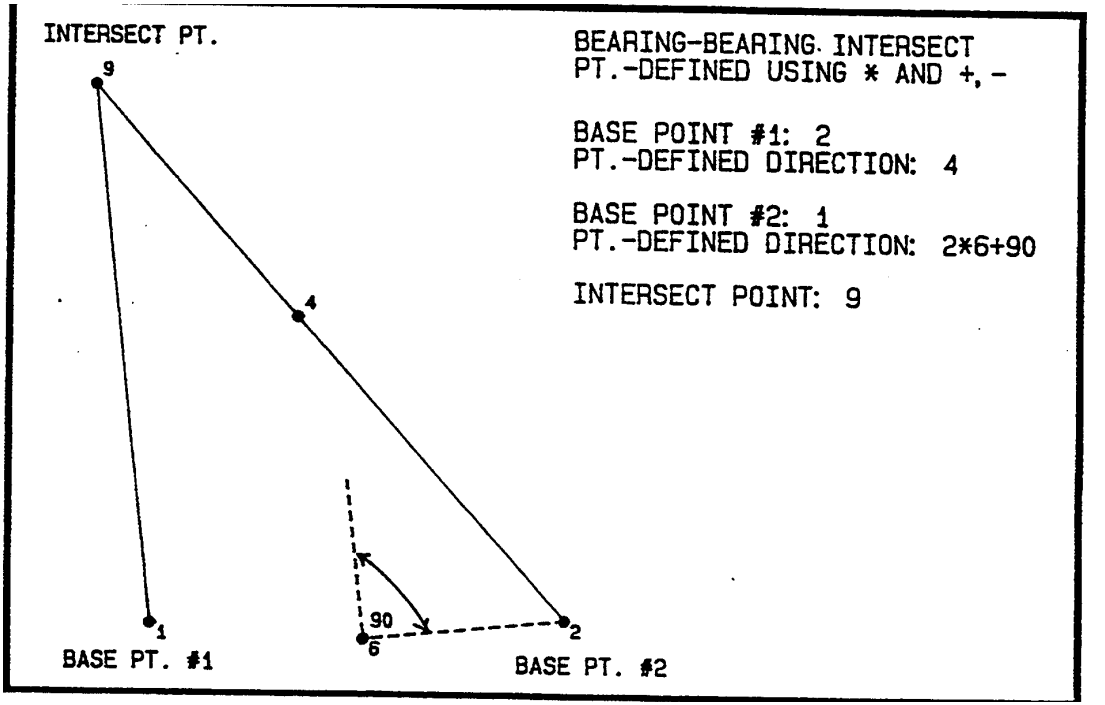


FIGURE 6.27

In the above example, the point-defined direction from point 1 would be entered as 2*6+90. The entry 2*6-90 would produce the same result.

Bearing-Bearing Intersect at Offset Sometimes it is necessary to calculate the intersect points of offset lines to known lines. A classic example is the calculation of setback lines inside lots. Figure 6.28 illustrates one such example. The offset line is referenced when the base point is entered. If you want a line 10 feet to the right of the reference line to intersect a second line, the base point is entered with the suffix R10 as in 3R10. The right or left direction is determined by facing from the base point to the point which defines direction. In Figure 6.28, if 3 is a base point and 4 the point defining direction, the lot itself is to the right.

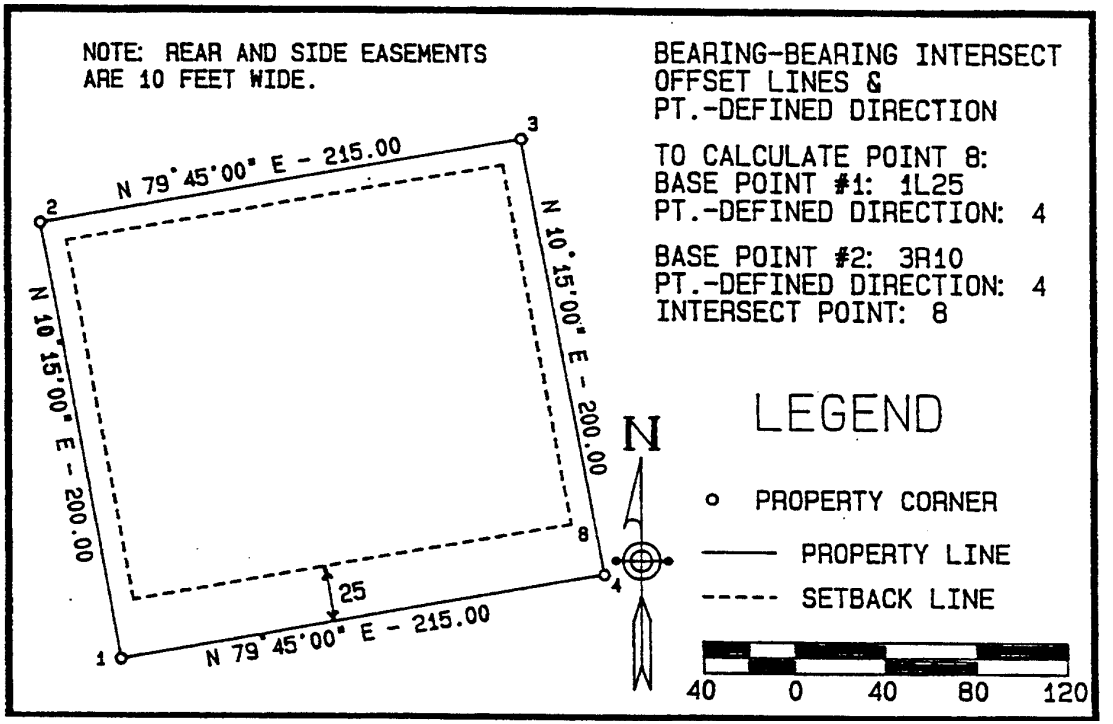


FIGURE 6.28

Prompting would begin as follows:

INPUT BASE PT. # 1
?1L25
BEARING OR PT-DEFINED DIRECTION (<B> OR P)? P
BEARING-DEFINING PT. # FOR LINE 1
?4
etc.

If the bearing option (B) is selected the user is prompted for quadrant and bearing. The quadrant must be 1 to 5, 5 representing azimuth. If the user is configured for the Metric 400 circle, azimuths are assumed and there is no prompt for quadrant. The "bearing" that is entered will be taken as an azimuth.

Bearing-Distance Intersect (BD)

Application: To calculate the intersections of a line with an arc.

Features: The bearing of the line can be defined by quadrant and bearing or by reference to points. Intersects may also be calculated at an offset to the bearing line.

Procedure: Enter BD. This routine is similar to Bearing-Bearing Intersect except that a distance rather than bearing is requested from the second base point. There are two points of intersect in Bearing-Distance. They are illustrated in Figure 6.29.

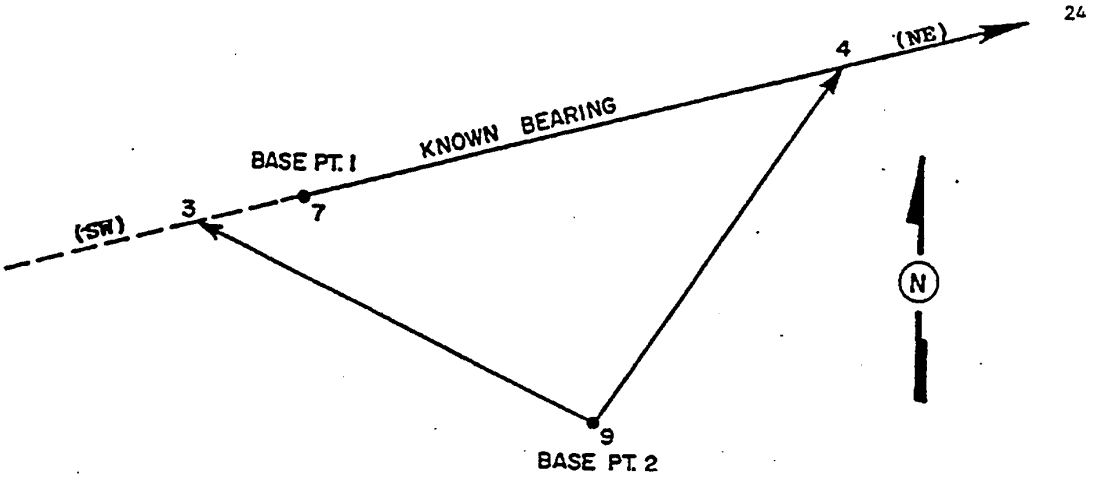


FIGURE 6.29

In the above example, point 7 is the base point with the known bearing. If the bearing is referred to as SW, point 3 is the intersect point. If NE is specified, point 4 is the intersect point. The known distance is shown as 9 to 3 or 9 to 4. If both intersect points lie on the same side of base point 1 (ie. point 7 is more SW than 3), then specifying the opposite direction (ie. SW) calculates the near intersect point.

Input for the above example is as follows:

BEARING DISTANCE INTERSECT

PT. #1? 7

BEARING OR PT.-DEFINED DIRECTION (<B> OR P)? B
QUADRANT? 3 (must be 1-4 using 360 circle)
BEARING? 74.135

PT. #2? 9
DISTANCE FROM PT.#2
DISTANCE? 330
PT. # OF INTERSECT PT.? 3

PT. #1? 7
BEARING OR PT.-DEFINED DIRECTION (<B> OR P)? B (or RETURN)
QUADRANT? 1
BEARING? 74.135

PT. #2? 9
DISTANCE FROM PT.#2
DISTANCE? 330
PT. # OF INTERSECT PT.? 4

Printout (2-line format):

```
      7              10342.1200      9768.2500
BD          SW  74 DEG 13 MIN 50 SEC -- 51.49 FEET
      3              10328.1281      9718.7028
BD          SE  49 DEG 39 MIN 25 SEC -- 330.00 FEET
      9              10114.4988      9970.2232
BD
      7              10342.1200      9768.2500
BD          NE  74 DEG 13 MIN 50 SEC -- 316.51 FEET
      4              10428.1365      10072.8457
BD          SW  18 DEG 07 MIN 05 SEC -- 330.00 FEET
      9              10114.4988      9970.2232
```

If Bearing-Distance is run using the 400 circle configuration, no QUADRANT prompt appears, and the prompt AZIMUTH, is substituted for BEARING? In all cases, the BASE PT. # prompt is the transfer question, accepting any other menu command for instant transfer. If the distance from base point 2 doesn't "reach" the reference bearing line, the program prints "NO INTERSECT" and returns to the PT. #1? prompt.

The Bearing-Distance Intersect can be used to solve key points in cul-de-sacs and street intersections

involving curved centerlines. Consider the cul-de-sac shown below in Figure 6.30. The known points are 10 and 11 (radius of cul-de-sac) and the key points to calculate are 12 through 17. Points 13 and 15 are calculated by Bearing-Distance Intersect, and the other key points are then easily derived.

Point 13 is calculated as the intersect of the 60-foot radius from 11, and a line 40-foot to the right and parallel to the line from 10 to 11 (40' is the sum of the 25' street right-of-way and the 15' "return radius"). As with the Bearing-Bearing Intersect, the initial base point is entered as 10L40. Since point 13 is the "near" intersect point, the point-defined direction must be entered in the opposite direction, as 11 to 10 (11*10) Since the direction is 11 to 10, the offset line is 40 left, so the initial base point entry is 10L40. The inputs are shown in Figure 6.30. Points 12 and 14 are then calculated by inversing to 11 and sideshooting point-defined directions 11*13 and 11*15 for a distance of 60 feet. Points 16 and 17 are similarly calculated by point-defined sideshots.

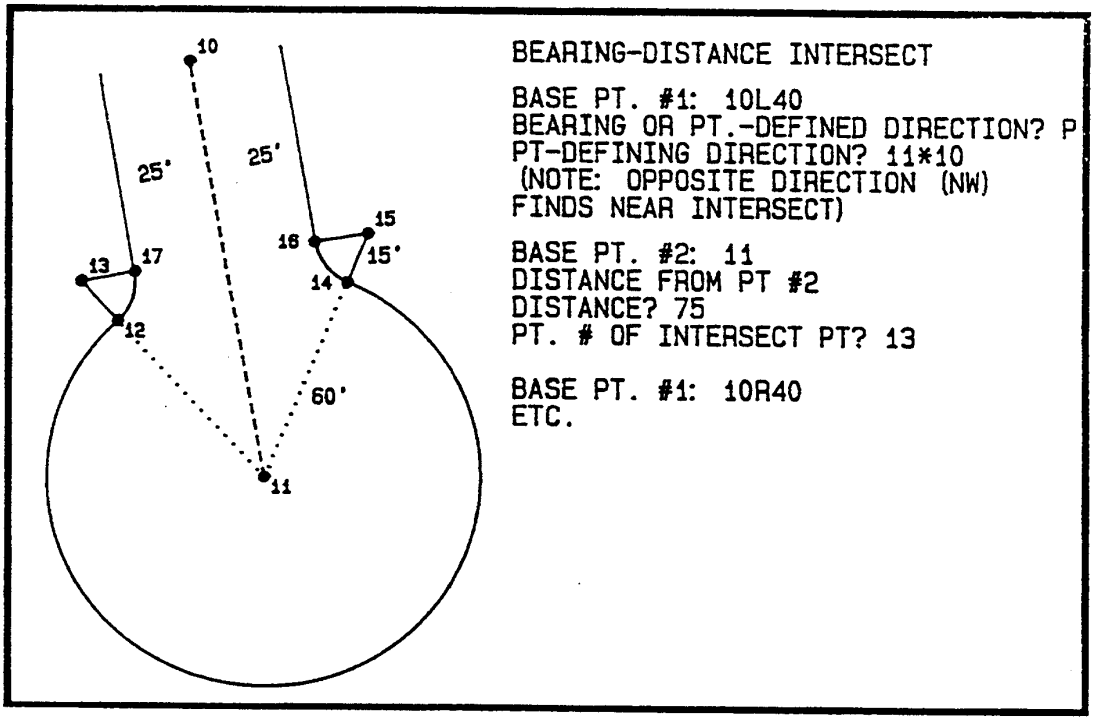


FIGURE 6.30

The combination of BB or BD with point-defined directions and offset lines largely removes the need to ever use "dummy" points to derive needed coordinates. Use of BB or BD will allow most any form of cul-de-sac or street intersection to be calculated quickly.

Distance-Distance Intersect (DD)

Application: Sometimes called "arc-arc" intersect or "circle-circle" intersect, this routine calculates the intersect of two lines with discrete distances radiating from two points.

Features: The program calculates one of two solutions. The "clockwise" solution is calculated. The clockwise solution is the intersect point that would cause the user to "turn right" if going from the first base point to the intersect point to the second base point. Reversing the order of entry of the base points calculates the other solution.

Procedure: Enter DD. Refer to Figure 6.31. Consider point 1 and point 2 as the center point of circles. The known distance can be viewed as a radius. If the sum of the radii is less than the distance between point 1 and point 2, the circles will not intersect. The program will print "NO SOLUTION" and start at the top of the DD routine. If one radius is so large that it encloses the second circle without intersecting it, the program also will print "NO SOLUTION".

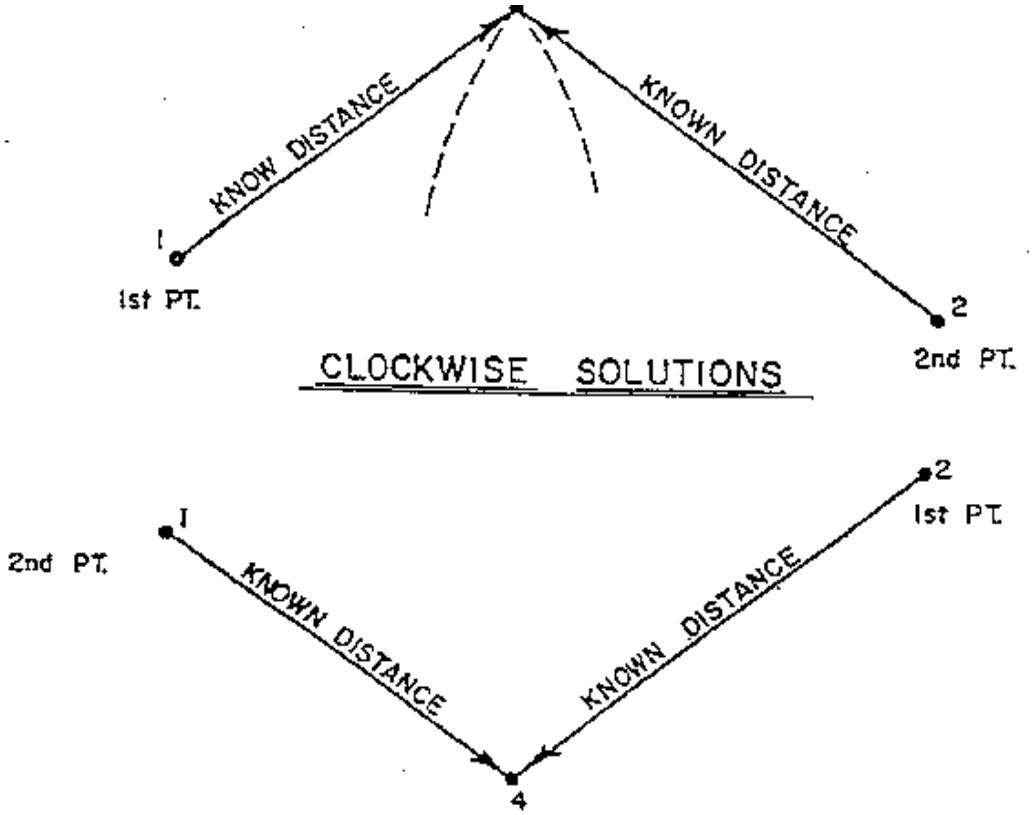


FIGURE 6.31

Prompting is as follows:

PT. #1 PT.#?2
DISTANCE FROM PT#1
DISTANCE? 190
PT.#2?2
DISTANCE FROM PT#2
DISTANCE?270
PT.# OF INTERSECT PT? 3

PT.#?2
DISTANCE FROM PT#1
DISTANCE?270
PT.#2?1
DISTANCE FROM PT#2
PT .# OF INTERSECT PT?4

Printout (2 - line format):

```
        1       10000.0000      10000.0000
DD              NE 41 DEG 28 MIN 41 SEC - - 190.00 FEET
        3       10142.3497      10125.8434
DD      SE 73 DEG 21 MIN 41 SEC - - 270.00 FEET
        2       10065.0398      10384.5385
DD
        2       10065.0398      10384.5385
DD      SW 54 DEG 09 MIN 41 SEC - - 270.00 FEET
        4       9906.9538       10165.6576
DD      NW 60 DEG 40 MIN 41 SEC - - 190.00 FEET
        1       10000.0000      10000.0000
```

The PT.#1 and PT.#2 prompts are the transfer prompts within the DD routine.

Distance-Distance Intersect can be used to calculate tangent lines to a circle. In the example of Fig. 3-32, points 1, 3, 4 and 5 are known, along with the radius of 50. To calculate tangent intersects at 6 and 7, use letter “T” as the unknown tangent length distance. Entries are shown below:

Solution for PT. 6
PT.#1?3
DISTANCE FROM PT.#1
DISTANCE ?T
PT.#2?5
DISTANCE FROM PT.#2
DISTANCE ?50
PT. OF INTERSECT PT?6
Solution for PT. 7
PT.#1?5
DISTANCE FROM PT.#1
DISTANCE ?50
PT#2?4
DIST FROM PT.#2
DISTANCE ?T
PT.# OF INTERSECT PT?7

The point-defined distance convention of 7*8 (the distance of 7 to 8) along with arithmetic operators (+, -,x,/) apply to Distance-Distance Intersect.

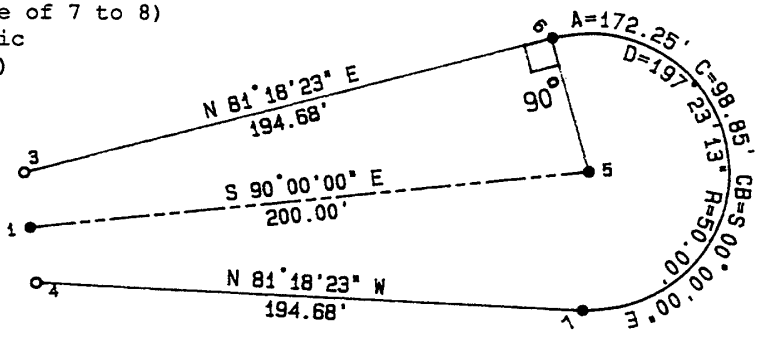


FIGURE 6.32

Offset Routines (OF)

Application: The right-of-way offset routine, sometimes called the parallel offset routine, is useful for calculating right-of-way lines based on point-to-point centerlines For example, the centerline points of a farm road easement might be known, and a completed right-of-way description is needed. Since such an easement is usually not described with smooth curves, the R-O-W offset routine offers a quick and full solution. The R-O-W offset routine is also useful for offsetting interior easement lines when such lines are at uniform offset from the perimeter.

The point offset routine calculates the offset distance of a point from a specified line. One application is to check the offset distances of actual fence line shots with the deed line. The program is particularly useful in subdivision design and to determine building offsets from right-of-ways, property lines, etc.

Features: The R-O-W offset routine determines the coordinates of offset points to a centerline composed of line segments of variable bearing. The user is prompted first for left and right offset distances. By specifying 0, the offset to that side will not be calculated. Left and right offsets need not be the same. As shown in Figure 6.33, the offsets are not calculated for the first and last points of the centerline. If they represent end points, offsets can be derived by use of 90 degree sideshots off the first and last legs. The coordinates for all offset points are assigned point numbers.

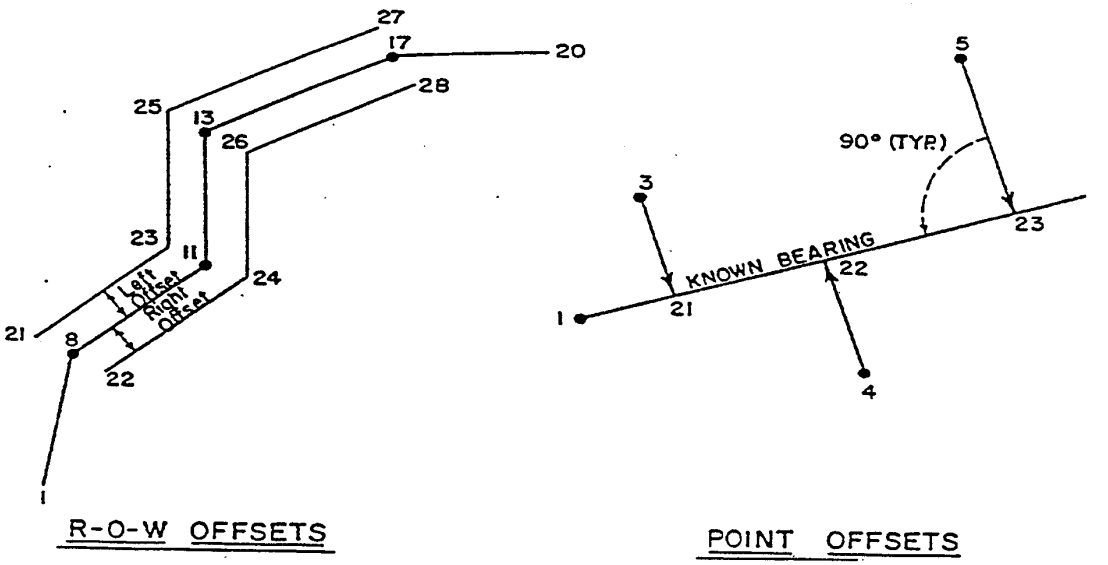


FIGURE 6.33

The point offset option computes the offset distance from any known point to a line. Prompting asks first for the baseline, beginning with base point (ie. pt. 1 above) and direction (defined by bearing or by a second point). It then asks for the offset point number, and then for a number to be assigned to the intersect point. Then it computes bearing and distance from base point to intersect point and from intersect point to offset point. A number must be assigned to the intersect point (pts. 21, 22

and 23 in the point offset example of Figure 4.37). If these points are not needed for any reason, enter dummy points with numbers like 0 or numbers above the file size.

R-O-W Offset Example: Press **OF**. To enter the above example, prompting would be as follows:

R-O-W OR PT. OFFSETS (R OR <PT>)? R

R-O-W OFFSETS

LEFT R-O-W OFFSET? 20
RIGHT R-O-W OFFSET? 20
BASELINE STARTING POINT? 1
BASELINE PT. #2? 8
BASELINE PT. #3
? 11
PT.# FOR LEFT OFFSET? 21
PT.# FOR RIGHT OFFSET? 22

BASELINE PT. #4
? 13
PT.# FOR LEFT OFFSET? 23
PT.# FOR RIGHT OFFSET? 24
ETC.

The printout produced, including the traverse entry of the baseline, is shown in Table 6.8. Note how the printout skips a line between pairs of offsets.

E&A	**1**			**10000.0000**	**10000.0000**	
TRAV	**8**	**NE 10 00 00**	**100.00**	**10098.4808**	**10017.3648**	
TRAV	**11**	**NE 40 00 00**	**100.00**	**10175.0852**	**10081.6436**	
TRAV	**13**	**NE 0 50 00**	**98.00**	**10273.0749**	**10083.0689**	
TRAV	**17**	**NE 76 34 13**	**104.30**	**10297.2988**	**10184.5169**	
TRAV	**20**	**NE 88 45 00**	**76.49**	**10298.9674**	**10260.9887**	
RW	**21**			**10107.0495**	**9998.5672**	**20L @ PT 8**
RW	**22**			**10089.9120**	**10036.1624**	**20R @ PT 8**
RW	**23**			**10182.4905**	**10061.7492**	**20L @ PT 11**
RW	**24**			**10167.6800**	**10101.5380**	**20R @ PT 11**
RW	**25**			**10288.9160**	**10063.2972**	**20L @ PT 13**

RW	**26**	**10257.2337**	**10102.8406**	**20R @ PT 13**
RW	**27**	**10317.2475**	**10181.9473**	**20L @ PT 17**
RW	**28**	**10277.3501**	**10187.0865**	**20R @ PT 17**

TABLE 6.8

Point Offset Example: The Point Offset example of Figure 6.33 might be entered as follows:

R-O-W OF PT.OFFSETS (R OR <PT>)? RETURN

PT. OFFSETS PERPENDICULAR TO A LINE

DEFINE LINE FIRST.INPUT BASE PT.#1.
?1
BEARING OR PT-DEFINED DIRECTION (<B> OR P)? RETURN
QUADRANT? 1
BEARING? 75
OFFSET POINT? 3
PT.# FOR INTERSECT PT.? 21
OFFSET POINT? 4
PT.# FOR INTERSECT PT.? 22
OFFSET POINT? 5
PT.# FOR INTERSECT PT.? 23

The printout obtained (2-line format) is shown below:

OP
1 10000.0000 10000.0000
OP NE 75 DEG 00 MIN 00 SEC --50.00 FEET
21 10012.9410 10048.2963
OP NW 15 DEG 00 MIN 00 SEC --86.60 FEET
3 10096.5926 10025.8819 OFFSET POINT
OP
1 10000.0000 10000.0000
OP NE 75 DEG 00 MIN 00 SEC --88.64 FEET
22 10022.9430 10085.6244
OP SE 15 DEG 00 MIN 00 SEC --96.69 FEET
4 9929.5431 10110.6508 OFFSET POINT
OP

1 10000.0000 10000.0000
OP NE 75 DEG 00 MIN 00 SEC --309.81 FEET
23 10080.1841 10299.2512
OP NW 15 DEG 00 MIN 00 SEC --236.60 FEET
5 10308.7246 10238.0139 OFFSET POINT

With Metric configuration, there is no quadrant prompt, and the 400-circle azimuth is entered to the prompt “BEARING?”. The BASELINE PT. #? prompt is the transfer question within Point Offsets.

Both the R-O-W Offset and Point Offset routines have counterparts in right-column menu items in the main COGO menu. For example, the Stationing Routine allows the user to enter an entire centerline, including curves, and calculate offsets left and right at any station and interval. Centerlines can also be point-to-point line segments. Menu item CC (Compute Sections from COGO points) requires line definition and "captures" all points within a specified offset of the line, printing out the displacement from the defined line. The user should be aware of these routines when making menu decisions.

Coordinate Transformation (CT)

Application: This program is useful when converting from an assumed bearing to a true bearing. The program will also allow for transforming a set of coordinates onto another coordinate system. This is useful in converting field coordinates into state plane coordinates.

Features: The program has two options (B or P). The bearing option (B) allows the user to rotate the points onto a new bearing by specifying two known points and the desired bearing between them. The first point acts like the pivot point and its coordinate values do not change. Figure 6.34 below shows such a rotation. If the 4-point traverse was conducted based on assuming 1 to 2 due north, and a sun shot later reveals a bearing from 1 to 2 of N 44 deg 14 min 30 sec E, then the points can be rotated by specifying base point (1), reference point (2) and desired bearing. The program will give the option to rotate all points or just a specific range of points.

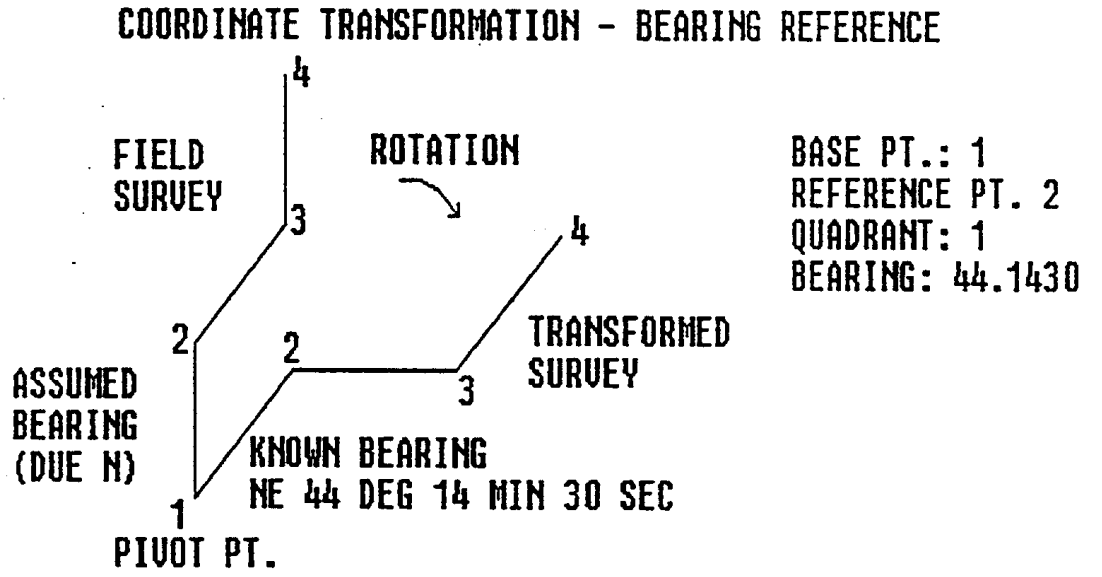


FIGURE 6.34

The second option P allows the user to move from one coordinate system to another by pairing known points in one system with known points in another system. If more than two pairs of points are compared, the program will conduct a least squares best fit to determine the optimal rotation/ translation factors. Figure 6.35 shows an example of moving from one coordinate system to another.

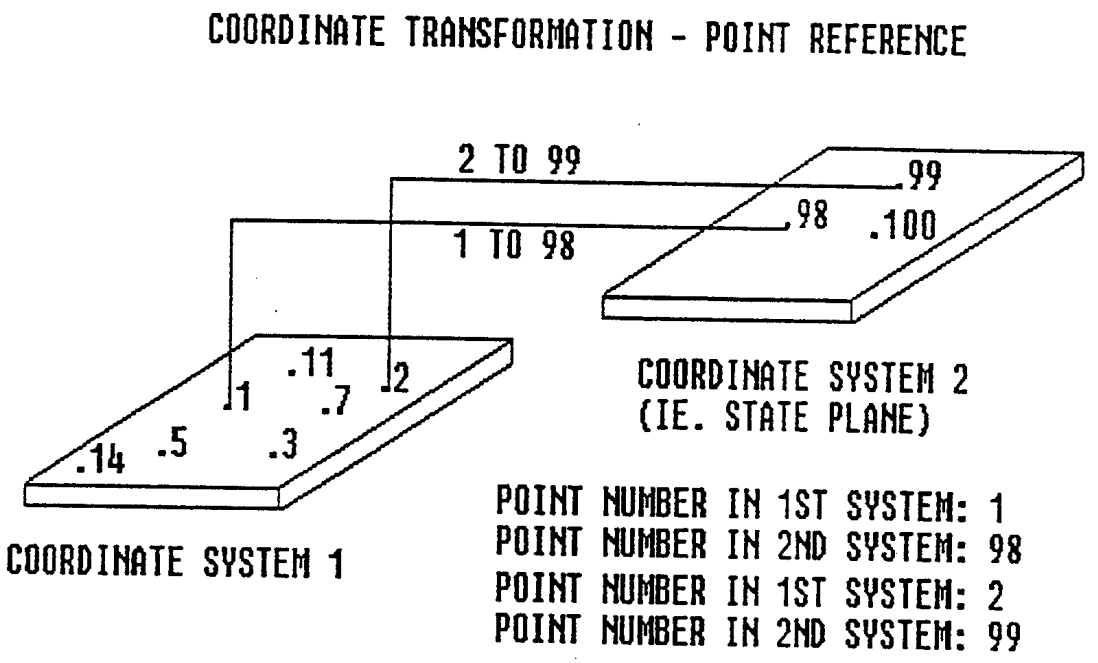


FIGURE 6.35

As with option (B), an entire file or a range of points can be transformed. Points with 0 coordinates are not changed by coordinate transformation.

Coordinate Transformation - Point Reference Example: In Figure 6.35, the first coordinate system consists of field shots with arbitrary coordinates. Assume points 1, 2 and 11 are points with known coordinates in a different coordinate system. The true coordinate values need to be assigned separate points numbers. If we are working in a file named GARTNER.100, then it might be a good idea to assign the "second system" points numbers near the top of the file, like 98, 99 and 100. Now select menu item CT.

COORDINATE TRANSFORMATION

TRANSFORM BY PT.# OR BEARING REFERENCE?
(P OR <B>)? P
PT.# IN 1ST SYSTEM (0 IF NO MORE)? 1
PT.# IN 2ND SYSTEM? 98
PT.# IN 1ST SYSTEM (0 IF NO MORE)? 2
PT.~ IN 2ND SYSTEM? 99

Note: You must pair at least 2 sets of points. After rotation is complete point 1 will have the coordinates of point 98, and point 2 will have the coordinates of point99, and all other points will be transformed accordingly. If the distance between the original 1 and 2 is different than the distance from 98 to 99, then the relational distances between all first system points will change as well. A third pair of points (such as 11 and 100) can be entered, but then a best fit calculation will be made, and neither points 1, 2 or 11 may exactly equal 98, 99 and 100.

PT.# IN 1ST SYSTEM (0 IF NO MORE)? 0
ADJUST ALL COORDINATES (Y/<N>)? N
RANGE OF POINTS TO BE TRANSFORMED?
(IE. 3 TO 5 = 3,5 AND 4 ONLY = 4,4)? 1,97

Note: Do not include the second system points in those being transformed.

START PT.# FOR RELOCATED PTS. (RET. IF SAME)? RETURN

Note: This prompt allows the user to take a set of cul-de-sac points for example, numbered 31 to 40, and place them somewhere else, renumbered perhaps 81 to 90. A radius point and a street centerline point could be calculated for a new cul-de-sac, paired with corresponding points on a cul-de-sac already calculated and the points of the first cul-de-sac transformed to the new position and renumbered.

MORE POINTS (Y/<N>) ? RETURN

Note: If a different ranges of points are to be transformed, answer Y to the above prompt and you are returned to the RANGE OF POINTS... question.

The routine concludes by printing (as an example):

NORTH TRANSLATION = 495432.2415
EAST TRANSLATION = -191455.1254
SCALE FACTOR = 1.001
ROTATION ANGLE (DD.MMSS) = 52.1951

The user is then returned to the main COGO menu.

Coordinate Transformation - Reference Bearing Example: Figure 6.36 shows a typical field survey with an initial assumed bearing from l to 2, followed by shots to a fence line (points 7 and 8). Based on the assumed bearing, the call from point 7 to point 8 calculates as S 41 12 39 E. Let's then say that a deed for the subject property gives the bearing of the fence as S 70 E, and it is desired to hold

this bearing and rotate the field shots accordingly. All that is necessary is to select option B. Specify the two points and then the desired bearing. The procedure is as follows:

TRANSFORM BY PT.# OR BEARING REFERENCE?
(P OR <B>)? RETURN
DEFINE BASELINE BY 2 PT. #S
BASELINE POINT? 7
BASELINE POINT? 8
ANGLE/BEARING CODE? 2
BEARING? 70
ADJUST ALL COORDINATES (Y/<N>)? RETURN

Note: For pure rotation, adjust all coordinates, unless you are concerned with a particular range of points.

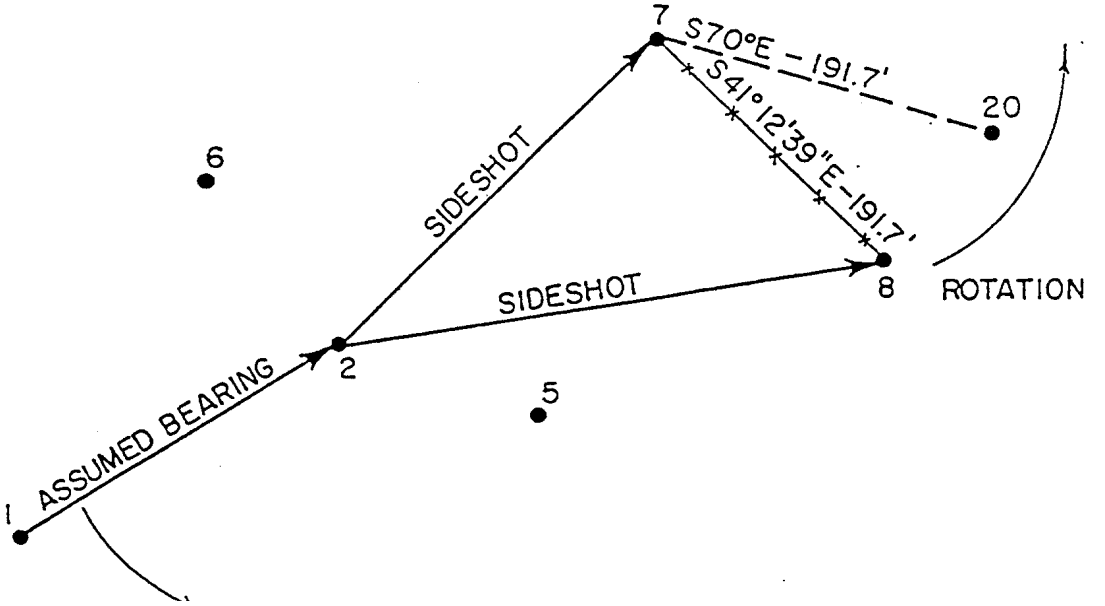
START PT.- FOR RELOCATED PTS. (RET. IF SAME:)? RETURN MORE POINTS (Y/<N>)? RETURN

The program prints:

NORTH TRANSLATION =-1846.7379
EAST TRANSLATION = 3152.5146
SCALE FACTOR = 1 (always l with bearing reference option)
ROTATION ANGLE (DD.MMSS)=331.1239

Note that the bearing reference approach can be duplicated by the point reference option by traversing the desired bearing from 7 to 20, using the same distance from 7 to 8. Then pair 7 (system l) to 7 (system 2) and 8 (system l) to 20 (system 2).

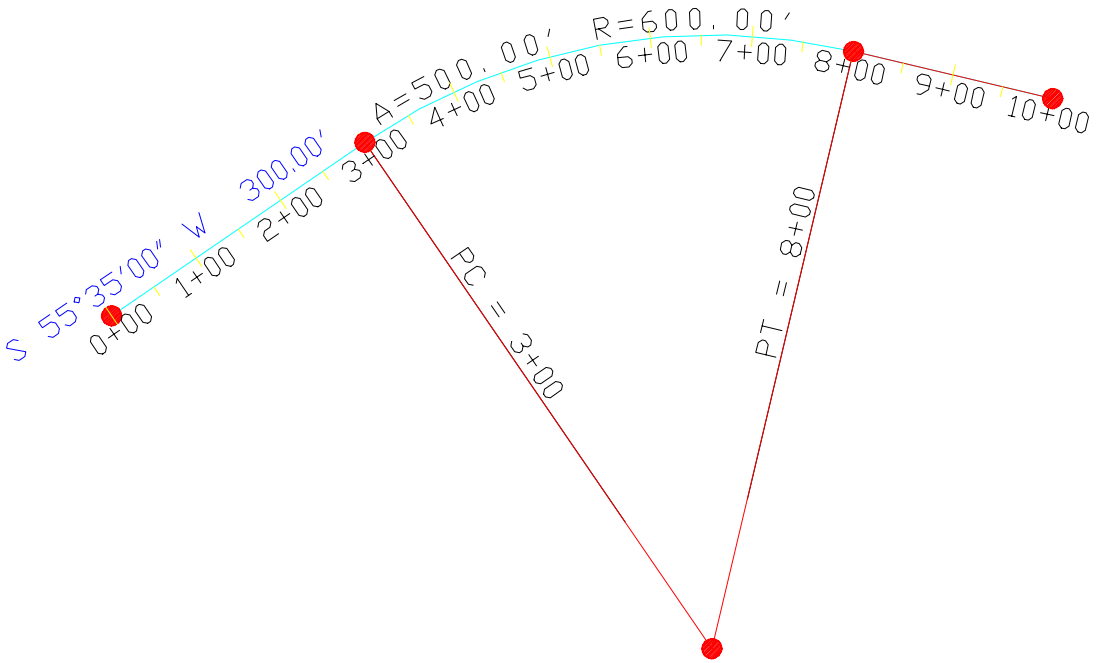
In Metric (400 circle) mode with ABC (ANGLE/BEARING CODE) prompting active, use 5 (azimuth) for the angle code entry. There is no transfer prompt within Coordinate Transformation. If you want to escape the routine, press F3 or F5, with RETURN.



COORDINATE TRANSFORMATION

FIGURE 6.36

Stationing (SN)



STATIONING

FIGURE 6.37

Application: To enter centerlines for calculation of stations and offsets and for stakeout. Centerlines are one of three required elements in template-based stakeout, the others being the profile and template itself.

Procedure: Select option SN from the COGO menu. The command is not prompted for in the menu, since it can be accessed using Design Centerline within Roadwork. The menu appears as follows:

(1) MAKE NEW CENTERLINE
(2) RECALL CENTERLINE
(3) SAVE(AS) CENTERLINE
(4) CALCULATE OFFSET PTS.
(0) END (Enter will end as well)

Option 1, Make New Centerline requires that point numbers have been established for all PC's,

PT's and PI's of the centerline, as well as for radius points. Since it is necessary to establish point numbers for the above points, we will do so using standard COGO. Starting at 5000,5000, here are the entries necessary, beginning with Enter & Assign:

ENTER & ASSIGN

POINT NUMBER <1>? Enter
INPUT NORTH? 5000
EASTING? 5000
ELEVATION? Enter

POINT NUMBER <2>? T (for traverse)

TRAVERSE ROUTINE

ANGLE CODE? 1 (assume the first bearing is N 55 deg, 35 min E, 300 feet)
ANGLE/BEARING <>
? 55.35
DISTANCE? 300
POINT NUMBER <2>? PC2 (if you forgot to traverse to PC2 and entered just 2, you can always use I for inverse to go from 1 to PC2 to initiate the curve prompting.)

SELECT CURVE OPTION:

(1) RADIUS AND DELTA ANGLE
(2) PI AND PT NUMBERS
(3) 3 POINTS ON CURVE
(4) RADIUS # AND PT #
(5) PI AND BOTH TANGENTS

1,2,4 FOR AREA
2 OR 4 FOR COMPOUND CURVE

? 1 (this option is not simply radius and delta but allows arc length and tangent length entries as well)
CURVE LEFT OR RIGHT (L OR <R>)? Enter (for right)
RADIUS LENGTH? 600
RADIUS POINT? 3

DELTA ANGLE (IDD.MMSS)

OR ARC (A##.##) OR
TANGENT (T##.##)? A500
PT OF TANGENCY (PT#)? 4

CREATE COORDS. ALONG CURVE (Y/<N>)? Enter

Curve data is then printed, followed by the prompt:

MENU ITEM? T (for traverse—remember that you are on the PT, backsighting the radius point, so an angle to the left of 90 degrees will proceed on the tangent the final 200 feet)

TRAVERSE ROUTINE

ANGLE CODE <1>? 6
ANGLE/BEARING (55.35)
? 90
DISTANCE? 200
POINT NUMBER <5>? 5

Now that we have the point numbers established, we can go directly to menu option SN for stationing:

ANGLE CODE <6>? SN

CENTERLINE STATIONING

USE PC7 TO BEGIN CURVE AT POINT 7

STARTING STATION? 0 (in our example, but it could be 1500 or any other value)
STARTING POINT? 1
NEXT PT, 0 TO END? PC2
RADIUS #? 3
CURVE LEFT OR RIGHT (L OR <R>)? Enter
PT OF TANGENCY? 4
Curve data is then displayed.
NEXT PT, 0 TO END? 5
NEXT PT, 0 TO END? 0

(1) PRINT CENTERLINE FILE
(2) STORE FILE TO DISK
(0) RETURN TO MENU

? 2
FILE NAME? ROADWAY (do not enter an extension—".CL" will be used automatically)

(1) PRINT CENTERLINE FILE
(2) STORE FILE TO DISK
(0) RETURN TO MENU
? 1

PT.#	STATION	DESCRIPTION
1	0	POINT ON LINE
2	300	POINT OF CURVATURE
3	RADIUS PT 47.4447	DELTA ANGLE (DD.MMSS)
4	800	POINT OF TANGENCY
5	1000	POINT ON LINE

This centerline file can then be recalled within centerline-based stakeout routines for both GPS and total station field work. The centerline file is an ASCII file which can be reviewed in a text editor.

Spiral curves are entered by using SI8 to indicate spiral at PI 8. Then you will be prompted for the spiral lengths, radius of the simple curve, and the forward PI point number.

The Offset Point Entry routine allows the calculation of new point numbers at specific stations and offsets. Prompting is: Enter File Name (No Extension)? Road1 (for Road1.CL)
List Centerline Y/<N>:?
Station (0 to end)? 1505.5
Side to Offset L/<R>: L
Offset Distance? 55.5
Point Number <14>: Enter for 14 or enter new point number

Toggles

SurvCOGO includes numerous toggles, or commands that can be entered at the menu or at the first prompt within most routines, that set "modes" of operation. Here is a list:

M – Recovers the menu from any "transfer" prompt. The transfer prompt is usually the initial prompt or the most repeated prompt within a given routine. M also cancels the HI and HIV modes of carrying elevations. Stationing, profile entry, configuration, file adjustment, view screen and ASCII file reading and writing exit to the menu only when explicitly prompted.

TON – Text ON. This command turns on the description prompt. The program stores this status

until altered.

TOFF – Text OFF.

ZON – Zenith ON. When traversing of entering sideshots, a zenith angle (or vertical angle) prompt will occur after the distance entry. This status is not recalled between work sessions within SurvCOGO.

ZOFF – Zenith OFF.

PON – Prism ON. This will activate a prism +/- prompt after entry of the zenith angle when carrying elevations. It is used when the "rodman" chooses to raise or lower the prism pole when target height and instrument height have been previously set equal (to cancel out the need for instrument and target height entries).

POFF – Prims OFF.

SI – Sideshot Inverse

AZ – Causes printouts to appear in azimuth form.

BR – Causes printouts to appear in bearing form.

AZI – Eliminates the ANGLE CODE prompt in Traverse and Sideshot routines and assumes all angles entered are azimuths.

AR – Eliminates the ANGLE CODE prompt in Traverse and Sideshot routines and assumes all angles entered are to the right.

ABC – Restores ANGLE CODE prompting.

HI – Sets HI mode of carrying elevations, where the user is prompted for instrument height and target height, in combination with the zenith angle.

HIV – Sets HIV mode of carrying elevations, where the user is prompted for instrument height and target height, as well as vertical difference.

ON – Turns on printouts to a printer, useful when SurvCOGO is copied to a PC.

OFF – Turns off printouts to a printer.

F3, F5 – These function keys apply only to PC-usage of SurvCOGO, and return the user to the main menu from anywhere in the program at any time.

View Screen (V)

Application: To view points on the screen and to conduct screen-verify linear areas.

See Chapter 3, Pages 3-2 to 3-4 for full description.

A Instrument Communications Settings

Instrument	Baud	Parity	Bits	Stop
Zeiss 50	9600	None	8	1
Zeiss RL	9600	None	8	1
Zeiss 4	1200	Odd	7	1
Topcon (All)	1200	Even	7	1
Nikon	9600	None	8	1
Geodimeter	9600	None	8	1
Leica TCA1100	9600	None	8	1
All GPS	9600	None	8	1

B Instructions for Using Pacific Crest Radios with Novatel

1. Before going out in the field, use the RFMCONF.EXE program from Pacific Crest to set each radio to "Transparent" mode. This is the default, so if you are receiving new radios, it may not be necessary to do this. You may, however, want to make yourself aware of which channel numbers and frequencies you have available to you on each radio.
2. Connect the radio modems to the Base and Rover receivers. Then connect the data collector to the NovAtel and start SurvStar.
3. To change the radio channel while running SurvStar, go to the SetUp menu. Make sure that the Station Type (Rover or Base) is set correctly. Select option 10 (Set Radio Channel).
4. It is recommended that you change the Base radio first. It is also recommended that when changing the Rover radio, you disconnect the radio antenna or disconnect the base radio temporarily from the base. This is to decrease outside interference that may hinder the communication between SurvStar and the radio.
5. You will see the following message on your data collector: "Disconnect Radio from Power. Press Enter when Ready." Disconnect the limo cable that supplies power to the radio and press enter.
6. When you see the "Connect Now!" message, reconnect the power to the radio. SurvStar will attempt communication with the radio for approximately ten seconds. If there is no communication established in this time, you will see the message "Timed Out." Press enter to return to the SetUp menu.
7. If communication is successfully made, SurvStar will read the current radio channel from the radio and print it to the screen. SurvStar will also prompt you for the new channel to set.
8. Enter a valid channel number and press enter.
9. If the channel change is successful, the program will ask you "Save new channel to memory (<Y>/N)?" If you say no, the current channel will only last until the next time the radio looses power. After this, the radio will revert to the previously programmed channel. It is recommended that you answer yes to this prompt. If the channel change is unsuccessful, the program will let you know.
10. This program will only reset the channel for the radio you are currently connected to. It will be necessary to go to any other bases or rovers you are currently using and run steps 3 through 9 again.

C Sample Code File

Each Entry (line) of a Code File should have the following format:

Code , Full Name, Symbol, Symbol Size, Layer, Entity Type, Tie, Linetype, Text Size, Line Width, Processing On, Nearest Found, Description, Distinct Pt Layer, Separate Layers, Smooth, Hard, Color, Precision, Real Z

Each value is separated by a comma and any value (except "Code") may be left blank. Below is a short example of a code file:

```
#  This is a field code definition file.
#  All comments must begin with a '#'.  Delete and add them as you wish.
# Code , Full Name, Symbol, Symbol Size, Layer, Entity Type, Tie, Linetype, Text Size, Line
#Width,  Processing On, Nearest Found, Description, Distinct Pt Layer, Separate Layers, Smooth,
#Hard, Color,  Precision, Real Z
DMH,,spt12,0.080000,UTIL,0,1,CONTINUOUS,0.080000,0.000000,1,0,Drain Man-
hole,0,0,0,0,256,2,1,,
EMH,,spt6,0.080000,UTIL,0,1,CONTINUOUS,0.080000,0.000000,1,0,Electric Man-
hole,0,0,0,0,256,2,1,,
FH,,spt18,0.080000,UTIL,0,1,CONTINUOUS,0.080000,0.000000,1,0,Fire Hy-
drant,0,0,0,0,256,2,1,,
MH,,spt5,0.080000,UTIL,0,1,CONTINUOUS,0.080000,0.000000,1,0,Manhole,0,0,0,0,256,2,1,,
SMH,,spt11,0.080000,UTIL,0,1,CONTINUOUS,0.080000,0.000000,1,0,Sewer Man-
hole,0,0,0,0,256,2,1,,
UP,,spt19,0.080000,UTIL,0,1,CONTINUOUS,0.080000,0.000000,1,0,Utility
Pole,0,0,0,0,256,2,1,,
```

D Constants and Conversion Factors

The following constants and conversion factors are used in the SurvStar program:

-Constants-

For State Plane Zones:

Ellipsoid	: World Geodetic System 1984 (WGS84)
Major Axis	: 6378137.0 m
Flattening	: 0.00335281066475

For UTM Zones:

Ellipsoid was determined by Datum chosen. For major axis and flattening information, see the NovAtel GPSCard Command Descriptions Manual, Appendix A.

-Conversions-

m to U.S. ft	3.280833333
m to Int'l ft	3.280839895

E Trouble-Shooting Guide

Problem - You have collected several points and can list them. However, when you go to write a text file or view the points, the program tells you the "0" is the highest number in the file and will not process your data.
Solution - Enter SurvCOGO (SC) and choose the File Adjustment feature (FA). Select option 2 (Change No. of Pts) and set the highest point number to your highest point plus one.

Problem - The data collector does not seem to communicate with the instrument.
Solution - If you are using a total station, check the baud rate of the instrument. For all Nikon total stations, the baud rate should be set to 9600. For GPS, it is not necessary to set the baud rate, SurvStar will find the receiver at whatever baud rate it is set to. Check your cable connecting your data collector to the receiver. Make sure it is pushed in all the way and not frayed. If this does not seem to be the problem, try exiting SurvStar and entering again. If there is still no communication, try re-booting the data collector (F1-0-9 on the 9800, B-O-S on the 9500). Also check your power levels on both the GPS and data collector to be sure that low power is not the cause of the problem.

Problem - I can't get into the program. It crashes before it even reaches the Main Menu.
Solution - There could be a conflicting setting in your gps.ini file (i.e. Com Port set to 1 instead of 2). From dos, go into the SurvStar directory and delete the gps.ini file. SurvStar will create a new default file when you re-enter the program.

Problem - The Disk Full Error Message Appears.
Solution - You have run out of disk space and need to free some up by deleting old files. One common hiding spot of old data is the A:\Novatel\Deleted directory. Here you will find projects that were "deleted" through NovAtel's data collection program. They weren't really deleted, just moved to this folder so that you can "undelete" them later. From dos, change to this directory and delete any files you feel you will no longer need. Also, from within SurvStar you can delete old SurvStar files. From the File Utilities menu, choose the File Manager. Type "F2" followed by the number of the file you wish to delete. Type "Y" to confirm the deletion. Your disk space remaining will be displayed in this window.

F Common DOS Commands

1. **DIR -** This command lists all files in the current working directory. Also displayed will be the date and size of each file along with the number of bytes in the current directory and the number of free bytes remaining on that drive of the data collector.

   ex. A:\>DIR
   result Volume in drive A has no label
   Directory of A:\

DATA		<DIR>		01-08-99	4:56p
SURVSTAR		<DIR>		01-08-99	4:56p
STAR	BAT		76	01-18-99	5:12p

2. **CD -** This command changes the current working directory. In the example above, both DATA and SURVSTAR are directories (denoted by the <DIR> next to their name).

   ex. A:\>CD DATA
   result A:\DATA> (*note: some data collectors do not display the current working directory in the prompt, so the result may just look like **A>**)

   To move up one directory, ".." is used to denote "previous directory".

   ex. A:\DATA>CD ..
   result A:\>

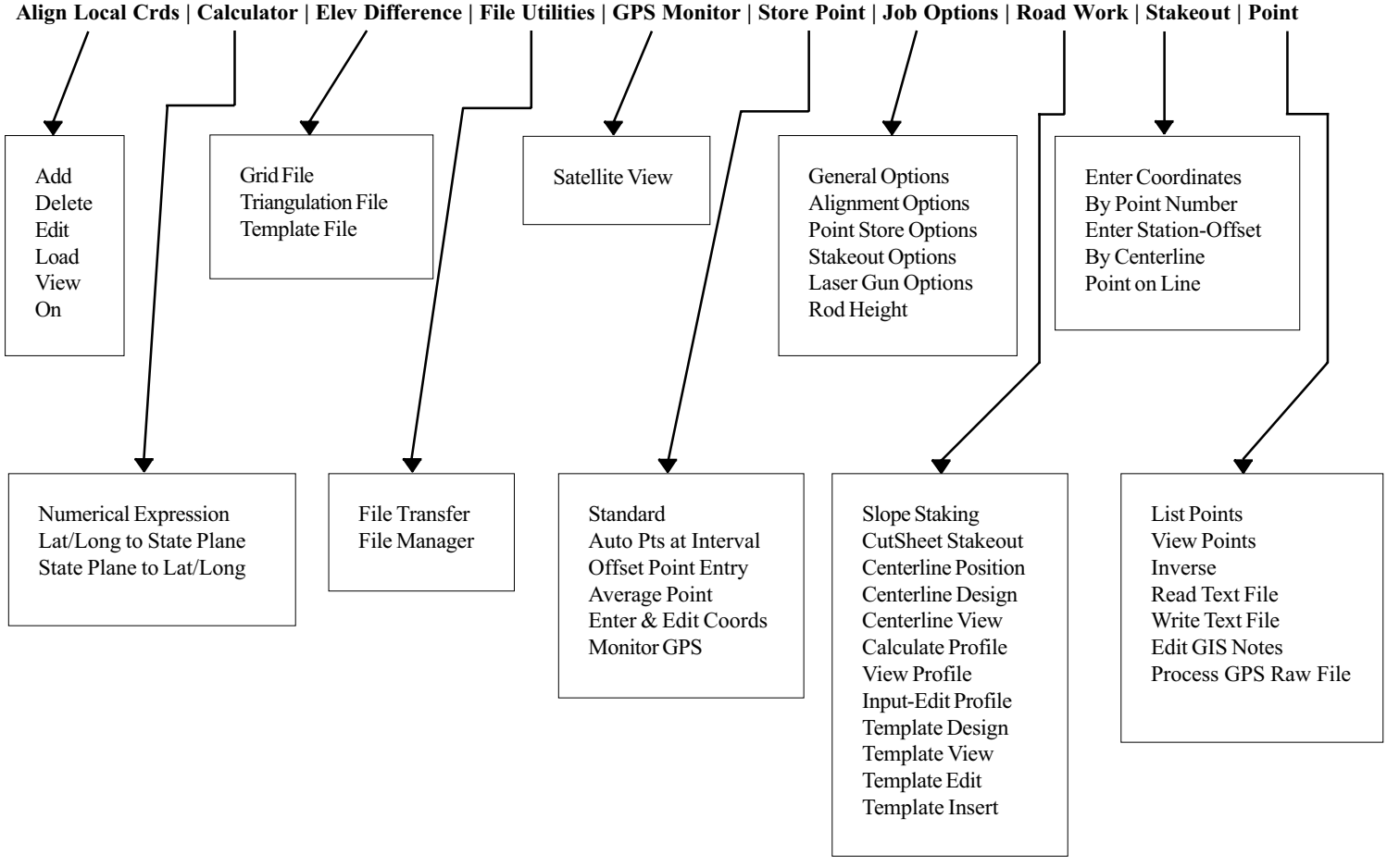
3. **DEL -** This command will delete a file from the data collector.

   ex. A:\DATA>DEL MY_JOB.CRD
   result The file "my_job.crd" is permanently removed from the data collector.

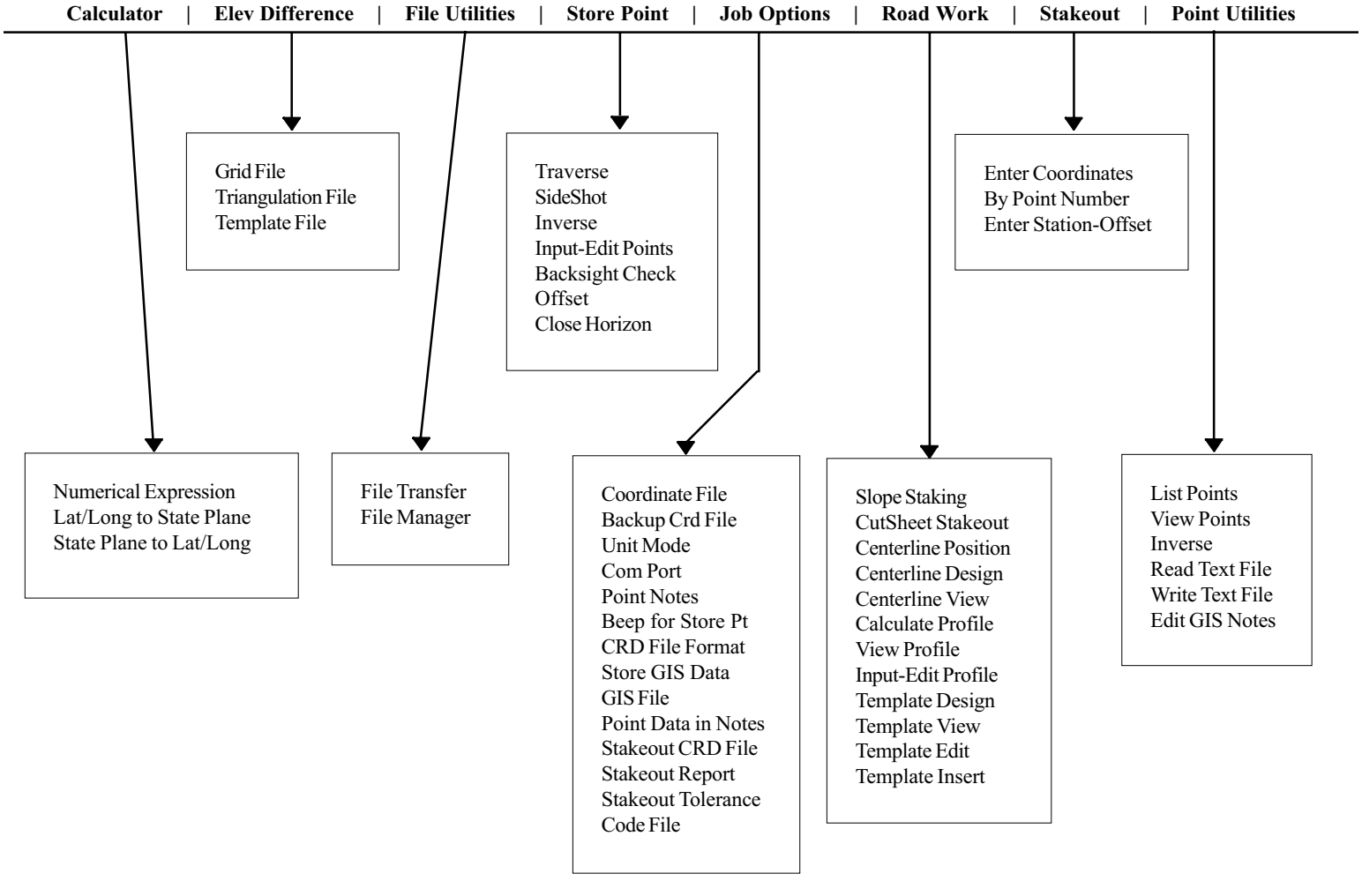
4. **COPY -** This command can be used to copy a file to a file of a different name or to a different directory. Type the original file name, followed by a space, followed by the destination file name.

   ex. A:\DATA>COPY MY_JOB.CRD MY_JOB.BAK
   result Creates a new file called "my_job.bak" identical to the file "my_job.crd".

G SurvStar Menu Structure - GPS



H SurvStar Menu Structure - Total Stations



I SurvStar Hot Keys

A	Align Local Crds
AO	Alignment Options
AP	Auto Points at Interval
AVG	Average Store Point
CAL	Calculate Numeric Exp
CL	Centerline Design
CP	Centerline Position
CS	CutSheet Stakeout
CV	Centerline View
EC	Enter & Edit Coords
EGD	Elev Difference by Grid File
ETR	Elev Diff by Triangulation File
ETP	Elev Difference by Template File
FM	File Manager
FT	File Transfer
GIS	Edit GIS Notes
GO	General Options
H	Help
I	Inverse
IO	Instrument Options (Nikon & Geodimeter)
L	List Points
LO	Laser Gun Options
LSP	Lat-long to State Plane
M	GPS Monitor
MP	Monitor Store Point
OP	Offset Point Entry
PD	Profile Design
PE	Profile Input-Edit
PO	Point Store Options
PV	Profile View
RAW	Process GPS Raw File
RH	Rod Height
RT	Read Text File
SAT	Satellite View
SC	SurvCOGO

SCL	Stakeout By Centerline
SE	Stakeout By Enter Coords
SL	Slope Staking
SO	Stakeout Options
SLN	Stakeout By Point on Line
SP	Standard Store Points
SPL	State Plane to Lat-Long
SPN	Stakeout By Point Number
SSO	Stakeout By Station-Offset
SU	GPS Setup
T	Traverse
TD	Template Design
TE	Template Edit
TI	Template Insert
TV	Template View
V	View Points
WT	Write Text File
X	Exit SurvStar

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