



**USER'S GUIDE**

**FOR**

**WRITING BENCH MARK DESCRIPTIONS**

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**Requirements and Development Division  
Center for Operational Oceanographic Products and Services  
National Ocean Service  
National Oceanic and Atmospheric Administration**

# USER'S GUIDE FOR WRITING BENCH MARK DESCRIPTIONS

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## BACKGROUND

This document provides specifications for writing the descriptive text used 1) to locate a water level station site (TO REACH statement) and 2) to recover an individual bench mark. This document supplements the Input Formats and Specifications of the National Geodetic Survey Data Base (Volume I and II, September 1994) "Bluebook". The vertical descriptive data of Volume II is actually in Volume I, Chapter 3 and is available on the NGS web site ([www.ngs.noaa.gov/FGCS/tech\\_pub.html](http://www.ngs.noaa.gov/FGCS/tech_pub.html)). In general, tidal bench mark descriptions shall be written in accordance with the additional guidance provided in this document, while Great Lakes bench mark descriptions follow the NGS Bluebook specifications exactly. Items that conform to NGS Bluebook format such as DR (Description/Recovery) code, recovery type code, setting code, marker type (monumentation) code, agency code, condition code, and stability code are not repeated here.

The bench mark text descriptions shall be provided to the Requirements and Development Division of the Center for Operational Oceanographic Products and Services in NGS DESC program format on diskettes and as a paper copy for records in station files. The next version of the DESC program (to be released soon) will not perform the conversions automatically, therefore Metric measurements followed by English units in parenthesis will have to be listed in the descriptions. The DESC program does not provide the "TO REACH" statement, hence the "TO REACH" statement shall be provided in a separate digital file with filename as an seven digit station number and a three digit extension as TOR; e.g., 9414290.TOR.

## GENERAL INFORMATION

### Consistent Referencing Procedures

The following referencing techniques are recommended for measurements:

1. All measurements are assumed to be horizontal unless labeled "sloped".
2. Distances measured from a line (e.g., centerline of road or a fence line) are assumed measured perpendicular to that line.
3. The origin of measurement of the junction of two roads is assumed to be the intersection of centerlines of both roads.
4. Measurements made are assumed to be from the center of an object unless another starting point is selected such as edge of the curb. In general, all measurements are assumed to be made from (and to) the center of the bench mark disk.
5. Reference objects selected shall be fairly permanent and will not likely be moved or destroyed.

6. The vertical tie gives the height of the mark above or below the surrounding area; e.g., level with the ground or 0.20 m (0.7 ft) above ground. The word flush should only be used if the edge of the disk is countersunk into the setting; e.g., set flush in the base of the flagpole.

### **Measuring New Distances**

All new distances shall be measured in Metric units.

Taped distances shall be measured and recorded to the nearest 0.01 meter for distances less than 100 m; all other distances shall be measured and recorded to the nearest 0.1 meter. Distances measured while driving an automobile shall be recorded to the nearest 0.1 kilometer.

All distances shall be documented in Metric units with the English unit equivalent immediately following in parenthesis. The only exception is when an item's name contains a nominal size, i.e., a ½ inch bolt, a 4-inch diameter PVC pipe, etc. These names shall remain unchanged with no equivalent given.

Abbreviate meter as m, kilometer as km, feet or foot as ft, mile as mi, and nautical mile as nm. Measurements made in centimeters (cm), millimeters, inches, etc., shall be changed to meters or feet as appropriate, except for the vertical reference measurements for rod marks which are reported in cm.

### **Conversions**

Conversion rules between English and Metric units are as follows:

<u>Metric to English</u>	<u>English to Metric</u>
$3.2808 \times X \text{ m} = Y \text{ ft}$	$0.3048 \times Y \text{ ft} = X \text{ m}$
$0.6214 \times X \text{ km} = Y \text{ mi}$	$1.6093 \times Y \text{ mi} = X \text{ km}$
$0.5400 \times X \text{ km} = Y \text{ nm}$	$1.8520 \times Y \text{ nm} = X \text{ km}$

A procedure is described below for documenting these measurements in Metric and English units for both new measurements and past historic measurements. All new measurements are required to conform to these specifications. Past historic measurements which do not conform to these specifications such as approximate values without decimal place shall be re-measured.

(A) New Measurements: Original measurements in Metric units.

Conversion from Metric units to English units: When measurements are made in meters to the hundredth, or meters to the tenth place, as described in the previous section titled Measuring New Distances; then when converting from meters to feet, round the converted number as appropriate, but do not exceed the tenth's place.

Converting from meters to feet: Some examples;

$$\begin{array}{ll} 0.20 \text{ m} = 0.7 \text{ ft} & 10.55 \text{ m} = 34.6 \text{ ft} \\ 1.00 \text{ m} = 3.3 \text{ ft} & 102.4 \text{ m} = 336.0 \text{ ft} \end{array}$$

Converting from kilometers to miles: When converting from kilometers to miles, convert to miles and the tenth's place. Some examples;

$$0.5 \text{ km} = 0.3 \text{ mi} \qquad 2.8 \text{ km} = 1.7 \text{ mi}$$

(B) Historic (old) Measurements: Original measurements in English units.

Conversion from English units to Metric units: Distances measured in English units such as feet or inches are converted from feet to meters using an extra decimal place in the converted Metric value, round the number as appropriate but do not exceed the hundredth place for distances less than 328 ft. If the original distance measured exceeds 328 ft, round the converted Metric value to meters, or meters and the tenth's place, as appropriate. If the decimal place is not shown, then the original measurement is assumed approximate and no decimal place is required in the converted value. An exception to this rule is when the past measured distance is 1 ft, as illustrated in the conversion examples below.

Converting from feet to meters: Some examples;

$$\begin{array}{ll} 0.5 \text{ ft} = 0.15 \text{ m} & 30.0 \text{ ft} = 9.14 \text{ m} \\ 1 \text{ ft} = 0.3 \text{ m} & 30 \text{ ft} = 9 \text{ m} \\ 3 \text{ ft} = 1 \text{ m} & 365.6 \text{ ft} = 111.4 \text{ m} \\ 3.0 \text{ ft} = 0.91 \text{ m} & 365 \text{ ft} = 111 \text{ m} \end{array}$$

Converting from miles to kilometers: When converting from miles to kilometers, use only one decimal place if the original number has a decimal place, otherwise the original number is deemed approximate. Mileage is usually made in statute miles on land and nautical miles on water. Some examples;

$$\begin{array}{ll} 0.3 \text{ mi} = 0.5 \text{ km} & 1.0 \text{ mi} = 1.6 \text{ km} \\ 1 \text{ mi} = 2 \text{ km} & 1.3 \text{ mi} = 2.1 \text{ km} \\ 2.5 \text{ nm} = 4.6 \text{ km} & 3 \text{ nm} = 6 \text{ km} \end{array}$$

## TO REACH STATEMENT TEXT

The TO REACH statement is only required for tide stations. The purpose of the TO REACH statement is to provide easily followed directions on how to reach the station site and describe the specific location of the water level sensor. The assumption is made that the user is unfamiliar with the area. Thus, the TO REACH statement should start from a readily found prominent landmark, use the mode of transportation most common to the area, and guide the user via the most direct, main, route.

### **Directions**

When describing a turn, always note the compass direction. Spell out north, east, south, and west. Use standard two or three capital letter symbols for intercardinal points of the compass.

north	NNE	NE	ENE
east	ESE	SE	SSE
south	SSW	SW	WSW
west	WNW	NW	NNW

Right and left may be also be used if it clarifies a direction.

### **Landmark**

A landmark should be a permanent location, public building, or structure that can be easily located by any person with a common road map or other guide. Typical landmarks are the intersection of two roads, town hall, post office, airport, etc. It should be as close as is reasonable to the site and offer as direct a route as is possible.

### **TO REACH Statement Format**

To reach the bench marks from (landmark), proceed (direction) on (name and/or road number) for X km (Y miles) to (next salient point), then (turn, proceed, etc.) (direction) on (name and/or road number) for X km (Y miles) to (next salient point), then (repeat statement as necessary) to (the station facility). The bench marks are in the vicinity of (general area description). The tide station was/is (location on the facility and its name).

Some examples are;

To reach the bench marks from the U.S. Post Office on Main Street, proceed north on Main Street for 1.3 km (0.8 mi) to the intersection with Second Avenue, then west on Second Avenue for 3.2 km (2.0 mi) to its termination with Harbor Road, then SW on Harbor Road for 5.6 km (3.5 mi) to the small boat harbor and fishing pier. The bench marks are along Harbor Road and the waterfront area. The tide gage and staff were located 4.51 m (14.8 ft) south of the offshore end of the wharf.

#### TO REACH STATEMENT Example #1

To reach the bench marks from the fishing village of Nunchuk via boat, proceed NNE along the Snowamish Channel for 23.3 km (12.6 nm) to the entrance to Chiklik Bay, then NW along Chiklik Bay for 9.8 km (5.3 nm) to Lonely Island, then east for 0.9 km (0.5 nm) along the south coast of Lonely Island to the sole fishing pier on the west side of Isolation Bay. The bench marks are along the shoreline adjacent to both sides of the pier. The tide gage and sensor were located at the offshore end of the fishing pier.

#### TO REACH STATEMENT Example #2

### **BENCH MARKS DESCRIPTION TEXT**

The bench mark descriptive text should provide clear, concise, and accurate instructions on how to recover a bench mark using easily identified objects located within a reasonable distance from the bench mark. The assumption is made that the user is not familiar with the surroundings. In this document, the term “bench mark” is used as a generic expression for a vertical control point whose height above a tidal datum has been, or will be, determined.

The following general format shall be used for all surface bench marks (for rod marks or 3-D rod marks refer to the special requirements below).

A bench mark descriptive text is made up of three parts, as listed below.

The bench mark is a \_\_\_(1)\_\_\_, \_\_\_(2)\_\_\_, \_\_\_(2)\_\_\_, \_\_\_(2)\_\_\_, and \_\_\_(3)\_\_\_.

Part (1) consists of three critical pieces of information: A) the marker (monumentation) type; B) how it is set; and C) a general locator. For a primary bench mark, use the words primary bench mark in the above sentence.

Part (2) provides taped measurements and compass directions from at least three objects in the

immediate area of the bench mark, recorded in the descending order of distance.

Part (3) is a vertical reference to grade, or other appropriate reference, used only if the bench mark setting is not level with its immediate surroundings. The relationship of the bench mark to grade need be cited only if the difference exceeds 0.05 m (0.2 ft). For rod marks the vertical reference to grade is reported in centimeters in the NGS DESC program.

Other details such as the condition and agency responsible for setting the bench mark are typically not recorded in the descriptive text field.

### **Part (1 A): Marker Type**

The marker (monumentation) type identifies the object used to monument the vertical control point such as a disk, bolt, rivet, flanged encased rod, etc. This immediately tells the user what physical object is being searched for. In the NGS DESC program a marker type code will be entered for marker types such as code B for bolt, or R for Rivet, but use a more specific descriptor for the text portion such as brass bolt or monel rivet as shown below.

The bench mark is a disk ...  
The bench mark is a brass bolt ...  
The bench mark is a monel rivet ...  
The bench mark is a flange encased rod ...  
The bench mark is a chiseled cross ...

(Part 1 A) Marker Type Examples

### **Part (1 B): Setting**

The setting indicates how the bench mark has been installed and whether it is set in concrete, rock, structures, etc. If the bench mark is a rod mark of some type, note how the disk or point is attached to the rod. In the NGS DESC program a setting code will be entered for a marker, such as code 31 for pavements (street, sidewalk, curb, apron, etc.), but describe the setting in particular to what is applicable such as granite curb as shown below. The marker shall be assumed to be set horizontally unless noted as set vertically.

... set in a granite curb ...  
... set vertically in the brick wall ...  
... cut in a rock ledge ...

(Part 1 B) Setting Examples



### **Part (1 C): General Locator**

The general locator statement directs the user to the general vicinity of the bench mark. It should identify something that can be readily found once the user has reached the location described by the TO REACH statement. It does not usually contain a distance and direction from a landmark, unless there is no other way to locate the mark. The general locator statement should be a continuous phrase if at all possible.

... at the bottom of the east entrance to the U.S. Post Office, ...  
... at the NW corner of the First National Bank on Fifth Street, ...  
... of the old munitions factory along Fort Avenue, ...  
... in the park near the intersection of First and West Avenues, ...  
... just south of the residence at 111 Jones Road on the west side of the street, ...

(Part 1 C) General Locator Examples

### **Part (2): Taped Measurements and Compass Directions**

... 14.51 m (47.6 ft) west of telephone pole numbered E345C6, 12.66 m (41.5 ft) south of the centerline of Main Street, and 4.94 m (16.2 ft) north of a fire hydrant, ...  
  
... 64.07 m (210.2 ft) WSW of bench mark 9601 B 1980, 10.85 m (35.6 ft) south of the SW corner of the old fort, 3.22 m (10.6 ft) north of a USPS mailbox, ...  
  
... 11.58 m (38.0 ft) north of the north edge of Highway 101, 1.95 m (6.4 ft) east of a 1.49 m (4.9 ft) square concrete pad, and 0.55 m (1.8 ft) west of the east end of the bridge abutment.

(Part 2) Specific Locator Example

Notes for part (2): Taped Measurements and Compass Directions.

1. Always attempt to reference the bench mark to objects in three different directions so that the mark may be located more easily through triangulation in the event that it becomes buried, grown over, etc..
2. More than three landmark references are recommended if they are necessary to ensure locating the bench mark, or if some landmarks appear semipermanent.

3. Other bench marks may be used as references, but only use them if good local landmarks are scarce. When referencing another bench mark in the text, use the full stamping or designation, preceded by bench mark; ... west of bench mark 1234 A 1995, ...
4. If there are no immediate landmarks, distant objects may be used by determining the angular relationship (azimuth), in lieu of a distance between the object and the bench mark. Azimuths are given in parenthesis after the direction and cite the reference meridian used, for example, SSW (202<sup>0</sup> magnetic).
5. Items that are identified by nominal sizes (3/4 inch bolt, 5 inch diameter pipe, 4 x 6 timber, 12 mm screw) do not have their sizes converted into the opposite units. The size is considered a descriptive name and not a measurement. When an object is measured, however, such as the dimensions of a concrete slab, the units are converted.

### **Part (3): Vertical Reference**

<p>... and 1.25 m (4.1 ft) above grade. ... and 0.60 m (2.0 ft) above the base of the retaining wall. ... and 0.33 m (1.1 ft) above road level.</p>
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#### (Part 3) Vertical Reference Examples

The vertical tie gives the height of the disk above or below the surrounding area. It is assumed to be about level with its surroundings if no vertical reference is given.

If the bench mark is a rod type, an additional statement is included at the end that provides more detailed information on the rod mark. For a rod type mark use the following format:

... The bench mark is set XX cm (Y.Y ft) below grade, crimped to a (rod type) driven X.X m (Y ft) to (refusal/substantial resistance), and encased in a (Z-inch) PVC pipe with concrete kickblock or 5-inch (NOS/NGS) logo cap.

If the bench mark is a sleeved rod type, an additional statement is included at the end in the following format:

... The bench mark is set XX cm (Y.Y ft) below grade, crimped to a (rod type) driven X.X m (Y ft) to (refusal/substantial resistance), in a sleeve extending to a depth of X.X m (Y ft), and encased in a (Z-inch) PVC pipe with concrete kickblock or 5-inch (NOS/NGS) logo cap.

If the bench mark is a flange encased rod type, an additional statement is included at the end in the following format:

... The datum point is set XX cm (Y.Y ft) below ground, being the top of a (rod type) driven X.X m (Y ft) to (refusal/substantial resistance), in a sleeve extending to a depth of X.X m (Y ft) and encased in a 5-inch (NOS/NGS) logo cap.

... The bench mark is set 10 cm (0.3 ft) below grade, crimped to a copper-clad steel rod driven 11.9 m (39 ft) to refusal, and encased in a 4-inch PVC pipe with concrete kickblock.

... The bench mark is crimped to a galvanized steel rod driven 22.9 m (75 ft) to refusal, and encased in a 4-inch PVC pipe.

... The bench mark is set 15 cm (0.5 ft) below grade, crimped to a stainless steel rod driven 6.1 m (20 ft) to refusal, in a sleeve extending to a depth of 3.0 m (10 ft), and encased in a 5-inch PVC pipe with concrete kickblock.

... The datum point is set 8 cm (0.3 ft) below grade, being the top of a stainless steel rod driven 15.9 m (52 ft) to refusal, and encased in a 5-inch NOS logo cap.

### Rod Mark Vertical Reference Examples

#### Notes for part (3): Vertical Reference to Grade.

1. The rod type information specifies the material the rod is made of, typically galvanized, stainless, or copper-clad steel.

2. The term "refusal" shall be used only if refusal conditions are actually met. Otherwise, the term "substantial resistance" shall be used.
3. The PVC pipe diameter shall be specified in the original nominal units only.
4. If the rod mark is set in a sleeve, the sleeve depth shall be noted also. The depth of a rod or sleeve is given to 0.1 meter and its English equivalent to the nearest foot (without decimal point).
5. Flange-encased rods can be found with or without disks crimped to the rod, and with or without a grease-filled sleeve.
6. Document whether a NGS or NOS stamped logo cap is used on the pipe, as applicable.

### **BENCH MARK DESCRIPTION EXAMPLES**

The following four are typical examples of bench mark descriptions found in general cases. Example #4 is a typical bench mark description for subordinate hydrographic tide stations in Alaska.

The primary bench mark is a disk located near the front lawn of the USCG Marine Safety Office property, 45.90 m (150.6 ft) NW of the flagpole at the entrance of the main building, 24.69 m (81.0 ft) south of the light pole on the east side of Christopher Columbus Avenue, 9.20 m (30.2 ft) NNE of the north curb of Washington Avenue, 8.41 m (27.6 ft) SE of the eastern curb of Christopher Columbus Avenue, and 8.14 m (26.7 ft) east of the traffic signal post at the NE corner of Washington and Christopher Columbus Avenues. The bench mark is set 18 cm (0.6 ft) below ground, crimped to a stainless steel rod driven 11.9 m (39 ft) to refusal, and encased in a 5-inch PVC pipe with concrete kickblock.

Primary Bench Mark Description Example #1

The bench mark is a disk set in top of the concrete footing for a building on the east end of Municipal Pier No. 11 North (Marine Police and Fire Boat Pier), 14.57 m (47.8 ft) north of the south face of the pier, 9.81 m (32.2 ft) south of the north face of the pier, 6.49 m (21.3 ft) west of the east end of the pier, and 0.37 m (1.2 ft) south of the north end of a steel door opening.

#### Bench Mark Description Example #2

The bench mark is a flange-encased rod located 1.4 km (0.9 mi) north on Baltimore Street from the intersection of Baltimore Street and Moale Avenue, 23.59 m (77.4 ft) SW of the center and at the end of the Baltimore Street, 7.32 m (24.0 ft) SSW of the approximate centerline of the Baltimore Street, 0.49 m (1.6 ft) NE of the SE corner of a 3.00 m x 3.00 m (9.8 ft x 9.8 ft) concrete pad that surrounds a drainage culvert, and 0.40 m (1.3 ft) NE of a 3-inch PVC witness post. The datum point is set 15 cm (0.5 ft) below the ground, being the top of a stainless steel rod driven 17.1 m (56 ft) to refusal, and encased in a 5-inch NGS logo cap.

#### Flange Encased Rod Bench Mark Description Example #3

The bench mark is a disk set in bedrock located 5.50 m (18.0 ft) south of the tree-line, rising above the surrounding grass and driftwood, 35.61 m (116.8 ft) NE ( $54^{\circ}$  magnetic) from bench mark 1234 B 1996, 35.39 m (116.1 ft) NW ( $324^{\circ}$  magnetic) from bench mark 1234 A 1996, and 5.45 m (18.2 ft) above the approximate high water line.

#### Alaska Hydro Gauge Bench Mark Description Example #4

## APPENDIX A

The following information was obtained from ANSI/IEEE Standard 268-1982 "American National Standard Metric Practice" (ANSI Standard) and is provided here for technical detail.

Conversion of quantities should be handled with careful regard to the implied correspondence between the accuracy of the data and the given number of digits. Any digit that is necessary to define the specific value or quantity is said to be significant. In all conversions, the number of significant digits retained should be such that accuracy is neither sacrificed nor exaggerated. When converting integral values of units, consideration must be given to the implied or required precision of the integral value to be converted. Obviously, the converted value must be carried to a sufficient number of digits to maintain the accuracy implied or required in the original quantity.

It is therefore necessary to determine the intended precision of a quantity before converting. The estimate of intended precision should never be smaller than the accuracy of the measurement and should usually be smaller than one tenth the tolerance if one exists. After estimating the precision of the dimension, the converted dimension should be rounded to a minimum number of significant digits such that a unit of the last place is equal to or smaller than the converted precision.

Distance measured	Examples of the distance measured	Implied range of the distance measured	Implied tolerance of the distance measured
< 100 m	10.85 m	10.845 m to 10.855 m	0.01 m
100 m to 1000 m	124.5 m	124.45 m to 124.55 m	0.1 m
> 1 km	1.2 km	1.15 km to 1.25 km	0.1 km

TABLE NO A-1: Implied Range and Tolerance of the Distance Measured

In the case of bench marks descriptions one comes across distances as small as a few mm or inches to a few hundred meters or feet. For example, a distance of 9 m can signify a range from 8 m to 10 m or from 8.5 m to 9.5 m, depending upon the tolerance desired. Also for the past measured distances, the precise tolerances to which these distances were measured would be unknown and whether original distances were measured in the Metric system or English units also would be unknown. Table A-1 provides information regarding the scope of distances measured for the bench mark descriptions and the implied range and implied tolerances of the distance measured.