CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TECHNICAL OPERATING PROCEDURE

Proc. TOP-024

Revision 0

Title Differential Global Positioning System (DGPS) Operation

EFFECTIVITY

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This procedure consists of the pages and changes listed below.

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Approvals			
Written by Peter C. La Femina Peter C. La Femina	Date 12/16/97	Technical Review John A. Stamatakos	Date 12/16/97
Quality Assurance Bruce Mabrito	Date 12/16/97	Cognizant Director Budhi Sagar	Date 12/16/97

TOP-024
DIFFERENTIAL GLOBAL POSITIONING SYSTEM (DGPS) OPERATION

1. PURPOSE

The purpose of this procedure is to describe the set-up and use of the differential global positioning system (DGPS) for field surveys. This system is comprised of two components; a DGPS base station with radio telemetry system and laptop computer with DGPS software, and a DGPS "rover unit" with micro-computer and DGPS software. This procedure is applicable for field surveys in which position data is recorded by the DGPS "rover unit" micro-computer or in conjunction with collecting magnetic data as described in TOP-023.

2. RESPONSIBILITY

The Principal Investigator of the project and personnel involved in conducting the field surveys shall be responsible for the implementation and control of this procedure.

3. EQUIPMENT & SUPPLIES

The following equipment is required for implementing the procedure and is separated by system component: DGPS base station and DGPS rover unit.

DGPS BASE STATION

Qty.	Equipment	Manufacturer	Model No.	Calibration Required
1	Propak 3151R GPS receiver	Novatel	GIS Mobile BASE	No
1	RS232 serial null modem cable (Lemo 10-pin to DB-9)	Novatel	N/A	No

Qty.	Equipment	Manufacturer	Model No.	Calibration Required
1	Radio serial cable (Lemo 10-pin to Lemo 5-pin with twin power cable)	Novatel	A00469	No
1	GPS receiver power cable (Lemo 4-pin to cigarette lighter)	Novatel	01016343	No
1	RFM96W radio modem amplifier power cable (Lemo 2-pin to SAE lug)	Pacific Crest	N/A	No
1	RFM96W radio modem 3" p"pigtail" coaxial jumper cable (TNC male to TNC male)	Pacific Crest	N/A	No
1	GPS base station antenna cable - coaxial (TNC male/TNC male) 15 m	Novatel	C016 01016340	No
2	Aluminum or wooden tripods	Seico	S70 or S50	No
1	GPS antenna choke ring	Novatel	GPS A031	No
1	Active GPS antenna (TNC female)	Novatel	Model GPS 501	No

Qty.	Equipment	Manufacturer	Model No.	Calibration Required
1	3 - piece antenna pole	Pacific Crest	N/A	No
1	Receiver and radio holding platform	Pacific Crest	N/A	No
1	Radio modem -2 watt and 35 watt	Pacific Crest	RFM96W -2W & 35W	No
1	Range pole mount	Pacific Crest	N/A	No
1	Mobil radio whip antenna	Antenex	N/A	No
2	12 v motorcycle battery	Pacific Crest	N/A	No
1	12 v/6 amp battery charger	ClipLight Mobil Line	N/A	No
1	GPS base station receiver power cable - alligator clips to cigarette lighter adapter	Various sources	N/A	No
1	Panasonic Personal Computer	Panasonic	Model No. CF-25	No
1	GIS MObil software version 1.15	Novatel	Version 1.1	No
1	Sentinal key (blue)	Novatel	HW-501 GIS Mobile PST96M1103SR	No

Qty.	Equipment	Manufacturer	Model No.	Calibration Required
1	Sentinal Key (red)	Novatel	HW-502 GIS Base PST96B11055SR	No

DGPS ROVER UNIT

Qty.	Equipment	Manufacturer	Model No.	Calibration required
1	GISMO backpack	Novatel	14315048	No
1	Propak RT-20 GPS receiver	Novatel	GISMO RT-20	No
1	GPS receiver power cable (Lemo 4-pin to cigarette lighter)	Novatel	01016343	No
1	GPS Data Collector	DAP Technologies	Microflex PC 9500 01016266	No
1	Active GPS antenna (TNC female)	Novatel	Model GPS 501	No
2	GPS antenna and radio pole	Novatel	12023130	No
1	Range pole mount	Pacific Crest	N/A	No
1	Mobil radio whip antenna	Antenex	N/A	No

Qty.	Equipment	Manufacturer	Model No.	Calibration Required
1	GISMO radio battery - 12Vdc/2.3Ah	Various sources	N/A	No
1	GISMO radio charger with cigarette lighter adapter	Manada	AC Adaptor	No
3	NiCad rechargeable battery - 1.2V/1400mAh	Sanyo	N/A	No
3	Alkaline battery - 1.5V emergency replacement for DAP unit	Various sources	N/A	No
1	DAP PC9500 battery charger	DAP Technologies	C8510	No
1	RS232 serial null modem cable - DAP to PC (Lemo 7-pin to DB-9 w/round charger connector)	Novatel/DAP Technologies	01016266	No
1	RS232 serial null modem cable - receiver to DAP (Lemo 10-pin - COM1 on receiver to Lemo 7-pin - DAP serial port)	Novatel	01016341	No

Qty.	Equipment	Manufacturer	Model No.	Calibration Required
1	Sealed lead/acid battery - 12Vdc/6.5Ah	Panasonic	N/A	No
1	GPS RT-20 receiver battery cable w/ cigarette lighter adapter	Various sources	01016344	No
1	GPS RT-20 receiver battery charger	PowerSonic, Corp.	Model PSC-12800A	No
1	GPS antenna cable - coaxial (TNC male/TNC male) 3 m	Novatel	C016 01016340	No
1	Radio modem -2 watt	Pacific Crest	RFM96W-2W	No
1	RS232 serial null modem cable - radio to GPS receiver (Lemo 5-pin to DB-9 w/ radio power connector)	Various sources	N/A	No
1	RS232 serial null modem cable - receiver to Radio (Lemo 10-pin COM2 on receiver to DB-9)	Various sources	N/A	No
1	RS232 serial null modem data cable - G858 NMEA OUT to receiver and radio (DB-9 to split DB-9/DB-9)	Various sources	N/A	No

4. PROCEDURE

4.1 DGPS Base Station System Assembly

4.1.1 Set-up both tripods.

4.1.2 On one tripod attach the choke ring by screwing the 5/8" tripod screw into the mount on the bottom of the choke ring.

4.1.3 Attach the GPS antenna on the choke ring ground plane and attach the coaxial antenna cable to the antenna (TNC male/TNC female). The GPS antenna needs to be held down on the choke ring using clear tape placed on the outside lip of the antenna. If this DGPS base station location is to be used for more than one day, the position of the center of the tripod must be marked so that it is placed in the same position each day. If a USGS benchmark is not being used as the DGPS base station marker, a stake hammered into the ground below the center of the tripod works well for this purpose.

4.1.4 Screw together the three blue and white striped antenna poles and range pole mount. The range pole mount is placed on top of the range pole and held in place with a 5/8" threaded washer. A whip antenna is then screwed onto the range pole mount.

4.1.5 Place the black metal receiver and radio platform on top of the other tripod and attach the antenna pole to the tripod using the 5/8" tripod screw.

4.1.6 Place the GPS receiver and RFM96W radio modem (2W and 35W) on top of the platform. This RFM96W radio modem is able to transmit at 2 watts or 35 watts. This set-up is for transmitting at 2 watts. Section 4.1a addresses the set-up for the 35 watt mode.

4.1.7 Connect the opposite end of the coaxial GPS antenna cable to the GPS receiver (TNC male/TNC female - labeled "RF" on the receiver). See figure 1.

4.1.8 Connect the radio antenna cable to the RFM96W radio modem (TNC male/TNC female - labeled "antenna - low power out"). See figures 2a and b.

4.1.9 REMEMBER: The GPS and radio coaxial antenna cables must be connected before powering the system. If, for any reason, the cable is disconnected from the antenna or the receiver, you must turn off power before reconnecting the cable. This is to prevent the GPS receiver from unnecessarily activating the antenna current-limiting circuit.

4.1.10 Connect the GPS receiver to the radio modem using the blue radio serial cable (Lemo 10-pin to the receiver [COM2 port]), and Lemo 5-pin with SAE lug connector to the radio modem ("power radio" port). See figures 1 and 2a.

4.1.11 Connect the GPS receiver power cable to motorcycle battery with the alligator clips (black to negative; red to positive) and cigarette lighter female adapter. Then connect the GPS receiver power cable (Lemo 4-pin female to cigarette lighter male adapter) to power cable with cigarette lighter female adapter.

4.1.12 Connect the radio power cable (SAE lug) to power cable from motorcycle battery (SAE lug).

4.1.13 The GPS base station receiver is now ready to receive position data from the laptop computer using the manufacturer's software.

4.1a Alternative Radio Telemetry System Set-Up - 35 watt Mode

4.1.1a Connect the radio antenna cable to the RFM96W radio modem (TNC male to TNC female - labeled "antenna - high power out"). See figure 2b.

4.1.2a Connect 3-inch pigtail jumper cable (TNC male/TNC male) to RFM96W radio modem (TNC male to TNC female - labeled "antenna - low power out" and TNC male to TNC female - labeled "radio").

4.1.3a Connect amplifier power cable (Lemo 2-pin to SAE lug) to RFM96W radio modem labeled "power amp" and to second SAE lug from base station battery.

4.1.4a Connect the GPS receiver to the radio modem using the blue radio serial cable (Lemo 10-pin to the receiver COM2 port), and Lemo 5-pin with SAE lug connector to the radio modem ("power radio" port). See figures 1 and 2a.

4.1.5a Connect the radio power cable (SAE lug) to power cable from motorcycle battery (SAE lug).

4.1.6a The base station radio telemetry system is now radio to transmit at 35 watts.

4.2 DGPS Base Station Position Set-up

4.2.1 Turn the laptop on.

4.2.2 Put the RED Sentinal/Rainbow key in the printer/parallel port located in the back of the computer. The GISMO software will **NOT** work, without this software key.

4.2.3 Connect the GPS receiver to the computer by means of the serial cable (RS232) null modem cable; Lemo 10-pin to the GPS receiver (COM1 port); and DB-9 to the computer serial port located in the back of the computer.

4.2.4 In Windows 95, hit the "windows" or "start" key.

4.2.5 Press "p" or highlight the word "Programs" with the mouse arrow. All of the programs will appear to the right.

4.2.6 Highlight "GIS Mobile software 2 or 3". The subdirectories of this program will appear to the right.

4.2.7 Highlight "GPS Base Station" and hit "enter" or "return."

4.2.8 From the main menu located at the top of the screen, select "Options" (you may also press the "ALT" key and "O" at the same time. The "Options" menu will drop down.

4.2.9 Select "Base Station coordinates" from the menu and hit "enter."

4.2.10 A "Base Station coordinates" dialog box will appear. This window prompts the user to fill in the base station coordinates in latitude and longitude, the height of the base station relative to mean sea level, the geoid height and the ellipsoid height. The coordinates must be entered in degrees, minutes and decimal seconds and the hemisphere must be chosen. The heights are input in meters. The ellipsoid height will be calculated, but it may be entered if the user knows it. See figure 3.

4.2.10a "Base Station" coordinates may be obtained by the following methods: (i) coordinates may be read from USGS topographical maps, (ii) a handheld GPS (e.g., the Eagle Explorer) or one of the Novatel GPS rover units may be used to obtain the coordinates, and (iii) from the National Geodetic Survey's web site at http://www.ngs.noaa.gov:80/cgi-bin/ds_radius. The latter offers the most accurate means of obtaining USGS benchmark coordinates.

4.2.11 The base station coordinates may be saved into a database by clicking on the "NEW" button in the dialog window. Enter a station name and press "OK." The base station coordinates will be saved.

4.2.12 The GPS base station receiver and antenna now "know" their location and will begin transmitting differentially corrected position data to the rover unit.

4.2.13 **NOTE**: The RS232 cable must be unplugged from the GPS receiver COM2 port before leaving the base station program. The GPS base station will "forget" where it is, if this is not done.

4.2a Alternative DGPS Base Station Position Set-up - Using the DAP Microflex 9500

4.2.1a This method is quicker and easier than using the laptop computer to input the base station coordinates.

4.2.2a Connect the DAP 9500 to the GPS base station receiver with the spiral RS232 serial null modem cable (Lemo 10-pin to the receiver's COM1 port and Lemo 7-pin to the DAP's serial port).

4.2.3a Turn on the PC9500 unit by pressing the letter "**B**" (for Begin). The GISMO Manager menu appears on the screen. There are four options: GIS Data Collector, Transfer, DOS and Sleep.

4.2.4a Highlight "GIS Data Collector" and hit the enter key. A message will appear "Searching at 19200, 38400 or 9600 - Esc to abort search." Press the red "FCT" key then the "ESC" key (this is also the period key). The GIS Data Collector main menu will appear. Highlight "GPS" and hit enter. Toggle down to "Reference" by using the down arrow key and hit enter. The "Reference" screen will appear.

4.2.5a The "Reference" screen allows the user to enter the position coordinates for the GPS base station or reference station. The user must input the base station coordinates in latitude and longitude coordinates, the height of the base station relative to mean sea level, the geoid height and the ellipsoid height. The coordinates must be entered in degrees, minutes, and decimal seconds. The heights are input in meters. The ellipsoid height will be calculated based on the other heights, but it may be entered if the user knows it. See figure 4.

4.2.6a Once the coordinates and heights are input, press the black "ALT" button followed by the letter "C" and the settings will be accepted. The GPS menu will appear again. Using the down arrow key, toggle to "Differential" and press enter.

4.2.7a In the Differential menu toggle down to "Transmit RT20" and hit enter. Press "ALT" followed by "C".

4.2.8a The GPS base station receiver and antenna now "know" their location and will begin transmitting differentially corrected position data to the rover unit.

4.2.9a NOTE: The RS232 cable must be unplugged from the GPS receiver COM2 port before powering down the DAP PC9500. The GPS base station will "forget" where it is, if this is not done.

4.3 GPS Rover System Assembly

The GPS rover system components can be stored assembled in the backpack. If the backpack components need to be reassembled, the attached Novatel GISMO user's manual procedure should be implemented.

4.4 Data Collector - DAP PC9500

4.4.1 Battery Charging

4.4.1.1 The PC9500 normally comes powered by a group of three A size rechargeable nickel cadmium (NiCad) batteries. These batteries allow three work days of autonomous operation. In addition, the PC9500 can use three, AA size, Alkaline batteries. These batteries allow 1.5 days of autonomous operation. Never mix the NiCad batteries with the Alkaline batteries; doing so risks explosion or serious damage to the PC9500. It is good practice to leave an "emergency" set of AA batteries in the GISMO backpack.

4.4.1.2 When the battery level is low, the unit turns off automatically. When you resume your application program, whether you have recharged the batteries or not, the unit displays a message. This message says that the unit shut down automatically because the batteries were low, and that the batteries should be recharged if you have not already done so. The unit may not turn back on because the batteries are too low. In that case, the message appears when you connect the PC9500 to a charger. The PC9500 is equipped with a backup battery. This battery ensures that the application program, data and files are always saved, even when the main batteries are too low or when you are replacing them.

4.4.1.3 The PC9500 comes with a modular charger and an RS232 serial cable with charger connector split from the DB-9 end of the cable. Insert the round connector of the modular charger into the round connector of the small cable attached to the communication cable DB-9 connector. Connect the modular charger to the wall outlet. Insert the serial 7-pin Lemo connector into the serial port on the side of the PC9500. See figure 5.

4.4.1.4 It is preferable to replace batteries in a clean, dry area. Make sure that neither water nor dust can enter the PC9500. Never mix NiCad batteries of different models, age or state of charge as well as never mix NiCad with Alkaline type batteries. This would produce a risk of chemical leakage, or even explosion. Always replace all 3 at the same time. Replace batteries according to the instructions in the DAP Microflex PC9500 users manual.

4.4.2 Use of the PC9500

4.4.2.1 To turn the unit on press the B key (for Begin) on the keyboard.

4.4.2.2 You generally do not have to worry about turning off the PC9500 to save batteries. If the PC9500 remains inactive for more than 45 seconds, it will shut off automatically. The PC9500 will save the exact status of your application program and data before shutting off. To turn off the PC9500 manually, press the following keys: blue arrow, FCT, and B one after the other, releasing the previous key before pressing the next. The display will clear and the keyboard will no longer beep when a key is pressed.

4.4.3 Use of the GIS Mobile Software Version 1.15 for Collecting Position Data

4.4.3.1 The description of this procedure will follow in a step-by-step format and will take the user through a basic set-up for a DGPS survey. To make a choice from the menu screens the user must highlight the choice by "toggling" up or down the list using the arrow keys, followed by pressing enter.

4.4.3.2 Turn on the PC9500 unit (see section 4.4.2.1). The GISMO Manager menu appears on the screen. There are four options: GIS Data Collector, Transfer, DOS and Sleep.

4.4.3.3 Highlight "GIS Data Collector" and hit the enter key. A message will appear "Searching at 19200, 38400 or 9600 - Esc to abort search." This message is stating that the unit is searching for the GPS antenna. Once the unit has found the GPS antenna, the message switches to "waiting for clock." This means that the GPS is waiting for clock data from the satellites.

4.4.3.4 The "GIS Data Collector" main menu will then appear. The user has seven options: File Management, Configure, GPS, Feature Tagging, Navigation, Version and Quit.

4.4.3.5 Highlight "Configure" and press enter. The general configuration screen will appear. This screen allows the user to configure the GPS rover unit, so that it will calculate accurate position information. On this screen there are two options the user may have to change: Projection and Time zone. Projection allows the user to enter the map projection which they would like their position data referenced to. The North American Datum 1983 (NAD83) is used for most of the surveys. This will give position data in Universal Transverse Mercator (UTM) coordinates. Time zone is the time zone relative to Greenwich Mean Time of the survey area. For example, San Antonio is in the -7 time zone. After all the settings are entered press "ALT" followed by the letter "C" and the settings will be accepted. If the user wishes to cancel the settings, press "ALT D". By pressing "ALT-B", the user will be returned to the GIS Data Collector main menu.

4.4.3.6 Now highlight "GPS" and press enter. The GPS menu will appear. The user has eight options: Position, Visibility, Geometry, Health, Reference, Observations, Advanced Configuration and Differential. First highlight Position and press enter. This will allow the user to see if a position is being calculated. Press "ALT-B" to return to the GIS Data Collector main menu. Now highlight Differential and press enter. This screen is to set differential corrections transmission or reception. In this case, the user wants to "Receive RT20." Highlight "Receive RT20" and press enter. The "Receive RT20" screen will appear. Press "ALT C" to accept. The GPS will now receive differentially corrected data.

5. Data Collection, Recording, and Retention

As stated in section 1.0, the Differential Global Positioning System (DGPS) may be used in surveys where position data is recorded by the rover unit micro-computer (PC9500) or in conjunction with collecting magnetic data as described in TOP-023. In the latter surveying method, position data is transmitted from the DGPS rover unit to the Geometrics G858 cesium vapor magnetometer via an RS232 serial null modem data cable. The G858 then stores the position data in conjunction with a magnetic reading. For further data collection, recording, and retention information for this surveying method, please consult TOP-023. The following section will describe the collection, recording and retention of position data by the rover unit micro-computer.

5.1 Collecting Position Data with the DAP Microflex PC9500

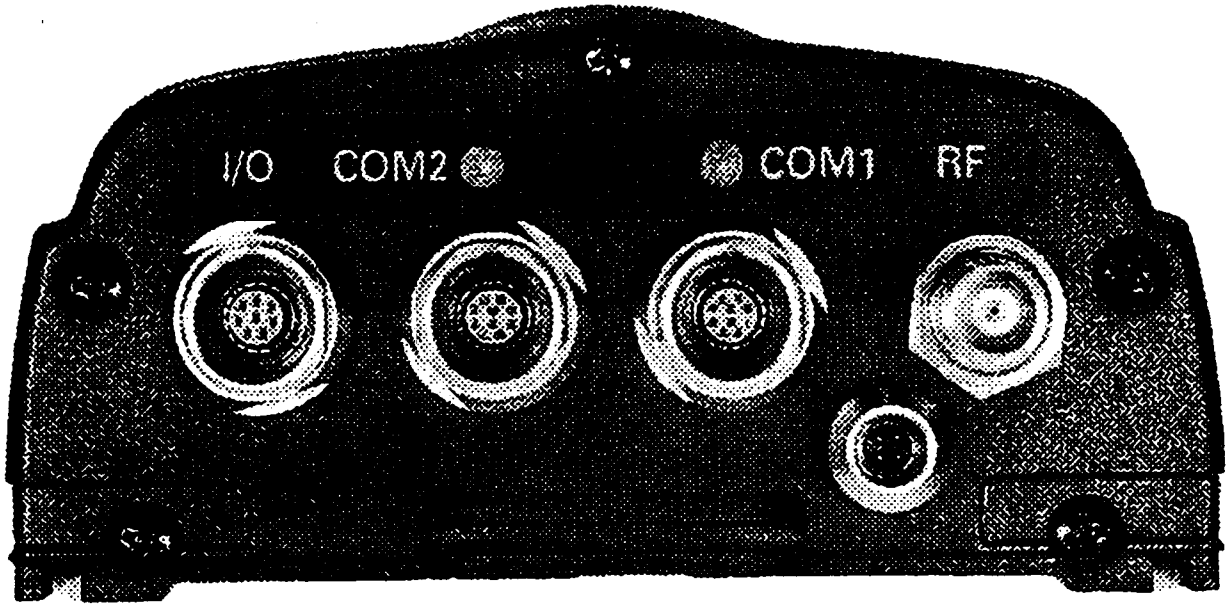
5.1.1 To record position data, highlight "File Manager" in the GIS Data Collector main menu. The File Management menu lists the following options: New File, Open File, Close File, Directory, Delete, Undelete and Edit Header. Highlight "New File" and press enter. Then highlight "GPS Project" and press enter. Enter a new GPS project name which may be up to seven letters or numbers in length. Press "enter" followed by "ALT-C" and the GPS will begin recording position data. By pressing "ALT-B", the user will be returned to the GIS Data Collector main menu. A bar (/) will appear in the lower left hand corner of the screen and will rotate counter clockwise when the PC9500 is collecting data. In addition, the word "**pause**" will appear above the "ALT-D" function if a GPS project file is open. To pause data collection press "ALT-D." To resume data collection, press "ALT-D" again. The DAP PC9500 can record position data for 13 hours at a one second data rate. Position data files are in the ASCII format.

5.1.2 Data collected and recorded with the DAP PC9500 is transferred to the laptop computer at the end of each surveying day, utilizing software provided by the manufacturer. The cable used to charge the PC9500 is also used to transfer data between the PC9500 and the laptop computer (figure 5). Insert the Lemo 7-pin connector into the COM2 port on the right hand side of the PC9500 and the DB-9 end into the serial port on the back of the laptop computer. To begin the file transfer protocol, the user will set-up the laptop computer. In Windows 95, press the "windows" or "start" key. Press "p" or highlight the word "Programs" with the mouse arrow. All of the programs available will appear to the right. Highlight "GIS Mobile software 2 or 3". The subdirectories of these programs will appear to the right. Highlight "GIS Utilities" and press "enter" or "return." From the menu bar across the top of the screen, select "Communication." The "Communication" menu will drop down. Select "Setup" and press "enter." The communication setup dialog box will appear. This will allow the user to designate where the transferred file will reside. This dialog box also allows the user to designate which communication port is being used by the laptop and the speed at which the data is transferred. Press "OK" when the set-up is complete. Select the "Communication" menu again, and then select "Receive." The laptop is now ready to receive data from the PC9500.

The user must now set-up the PC9500 to transfer the DGPS position data files. In the GISMO Manager main menu select "Transfer" by highlighting it and pressing "enter." The "Transfer" menu has four options: Connection, Close Connection, Transmit and Receive. Begin by selecting "Connection." In the "Connection" menu select "Null Modem." In the "Null Modem" menu it is important to check the "Comm Port" and "Bauds" settings. The "Comm Port" should be set for "Com2" and the "Bauds" should be set at the same rate as the laptop. Press "ALT-C" to accept the settings. This will return you to the "Transfer" menu. In the "Transfer" menu select "Transmit." Then select "GPS Project." To select a GPS project to transfer, press the "SP" button. To execute the transfer press "enter." The GPS project files will then begin to be transferred. The progress of the transmission will appear in the "Transmit" window. The progress screen will display the name of the file currently being sent, the size of the file, the current number of bytes sent, and the percentage of the file sent. A dialog box in the GIS Utilities program on the laptop computer will also show the progress of the file transfer.

5.1.3 GPS project files are transferred from the laptop computer hard drive to 3.5 inch floppy disk and later to 8 millimeter magnetic tape for storage. As noted earlier, GPS project files are in ASCII format. GPS project files shall be maintained as QA records in accordance with CQAM section 17 and permanently retained.

Figure 1 NovAtel GPS Receiver



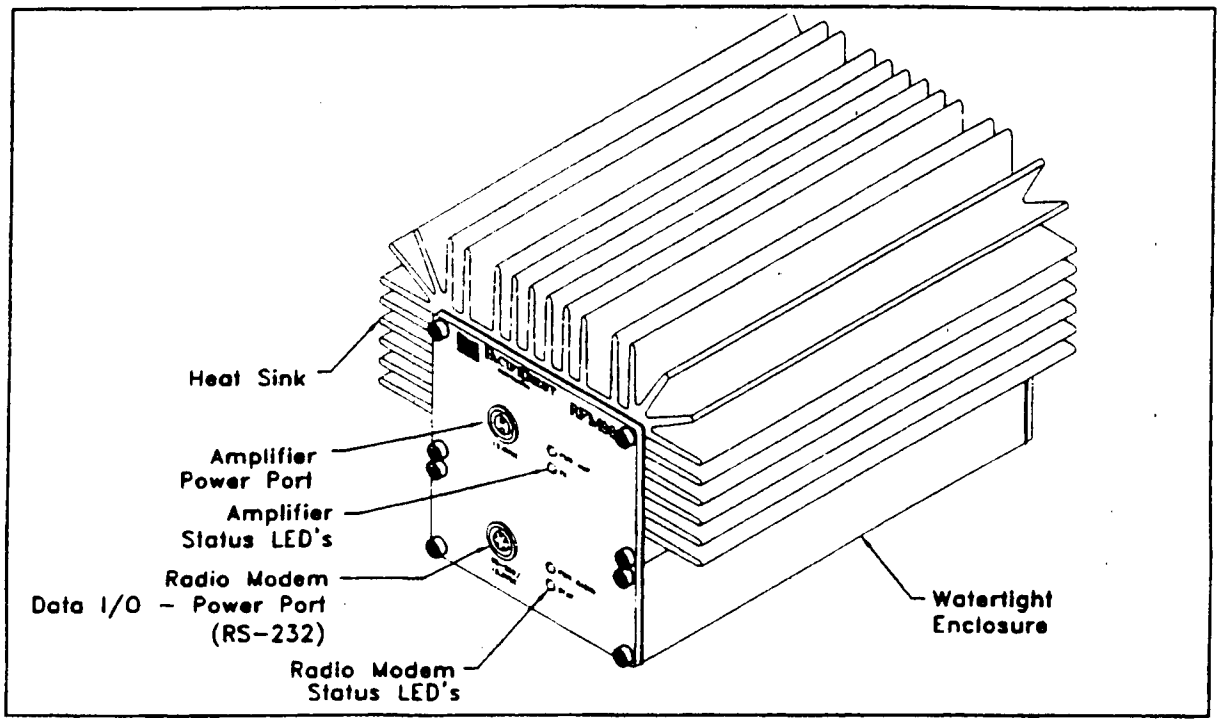


Figure 2a. Pacific Crest RFM96W 2 and 35 watt radio modem. This unit is used for telemetering differentially corrected GPS data from the base station to the rover unit(s).

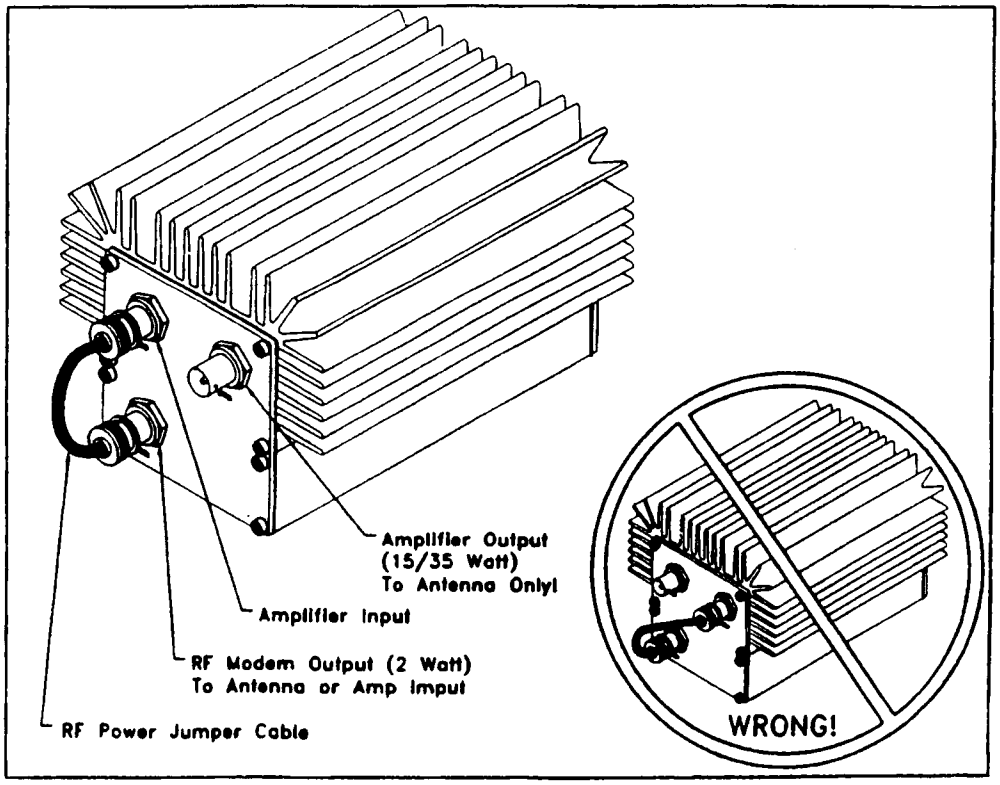


Figure 2b. RF power jumper cable connection. Do not connect the RF output ports together (see insert). Damage may occur if the output ports are connected.

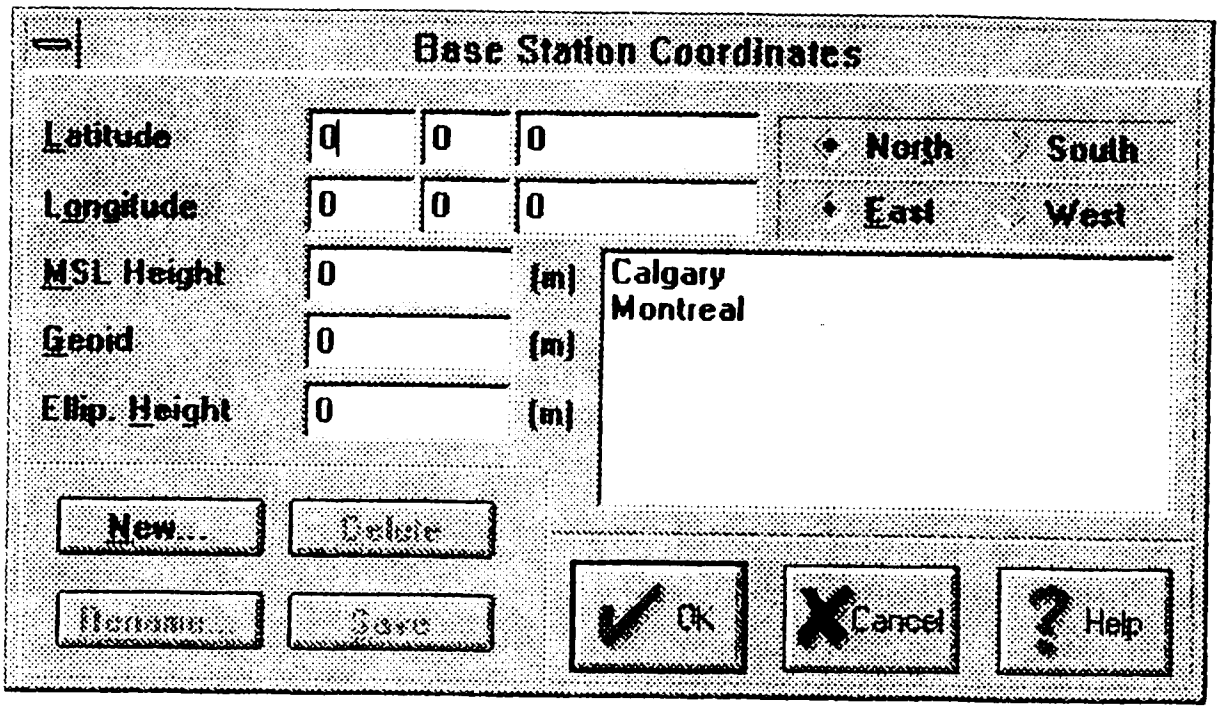


Figure 3. The GIS Mobile software Base Station Coordinates dialog box.

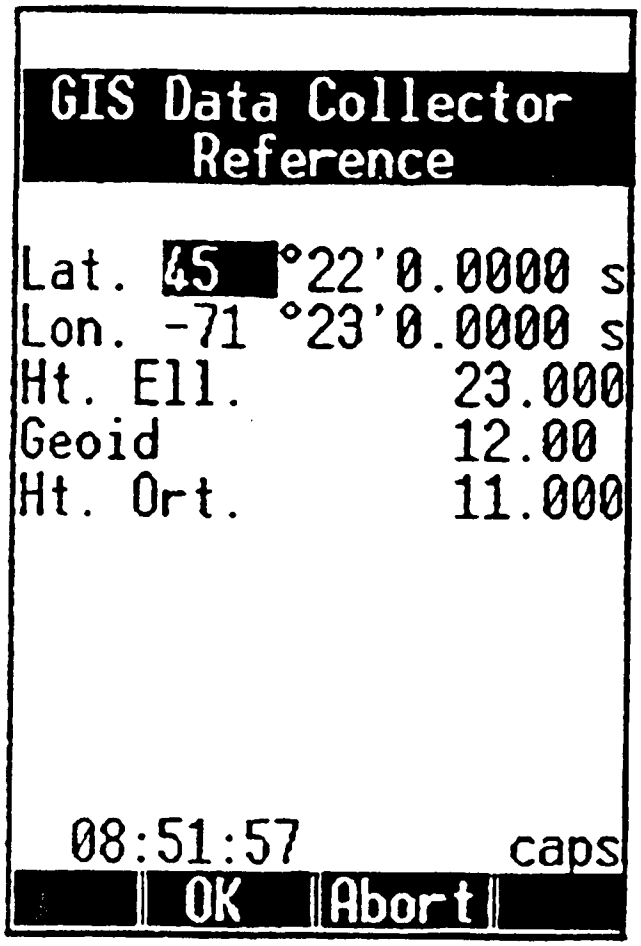


Figure 4. An example of the GIS Data Collector Reference screen. The reference screen is used to set-up the DGPS base station.

TO ASSEMBLE THE GISMO SYSTEM, follows these steps, using the illustration as a guide:

Load cables first:

1. Open the bottom pouch of the backpack.

2. Grasp one end of the three-metre antenna cable and insert it into the exit slit located on the side of the pack behind the waist belt. (There is an exit slit on both sides of the pack. This allows the user to carry the antenna pole on either side.) It is helpful to open the centre zipper of the inside compartment of the pack, feel for the antenna cable, and guide it into the pack. Feed it from the interior compartment through the exit slit above the receiver. Thread the opposite end of the antenna cable through the two elastic guide loops found on the outside of the antenna pole pouch. These loops will help hold the cable close to the pack and help to prevent it from becoming caught. Neatly coil the remainder of the cable behind the centre zipper inside the interior compartment.

3. Thread the 10-pin Lemo connector end of the coiled serial cable through the exit slit on the side of the pack and feed it into the pack through the right-hand interior slit. The right-hand vertical pouch will be used to hold the receiver. Attach the outside end (7-pin Lemo connector) to the Data Collector.

4. Pull the 4-pin Lemo-connector end of the coiled power cable out through the exit slit above the receiver pouch, and thread the opposite end, the cigarette lighter adapter, out through the slit above the bottom left-hand pouch. The bottom left-hand pouch is used to hold the battery.

Insert components:

5. Insert the GPS receiver into the sleeve on the right side of the pack, with the rear panel connectors being accessible.

6. Insert the battery into the bottom left section, and secure the flaps around the battery. Ensure that the cigarette lighter socket is accessible.

7. Insert the antenna pole into the side pocket of the backpack, and push it down to the bottom of the pocket to ensure stability.

8. Attach the antenna to the top of the pole. Do not overtighten.

Connect the antenna cable:

9. Connect the antenna cable to the antenna. Ensure that the TNC connector is snug.

10. Attach the cable to the antenna connector on the receiver. When ready, the antenna pole should be extended by pulling the quick release handle on the pole, and extending the pole to its maximum height. Be careful when pulling the antenna cable out of the pack to accommodate the extra length required. The antenna cable should not be kinked, or signal strength loss may occur, and the cable may be damaged.

Connect the receiver:

11. Connect the serial cable 10-pin Lemo connector to the receiver's COM1 port, making sure that the red dot on the connector shell is lined up with the red index mark on the socket. Insert the connector until it seats with a click, locking it in place.

12. Attach the power cable 4-pin Lemo connector to the receiver, making sure that the red dot on the connector shell is lined up with the red index mark on the socket. Insert the connector until it seats with a click, locking it in place.

13. Lay the receiver down in the pack compartment, loop the restraining strap through the retaining loop behind the receiver sleeve, and secure the Velcro strap around the sleeve to hold it in place.

Turn on power:

14. Connect the power cable cigarette lighter adapter into the battery cable socket. Ensure that it is firmly seated. This connection acts as the unit's power switch.

15. Close the centre zipper, and close the backpack lower compartment.

The GISMO system is now assembled, and the components can be stored in the pack this way. The battery may be charged in the backpack but it is recommended to keep the backpack flap open to allow proper ventilation (gas emissions) of the battery during recharging. The battery must be charged in an upright position.

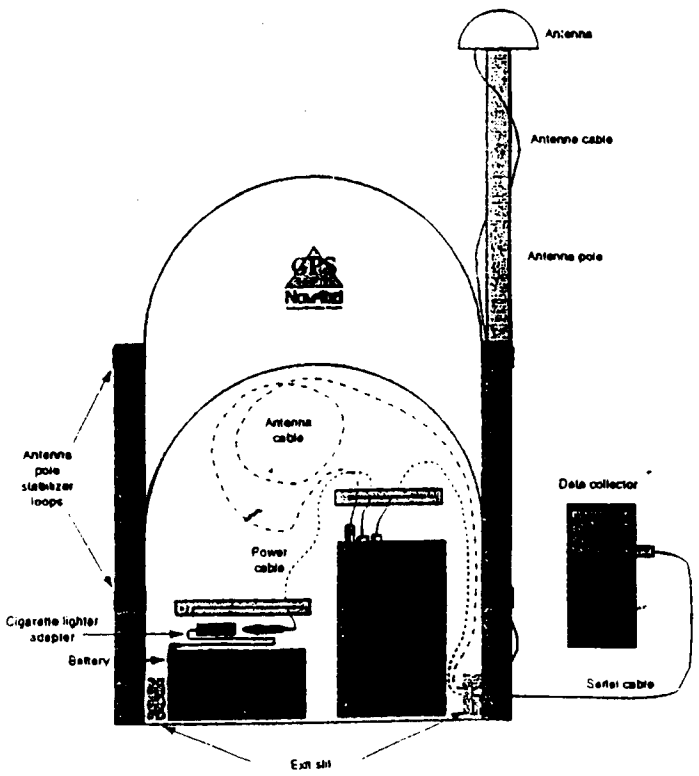
The data collector can be carried in the pouch provided, which may be attached to the pack by means of the hook and strap. You will find straps sewn onto both shoulder straps and both sides of the hip belt to accommodate carrying the pouch.

There is a small pouch located inside the bottom compartment on the upper left side, which can be used to hold small accessories such as spare cables, notebook, pen, small flashlight, etc.

The upper compartment of the backpack can also be used to hold accessories, lunch, etc. It is recommended that miscellaneous items such as keys, tools, etc. not be stored loosely in the lower compartment of the backpack where they could damage or interfere with the operation of the receiver and battery.

The shoulder straps can be shortened or lengthened to a custom fit by inserting the hand behind the pack frame and re-adjusting the fit of the Velcro panel.

Tighten the cinch straps to fit the pack comfortably to the body.



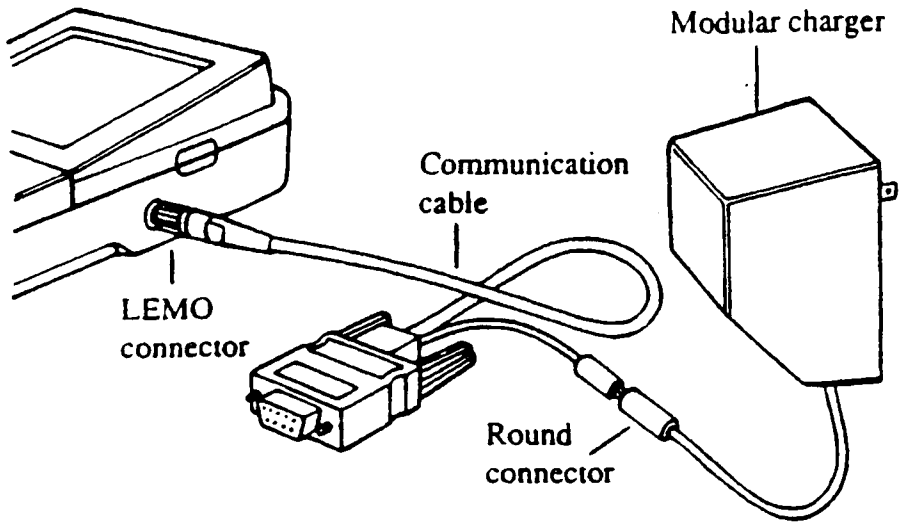


Figure 5. The DAP PC9500 battery charger set-up. The cable used for charging the unit is also used for data transfer between the PC9500 and a computer.