**D. ✸ ELECTRONIC NAVIGATION ✸**

## NAVIGATION CENTER

### Providing GPS/LORAN Information, and Online Access to the Local Notice to Mariners

The U.S. Coast Guard is the government interface for civil users of GPS and has established a Navigation Center (NAVCEN) to meet the needs of the civil users. NAVCEN is a Coast Guard facility manned 24 hours a day, 7 days a week, and is located in Alexandria, Virginia. The Navigation Information Service (NIS) (formerly GPSIC) is part of NAVCEN and provides GPS status information to civilian users of the system at no charge. To reach the NIS write:

Commanding Officer (NIS)
US Coast Guard Navigation Center
7323 Telegraph Rd
Alexandria VA 22315-3998
Telephone: **1-703-313-5900**

Fax: **1-703-313-5920**

Internet: http://www.navcen.uscg.gov or
Mirror Site: www.navcen-mirror.com

E-mail: mailto:nisws@navcen.uscg.mil

Fax on Demand (FOD):

Navigation Information is available through a Fax on Demand System 24 hours a day at:
Telephone: **1-703-313-5931/5932**

NIS 24-Hour GPS Recording:
GPS: Telephone **1-703-313-5907**

WWV/WWVH Radio Broadcast Users can hear WV*RV broadcasts by telephone or radio at 14-15 minutes past the hour and WVNH at 43 - 44 minutes past the hour.
Radio frequencies: 2.5, 5, 10, 15, 20 MHz
Telephone: **1-303-499-7111**
Telephone: **1-800-368-5647**

## LORAN INFORMATION

LORAN-C, which was first established in 1958, is the last form of Loran still in use today. LORAN-C is the logical extension of LORAN-A and offers greatly increased range and accuracy to the user. It operates in the 90-110KHZ band and the time difference measurements are made utilizing both the pulse envelopes and the phase for the cycle within the pulse envelope to obtain a highly accurate reading.

**LORAN-A:**

**LORAN-A has been discontinued throughout the world.**

**LORAN-C:**


LORAN-C has been selected by the Federal Government as the Civil Navigation System for the U. S. Coastal Confluence Zone. The expansion of LORAN-C to enable coverage for all areas of the Coastal Confluence Zone and the Great Lakes has been completed.

All LORAN-C tables carry Publication Series numbers of LCPUB221 and LABUB221, respectively and are so indexed in the National Imagery and Mapping Agency, P Catalog of Hydrographic Products (NIMA Stock Number CATP2V10).

The publication number, pertinent suffix, and station pair will fully identify the table for requisitioning purposes. LORAN-C chart coverage is in volume 1 through X (DMA Stock Numbers CATP2V01 through CATP2V10).

- There are many types of LORAN-C receivers available. They employ various techniques for acquiring and tracking the LORAN-C signals, and indicating the time difference or position information to the user. A LORAN-C receiver which will be useful to the limits of the Coast Guard's advertised LORAN-C coverage for the U. S. Coastal Confluence Zone, and which is capable of measuring position with accuracy which is advertised for LORAN-C has the following characteristics:

- It acquires the LORAN-C signals automatically, without the use of an oscilloscope.
- It identifies master and secondary ground wave pulses automatically, and accomplishes cycle matching on all eight pulses of each master-secondary pair used.
- It tracks the signals automatically once they have been acquired.
- It displays two time-difference readings, to a precision of at least one-tenth of a microsecond.

- It has notch filters to minimize the effects of radio frequency interference in the area of its operation.
- It automatically detects blink and alerts the operator. Blink is a condition of blinking on and off the first two of the eight pulses of a secondary station to indicate an out of tolerance condition for that master-secondary pair.


LORAN-C coverage presently exists along most of the Western Coast of North America from the Bering Sea southward along the Gulf of Alaska, Western Canada, and the U. S. West Coast down to the Gulf of Mexico. Along the East Coast, coverage exists from Nova Scotia southward along the entire East Coast to the southern tip of Florida including the entire Gulf of Mexico area and the Great Lakes. The Mid – Continent Chain also provides coast to coast coverage for land navigation purposes

World wide LORAN-C coverage (including that described above may be found on the LORAN-C Coverage Diagram at the end of this section.

The Radio Navigation Bulletin, distributed quarterly by the U. S. Coast Guard, presents current information on various radionavigation systems and related items of interests. To be placed on the mailing list for this free publication write, Commanding Officer Coast Guard Navigation Center, Attn: Joyce Brown, 7323 Telegraph Rd., Alexandria Va. 22315-3998, or call **(703) 313-5846**. Radio Navigation questions should be directed to the Navigation Information Service (NIS) at the same address or call **(703) 313-5900**.

The current operational status of all Atlantic Area LORAN-C stations is available from the four Chain Operations Control Officers (COCOs). The COCO monitors the day-to-day operations of the LORAN-C chain and responds to queries directed to the COCO personally. Pertinent telephone numbers follow:

COCO Great Lakes (8970) and Northeast (9960) chain is located at the Navigation Center, 7323 Telegraph Rd., Alexandria, Va. 22315, COCO: **(703) 313-5887**.

COCO Southeast (7980) chain is located at the Navigation Center, 7323 Telegraph Rd., Alexandria, Va. 22315, COCO: **(703) 313-5873**.


COCO Canadian East Coast (5930) chain is located at LORAN station St. Anthony, NFDL, Canada. COCO (709) 454-2392

If after contacting COCOs additional information is required, contact The Navigation Information Service (NIS) at (703) 313-5900.

### AVAILABILITY OF "LORAN-C USER HANDBOOK" AND LORAN-C CHARTS

LORAN-C radio navigation system users can purchase the 1992 revision of the U.S. Coast Guard's 1980 "Green Book" by mail or telephone. The updated and expanded handbook explains in detail the installation and use of technological advances such as solid-state transmitters and state-of-the-art receivers. It provides guidance on such topics as position determination and accuracy, practical aspects of marine navigation, and use of LORAN-C charts. There are many fine publications on LORAN that are commercially available through chandlers and marine suppliers.

To order the current edition (1992) by mail, send a check or money order payable to "Superintendent of Documents" or by telephone using VISA or MasterCard between the hours of 8 a.m. and 4 p.m. Ask for the publication by name and give stock number 050-012-00331-9. Send written requests to:

Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402

To order by phone, call **(202) 783-3238** and give the name and stock number of the publication. Navigational charts overprinted with LORAN-C lines of position are published by:

Defense Supply Center Richmond
Attn: DSCR-JNB
8000 Jefferson Davis Hwy
Richmond VA. 23297-5339

And may be purchased directly from NOS. Alternative sources are the National Imagery and Mapping Agency, Combat Support Center, Attn.: PMSS, 6001 MacArthur Blvd. Bethesda, MD 20816-5001 or through local chart sales agents.

## OMEGA NAVIGATION

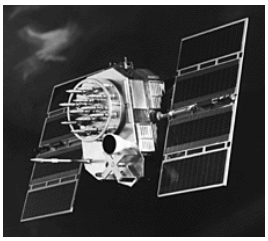
**Omega operations terminated permanently on 30 September 1997 as addressed in the 1996 Federal Navigation Plan.** On 11 October 1996, the U.S. Coast Guard published a Federal Register Notice of Intent for the Omega Radio navigation System Termination that included terminating the existing bilateral Omega agreements with the six partner nations (Argentina, Australia, France, Japan, Liberia and Norway). A formal letter was also delivered to the Interna-

tional Civil Aviation Organization (ICAO) for distribution to the 184 member states.

**FOR FURTHER INFORMATION CONTACT:**

Mr. Stewart Shoulta
Radio Aids Division (G-OPN-3),
U.S. Coast Guard Headquarters,
2100 Second St., SW,
Washington, DC 20593-0001
Phone: (202) 267-6052

## GLOBAL POSITIONING SYSTEM - (GPS)



**GPS satellites, 24 in all, orbit 11,000 miles above the Earth. Ground stations located worldwide continuously monitor them. The satellites transmit signals that can be detected by anyone with a GPS receiver.**

## GPS ELEMENTS

The space part of the Global Positioning System (GPS) is composed of 24 satellites, each in its own particular orbit 10,900 nautical miles above the Earth. The other two main components of the GPS system are the receivers, which you can hold in your hand or mount in your car, and the ground stations (five of them, located around the world) that make sure the satellites are working properly.

**HOW GPS WORKS – AN AMAZING SYSTEM**

One trip around the Earth in space equals one orbit. The GPS satellites each take 12 hours to orbit the Earth. Each satellite is equipped with a very accurate clock to let it broadcast signals coupled with a precise time message. The ground unit receives the satellite signal, which travels at the speed of light. Even at this speed, the signal takes a measurable amount of time to reach the receiver. The difference between the time the signal is sent and the time it is received, multiplied by the speed of light, enables the receiver to calculate the distance to the satellite. To measure precise latitude, longitude, and altitude, the receiver measures the time it took for the signals from four separate satellites to get to the receiver.

The GPS system can tell you your location anywhere on or above the Earth to within about 10 meters. Even greater accuracy, usually within less than three feet, can be obtained with corrections calculated by a GPS receiver at a known fixed location.

So you can more easily understand some of the scientific principles that make GPS work, let's discuss the basic features of the system. The principle behind GPS is the measurement of distance (or range) between the receiver and the satellites. The satellites also tell us exactly where they are in their orbits. It works something like this: if we know our exact distance from a satellite in space, we know we are somewhere on the surface of an imaginary sphere with radius equal to the distance to the satellite radius. If we know our exact distance from two satellites, we know that we are located somewhere on the line where the two spheres intersect. And, if we take a third measurement, there are only two possible points where we could be located. One of these is usually impossible, and the GPS receivers have mathematical methods of eliminating the impossible location.

**U.S. GLOBAL POSITIONING SYSTEM POLICY**

The President has approved a comprehensive national policy on the future management and use of the U.S. Global Positioning System (GPS) and related U.S. Government augmentations. Background The Global Positioning System (GPS) was designed as a dual-use system with the primary purpose of enhancing the effectiveness of U.S. and allied military forces. GPS provides a substantial military advantage and is now being integrated into virtually every facet of our military operations. GPS is also rapidly becoming an integral component of the emerging Global Information Infrastructure, with applications ranging from mapping and surveying to international air traffic management and global change research. The growing demand from military, civil, commercial, and scientific users has generated a U.S. commercial GPS equipment and service industry that leads the world. Augmentations to enhance basic GPS services could further expand these civil and commercial markets.

The "basic GPS" is defined as the constellation of satellites, the navigation payloads which produce the GPS signals, ground stations, data links, and associated command and control facilities which are operated and maintained by the Department of Defense; the "Standard Positioning Service" (SPS) as the civil and commercial service provided by the basic GPS; and "augmentations" as those systems based on the GPS that provide real-time accuracy greater than the SPS. This policy presents a strategic vision for the future management and use of GPS, addressing a broad range of military, civil, commercial, and scientific interests, both national and international.

## POLICY GOALS

In the management and use of GPS, we seek to support and enhance our economic competitiveness and productivity while protecting U.S. national security and foreign policy interests.

**Our goals are to:**

(1) Strengthen and maintain our national security.

(2) Encourage acceptance and integration of GPS into peaceful civil, commercial and scientific applications worldwide.

(3) Encourage private sector investment in and use of U.S. GPS technologies and services.

(4) Promote safety and efficiency in transportation and other fields.

(5) Promote international cooperation in using GPS for peaceful purposes.

(6) Advance U.S. scientific and technical capabilities.

## POLICY GUIDELINES

We will operate and manage GPS in accordance with the following guidelines:

(1) We will continue to provide the GPS Standard Positioning Service for peaceful civil, commercial and scientific use on a continuous, worldwide basis, free of direct user fees.

(2) Through a Presidential Order GPS Selective Availability (SA) was set at zero for increased accuracy to civilian and commercial users.

(3) The GPS and U.S. Government augmentations will remain responsive to the National Command Authorities.

(4) We will cooperate with other governments and international organizations to ensure an appropriate balance between the requirements of international civil, commercial and scientific users and international security interests.

(5) We will advocate the acceptance of GPS and U.S. Government augmentations as standards for international use.

(6) To the fullest extent feasible, we will purchase commercially available GPS products and services that meet U.S. Government requirements and will not conduct activities that preclude or deter commercial GPS activities, except for national security or public safety reasons.

(7) A permanent interagency GPS Executive Board, jointly chaired by the Departments of Defense and Transportation, will manage the GPS and U.S. Government augmentations. Other departments and agencies will participate as appropriate. The GPS Executive Board will consult with U.S.

Government agencies, U.S. industries and foreign governments involved in navigation and positioning system research, development, operation, and use.

This policy will be implemented within the overall resource and policy guidance provided by the President.

## REPORTING REQUIREMENTS

Beginning in 2000, the President will make an annual determination on the use of GPS Selective Availability. To support this determination, the Secretary of Defense, in cooperation with the Secretary of Transportation, the Director of Central Intelligence, and heads of other appropriate departments and agencies, shall provide an assessment and recommendation on SA use. This recommendation shall be provided to the President through the Assistant to the President for National Security Affairs and the Assistant to the President for Science and Technology.

## DIFFERENTIAL GLOBAL POSITIONING SYSTEM (DGPS)

The United States Coast Guard provides a Differential Global Positioning System (DGPS) service for the Harbor and Harbor Approach (HHA) phase of marine navigation. DGPS technology is the first to economically offer geodetic accuracy meeting the Federal-planning requirement of sub10 meters for harbor and harbor approach navigation. The DGPS service coverage area includes the coastal United States, Great Lakes, Puerto Rico, and most of Alaska and Hawaii. This DGPS service is available to the public navigator as an all-weather navigation sensor to supplement traditional visual, radar, and depth sounding techniques.

Differential GPS (DGPS) is a system in which differences between observed and predicted GPS signals at a particular location are transmitted to users as a differential correction to upgrade the precision and performance of the user's receiver processor. The DGPS will use fixed GPS reference stations that will broadcast pseudo-range corrections using maritime radiobeacons and will provide radionavigation accuracy better than 10 meters for U. S. harbor and harbor approaches.

## DGPS ARCHITECTURE

The functional elements of the U.S. Coast Guard DGPS Navigation Service include:

- Reference Station - Precisely located GPS receiving equipment that calculates satellite range corrections based on a comparison of the satellite navigation message to its known location.
- Integrity Monitor - Precisely located GPS receiver and MSK radio beacon receiver that apply differential corrections. The corrected position is compared to its known location to determine if the correction broadcast from the Reference Station is in tolerance.
- Broadcast Site - A marine radiobeacon transmitting correction data in the 285 to 325 kHz band.
- Control Station - Site for human centralized control of the DGPS service elements. DGPS performance data processing and archiving is accomplished here. The

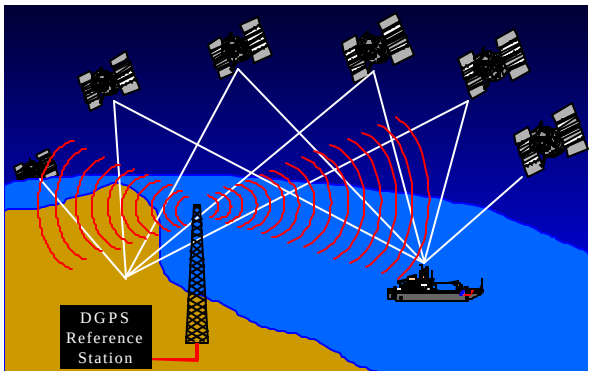
East Coast Control Station is located at the USCG Navigation Center in Alexandria, Virginia. The West Coast Control Station is located at the Navigation Center Detachment in Petaluma, California. Both sites are manned 24 hours per day.

- Communication Network - An X.25 packet-switched service providing connectivity between broadcast sites and control stations.
- DGPS User Equipment - Consists of two interfaced receivers with a display; a radiobeacon receiver for MSK demodulation and a GPS receiver capable of applying differential corrections.

**SYSTEM PERFORMANCE** [Broadcast Standard]

-Accuracy- The position accuracy of the USCG DGPS Service is within 03 meters (2drms) in all specified coverage areas. A reasonable approximation for determining the achievable accuracy at a given point is to take the typical error at a short baseline from the reference station (approximately 0.5 meters), add an additional meter of error for each 150 kilometers of separation from the reference station broadcast site, and add an additional 1.5 meters for the user equipment. Some high-end user sets are achieving pseudorange measurement accuracy of less than 30 centimeters in the absence or the abatement of multipath. Hence, the user with high-end equipment who is within 300 kilometers from a given broadcast can achieve accuracy better than 3 meters (2drms). The continuous velocity accuracy of the system (i.e. the vessel's speed over ground) is better than 0.1 knots rms in VTS areas that utilize Dependent Surveillance.

-Availability- This is defined as the percentage of time in a one-month period during which a DGPS Broadcast site transmits healthy pseudorange corrections at its specified output level. The DGPS Navigation Service was designed for, and is operated to, maintain a broadcast availability level that exceeds 99.7%, assuming a complete and healthy satellite constellation is in place (i.e. HDOP<2.3). Any DGPS area of coverage that falls within a Vessel Traffic Service region that utilizes 'dependent surveillance' for vessel tracking will maintain signal availability in the coverage area of 99.9%. Signal availability will be higher than broadcast availability if a coverage area receives more than one broadcast.




-Integrity- System integrity is built upon the foundation of the monitor stations. The Integrity Monitors will ensure broadcast and signal strengths are in tolerance. Users are alarmed within 10 seconds if an out-of-tolerance condition exists. The user equipment suite plays a significant role in assuring that the integrity of the system is preserved. It should be capable of automatically selecting the appropriate radio beacon. A satisfactory broadcast is one that is classified as healthy, is presently monitored, and the pseudorange time out limit of 30 seconds for at least four satellites has not been reached. The user need not be within the advertised range of the broadcast for it to be satisfactory.

-Coverage- The USCG DGPS Navigation Service is designed to provide coverage at the specified levels for all "Harbor and Harbor Approach Areas" and other "Critical Waterways" for which the U.S. Coast Guard provides aids to navigation. Due to the omnidirectional nature of the broadcasts, and that a high power radiobeacon may cover more than one harbor, coverage often extends into additional areas. As a result, complete coverage of the coastline of the continental United States is provided out to 50 nautical miles. Coverage is also provided for the Great Lakes, most of Hawaii, Alaska, and Puerto Rico.

The Coast Guard DGPS service is available for positioning and navigation. Users may experience service interruptions without advance notice. Coast Guard DGPS broadcasts should not be used under any circumstances where a sudden system failure or inaccuracy could constitute a safety hazard.

For more information and discussion check out the Coast Guard NAVCEN Web Site:

http://www.navcen.uscg.mil

## WHAT IS DGPS?

Differential GPS (DGPS) is the regular Global Positioning System (GPS) with an additional correction (differential) signal added. This correction signal improves the accuracy of the GPS and can be broadcast over any authorized communication channel.

## HOW DOES DGPS WORK?

The GPS determined position of a reference station is computed and compared to its surveyed geodetic position. The differential information ... some systems use the error in fix position, while others use individual satellite range errors ... is transmitted to user receivers by radio or other means.

## WHY USE DGPS?

DGPS accuracy and integrity are better than GPS.

Accuracy improvement (2drms ): Positions of 10 meters or better are achievable using DGPS (USCG signals) vs. 100 meters or better for GPS (Standard Positioning Service)

Integrity improvement: Provides an independent check of each GPS satellite's signal, and reports whether it's good or bad.

## WHERE DO I GET RTCM DOCUMENTS?

The Coast Guard does not provide RTCM documents. You can order them directly from the RTCM. Their phone number is (703) 684-4481, fax (703) 836-4229. All orders must identify specific documents being ordered and number of copies. Orders, with payment, should be sent to:

Radio Technical Commission for Maritime Services
1800 Diagonal Road, Suite 600
Alexandria VA 22314
USA

### HOW IS DGPS USED?

DGPS receivers collect navigational signals from all GPS satellites in view, plus differential corrections from a nearby DGPS site. (Many DGPS receivers consist of two units: a GPS receiver, with a data "port" for DGPS corrections, directly connected to a radio receiver.) DGPS receivers display position, velocity, time, etc., as needed for their marine, terrestrial, or aeronautical applications.

### WHAT ARE THE COAST GUARD'S PLANS FOR DGPS?

The Coast Guard is developing a DGPS service for public use in harbor entrance and approach (formerly harbor and harbor entrance) areas of the continental United States, the Great Lakes, Puerto Rico, and portions of Alaska and Hawaii. The DGPS signals will be broadcast via USCG marine radiobeacons.

### REPORTING DGPS DISCREPANCIES

If you have experienced a problem using the Coast Guard DGPS Service, we would like to know about it. Please notify the NIS watchstander at **(703) 313-5900** or send an e-mail or fax.

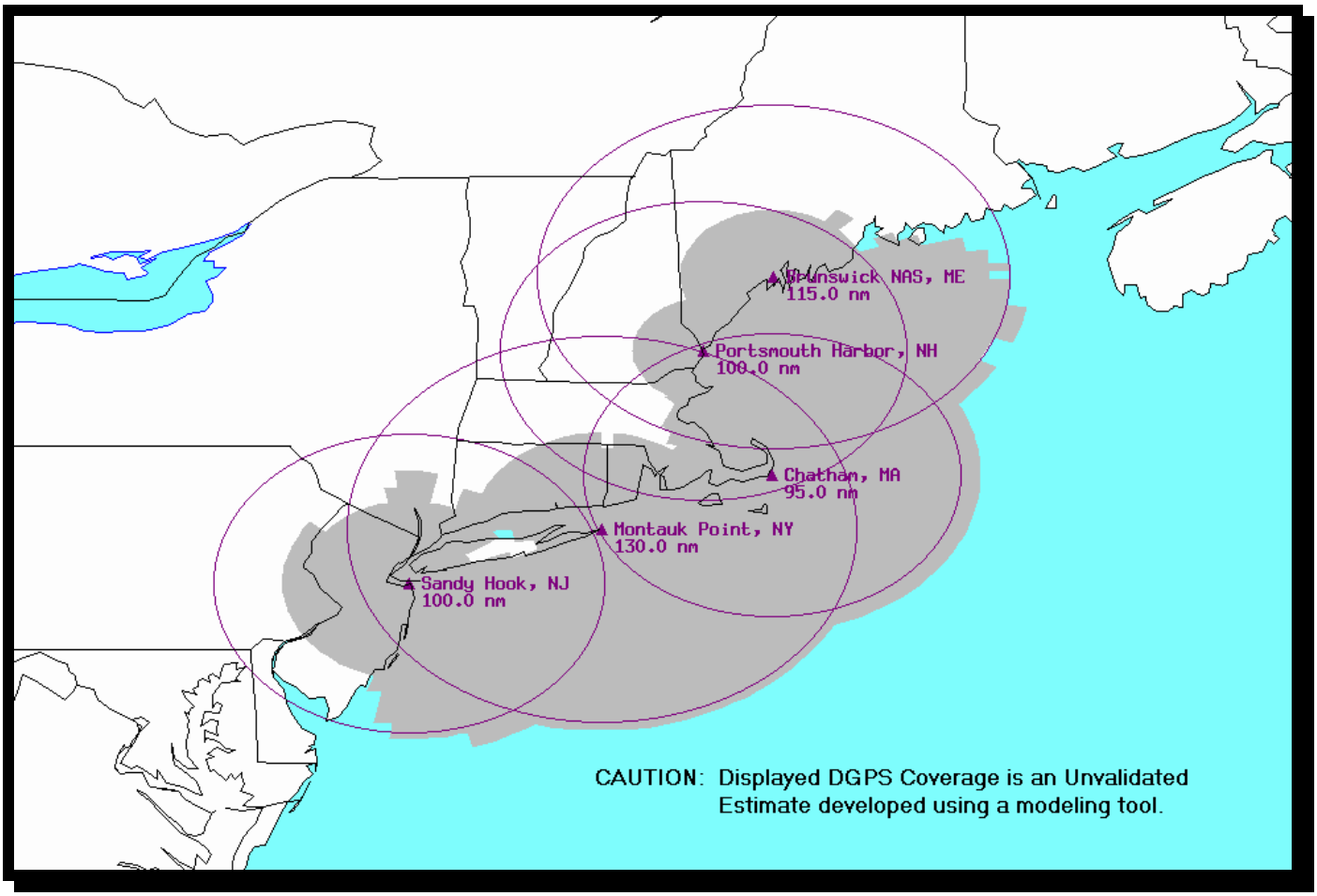
There are some specific questions we'd like you to answer in your report. Here is the information needed:

- Date:
- Vessel/Unit/Person's Name:
- General Geographic Location:
- Vessel Position: Latitude: Longitude:
- Vessel Activity:
- Weather Conditions:
- Wind:
- Sea State:
- Temp:
- Visibility:
- Bearing and range (apx.) to electrical storm:
- Time of Outage:
- Did GPS work?
- Number of satellites tracked on GPS receiver:
- DGPS/Radiobeacon Site Using:
- Normal Radiobeacon Operational:
- DGPS Beacon Receiver Signal Strength (SS) Reading;
- DGPS Beacon Signal to Noise Ratio (SNR) Reading:

**United States Coast Guard DGPS Site Information**
**Atlantic Coast and Gulf Coast**

| Broadcast Site | Frequency | Trans. Rate BPS | Latitude (N) | Longitude (W) | Range (NM) | Radiobeacon ID |
|---|---|---|---|---|---|---|
| NAS Brunswick, ME | 316 | 100 | 43 53.70 | 69 56.28 | 115 | 800 |

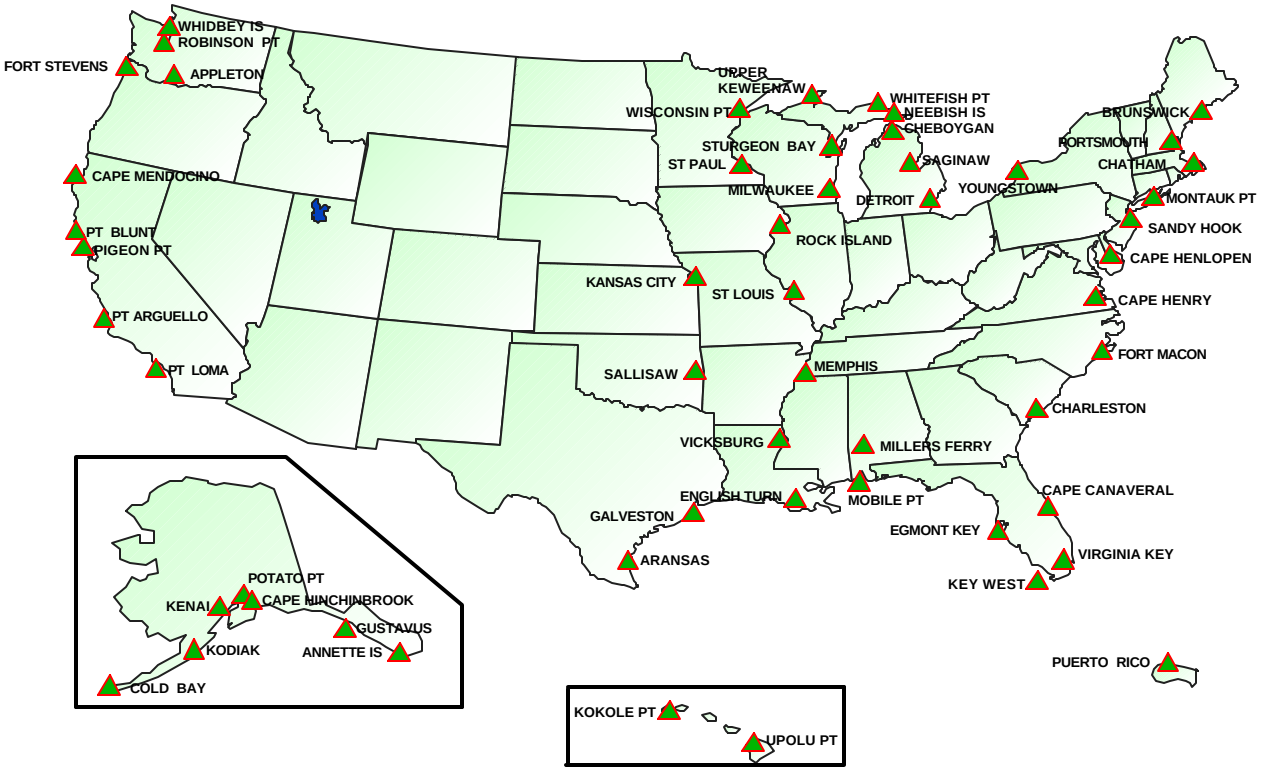
| | | | | | | |
|---|---|---|---|---|---|---|
| Portsmouth Harbor, NH | 288 | 100 | 43 04.26 | 70 42.59 | 100 | 801 |
| Chatham, MA | 325 | 200 | 41 40.27 | 69 57.00 | 95 | 802 |
| Moriches NY | 293 | 100 | 40 48.3 | 72 45.68 | 130 | 803 |
| Sandy Hook, NJ | 286 | 200 | 40 28.29 | 74 00.71 | 100 | 804 |
| Cape Henlopen, DE | 298 | 200 | 38 46.61 | 75 05.26 | 180 | 805 |
| Cape Henry, VA | 289 | 100 | 36 55.58 | 76 00.45 | 130 | 806 |
| Fort Macon, NC | 294 | 100 | 34 41.84 | 76 40.99 | 130 | 807 |
| Charleston, SC | 298 | 100 | 32 45.45 | 79 50.57 | 150 | 808 |
| Cape Canaveral, FL | 289 | 100 | 28 27.60 | 80 32.60 | 200 | 809 |
| Miami, FL | 322 | 100 | 25 43.97 | 80 09.61 | 75 | 810 |
| Key West, FL | 286 | 100 | TBD | TBD | 110 | 811 |




## 1st District DGPS Coverage Map

| | | | | | | |
|---|---|---|---|---|---|---|
| Ft Mc Dill, FL | 312 | 200 | 27 51.00 | 82 31.57 | 210 | 812 |
| Puerto Rico | 295 | 100 | 18 27.77 | 67 04.01 | 125 | 817 |
| Mobile Point, AL | 300 | 100 | 30 13.65 | 88 01.45 | 170 | 813 |
| English Turn, LA | 293 | 200 | 29 52.74 | 89 56.50 | 170 | 814 |
| Galveston, TX | 296 | 100 | 29 19.79 | 94 44.21 | 180 | 815 |
| Aransas Pass, TX | 304 | 100 | 27 50.30 | 97 03.53 | 180 | 816 |

# DGPS Sites


WHIDBEY IS
ROBINSON PT
FORT STEVENS
APPLETON
CAPE MENDOCINO
PT BLUNT
PIGEON PT
PT ARGUELLO
PT LOMA
UPPER KEWEENAW
WISCONSIN PT
STURGEON BAY
ST PAUL
MILWAUKEE
ROCK ISLAND
KANSAS CITY
ST LOUIS
SALLISAW
MEMPHIS
VICKSBURG
ENGLISH TURN
GALVESTON
ARANSAS
WHITEFISH PT
NEEBISH IS
CHEBOYGAN
SAGINAW
DETROIT
YOUNGSTOWN
BRUNSWICK
PORTSMOUTH
CHATHAM
MONTAUK PT
SANDY HOOK
CAPE HENLOPEN
CAPE HENRY
FORT MACON
CHARLESTON
MILLERS FERRY
MOBILE PT
CAPE CANAVERAL
EGMONT KEY
VIRGINIA KEY
KEY WEST
PUERTO RICO
POTATO PT
KENAI
CAPE HINCHINBROOK
GUSTAVUS
KODIAK
ANNETTE IS
COLD BAY
KOKOLE PT
UPOLU PT