U. S. COAST GUARD AUXILIARY

SEVENTH DISTRICT

Aids to Navigation – Locating Private Aids to Navigation

Based on COMDINST M16500.1D Aids to Navigation Manual – Positioning & Range Surveying 18DEC2012

This manual is not intended to, nor does it impose legally binding requirements on any party.The sole intent is to provide guidance to Auxiliarists engaged in private aid verification to achieve accuracy and precision of location measurements as close as possible to the Coast Guard standards for Federal Aids.

U.S.C.G AUXILIARY SEVENTH DISTRICT NAVIGATION SYSTEMS

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CHAPTER 1 - INTRODUCTION

A. Aids to Navigation – Locating Private Aids to Navigation

1. Purpose. The United States Coast Guard (USCG) operates and administers the United States Aids to Navigation System. The Auxiliary is tasked by the USCG with major responsibilities for the verification of Private Aids to Navigation (PATON's). Accurate locating of PATON's to ensure they are correctly positioned is critical to:
   a. Assist the navigator in determining their position.
   b. Assist the navigator in determining a safe course.
   c. Warn the navigator of dangers, obstructions, and restricted areas.
2. Content. This manual contains guidelines for determining the position (location) of private buoys and beacons. It is based on COMDINST M1650.1D Aids to Navigation Manual – Positioning & Range Surveying 18 December 2012.
3. Use. This manual is not intended to, nor does it impose legally binding requirements on any party. The sole intent is to provide guidance to Auxiliarists engaged in private aid verification to achieve accuracy and precision of location measurements as close as possible to the Coast Guard standards for Federal Aids.
4. Locating Objective. To ensure each PATON is found as close as is reasonably possible to its Assigned Position (AP). However, having a PATON at a specific geographic location is secondary to ensuring the PATON's actual location best marks the waterway and serves the purpose for which it is intended.
5. Tolerance. Historically, location standards for beacons were set by "Cartographer's Tolerance" meaning accuracy commensurate with the scale and resolution of the paper chart. Today, with electronic charts and GPS, the USCG has more rigorous criteria.

B. Professionalism.

1. Responsibility. The Auxiliary is responsible for providing accurate and useable location data to the Coast Guard, within the limits of their capabilities. Because the Auxiliary does not use standard equipment, it is essential that full details of the devices, methods and circumstances be included with every reported position measurement.

C. Visual PATON Positioning Data Management.

1. Assigned Position (AP). Except for most buoys on the U.S. Western Rivers,aids to navigation are assigned a specific geographical location, known as an "AP." These positions are expressed in latitude and longitude to the thousandths of a second (less than 1.2 inches). The AP are listed in the Light List.

   United States Aids to Navigation Information Management System (USAIMS). The USCG uses the USAIMS application, which interfaces with the Global Positioning System (GPS), the Wide Area Augmentation System (WAAS), and GPS Receiver Autonomous Integrity Monitoring (GPS-RAIM) positioning data to graphically depict the position of ATON and the attributes of that position on a computer display. The Auxiliary generally uses recreational-grade GPS receivers with WAAS, but which do not have RAIM or

equivalent software and lack the automation of the Coast Guard system.

2. Integrated Aids to Navigation Information System (I-ATONIS). USAIMS data are transferred to I-ATONIS, a web-based application that is the central data repository for ATON data and related information. This information in turn is used to populate various nautical publications and charts; namely USCG Light Lists, Local Notices to Mariners (LNM), and Electronic Navigation Charts (ENCs). These data are directly imported from I-ATONIS into these nautical products, requiring due care for ensuring data integrity.

   Data from Auxiliary Aids to Navigation Reports is manually entered into I-ATONIS. There are planned projects to enable electronic input of Auxiliary reports. This will require a high level of standardization and precision by the Auxiliary.

3. Positioning Requirements for Ranges. Ranges are a unique type of PATON and require High Accuracy Survey Systems (HASS) to locate their design position.

   a. The Auxiliary does not have equipment or procedures suitable for accurately locating ranges.

CHAPTER 2 - POSITIONING SYSTEMS AND EQUIPMENT

A. General. The Global Positioning System (GPS) with Wide Area Augmentation System (WAAS) is the primary method for locating PATON's except for range structures.

B. Global Positioning System (GPS). GPS is a space-based radionavigation system that provides reliable positioning, navigation, and timing services. GPS provides accurate location and time information in all-weather, day and night, anywhere in the world. Positions provided by the GPS constellation are expressed in WGS-84 Datum.

   1. GPS Segments. The system consists of three segments: space, control, and user.

      a. Space. The space segment consists of a constellation of a minimum of 24 operating satellites that transmit one-way signals giving the current GPS satellite position and time.

      b. Control. The control segment consists of worldwide monitor and control stations thatmaintain the satellites in their proper orbits through occasional command maneuvers and adjustment of the satellite clocks. The control segment tracks the GPS satellites, uploads updated navigational data, and maintains health and status of the satellite constellation.

      c. User. The user segment consists of the GPS receiver equipment that receives the signal from the GPS satellites and uses the transmitted information to calculate the user's three-dimensional position and time.

   2. GPS Positioning Theory. The GPS concept is predicated upon accurate and continuous knowledge of the spatial position of each satellite in the system with respect to time and distance from the user. The GPS receiver makes time-of-arrival measurements of the satellite signals to obtain the distance between the user and the satellites. These distance calculations, called pseudoranges, together with range rate information, are combined to yield system time and the user's three-dimensional position and velocity with respect to the satellite system. A time coordination factor then relates the satellite

system to Earth coordinates.

3. GPS Accuracy. The accuracy of a GPS fix varies with the capability and quality of the equipment used.

   a. GPS has a positioning accuracy of 9 meters with a probability of 95 percent horizontally with time transfer accuracy within 40 nanoseconds (95 percent) of UTC (Coordinated Universal Time). This is the basis of recreational-grade GPS receivers.

4. Fix Rate. The fix rate is essentially continuous. Actual time to a first fix depends on user equipment capability and initialization with current satellite almanac data.

5. Fix Integrity. Some types of GPS error are reported by the satellites and transmitted with 6 seconds. Other errors detectable only by the ground control stations may take 15 minutes to process and transmit. GPS receivers should display a usable error figure.

6. International GNSS Systems. Many recreational-grade receivers can receive signals from other GNSS (Global Navigation Satellite Systems) such as GLONASS (Russia), Galileo (European Union), Beidou (China), and QZSS (Japan). This additional capability has no appreciable impact on the accuracy of WAAS GPS receivers in and near the United States because WAAS (see below) only works in conjunction with the GPS system.

C. Wide Area Augmentation Systems (WAAS). WAAS is a Satellite Based Augmentation System (SBAS) operated by the FAA. It works in combination with GPS satellites, but not the GNNS networks of other countries.

1. WAAS Segments. WAAS uses a network of ground-based reference stations in North America and Hawaii to measure small variations in the GPS satellites' signals. Data from the reference stations are routed to master stations, which queue the received Deviation Correction (DC) and send the correction messages to geostationary WAAS satellites every 5 seconds or less. These satellites broadcast the correction messages to WAAS-enabled GPS receivers, which use the corrections in computing their positions.

2. WAAS Accuracy. WAAS-enabled recreational grade GPS receivers can achieve an accuracy of 2.5 – 3.0 meters with a probability of 95 percent.

D. Differential GPS (DGPS). DGPS refers to any system using ground reference stations to determine GPS errors and transmit corrections. The DGPS operated by the USCG is no longer in service and was replaced by WAAS. RTK and PPP (Real Time Kinetic and Precise Point Positioning) are differential GPS systems.

E. GPS Accuracy. Recreational-grade WAAS GPS receivers generally used by the Auxiliary are specified by their manufacturers to be accurate to 2.5 - 3.0 meters with 95% probability. That means that under ideal conditions – the receiver is stationary, the sky is clear, there is no foliage or other obstruction of the sky, and no structures to reflect incoming signals – the measurement could be within 3 meters of the actual location.

The challenge in the field is that the location computed by the GPS receiver is continuously changing. If a receiver is placed in a fixed location and the readings are recorded over time, a scatter plot such as shown in Fig 2.1 is created.

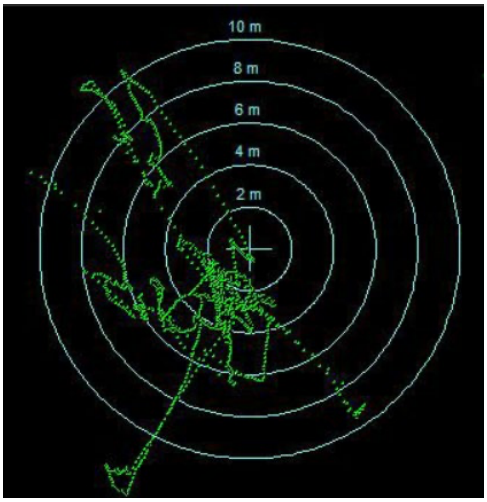


Figure 2.1

Scatter Plot of Garmin GPSMap 60csx

Source: GPS Tracklog

F. GPS Precision. GPS precision measures how close a set of GPS measurements are to their mean (average) value. Figure 2.2 shows the results of a stationary GPS receiver over 3 hours. Over 7,000 data points were collected.

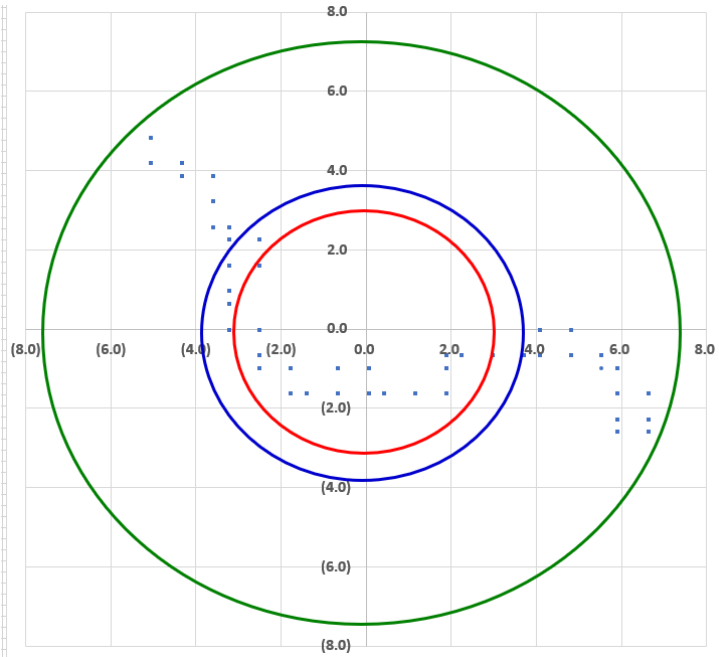


Figure 2.2
Bad Elf GPS Pro
3-hour stationary measurements

The red circle is the CEP = 3.2 feet radius

The blue circle is DRMS = 3.9 feet radius

The green circle is 2DRMS = 7.7 feet radius

We do not know where the true value lies, but we know that 95-98% of the readings are with the 2DRMS circle and the mean is at the center.

We must consider the statistics of the data scatter. There are standard measures of probability which apply to this data set.

Table 2.1	**GPS PRECISION MEASUREMENTS**		
Measure	**Abbreviation**	**Percent of Values inside Circle**	**Conversion Factor**
Circular Error Probable	CEP	50%	1.0000
Distance root mean square	DRMS	63-68%	1.2011
95% Radius	R95	95%	2.0789
Twice distance root mean square	2DRMS	95-98%	2.4022
99.7% Radius	R99.7	99.7%	2.8950

In effect, the smaller the circles of confidence, the less the data is scattered and the lower the likely error between the GPS reading and the actual position value. In other words, the smaller the size of these circles of probability, the greater the confidence we have in the GPS reading.

CHAPTER 3 - AID POSITIONS

A. General. Except for most aids to navigation on the U.S. Western Rivers, visual aids to navigation are assigned a specific geographical location. This location, authorized by the cognizant District Commander, is known as an Assigned Position (AP) for buoys and beacons. APs are expressed in latitude and longitude to the thousandths of a second (less than 1.2 inches).

1. Buoys and Beacons. The objective of locating buoys and beacons is to ensure they are as close as is reasonably possible to their AP. The AP recorded in the District- controlled field of I-ATONIS is conveyed to the mariner through the Light Lists and other automated processes that produce charts and related hydrographic products. Therefore, the data integrity of the AP is paramount, and its importance cannot be overstated. However, placing a PATON at a specific geographic location is secondary to ensuring the PATON's actual location best marks the waterway and serves the purpose for which it is intended. In these cases, a detailed description of the reason for the change shall be included in the remarks section of the Aids to Navigation Report (Form 7054) along with a recommendation to change the AP or move the aid.

2. Range Structures. The predetermined position for a range structure is known as its Design Position (DP). The post-construction or actual location of a range structure is known as its As-Built Position (ABP). The ABP recorded in the District-controlled AP field of I-ATONIS is conveyed to the mariner through the Light Lists and other automated processes that produce charts and related hydrographic products. As with APs, the data integrity of the ABP is paramount and its importance cannot be overstated. Locating range structures requires a significantly higher level of accuracy and precision than buoys and beacons. **The Auxiliary does not have the equipment and procedures to locate ranges structures and can only report an approximate position.**

B. Waterway Types. For the purpose of specifying AP tolerances, there are five general types of waterways:

1. Deep Water – Maintained. These waterways are generally restricted by nature, are assigned a project depth, and may require periodic dredging to maintain that projectdepth. The waterway depth is greater than 12 feet.

2. Deep Water – Not Maintained. These waterways are generally unrestricted. The channel boundaries are not delineated; however, ATON may be established to mark a desired depth or hazard. The waterway depth is greater than 12 feet.

3. Shallow Water – Maintained. These waterways are generally restricted by nature, areassigned a project depth, and may require periodic dredging to maintain that project depth. The waterway depth is 12 feet or less.

4. Shallow Water – Not Maintained. These waterways are generally unrestricted. The

channel boundaries are not delineated; however, ATON may be established to mark adesired depth or hazard. The waterway depth is 12 feet or less.

5. Seacoast and Coastal Waters. PATON's in these unrestricted waterways are generally used for geographic reference or to mark specific hazards to navigation.

C. Geodetic Datum and Coordinates Systems.

1. Geodetic Datum. A geodetic datum is a reference from which measurements are made. In surveying and geodesy (the science that deals with the precise measurement of the size and shape of the Earth), a datum is a set of reference points on the Earth's surface against which position measurements are made, and an associated model of the shape of the earth to define a geographic coordinate system. Horizontal datums are used for describing a point on the earth's surface, in latitude and longitude. There are three relevant horizontal datum reference systems.

   a. World Geodetic System 1984 (WGS 84). WGS 84 is a horizontal datum using a consistent set of parameters describing the size and shape of the earth, the positions of a network of points with respect to the center of mass of the earth. It forms the common geodetic reference system for modern Electronic Navigation Charts (ENC) on which positions from electronic navigation systems (e.g. GPS) can be plotted directly without correction. All ENCs, regardless of the issuing Hydrographic Office use WGS 84 datum. GPS uses the WGS 84 datum.

   b. North American Datum 1983 (NAD 83). NAD 83 is the geodetic horizontal datum for North America and is the functional equivalent of the World Geodetic System (WGS). NAD 83 is the datum used on all NOS issued paper charts and their equivalent electronic Raster Navigation Chart with exception of the western Pacific.

   c. North American Datum 1927 (NAD 27). Prior to NAD 83 there was NAD 27, a horizontal datum constructed in 1927 based on the Clarke 1866 ellipsoid. NAD 27 was in use for many years and still appears on United States topographical maps.

2. Latitude and Longitude. Latitude (Lat) is the angular distance measured north or south ofthe equator and longitude (Long) is the angular distance measured east or west of the Prime Meridian. Latitude is referred to as Parallels; longitude is referred to as Meridians. By convention, the Equator establishes the position of zero degrees latitude and the PrimeMeridian, which passes through the Royal Observatory, Greenwich, England, establishes the position of zero degrees longitude. Together, latitude and longitude are used as a geographic coordinate system to specify a location on the globe.

D. Determining Assigned Positions (AP) for Buoys and Beacons. The AP for buoys and beacons should best mark the waterway. In maintained waterways, APs for buoys should be placed on the channel's shoulder or as near to the channel's toe as possible. However, input from user groups or other considerations may require placement of PATON at a set distance away from the channel's toe on the channel shoulder (see Figures 3.1, 3.2). Placement of an AP on a channel's slope should be avoided.

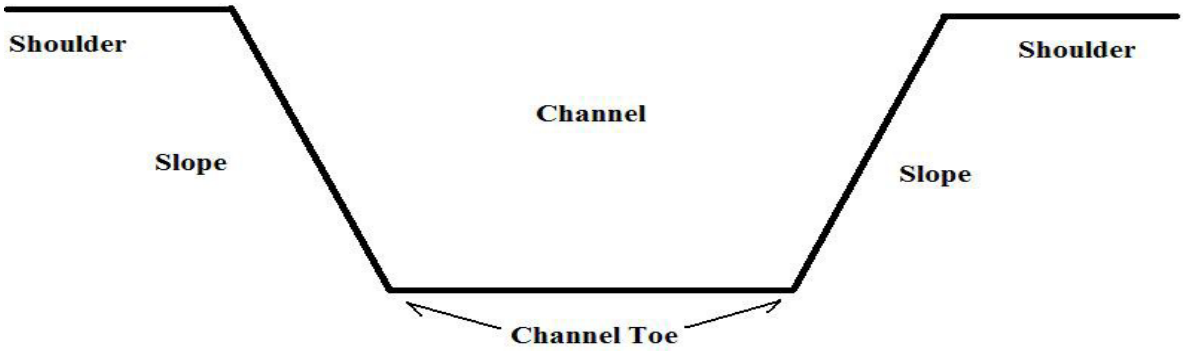


Figure 3.1
Example of Channel Toe, Slope, and Shoulder

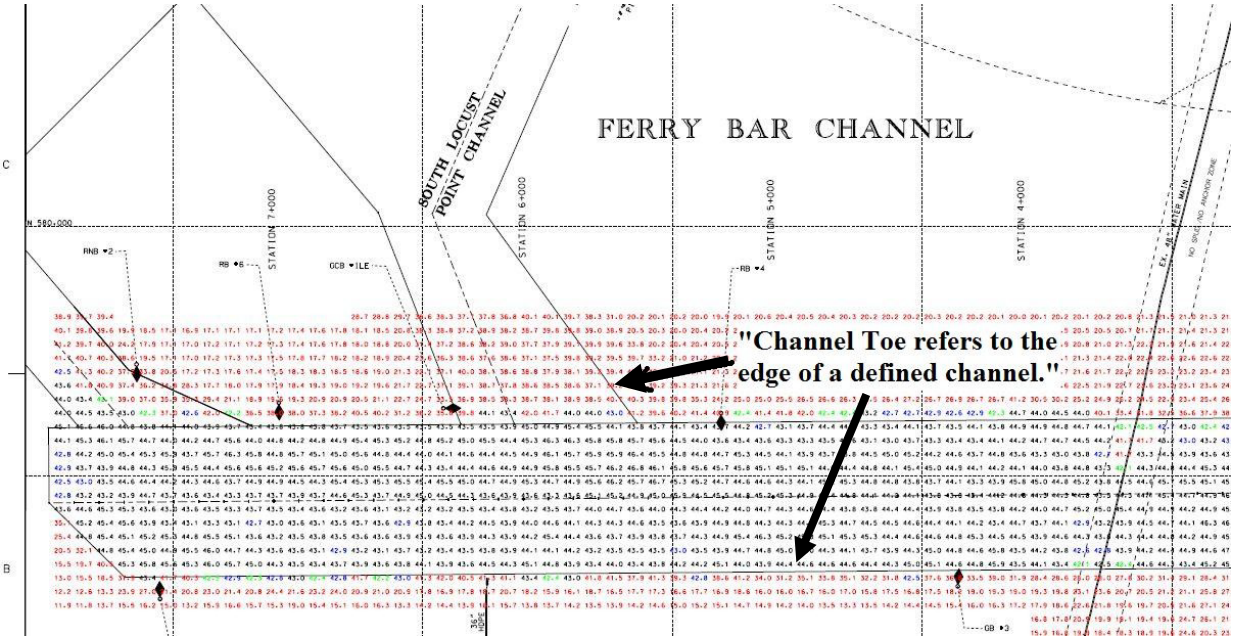


Figure 3.2
Channel Toe on USACE Survey Sheet

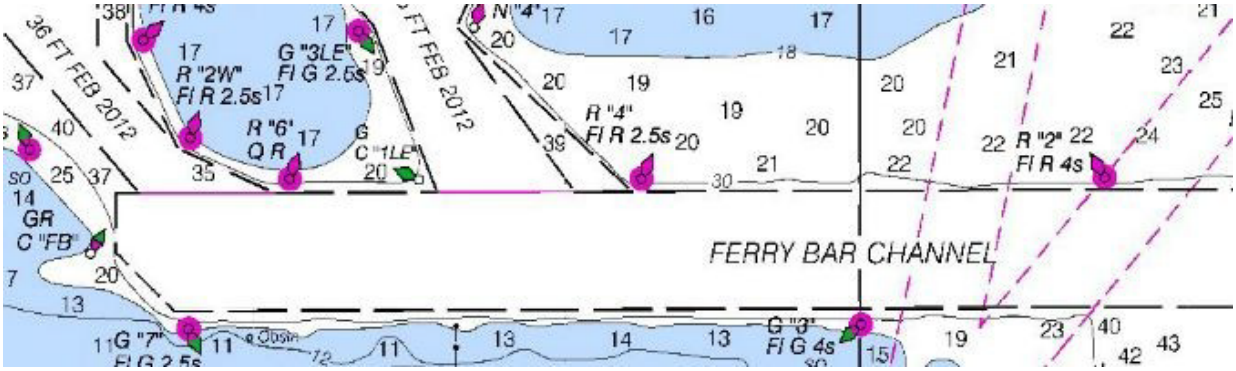


Figure 3-3
Channel Toe on a Raster Navigation Chart (RNC)

E. Most Probable Position (MPP) and AP.

1. The Coast Guard refers to the FOUND location of a Federal Aid as the MPP (Most Probable Position). A Federal Aid marking good water may have the MPP made the AP in the Light List.

2. The location of Private Aids is the responsibility of the owner. Therefore, the procedure when a Private Aid marks good water but is Not in AP or On Station is to require the owner to submit Form 2554 to change the location of the aid in the Light List.

3. For this reason, the Auxiliary in District 7 refers to the location at which a Private Aid is located with proper measuring techniques as the FIX.

4. For the purposes of calculating whether an aid is within its positional tolerance, there is no mathematical difference between an MPP and a FIX.

F. The FIX location of a PATON is the most probable position of a buoy's sinker or a beacon.

CHAPTER 4 - GENERAL PROCEDURES

A. General. GPS receivers used by the Auxiliary for aid location must meet these minimum requirements:

1. Have WAAS.
2. Be capable of placing the receiver or the antenna on the aid.
3. Have an error output that can be converted to 2DRMS.
    a. If in doubt about which error reading your GPS displays, consult the manufacturer.
    b. If the manufacturer is unable to be specific or lists an EPE (Estimate Position Error) treat that value as a CEP.
4. Preferably be able to record readings automatically in an app

To convert your GPS reading to 2DRMS use Table 4.1

Table 4.1

GPS Precision Error Conversion Factors						
	RMS	**CEP**	**DRMS**	**R95**	**2DRMS**	**R99.7**
CEP	0.8493	-	1.2011	2.0789	2.4022	2.8950
DRMS	0.7071	0.8326	-	1.7308	2.0000	2.4103
R95	0.4085	0.481	0.5888	-	1.1555	1.3926
2DRMS	0.3536	0.4163	0.5000	0.8654	1.3926	1.2051
R99.7	0.2934	0.3454	0.4149	0.7181	0.8928	-

B. Systems Used for Determining FIX). The following authorized positioning system may be used to determine a FIX.

1. Wide Area Augmentation System (WAAS). Use of WAAS is subject to the following conditions:
    a. WAAS capability must be incorporated in the receiver and must be activated.
    b. GPS receivers, if they cannot supply these National Marine Electronics Association (NMEA) sentences: GGA, GRS, GST, GSA, and DTM, must at least have an error output capable of being converted to 2DRMS.
    c. It is preferable but not mandatory that GPS data be electronically transmitted into an app and recorded automatically.
    d. Mobile devices, with few exceptions, lack true GPS capability and are not authorized for use in PATON locating.
    e. The GPS receiver must be set to the WGS 84 datum if that is not the default.
    f. The 2DRMS error reading must be greater than zero (0). A reading of 0 indicates that thesystem is not functioning properly.

C. Determining and Recording Water Depth. Aids to navigation must mark the depth of water appropriate to the waterway, and these positions must be verified in relation to the charted depth. An observed water depth (known as soundings) adds confidence that the PATON best marks the waterway as well as the FIX. An inconsistent sounding may indicate that the PATON is not in its AP or that the AP no longer best marks the waterway. Soundings should be taken as near to the PATON as possible. Soundings are measured using a fathometer, weighted line (lead line), or sounding pole.

1. Sounding Datums. Soundings used for PATON positioning are corrected to either Mean Low Water (MLW) or Mean Lower Low Water (MLLW) using NOAA reported tide data.

2. Sounding Methods. Equipment and methods must be included in the report.

   a. Electronic Soundings. A fathometer obtains depth measurements by transmitting ultrasound waves and measuring the time it takes for their echo to return after hitting the seabed. Electronic sounding equipment must be calibrated against a lead line or sounding pole. The amount of error will vary with the nature of the seabed. When soundings are obtained by fathometer, the vertical distance from the vessel's waterline to the fathometer transducer must be considered. Electronic sounding equipment must be checked against a lead line or sounding pole.

   b. Manual Soundings. Manual soundings are obtained using a lead line or sounding pole and are typically more accurate in shallow water. A lead line consists of a length of line with a weight attached to one end and markings to indicate depth. A sounding pole is marked (usually in feet), normally has a metal shoe on one end, and is used in water depths of less than 20 feet.

CHAPTER 5 - LOCATING BUOYS

A. General. A buoy is defined as a floating object of defined size, shape, and color, usually made of steel, plastic, or foam, which is anchored at a given position and serves as an aid tonavigation. It may be equipped with a light, sound, or other signal. Buoyant beacons are considered buoys for positioning purposes.

B. Location Accuracy Standards for Buoys. Buoys are assigned three levels of accuracy based on risk associated with a waterway type.

1. Positioning Tolerance (PT). The radius of a circle, expressed in yards, that represents the maximum distance in which a buoy sinker may be found in relation to AP.
2. A Positioning Tolerance shall be assigned to buoys. Table 5.1 illustrates the threelevels of positioning tolerance.

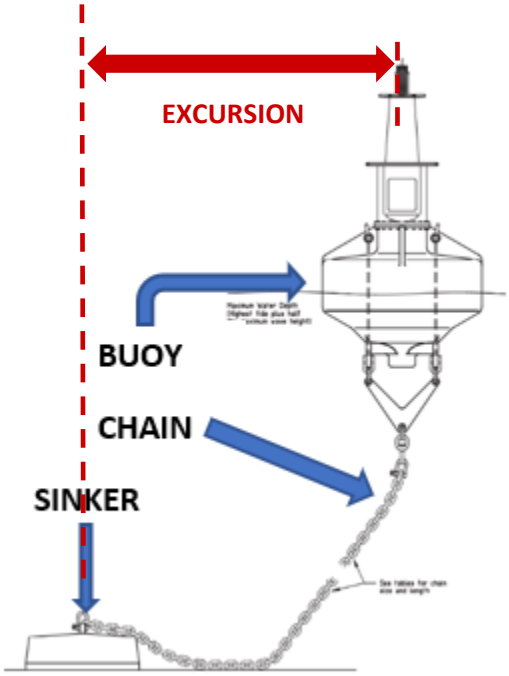
Waterway Type	Buoy Positioning Tolerance
Deep/Shallow Water Maintained-Restricted	**15 yards**
Deep/Shallow Water Not Maintained-Unrestricted	**25 yards**
Sea Coast and Coastal & Private Buoys	**40 yards**

Table 5.1

C. Determining FIX. The FIX of a buoy's sinker is determined while the buoy is at *Short Stay* or *Not at Short Stay*. The Coast Guard records the FIX as either *Set* or *Found*. A set FIX can only be determined while the buoy is at short stay or when the sinker is released from a mechanical chain stopper. A *found* FIX can be determined when the buoy is at short stay or not at short stay. Generally, the Auxiliary is not equipped to determine FIX at Short Stay so Auxiliary position fixes for buoys will either be an FIX from a calculated sinker location or a "Position Approximate."

1. Short Stay – FIX Determination. Short stay is defined as when the scope of chain is equal to, or nearly so, the depth of water, thereby having the sinker directly underfoot. FIX is recorded as *set* when the chain is at short stay or when the sinker is released (e.g. mechanical chain stopper, dump board, etc.).
2. Not at Short Stay – FIX Determination. Not at short stay is defined as when the scope of chain is greater than the depth of water and the buoy is subject to natural forces, creating a situation where the sinker and buoy are not vertically aligned. To determine an FIX in this situation necessitates an approximation of the horizontal distance and direction of the buoy from the sinker; known as *excursion*. A detailed explanation of how excursion was determined must be included in the report.

Figure 5.1 Buoy Not at Short Stay



a. Excursion. The preferable method for determining a sinker's FIX is while at short stay. Recognizing that circumstances may not allow this on every occasion, the calculation and assessment of excursion shall be used to determine the sinker's FIX. The direction of excursion is determined by a careful consideration of all the forces acting on or applied to the buoy and is expressed in degrees true from the sinker to the buoy. The length (horizontal distance) of excursion is determined by using the following methods:

(1) Hypotenuse Method. Excursion using this method is determined by extending the mooring to its maximum length and using Pythagorean's Theorem to calculate the distance. This is classically known as the watch circle radius.

$$\text{Excursion}_{\text{Hypotenuse Method}} = \text{SQRT}(\text{Chain Length}^2 - \text{Water Depth}^2)$$

(2) L method: Excursion using this method is determined by an assessment of environmental factors to determine the direction (bearing) of the buoy from the sinker and subtracting the observed water depth from the total length of the mooring (consider buoy draft and bridle length for larger buoys) to determine thehorizontal distance between the sinker and buoy.

$$\text{Excursion}_{\text{L Method}} = \text{Length of Mooring} - \text{Observed Water Depth}$$

1. Not at Short Stay – Excursion not Determined. If the fix taken on or near the buoy cannot be corrected for excursion, which will generally be the case for the Auxiliary, the fix shall be reported as "Position Approximate."

D. ON/OFF Station Determination. A buoy is determined to be on station when its sinker is within the prescribed positioning tolerance. The three functions that determine ON-Off Station are:

1. Assigned Position (AP). PATON except for buoys on the Western Rivers, are assigned a specific geographic location known as an Assigned Position.
2. 2X Distance Root Mean Squared (2DRMS). The 2DRMS represents the radius of a circle of probable error in which the FIX will be located with 95-98% confidence. This error value is obtained from the GPS receiver or calculated from an equivalent error value provided by the receiver.
3. Most Probable Position (FIX). The FIX of a buoy is the most probable position of its sinker based on an error analysis of the positioning fix (known as 2DRMS). FIX is in the center of the 2DRMS probability circle. Figure 5-1 depicts the "circle within a circle" locating concept used to determine on/off station determinations.

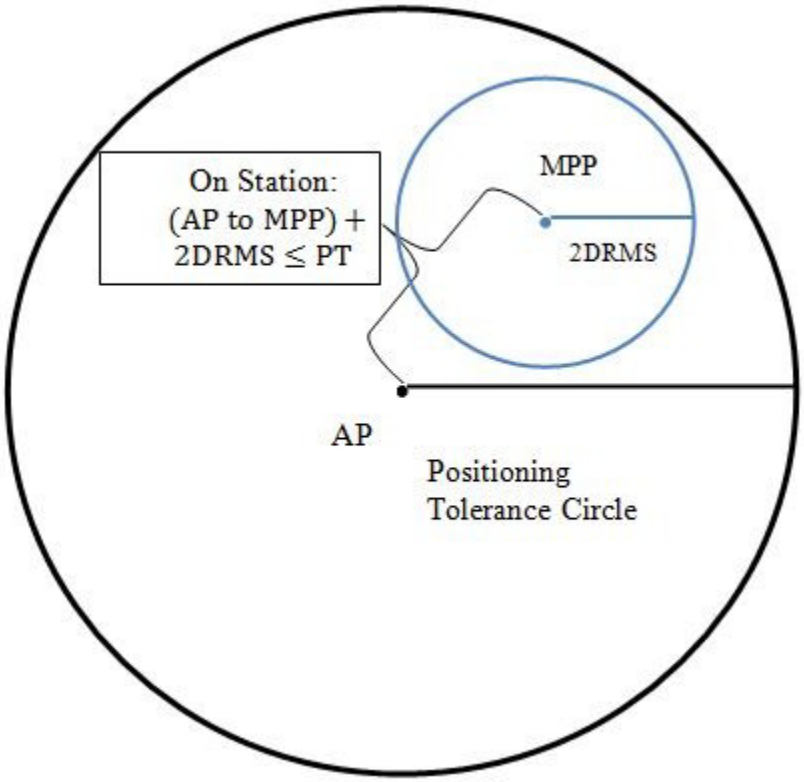


Figure 5-1
On Station: [(AP to FIX) + 2DRMS] < PT

E. Plotting. The USCG's USAIMS system makes this calculation for the user. If an Auxiliarist is able to measure a buoy at Short Stay, it will be necessary to calculate whether the AP to FIX distance + 2DRMS is greater than the Positioning Tolerance. District 7 NS provides a spreadsheet which performs these calculations. This calculation is only valid if an FIX has been obtained as described above and a detailed explanation of how it was determined provided in the report.

CHAPTER 6 - PROCEDURES FOR LOCATING BEACONS

A. General. A beacon is defined as an aid to navigation that is constructed on land or in the water and is permanently affixed to the terrestrial surface or seabed. Beacons are usually constructed of steel, wood, or cement with defined size, shape, and color. They may be equipped with a light, sound, or other signal. For locating purposes, range structures are not considered as beacons.

B. Locating Standards for Beacons. Accuracy standards for locating beacons have been established to assist units in meeting the objective of this Manual. The locating objective for beacons is to have them within 3 yards of AP.

3. Locating Tolerance. When the FIX to AP distance is 3 yards or less, the beacon is at its proper location.

4. Locating Source Confidence. Historically, positioning requirements for beacons were divided into "High" and "Low" accuracy categories. Additionally, requirements for accuracy were influenced by "Cartographer's Tolerance" which determined if the beacon's positioning accuracy was sufficient to justify advertising the aid with a closed circle navigation symbol on paper charts based upon the scale of the chart. However, with the advent of the electronic charts and satellite positioning systems, the USCG has adopted one level of certainty for positioning beacons. The 2DRMS of a FIX cannot exceed 9.8 yds (9 meters).

5. To achieve these higher levels of measurement accuracy, measurements must be taken with the GPS receiver, or its antenna placed on the aid.

Table 6.1

USCG MINIMUM GPS MEASUREMENT PRECISION TO REPORT NAVAID POSITION					
Stastistical Term	R99.7	2DRMS	R95	DRMS	CEP
Feet	35.7	29.5	25.7	14.8	12.3
Yards	11.9	9.8	8.6	4.9	4.1
Meters	9.00	9.00	9.00	4.50	3.75
Stastistical Term	99.7% Radius	Twice DRMS	95% Radius	Distance Root Mean Square	Circular Error Probability
Percent of values inside horizontal circle of this radius	99.70%	95 - 98%	95%	63% - 68%	50%
Position Fixes may be used only if the error value is greater than 0 and less that the value shown above					

6. A measurement taken with the GPS receiver distant from the aid shall be reported as "Position Approximate."

7. A beacon in a location that cannot be approached by the OPFAC will be reported as "Position Approximate."
8. A non-lateral beacon reported as "Position Approximate" will not be considered as Not in AP unless it is either misleading or not serving its intended purpose.
9. A lateral beacon that cannot be approached requires more careful consideration. A report of an Approximate Position for a lateral aid should be accompanied by an explanation of the reasons it is inaccessible and a statement about whether it is marking best water and serving its intended purpose.

C. Verifying the Location of Beacons. The AP of a beacon is recorded in I-ATONIS and is the position provided to NOS to depict the aid on nautical charts. Two common factors can cause the AP of a Private beacon to differ from the actual location.

- The PATON may have been installed in a location different than specified in the permit and the as-built location not provided to the Coast Guard.
- The PATON may have been moved by the owner to mark better water or for other reasons.

D. The Coast Guard uses Positional Tolerance and an algorithm to determine whether a fixed aid is in its Assigned Position:

Federal Aids: 3 yards / 9 feet (COMDTINST M16500.1D 18DEC2012)

Private Aids: 20 yards / 60 feet (CG-NAV Memo 17MAR2023 Provisional)

E. When an FIX is obtained, a comparison of the AP and FIX must be made to determine if the aid is at AP.

If the 2DRMS of the FIX encompasses the AP, then the aid is at AP.

In Figure 6.1, the AP is within the 2DRMS circle around the fix. The aid is at AP.

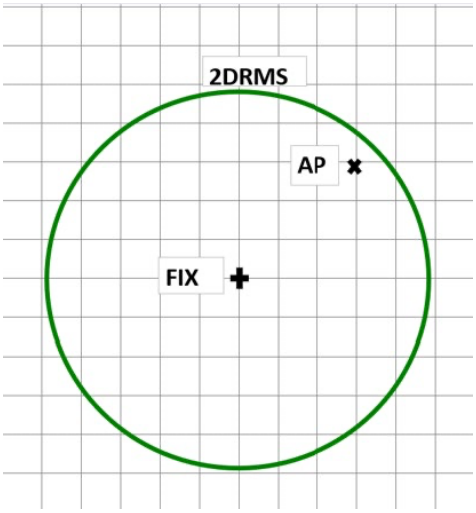


Figure 6.1

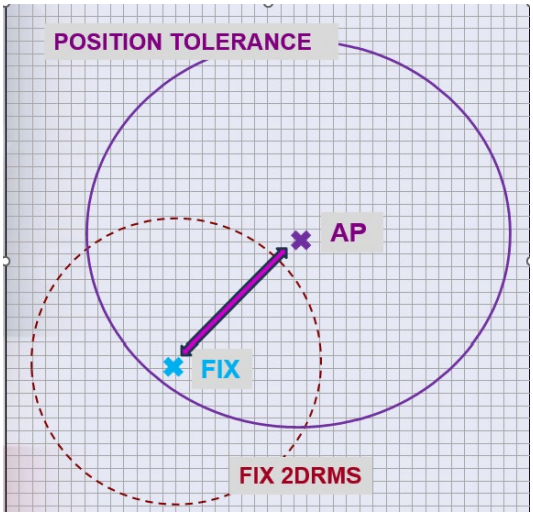


Figure 6.2

The AP is outside the 2DRMS circle around the fix.
The FIX to AP distance <= Position Tolerance.
The aid is at AP.

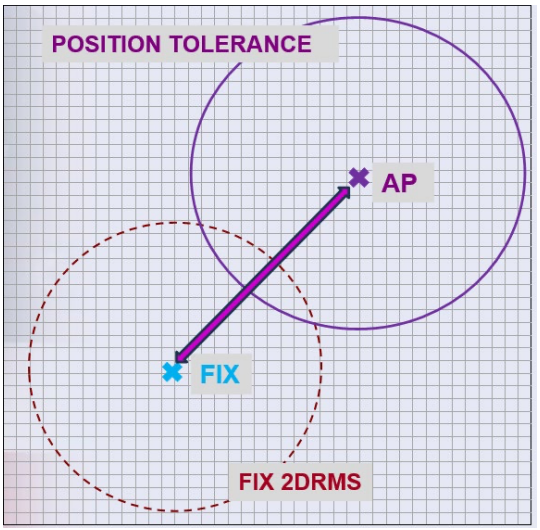


Figure 6.3

The AP is not within the 2DRMS circle around the fix.
The distance from the fix to the AP is more than the Position Tolerance
The aid is *Not at AP*
Either the AP must be changed, or the aid moved.

F. If the beacon is not marking good water or its location is misleading (could cause a navigator to mistake the location of the navigable channel) then the beacon should be moved. Recommendations to relocate beacons must be accompanied by full supporting documentation, including charts and satellite views of the channel and the existing and proposed aid locations.

CHAPTER 7 - RANGE STRUCTURES

A. General. Positioning range structures requires a significantly higher level of precision and accuracy than other PATON. A small error in the position of a Range Front Light (RFL) or Range Rear Light (RRL) can result in an unacceptable error in the range line and reduce the effectiveness of the range.

B. The USCG uses surveyor-grade GPS systems with accuracies of 1 cm or less, mounted on the range, to position ranges. This is beyond the capability of the Auxiliary. The Auxiliary can only report an approximate position for a range structure.

CHAPTER 8 - AID LOCATING RECORD

A. Introduction. The Aids to Navigation Report (Form 7054 – District 7) is the document which records the relevant and necessary information used to determine the position of a PATON. The purpose of the 7054 is to document observations made, methods and equipment used, and relevant data, when locating a PATON.

B. Submission of Reports. Each time a PATON is verified, the Auxiliary verifier shall complete a 7054.

C. Disposition of Reports. Form 7054 will be retained in the ANT PATON files in accordance with the USCG standard practices.

D. Information Required to Report a PATON Location.

1. Aid Name. The aid name shall be the same as it appears in the Light List.
2. LLNR. Enter the Light List number of the aid. For those aids with more than one LLNR the lowest number is used.
3. Latitude Longitude. Latitude and Longitude of the assigned position.
4. Reporting Verifier. The name, member number, unit, and contact information for the verifier.
5. Positioning Tolerance Radius. Represents the positioning tolerance of the buoy in yards.
6. Chart Number and Edition. The number and edition of the largest scale Raster Navigation Chart (RNC) on which the aid appears.
7. GPS Receiver Type. The manufacturer and model of the GPS unit.
8. Geodetic Datum. Represents the datum of the assigned position.
9. Fix Position. The position is best recorded electronically in an app. Manually recorded fixes must be carefully checked before submission.
10. Fix Date. The date the fix was taken.
11. Fix Time. The time the fix was taken.
12. Measured Depth. Represents the unadjusted depth of water measured at the time of the fix as measured by echo sounder, lead line, or sounding pole.
13. Tide Correction. Represents the tide correction computed from the Tide Tables for the time of the fix.
14. Draft. Represents the draft of the vessel used to visit the aid. If depth was obtained by lead line or sounding pole, the draft must be zero.
15. Datum. Represents the corrected water depth for the time of the fix and is calculated using the measured depth, draft, and tide correction. This depth shall be compared with the charted datum to ensure the aid best marks the waterway.
16. Short Stay. Aid was located at Short Stay Yes (Y) or No (N).

17. Excursion. The bearing and distance of excursion (if used).
18. FIX Latitude/Longitude. The Most Probable Position of the buoy sinker or beacon.
19. AP to FIX. The bearing and range between the Assigned Position and FIX.
20. 2DRMS. The 2DRMS value of the fix.
21. Remarks. The remarks section shall be used to record any additional information necessary to verify or validate the aid's position. At a minimum, the following items willbe entered if not previously recorded:
    a. Aid On or Off Station/Not in AP when found. If excursion was used, the method used to determine excursion and the FIX must be listed.
    b. Departures from normal procedures (if any).
    c. Any other information that may be required by the District office.