USER'S GUIDE

FOR WRITING

TO REACH STATEMENTS

AND

BENCH MARK DESCRIPTIONS

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Engineering Division
Center for Operational Oceanographic Products and Services
National Ocean Service
National Oceanic and Atmospheric Administration

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1 Background

This document provides specifications for writing the TO REACH statement for locating a water level and/or meteorological station site; and the creation of Bench Mark Descriptions for recovering individual bench marks. This document supplements the Input Formats and Specifications of the National Geodetic Survey Data Base (Volume I and II, September 1994) "Bluebook" which is available on this NGS web site - http://www.ngs.noaa.gov/FGCS/BlueBook/.

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 TO REACH statements shall be provided to the Engineering Division (ED) of the Center for Operational Oceanographic Products and Services (CO-OPS) in electronic format as a text file or as an entry on the e-site report submitted for the station. The bench mark descriptions shall be provided to the ED of CO-OPS in electronic format as a *.des description file from the NGS WinDesc program. The use of WinDesc for submission of bench mark descriptions from organizations other than CO-OPS performing third order leveling is optional.

2 General Information

2.1 Maintain Consistent Referencing Procedures

The following referencing techniques are recommended for measurements:

1. All measurements are assumed to be horizontal unless labelled "sloped".

2. Distances measured from a line (e.g., centerline of road or a fence line) are assumed to be measured perpendicular to that line.

3. The origin of the 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. If another starting point is selected such as edge of the curb, this must be noted in the descriptive text. In general, all measurements are assumed to be made from (and to) the center of the bench mark.

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 or below ground. The word flush is not used.

2.2 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 meters; 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 of a mile and converted to kilometers.

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, e.g., 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.

2.3 Conversions Between Units

2.3.1 Conversion Rules

The conversion rules between English and Metric units are as follows:

Metric to English	English to Metric
3.2808 x X m = Y ft	0.3048 x Y ft = X m
0.6214 x X km = Y mi	1.6093 x Y mi = X km
0.5400 x X km = Y nm	1.8520 x Y nm = X km

Procedures are 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 places, shall be re-measured.

2.3.2 New Measurements: Original Measurements in Metric Units.

When measurements are made in meters, convert from meters to feet by rounding the converted number as appropriate, but do not exceed the tenth's place.

Examples:	0.20 m = 0.7 ft	10.55 m = 34.6 ft
	1.00 m = 3.3 ft	102.4 m = 336.0 ft

When measurements are made in kilometers, convert from kilometers to miles, by rounding the converted number as appropriate, but do not exceed the tenth's place.

Examples:	0.5 km = 0.3 mi	2.8 km = 1.7 mi

2.3.3 Historic Measurements: Original Measurements in English Units.

Distances measured in English units such as feet or inches are converted to decimal feet, then from feet to meters using an extra decimal place in the converted Metric value, rounding the number as appropriate but not exceeding 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.

Examples:	0.5 ft = 0.15 m	30.0 ft = 9.14 m
	1 ft = 0.3 m	30 ft = 9 m
	3 ft = 1 m	365.6 ft = 111.4 m
	3.0 ft = 0.91 m	365 ft = 111 m

Distances measured in miles are converted from miles to kilometers, using only one decimal place if the original number has a decimal place. If the original number has no decimal places, it is deemed approximate and no decimal place is required in the converted value. Mileage is usually made in statute miles on land and nautical miles on water.

Examples:					
	0.3 mi	= 0.5 km		1.0 mi	= 1.6 km
	1 mi	= 2 km		1.3 mi	= 2.1 km
	2.5 nm	= 4.6 km		3 nm	= 6 km

3 TO REACH Statement Text

The TO REACH statement provides easily followed directions on how to reach a CO-OPS water level or meteorological station, the sensors and the associated bench marks. It is also used on the tidal Published Bench Mark Sheet. These directions are written for the user who 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 to the station via the most direct and major route.

The WinDesc program does not provide the "TO REACH" statement that is used in the header paragraph of the tidal published bench mark sheet. Hence, the "TO REACH" statement to be used on the published bench mark sheet shall be provided in a separate digital file with filename a seven digit station number and the three digit extension TOR; e.g., 9414290.TOR.

This statement may also be used for each individual bench mark description in the WinDesc program, with perhaps minor editing depending on the location of the mark.

3.1 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.

3.2 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.

3.3 TO REACH Statement Format (For Published Bench Mark Sheet)

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

Some examples are:

To reach the tidal 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 gauge 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 intersection of State Highways 213 and 291 in Chestertown, proceed west on Route 291 for 0.8 km (0.5 mi) to Highway 20, turn right and continue west on Highway 20 for 11.3 km (7.0 mi) to Highway 21. Turn right and proceed west on Highway 21 for 5.3 km (3.3 mi) to the Tolchester Marina. The bench marks are located between Route 21 and the entrance channel to the marina. The tide gauge is located on the north bulkhead along the entrance channel.

TO REACH STATEMENT Example #2

4 Bench Mark Descriptive 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.

NOTE: For electronic digital levels, each individual mark description on the DES file must include a statement on how to reach the mark from a local landmark or highway intersection. This is a requirement for inclusion of the mark in the NGS database. When the descriptive text is entered into the CO-OPS tidal bench mark database and for the published bench mark sheet, the statements on how to reach each individual mark are deleted, and the more general "To Reach" statement about how to reach the tidal marks and tide station is used in the header paragraph of the published bench mark sheet.

Bench mark descriptive texts for other types of levels, i.e. Third Order levels for hydro or control levelling in Alaska or the Pacific Islands, DO NOT require the statement on how to reach the mark for each individual mark because those levels are not currently submitted to NGS.
The following general format shall be used for the description of all surface bench marks for electronic levels (for rod marks or 3-D rod marks refer to the special requirements below).

The bench mark descriptive text is made up of four parts, as listed below.

From the intersection of ___(1)___, ___(2)___, ___(3)___, ___(3)___, ___(3)___, and ___(4)___.

Part (1) consists of general locator phrases that lead the user to the individual mark from a local landmark or highway intersection.

Part (2) consists of three critical pieces of information: A) the marker (monumentation) type; B) how it is set; and C) a specific locator. For the primary bench mark, use the words primary bench mark in the above sentence.

Part (3) 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 (4) 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 meters in the NGS WinDesc program.

Other details such as the condition and agency responsible for setting the bench mark are typically not recorded in the descriptive text field unless directed as such from the description header screen.

4.1 Part (1): General Locator

The descriptive text starts with this series of phrases that describes how to reach the mark from a local landmark or highway intersection, i.e. From the Post Office, from the intersection of..., etc. Ideally, this section should lead the user to the immediate vicinity of the mark.

> From the intersection of US Highway 322 and Washington Avenue in (city), proceed east on Washington Avenue for 2.4 km (1.5 mi), then go north on Christopher Columbus Avenue for 0.3 km (0.2 mi),
>
> From the Post Office in (city), proceed north on Main Street for 3.4 km (2.1 mi), then go east on Columbia Boulevard for 0.8 km (0.5 mi) to the city harbor and Municipal Pier No. 11 North,
>
> From the local marina at (town), proceed SW by boat for 9.5 km (5.1 nm) to Shag Island,

Part (1) General Locator Examples

4.2 Part (2 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 WinDesc program a marker type code will be entered for marker types such as “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.

Even though the marker monumentation information is coded in the WinDesc program, it is included in the bench mark description so as to be compatible with the CO-OPS published bench mark sheet format and for ease of reading the description on the data sheet.

> …, 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 chiselled cross...

Part (2 A) Marker Type Examples

4.3 Part (2 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 WinDesc program a setting code will be entered for a marker, such as “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 (2 B) Setting Examples

4.4 Part (2 C): Specific Locator

The specific locator statement directs the user to the specific vicinity of the bench mark. It should identify something that can be readily found once the user has reached the location described in Part 1 of the description (how to reach the mark). 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 (2 C) Specific Locator Examples

4.5 Part (3): Taped Measurements and Compass Directions

The taped measurements and compass directions give exact distances and directions from prominent landmarks to the bench mark. The following guidelines are used to formulate these 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; for example: "…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° 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.

> ..., 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, 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, 0.55 m (1.8 ft) west of the east end of the bridge abutment, …

Part (3) Specific Locator Example

4.6 Part (4): Vertical Reference

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.

> ...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.

(Part 4) Vertical Reference Examples

If the bench mark is a rod type with disk, this additional statement is included at the end of the description in place of the above vertical reference:

> ... 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.

(Part 4) Vertical Reference Format for Rod Marks

If the bench mark is a sleeved rod type with disk, this additional statement is included at the end of the description in place of the above vertical reference:

> ... 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.

(Part 4) Vertical Reference Format for Sleeved Rod Marks

If the bench mark is a flange encased rod type, this additional statement is included at the end of the description in place of the above vertical reference:

> ... 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.

(Part 4) Vertical Reference Format for Flanged Encased Rod Marks

The following guidelines are used to formulate the rod mark descriptive text:

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 whole foot.
5. Flange-encased rods can be found with or without disks crimped to the rod, and with or without grease-filled sleeves.
6. Document the agency stamping (typically NGS or NOS) from the logo cap used on the PVC pipe, as applicable.

... 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 6.1m (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

5 Bench Mark Description Examples

The following are three typical examples of bench mark descriptions found in general cases. The statements on how to reach the marks are fictitious. Example #4 is a typical bench mark description for subordinate hydrographic tide stations in Alaska.

From the intersection of US Highway 322 and Washington Avenue in (city), proceed east on Washington Avenue for 2.4 km (1.5 mi), then go north on Christopher Columbus Avenue for 0.3 km (0.2 mi), 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

From the Post Office in (city), proceed north on Main Street for 3.4 km (2.1 mi), then go east on Columbia Boulevard for 0.8 km (0.5 mi) to the city harbor and Municipal Pier No. 11 North, 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

From the intersection of Baltimore Street and Moale Avenue in (city), proceed north on Baltimore Street for 1.4 km (0.9 mi), the bench mark is a flange-encased rod set 23.59 m (77.4 ft) SW of the center and at the end of Baltimore Street, 7.32 m (24.0 ft) SSW of the approximate centerline of 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

From the local marina at (town), proceed SW by boat for 9.5 km (5.1 nm) to Shag Island, 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° magnetic) from bench mark 1234 B 1996, 35.39 m (116.1 ft) NW (324° 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

From Cape Vincent, Jefferson County, New York, at the foot of Murray street, in the east face at the southeast corner of the stone wall face of the U.S. Fish Hatchery building, the bench mark is the center punch in a 1/4-inch brass rod (bolt) cemented in the stone wall, 18 m (59 ft) south of the NE corner of the building, 4.42 m (14.5 ft) west of the west edge of the side walk on the east side of the property, 0.37 m (1.2 ft) north of the SE corner, and 0.91 m (3.0 ft) above the ground.

Great Lakes Bench Mark Description Example # 5

6 Appendix

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.

The 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 cm or inches to a few hundred meters or feet. For example, a distance of 9 meters can signify a range from 8 meters to 10 meters or from 8.5 meters to 9.5 meters, depending upon the tolerance desired. Also for the historic measured distances, the precise tolerances to which the distances were measured would be unknown and whether the original distances were measured using metric 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.