U.S. DEPARTMENT OF COMMERCE
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION
COAST AND GEODETIC SURVEY

Coast and Geodetic Survey Technical Memorandum USC&GSTM-4

Specifications for Horizontal Control Marks

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This memorandum provides the complete specification for establishing and stamping horizontal control marks established by this Agency.

PREFACE

The purpose of horizontal control marks are to accurately and permanently mark and reference point of precisely known latitude and longitude. The identification mark or names that are stamped in each disk must follow set rules to allow for properly identifying these stations at a later date.

At each horizontal control station a group or set of marks are established. These marks include the station mark for which the precise geographic position is known, reference marks for recovering or relocating the station and an azimuth mark for use by local surveyors in obtaining a starting azimuth.

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SPECIFICATIONS FOR MARKS

1. STATION TO BE MARKED

Each triangulation station which is not in itself a permanent mark (such as a lighthouse, a spire, or a tank) but which is located where it can be permanently marked and referenced shall be marked in accordance with the specifications which follow.

2. METAL DISKS

A triangulation station should be marked by a standard bronze disk so fastened as to effectively resist extraction, change of elevation, or rotation. The name of the station and the year established should be stamped upon the mark, preferably before it is set in the rock or concrete. A complete station installation includes station mark (center, with underground mark), reference marks, and an azimuth mark.

Metal disks which have been moved or defaced so that they no longer can serve as survey marks are to be broken out of the monuments and destroyed. Lettering on stone, concrete, or any material other than metal markers should be hammered or chiseled off if the monument has been moved from its proper location. Bureau Headquarters should be notified of this action by memorandum and/or recovery card.

3. NAMING OF STATIONS

The triangulation party normally uses the name assigned by the reconnaissance party unless there is some reason for changing it. Correct spelling of the name should be checked locally before the mark is stamped. The name as stamped on the mark will be used throughout the records. In the horizontal volume it will be recorded completely for the first, fifth, ninth, and thirteenth positions.

The name of the locality is preferable but the name of the property owner may be used for the designation of the station. To avoid ill-feeling, it should be made certain that the station is actually on the named property, and that the owner's name is correctly spelled.

Double names should be avoided, if practical, as they cause extra work throughout the recording and computing. Also, the double name including the word "peak," or "mountain," or "point," is not usually necessary, since the description should state that the station is on a peak or mountain of that name.

Stations previously established by other organizations may be used for our station if they are suitably located and the marks meet our specifications for station mark. If they do not meet these requirements, a new station mark should be established in the usual manner and the other organization's mark used as a reference mark.

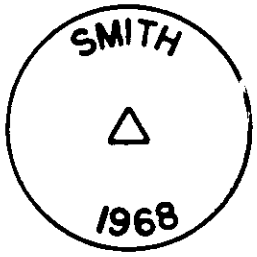
When stations of other organizations are used for our station, the name should be retained exactly as stamped on that organization's station mark. If additional azimuth or reference marks are established by a party of this Bureau, the stamping should include the original station name, the initials of the other organization, and the year in which the additional marks were established.

If the name of a recovered intersection station (not marked with a bronze disk) is incorrect, the correct name should be typed in the heading of Form 525b. The first statement in the body of the note should then list any previous triangulation names of the same object, as well as map names and any other names in current usage.

4. RULES AND EXAMPLES FOR MARKING STATIONS

All triangulation stations shall be marked or remarked and the disks stamped, in accordance with the following rules:

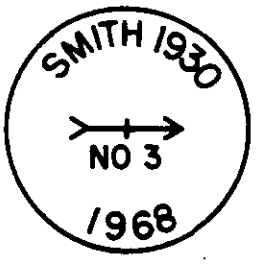
(a) Each newly established triangulation station shall be marked with a standard station mark disk which shall be stamped with the name of the station and the year of establishment.



(b) Each reference mark disk shall be stamped with the name of the station, the number of the reference mark, and the year.

(c) Each recovered station which is remarked shall be stamped with the original name of the station, the original date of establishment, and the year in which it was remarked.

(d) Additional reference marks, as necessary, may be established when a station is recovered and reoccupied. The name and date shown above the arrow on the reference mark disk shall be the same as the original station with the date established below the arrow.



(e) Do not renew an old reference mark. If it is in poor condition, either reinforce it or destroy it and set a new reference mark, which will be numbered with the next consecutive unused number, regardless of the existence or absence of any of the reference marks established previously.

(f) The abbreviation "Ecc." (for eccentric) should never be stamped on a disk. Its use in the records should be solely to indicate that the observations made at that point must be reduced to the station center.

(g) All new stamping on disks for station and reference marks shall be done with 3/16 or 1/4 inch dies.

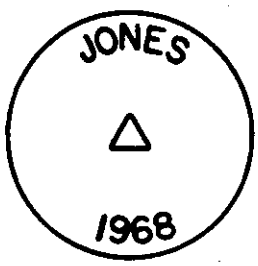
The following examples relative to stamping triangulation station and reference mark disks shall be strictly followed:

CASE I

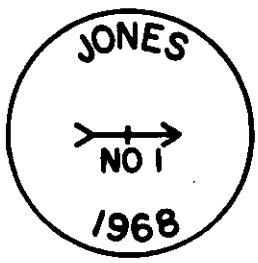
A new station is established. In the center of the station mark is a small triangle. The year of establishment is stamped under one side and the name above the opposite apex of the triangle. Two reference marks shall be established and the disks shall be stamped with the station name, number, and year. The reference marks shall be numbered consecutively in a clockwise direction from true north. They must be set so that the arrows on the disks point toward the station mark. Azimuth mark disks shall be stamped with the name of the station and the year of establishment.

Example Station JONES is established in 1968. The disks shall be stamped as follows:

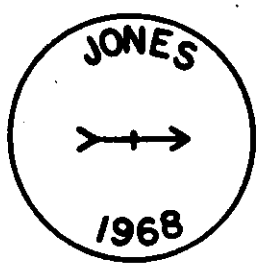
Station mark: JONES 1968
Reference marks: JONES NO 1 (or 2) 1968
Azimuth mark: JONES 1968



STATION



REFERENCE



AZIMUTH

CASE II

The station mark, reference mark, or azimuth mark are reinforced but not remarked or otherwise disturbed in any way.

If any or all of the above marks are reinforced only, the original stamping on the disks shall be retained without change, alteration, or addition.

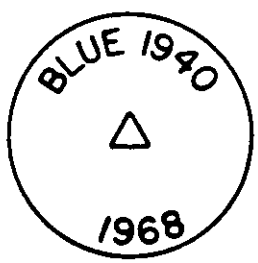
CASE III

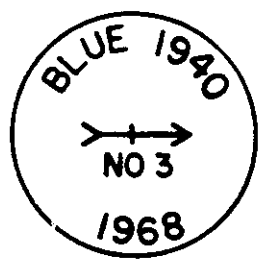
The station is remarked in the precise original position, and a new reference mark is established.

The original name and date of the station shall be retained and stamped above the triangle, the year of remarking shall be stamped below the triangle. In remarking the station, a new station mark disk shall be set.

The new reference mark should be stamped with the name and date of the original station above the arrow and next consecutive number and date of establishment below the arrow.

Example Station BLUE originally established in 1940 is remarked in its original position and a reference mark number 3 is established. The stamping on the remarked station mark would be "BLUE 1940-1968" and the reference mark would be stamped "BLUE 1940-NO3-1968."





CASE IV

The station mark only is moved. If a station is to be moved, it is generally more practicable to establish a new mark in the new location, and when this is done the old mark must be completely destroyed. The station name shall be preserved but the number "2" shall be stamped after the name. The year the station is moved shall be stamped on the station mark disk. The date of establishment of the original station shall not be stamped on a new disk, and if the old mark and

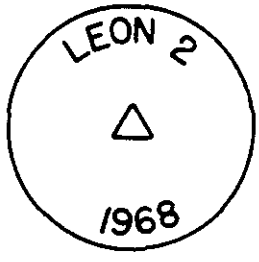
disk are roused, the original date shall be effaced by light tapping with the rounded end of a ball-peen hammer and the disk restamped with the new year.

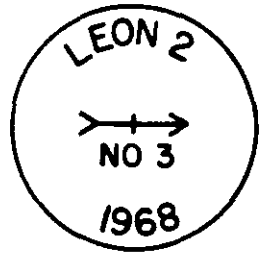
At least one new reference mark shall be established, stamped with the new station name and year of moving the station and given the next unused consecutive reference mark number.

The stamping on the previous reference mark disks shall not be changed.

Example The station mark for LEON 1950 is moved in 1968 but the reference marks are not moved.

The disk in the moved mark shall be stamped "LEON 2 1968." If there were two previous reference marks, the new reference mark shall be stamped "LEON 2 NO 3 1968."

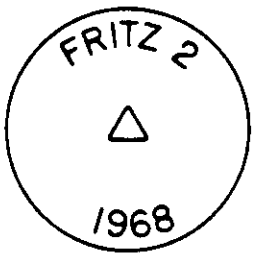




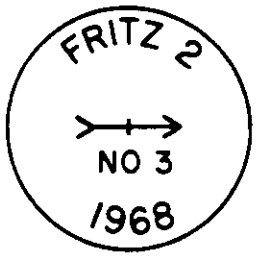
CASE V

The station mark and one or more of the reference marks or the azimuth mark are moved. The station mark shall be treated as in CASE IV. The newly established reference mark disks shall be stamped with the name of the station, the following consecutive numbers, and the year the station was moved. The old date of establishment should not appear on the disks of any of the moved marks. Should it be more practicable to reset one of the moved reference marks rather than establish a new one, the stamping on the disk which is no longer in order shall be effaced as in CASE IV, and the correct notation restamped. The former reference marks which have been moved or destroyed shall be reported as nonexistent.

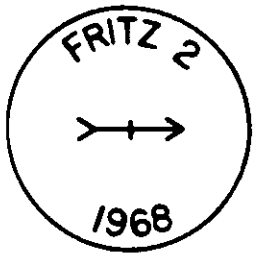
Example Station FRITZ 1941 and its reference mark No. 2 are moved in 1968. The station mark disk shall be stamped "FRITZ 2 1968." Reference mark No. 1 shall not be restamped. Reference mark No. 2, having been reset in a new location, shall be restamped "FRITZ 2 NO. 3 (or the next unused consecutive number) 1968." Should reference mark No. 2 be destroyed and a new reference mark set, the stamping on the new disk shall be exactly the same as in the preceding sentence. If the azimuth mark is moved, it is stamped "FRITZ 2 1968." No old disk is restamped unless it is moved, or reset.



STATION



REFERENCE



AZIMUTH

CASE VI

The station mark is not remarked or moved but one or more of the reference marks are moved or one or more new reference marks are established.

The reference marks shall be stamped the same as in CASE III.

CASE VII

The station mark is not remarked or moved but the azimuth mark is moved.

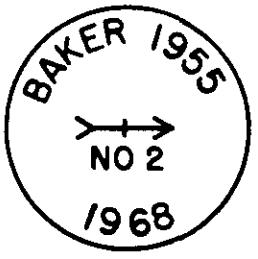
In this case the azimuth mark shall be stamped with the name and year of the original station above the arrow and the year of the new mark establishment below the arrow.

Example A new azimuth is established for station ARZO 1948. The mark should be stamped ARZO 1948-1968.

CASE VIII

The original azimuth at a station still exists and a second azimuth is established. The second azimuth should be stamped with the name of the station, including the original year established, NO 2 and the year in which the new mark is established.

Example Station BAKER 1955 has an azimuth which was established in 1955. In 1968 a second azimuth is established at the station. The second azimuth mark should be stamped BAKER 1955 NO 2 1968.



5. STATION MARK

Each station center should be marked with a standard triangulation mark. The mark should be set in the manner described in section 10. An underground station mark should also be set under the surface mark wherever conditions permit. Marks of other organizations may be used as described in Section 9. The upper station mark may also be set underground when necessary, as when the station is in a cultivated field.

6. REFERENCE MARKS

Each station should have at least two reference marks. The disk bears an arrow which is set to point toward the station mark. Reference marks are stamped with the name and date of station and are numbered serially clockwise from north (for new marks). When needed, monuments are constructed similar to the surface station monument but may be two inches smaller in diameter. They should be 30 inches or more in length as may be necessary to extend below the active frost line. No underground marks are used with reference marks. The directions to the two reference marks required at each new station should intersect in a good angle, preferably near a 90° angle, or the marks should be on range with the station. Reference marks should be located where they are least liable to be disturbed, such as in or near fence lines. It is also necessary that reference marks be placed where direct unobstructed measurements can be made to them from the station mark, and where the line of sight from the instrument to reference marks is clear both from the top of the tower and from the ground. Distances to reference marks from the station should preferably be kept less than a 30-meter tape length to facilitate taping, and far enough from the tower so that the line of sight will not be obstructed by the tower platform boards. It is the responsibility of the building foreman to see that lines of sight and measurement to reference marks do not hit tower legs or other obstructions, and that necessary clearing is done or plumb benches constructed.

In certain cases (for example, when a tower can no longer be built over a station because a power line has been constructed over it), a new reference mark may be established nearby, occupied as a station, and connected by a short traverse to the original station mark. In this case an underground reference should also be established.

Additional standard reference marks should be established at recovered stations where needed to insure two or more good reference marks at each station.

7. AZIMUTH MARK

The disk is labeled "AZIMUTH MARK" and bears an arrow which is set to point toward the station mark. The monument is constructed in the same manner as the reference mark monument. Each station should have an azimuth mark established not less than 1/4 mile distant therefrom and in such a location that it will be visible from the ground and from the top of the tower at the station.

The principal purpose of an azimuth mark is to furnish an azimuth at each station which will be available to local surveyors or engineers from an ordinary ground instrument set up and without the necessity of building any high towers.

Azimuth marks are most frequently placed in or near a fence line along a road which leads to the triangulation station.

8. WITNESS POSTS

In order to aid in the preservation and to serve as a means of easy recovery of the monuments being established a steel post will be set adjacent to the concrete station monument or near one of the reference marks at each station, preferably at the station mark and at the azimuth mark. This post shall project 3 to 4 feet above the ground surface. Affixed to the post will be a standard metal witness post sign. These posts will be set for monuments established along public highways, in rural districts, along the rights-of-way of railroads, and along the shore lines of rivers and lakes. They need not be set for monuments established along business streets, in residential sections of cities, on the grounds of schools and churches, in cemeteries, or in cultivated farm lands. For survey stations established in cultivated fields the post shall be set at a reference mark.

9. MARKS OF OTHER ORGANIZATIONS

If a satisfactory station mark, (meeting our specifications, according to section 3) of another organization is found at the station site in good condition, it should be used without alteration as the station mark of a new Coast and Geodetic Survey station. Reference marks and azimuth mark should be placed, as necessary, to bring the station installation up to the requirements of sections 6, 7, and 8.

In case the existing mark of the other organization is not in good condition for a station mark, a new Coast and Geodetic Survey station mark should be established in the vicinity, and the mark of the other organization should be used as an extra reference mark. The stamping of additional marks should be done as indicated in paragraph 3.

Care should be taken not to displace a mark of another organization in horizontal position, or even in vertical position if there is a possibility that it could have been used as a bench mark. The mark should not be altered without permission from the organization by which it was established.

10. SETTING OF DISKS

The location of the station, composition of the ground or presence of rock, and the availability of materials will usually control the choice of the most suitable type of setting for the metal disks. The principal settings used for metal disks are concrete monuments and drill holes in bedrock and in partially buried boulders.

It should be emphasized that the continued value of triangulation is dependent on permanence of the station marks. Special care and effort should be exerted to make each mark as permanent as possible.

The settings for reference and azimuth marks conform in general to those described below for various types of surface station marks, except that when concrete monuments are used, slightly smaller dimensions are acceptable for these marks.

A discussion of several typical kinds of marks follows:

(a) In concrete monument. - The concrete monument is normally poured in place in a hole dug in the ground, using a top form only. The hole is dug to a depth of 3½ to 5 feet (sufficient to extend below the frost line) with either a square or circular cross section (depending on shape of top form used), and about 14 inches or more in diameter, except that the lower six-inch section is made about 10 inches in diameter for the underground station mark. The concrete is poured and tamped in the lower six inches of the hole for an underground station mark and the disk is set. A point is plumbed directly over the center of the underground mark, on a plumb bench, signal stand, or collimator. This point is maintained during the pouring of the surface monument, so that the surface mark disk may be plumbed over the underground station mark. The underground mark is covered by a thin board to prevent disturbing, and then by several inches of soil. The bottom of the hole for the surface monument is enlarged about 2 inches in radius, tapering upward for about ½ foot in order to make the bottom of the monument bell-shaped. Concrete is poured and tamped in the hole until a level is reached where the top form when set on the concrete will protrude from 2 to 6 inches from the ground. The top form may be in the shape of a frustum of a cone or a pyramid, or a cylinder. It is usually made of 1" x 12" boards with a 1-inch batter, a 12-inch square inside cross section at top of the form and a 14-inch square at the bottom. The form should be tried for fitting into the hole before concrete is poured in order

to avoid any shoulders or mushrooming effect near the top of the monument which might afford purchase for frost action. The pouring, tamping, and back-filling are completed, and the top of the monument smoothed off and beveled with a trowel. The surface disk is then plumbed into position and set in the concrete monument.

A paper cement bag may be used as a top form for a concrete monument. Use of the paper cement bag as a form has the advantage of greater economy in materials, and the smooth rounded surface is less susceptible to damage by frost or vehicles than a square top. When pouring the mark a circular metal form should be placed inside the cement bag to avoid irregular monuments. When a cement bag is used as a top form, a cylindrical hole is dug about 14 inches in diameter and belled out as before to about 4 inches greater diameter at the bottom. The ends of the bag are trimmed, leaving about an 18-inch cylindrical section about 12 inches in diameter. After the hole is filled with concrete to within about 1 foot of the surface, the bag is set on the poured concrete and then carefully filled with concrete, working it around the edges with a trowel to prevent honeycombing. Care is necessary to keep the cross section of the bag circular and the bag vertical. A pair of cylindrical metal forms may be used for this purpose. The outer form is about 18 inches long and about 12 inches in diameter, and the inner metal form is 9 inches long and 11 inches in diameter. Both forms have a 1-inch flange around their top rims. The bag is held in position between these two forms while the concrete is being poured. Immediately after the pouring, first the inner and then the outer forms are lifted off.

The same type of concrete station monument is used in land subject to cultivation, except that the hole is dug deeper; the upper monument may be made a little shorter; no top form is used; and top of upper monument is 12 to 15 inches or more below the ground surface. When the station mark is below the ground surface, small pieces of broken glass, crockery, tile, etc., should be mixed with the dirt covering the mark to assist in recovery of the mark.

(b) In rock outcrop. - The rock in which a mark is set should be hard and a part of the main ledge and not a detached fragment. The disk should be countersunk and well cemented in a drill hole.

(c) In boulders. - The boulder should be of durable rock and as large or larger than a standard concrete monument. The boulder should be firmly imbedded in the ground. Unless the boulder is very large, a hole

should be dug, and the boulder buried so as to protrude from the ground about 2 to 4 inches in the same manner as a concrete monument. In areas where boulders are prevalent, a truck and log chain can frequently be used to advantage in dragging a boulder to a point where a hole has been dug in a suitable location for a mark. The disk should be set in a drill hole in the same manner as in rock outcrop.

(d) In rock ledges below surface. - When the ledge is only slightly below the surface, a disk set in the usual manner in the ledge will be sufficient, provided two surface reference marks are established. When the ledge is so far below the surface that a surface mark is required, a disk or copper bolt should be set in the ledge, the ledge carefully brushed or washed off for a space at least 18 inches in diameter, and a concrete surface monument placed above the underground mark. A disk should be set in the surface monument directly over the underground disk or bolt. If the rock ledge in which the underground mark is set is very smooth, it should be furrowed with a chisel to afford better anchorage for the concrete.

(e) In areas of permafrost and other places where monuments or drill holes are unsuitable. - The disk is brazed to the end of a pipe. Pipes 2 to 4 inches in diameter and 4 feet or more in length are desirable. Wrought-iron water pipes and cast-iron soil pipes are most durable. If one end of the pipe is belled or flanged, that end should be placed down. The lower end of the pipe should preferably be set in a mass of concrete. Pipe marks are used in sand areas, especially where there are drifting dunes. They are also used occasionally at pack stations where there is no suitable rock for setting the disks in drill holes.

If a mark is placed in a permafrost area, the pipe should extend through the active (freeze and thaw) layer into a good bond with the permafrost layer. It is desirable that the length of the pipe which is in the permafrost be twice the thickness of the active layer. Holes should be drilled in the lower end of the pipe and the lower part should be filled with water for an ice bond with the permafrost. Above the ice most of the upper half of the pipe should be filled with sand with a layer of peat near the surface for insulation. Sand with a peat cover should also be placed around the part of the pipe extending through the active layer.

(f) In marsh. - Tile forms for marks may be used in marsh areas. Preference should be given to the largest diameter that is practical. A wooden post which has been previously water soaked (to prevent later swelling and bursting of the tile) is forced down to encircle the post. The tile is cleaned out and filled with concrete and a disk set in the top.

(g) In buildings. - Marks in buildings should preferably be set in drill holes in concrete or stone. The method of setting will frequently depend on the wishes of the owner and ingenuity of the mark setter. On thin roof slabs the disk can sometimes be set in a small rounded concrete monument which is poured over slanting lag screws set into the roof slab.

In cases where it is not practicable or not permissible to place a station mark in the roof, two reference marks may be placed in the parapet as close as practicable to the unmarked station and in such positions that their directions from the station intersect at about 90°. In this case, a third reference mark should be placed for a check distance.

MATERIAL FOR CONCRETE MONUMENTS

The main considerations in making concrete are: Have clean materials, mix them well before adding water, have the mixture not too wet, and tamp well into the form. No dirt should be allowed in the mixture as each streak of dirt in concrete means a line of cleavage. Where rough aggregate is available, the proportions should be 1-2-3, with the top 12 inches of the mark of slightly richer mixture. Where only cement and sand are available, the lower part of the mark should be proportioned 1 part of cement to 3 parts of sand, and the upper part should be 1 part of cement to 2 parts of sand. No reinforcement should be used because triangulation stations are frequently occupied as magnetic stations. To avoid cracking of the concrete due to rapid drying, it should be covered with paper or cloth and then with earth or other material for a period of at least 48 hours.