

**ATTACHMENT 7
SETTING CONCRETE MARKS**

TO
GENERAL GUIDANCE AND SPECIFICATIONS FOR
AERONAUTICAL SURVEYS VOLUME A

FEDERAL AVIATION ADMINISTRATION
AIRPORT SURVEYS

Attachment 7 – Concrete Marks

(From NGS OPERATIONS HANDBOOK and
MANUAL OF GEODETIC TRIANGULATION, S.P. 247)

CONCRETE CHARACTERISTICS

1. **General.** Concrete should have properties that make it workable, strong and durable. Workability refers to the ease with which concrete can be effectively placed, consolidated, and finished, while remaining free from segregation. Workability depends on the proportions of the ingredients and the shape of the individual particles of aggregate. Strength refers to the ability to withstand external forces without rupturing. For survey monuments, high strength is not the most important property, although strong concrete usually indicates that it is durable. Durability is the ability to withstand deterioration over a long time and is primarily influenced by the watertightness of the cured concrete.

2. **Destructive Forces.** Several forces can lead to the weakening or deterioration of concrete. The freezing of water in cured cement exerts great pressure against the inner walls of the pores, tending to break down the concrete. In fresh concrete, the expansion of freezing water breaks the bonds developing between solid particles, making the concrete weak and porous. Leaching and chemical attack also have detrimental effects on concrete. Leaching occurs over a long period when water slowly percolates through concrete and dissolves some of its constituents. Chemical attack is particularly common in alkali soils. Dense, impervious concrete is resistant to these destructive forces.

3. **Ingredients.** The quality of the ingredients and their proportions help determine how dense and impervious the cured concrete will be. The ingredients include aggregate, cement, and water. The aggregate should be clean (free from silt and clay, harmful chemicals, and organic matter) and well-graded, i.e., it contains proportionate amounts of many particle sizes. In specifying mix proportions the aggregate is usually divided into two parts -- sand (particle size less than $2/3$ cm) and gravel (particle size greater than $2/3$ cm). Both parts should be well-graded. Aggregates that are porous, split easily, or are otherwise weak or permeable result in poor concrete. Examples of poor aggregates include shale, claystone, sandstone, and micaceous rocks.

Portland cement is designated by one of five types. Type I is for general use where no special properties are needed. Type III is a high-early-strength type for use when concrete will be curing during cold weather. Type V is used where the concrete will be subject to an alkali environment. Types II and IV are not suited for setting marks. Local concrete companies should be contacted to determine the best concrete type to use in the work area.

The water used in a concrete mix should be relatively free of impurities such as acids, alkalis, salts, oil, organic matter, and silt. These can decrease the strength and durability of cured concrete. As a rule, do not use water that you would not drink.

4. **Mixing, Placing, and Curing.** Pre-mixed concrete materials may be used. If raw materials are used, the suitable proportions (by bulk volume) of cement to sand to gravel are 1:2:3. If the gravel is made up of fragmented or angular particles, use a little less gravel and proportionately more sand. Add only enough water to make the mix workable. About half the water added to the mix is used in the chemical reaction (hydration) that causes the past to harden into binder. If too little water is used, however, the mix will not compact properly and spaces will be left in the mass. **A good indication of the right amount of water is that the mix neither runs nor falls off the shovel but sluggishly slides off and flattens upon hitting the ground.**

5. **Cold Weather Precautions.** The freezing of fresh concrete has a damaging effect because the expansion of water as it freezes separates the solid particles in the mix. This reduces the strength of the bond and makes the concrete more porous and correspondingly less durable.

Three protective measures should be taken in cold weather, either singly or in combination. First, use warm ingredients. During the first 24 hours after a mix has been placed, it develops little heat of its own to prevent freezing. After 24 hours some heat is developed as a product of the chemical reactions occurring in the mix. The use of warm ingredients is especially beneficial during the first 24 hours. Note, however, that mixing water above 165 degrees F could cause a flash set. To keep the aggregate and cement warm, store them indoors.

Second, use Type III (high-early-strength) cement or special additives that speed curing. Calcium chloride is good for this in amounts not exceeding 2 pounds per 94-pound sack of cement. The calcium chloride should be dissolved in the mixing water instead of mixing it with the other ingredients. Other additives include Thoroguard and Trimix. If a large number of concrete marks are being installed by mass production using a "ready-mix" contractor, fast-curing additives should not be added until the concrete is delivered on site.

Third, insulate the finished mark for a week after the concrete is poured. One method is to cover the mark with boards resting on supports. This is covered with paper or plastic, then by a layer of straw, styrofoam, or similar insulating materials above 15 centimeters thick and finally by a layer of soil 15 to 30 centimeters thick. Pile snow loosely on top if it is available.

CONCRETE MONUMENTS (Note, portions of this paragraph apply to concrete collars around rod marks as well as to concrete monuments.)

STEPS:

- 1. Obtain property owner permission prior to proposing new mark locations.**
- 2. Install a tall stake (lath) at each proposed site for a new mark.** Write the proposed station name on the stake.
- 3. Obtain clearance from "MISS UTILITY" types services (underground utilities) before digging.**

4. Drill or dig a 12 - 14 inch diameter hole in the ground 3.5 to 8+ feet deep. The depth depends on frost penetration in that area. The minimum depth is 3.5 feet. Keep the sides of the hole as smooth as possible. The rounded, bottom portion of the monument must extend at least one foot below the frost line. See NOAA Manual NOS NGS1, *Geodetic Bench Marks* which contains a diagram showing average frost line depth.

5. Enlarge the bottom portion of the hole using a shovel such as a “sharp-shooter” (also called “drain spade”) so that the hole is at least 2 inches larger in radius than the main shaft of the hole. This will make the bottom of the monument bell-shaped; see diagram.

6. Remove or tamp down the loose dirt at the bottom of the hole.

7. Remove any loose dirt that might fall into the hole during concrete installation. A layer of loose dirt from the sides or top of the hole, mixed with the concrete will create a fracture line (or plane) which could lead to the monument breaking, thus destroying the mark.

8. Procure a round, cardboard form 12 inches in diameter to line the top 12 - 18 inches of the hole. Test fit the form in the top of the hole. This form will help avoid any shoulders or mushrooming effect near the top of the monument which might afford purchase for frost heave. The form will also help make a neater looking monument. A cardboard, biodegradable, 12-inch diameter form is commercially available. Allow the form to protrude from the ground 2 - 6 inches.

9. Mix the concrete well before it is placed, otherwise the minute particles of cement will not be sufficiently wet and the aggregate will not be completely covered with paste. Prior to adding water, mix the ingredients well. Then, slowly add water and continue to mix. Do not make the mixture too wet.

10. Dampen the hole before concrete is added so moisture will not be drawn from the fresh concrete into the surrounding soil. In no case should it be so wet as to be muddy

11. Place concrete in the hole. Continuously tamp the mix into a compact mass so it becomes less pervious and consequently more durable. Do not contaminate the interior of the monument with dirt.

12. Place the form into the hole when the level of the concrete is approximately one foot below the surface. Continue to be careful not to allow any dirt to fall into the hole.

13. Add concrete until the top is even with or slightly below the surface of the ground. This helps ensure that the monument is not struck by lawn mowers or snow plows, etc.

14. Smooth off the top of the monument with a trowel. Create a gentle slope towards the outside so that rain water will drain off. Bevel the outside edge of the monument.

15. Stamp the disk prior to installing it in a concrete monument or a drill hole. Stamp the disk on a stamping block which has a curved surface that matches the curvature of the underside of the disk. Neatly stamp the station designation (name) above the triangle, centered below “HORIZONTAL CONTROL MARK,” and then stamp the year below the triangle, centered above “THE DIRECTOR.”

16. Set the disk into position in the top center of the monument with the top of the triangle below the name pointing north (so that a visitor facing north will be able to read the disk's lettering). Placing a small amount of concrete on the underside of the disk before setting helps ensure that air is not trapped under the disk.

17. Press the disk into the concrete until the disk edge touches the concrete. Then tap the disk with the handle end of the trowel **until the top edge of the disk is flush with or slightly recessed into the concrete** (to the point that vandals can not get a pry bar under the disk). Do not recess the disk a greater amount because this makes a hollow that will collect rainwater and possibly shorten the life of the mark due to freezing action.

18. Clean the disk. Sprinkle some dry cement on the exposed surface of the disk, then rub it with a clean rag or short bristled brush using circular strokes. This will clean the disk, removing all excess mortar from its surface and recessed letters. Rubbing the wet mortar around the edge of the disk in the same manner is done intentionally to finish its surface and help prevent cracking. Brush away loose cement and make sure that the finished product has a neat appearance.

19. Cover the mark for at least 7 days. This prevents rain from making the mix too wet and from ruining the finished surface. It also prevents the surface from drying too rapidly, leaving too little water for complete hydration. In addition, it prevents debris from sticking to the surface of the wet concrete. A 12 inch diameter lid is available that fits on the 12 inch cylindrical form. This lid will also keep out the dirt during the next step and final clean-up.

20. Replace dirt round the form and tamp into place. At the surface, replace dirt and sod around the form and tamp into place.

21. Rake the area until neat and remove excess materials. Do not leave any construction or other materials at the site. Leave the area as neat or neater than when you arrived. Note, the protruding form and lid shall be removed later during survey observations.

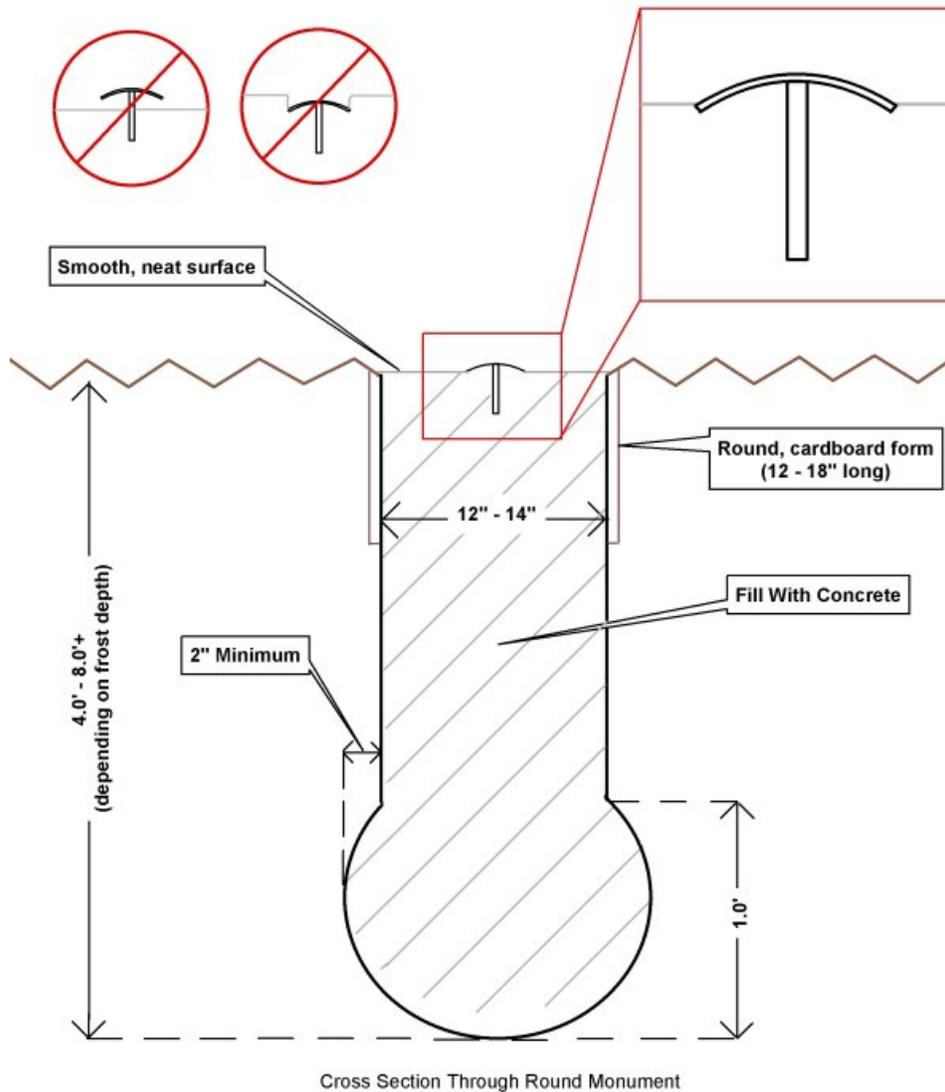
22. Remove excess dirt and dispose of it properly. In some rural areas there may be a logical spot to dump the extra soil where no one will notice. If the mark is in an area consisting of groomed lawns, the dirt shall be removed from the site.

23. Remove excess concrete from the site. Proper planning should minimize excess concrete. Any excess shall not be dumped on-site.

24. Installation of NGS Witness Posts is at the option of the firm. Generally do not use Witness Posts in areas of high population density nor on airports. They are very useful to future surveyors in more remote areas.

25. Do not add magnetic materials to the monument.

Standard NGS Concrete Monument



ATTACHMENT 8
SETTING A SURVEY DISK IN BEDROCK
OR A STRUCTURE

TO
GENERAL GUIDANCE AND SPECIFICATIONS FOR
AERONAUTICAL SURVEYS VOLUME A

FEDERAL AVIATION ADMINISTRATION
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Attachment 8

Setting a Survey Disk in Bedrock or a Structure

From NOAA Manual NOS, NGS 1, *Geodetic Bench Marks*

Sound bedrock is the most desirable setting for geodetic survey control points. Besides the ease and cost effectiveness with which a disk can be installed in bedrock, it provides the most stable setting that can be used in terms of both underground activity and disturbances inflicted by people. Always use bedrock when a suitable outcrop exists. As a rule of thumb, the bedrock is considered potentially good if the distance between joints and fissures is greater than 1 meter. The National Geodetic Survey geodetic control disks are made of brass or bronze. They are about 9 centimeters in diameter and have a spherical surface to support the foot of a leveling rod and a center point for plumbing survey equipment. Information is imprinted on this surface to identify the monument and to aid the user in obtaining data on it. This logo is recessed so that it does not interfere with the leveling rod or other survey equipment. A deformed shank, about 7.5 centimeters long, is silver-soldered or otherwise attached to the bottom surface of the disk to help prevent the disk from being dislodged.

The step-by-step procedure for setting the disk in bedrock utilizing cement is as follows:

1. Stamp the station designation and setting year on the top surface of the disk using 4.75 millimeter (3/16- inch) alpha-numeric steel dies.
2. Pick a fairly level and accessible spot on the outcrop that is intact with the bulk of the rock. A simple test can be performed to help determine the condition and integrity of the rock by placing ones hand in the area that the disk will be set, then striking the outcrop with a moderately heavy hammer and feeling for vibration. Sound outcrop will force the hammer to rebound with each impact and vibration through the rock should be minimal at best.
3. Drill a 2.5 centimeter diameter hole about 10 centimeters into the bedrock and recess the area around the top of the hole to a diameter slightly larger than that of the disk. When the installation is completed, the top of the surface of the disk should sit level and slightly below the surface of the surrounding rock. Chisel a drain channel through the low edge of the drilled recess to allow water to drain from around the finished mark. *Caution:* Safety goggles should be worn when drilling into bedrock or masonry.
4. Remove the rock powder from the hole and recessed area, flush and fill the hole with clean water, then pour cement into it. Mixing of the ingredients is done right in the hole. By adding more water and cement, make enough mortar so that an extra amount is available to place on the underside of the disk. When the mortar is completely mixed, it should be thick but still workable, like heavy mashed potatoes.

5. Clean the disk by wetting then rubbing all surfaces with cement to remove unwanted oils; rinse. Fill the depression on the underside of the disk with mortar using a trowel. Hold the disk loosely upside-down by the end of the shank then gently tap the domed surface of the disk from below with the handle of the trowel several times to allow the mortar to settle and trapped air to escape. This is very important because it will prevent the existence of highly undesirable voids under the disk once it is in place.

6. Place the shank of the disk into the drilled hole and press the mark firmly into place. A slight rotation of the disk back-and-forth and gentle tapping with the end of the trowel handle helps settle the disk completely and evenly into the drilled recess in the bedrock. The disk is considered set when the slight back-and-forth movement stops and the disk sets firmly in place. Work excess mortar around the outer edge of the disk, making sure that it is smooth and slightly overlapping the top outside edges of the disk for security. An exposed edge of the disk would provide an area which could be used by someone or the elements to dislodge it. Fresh mortar on the upper surface of the disk can be easily cleaned off and out of any stamping.

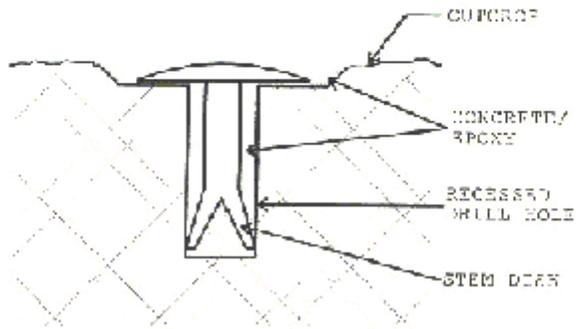
7. Sprinkle some dry cement on the exposed surface of the disk, then rub it with a clean rag or short bristled brush using circular strokes. This will clean the disk very nicely, removing all excess mortar from its surface and recessed letters. Rubbing the wet mortar around the edge of the disk in the same manner is done intentionally to finish its surface and help prevent cracking. Brush away loose cement and make sure that the finished product has a neat appearance.

8. While the mortar is still wet, it must be covered to prevent heavy rains or other foreign debris from ruining its surface and to conceal the disk from people who might tamper with it. A piece of wood, cardboard, heavy paper, or similar biodegradable item will suffice.

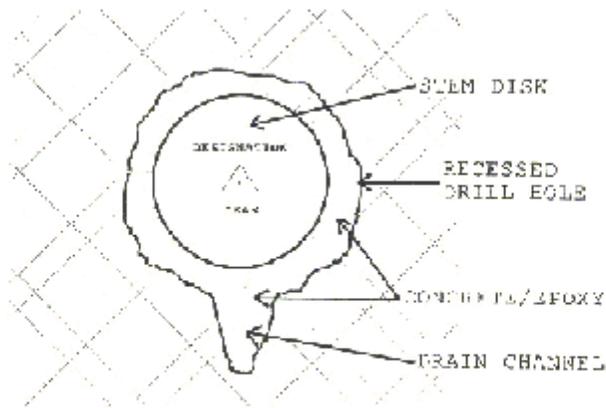
9. The installation is complete when all accumulated trash has been picked up. Leave the site clean and in good order.

Highway grade epoxy may be used in place of cement if it meets ultraviolet standards and will hold up to all weather conditions. The setting procedures are similar to those described previously except that the drilled hole, though needing to be extremely clean, cannot be wet.

DISK IN OUTCROP



SIDE VIEW



TOP VIEW

DISK IN OUTCROP

ATTACHMENT 9
SETTING A NGS 3-D MONUMENT

TO
GENERAL GUIDANCE AND SPECIFICATIONS FOR
AERONAUTICAL SURVEYS VOLUME A

FEDERAL AVIATION ADMINISTRATION
AIRPORT SURVEYS

Attachment 9

Setting a NGS 3-D Monument

Based on “Revised NGS 3-Dimensional (3-D) Rod Mark” [Draft Version] by:

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National Geodetic Survey

July, 1996

Disclaimer:

This document is intended only for the purpose of providing the user with guidelines for planning and implementation of this style of survey monument. The distribution of this document or the mention of a commercial company or product contained herein does not constitute, in any way, an endorsement by the National Geodetic Survey (NGS).

Introduction:

The extensive use and accuracies achieved by the Global Positioning System (GPS) for geodetic surveying applications have highlighted the need for increased stability in survey control point monumentation. Repeatability of accurate positions obtained through the GPS require that geodetic monuments reflect this accuracy with properties of permanence and stability both horizontally and vertically.

Factors affecting the stability of survey monuments include frost heave action, changes in ground water levels and local settlement. Consult soil and geotechnical specialists about local ground conditions. Manuals, such as NOAA Manual NOS NGS 1, Geodetic Bench Marks, document soil types and frost penetration zones nationwide.

The recommended survey marker that produces stability for most conditions is the three-dimensional (3-D) drivable survey monument. The principal component of this monument is a 9/16-inch stainless steel rod driven into the ground, utilizing a gasoline powered reciprocating hammer, until refusal or a reduced driving rate has been achieved. The rounded top of the rod is the survey datum point. The upper 3 feet of the rod is encased in a 1-inch greased filled plastic extruded fin sleeve that is held horizontally stable by back-filled, washed sand. Effects of up and down ground movement during freeze/thaw or wet/dry conditions are removed from the anchored rod by the grease filled sleeve promoting vertical stability. A 5 or 6-inch PVC pipe with attached standard aluminum logo cap protects and identifies the top of the monument. (See documentation in this manual for specific mark setting procedures).

References:

NOAA Manual NOS NGS 1. Geodetic Bench Marks, by Floyd, Richard P., September 1978.

Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques, by Federal Geodetic Control Committee, August 1989.

A. Recommended Equipment for Setting Monuments:

Rod Drivers and Accessories:

- 1- Any driver with a minimum impact force of 25 foot pounds per blow, such as Wacker Model BHB 25 (with tool kit) or Pionjar Model 120 (with tool kit), for driving stainless steel rods.
- 1- Rod Driving Insert, holds machine on rod and acts as impact point while driving rods.
- 1- Shovel Bit, for machine to help start and dig holes, not required but may be helpful.
- 1- Pint, Required Oil Type and Calibrated Container, for determining gas/oil mix.
- 1- Gas Containers and Gasoline, for driving machine and generator.

Digging the Hole:

- 1- Post Hole Digger, capable of digging a hole 4-feet deep.
- 1- Gas Powered post Hole Digger with Augurs, not required but increases productivity.
- 1- Digging Bar, for rocks and hard to dig holes.

Driving the Rod:

- 1- 2 lb. Hammer, to start rods, stamp designations, etc.
- 2- 8" Quality Pipe Wrenches (i.e. Rigid), for attaching lengths of stainless steel rods.
- 1- Bottle, Loctite, for cementing threads into the ss rods.

Finishing the Rod:

- 1- Hack Saw with extra Quality Blades, for cutting stainless steel rod.
- 1- 4" or 5" Grinder (electric or battery powered), for finishing top of rod.
- 1- Gas Powered Electric Generator, to power grinder and or drill.
- 2- Sanding Disks (medium grade), for grinder.
- 1- Steel File(s), for fine finishing top of rod.
- 1- Centering Sleeve, to help center punch mark on top of rod.
- 1- Center Punch, to punch plumbing point on top center of rod.
- Assorted Sand Paper or Sanding Pad, for fine finish to top of rod.

Finishing the Monument:

- 1- 1/4-inch Stamping Set, for lettering and numbering station designation/date.
- 1- Hand Saw, for cutting 5 or 6-inch PVC pipe.
- 1-Bucket or Wheel Barrel, to mix cement/move unwanted dirt.
- 2- 5-Gallon Water containers and Water, to mix cement and clean equipment.
- 1- Hoe, to mix cement, can be replaced by ASharp Shooter Shovel.@
- 1- Heavy Rubber Mallet, to help lower logo cap/5-inch PVC into cement.
- 1- Cement Finishing Trowel, to smooth top of concrete for neat appearance.
- 1- Stiff Vegetable Type Brush, to clean logo cap and hinges.

Assorted Accessories:

1- Tool Box with regular assortment of tools, for incidental repairs: slotted and Phillips Head Screw-Drivers, Pliers, needle Nose Pliers, Wire Cutters, Assorted Wrenches, Sockets, Allen Wrenches, Wire Brush.

1- Round Nose Shovel, to help dig hole and move unwanted dirt.

1- Tile Spade (A Sharp Shooter Shovel @), to help dig hole and mix cement.

1- Roll Black Tar Paper (Felt Paper), for making a round form for top of monument.

1- 30 Meter Tape Measure, for distances in station description.

Leather or Cotton Gloves, Assorted Rags or Paper Towels.

B. Materials Required for Each Mark:

Lengths of 9/16-inch Stainless Steel Rods, 4-foot sections.

1- 4 to 5-inch piece of Stainless Steel Rod, used as impact point and protection while driving rods.

Adequate supply of 3/8-inch Threaded Stainless Steel Studs.

1- Steel Spiral (fluted) Rod Entry Point, standard order.

1- Aluminum logo Cap, standard order.

1- Schedule 40 PVC Pipe, 5 or 6-inch diameter, 24-inch length.

1- Plastic Extruded Fin sleeve, 1-inch diameter, 3-feet minimum length.

2- Plastic end Cap Alignment Bushings, center drilled to 9/16-inch (for extruded fin sleeve).

1- Pint, PVC cement, can be replaced with adequate Epoxy type.

1- Pint, PVC Cleaning Solvent, when using PVC cement.

1- 17 ounce tube, Non-Toxic, Food Grade Grease, with Applicator (i.e. grease gun).

Ready Mix Concrete (Amount depends on width and depth of hole).

2- Pounds, Portland Cement, added to enhance integrity of ready mix concrete if necessary.

0.5- Cubic feet, Washed Sand, fills bottom of hole and inside of PVC pipe around grease sleeve.

C. Setting Procedures:

1. Ensure the monument site selection has been discussed with airport management and/or property owners, and the location meets all station siting requirements. Inquire about future construction which may affect mark longevity.

2. Contact "MISS UTILITY" type services to inquire about underground utilities before digging or driving rod.

3. The time required to set an average mark using the following procedures and referencing the diagram on the following page is 2 to 3 hours. Several steps, such as steps 4, 5, and 7, can and should be accomplished at a maintenance shop.

4. Stamp station designation and year of establishment into the blank area on the collar of the logo cap.

5. Cut a 20-inch section of 5 or 6-inch PVC pipe. Ensure the end that will receive the logo cap is cut true and is clean. Using primer and solvent cement formulated specifically for PVC, glue the stamped aluminum logo cap to the end of the 20-inch PVC section. If this step is performed on site, allow time for the glue to set by digging the hole and driving the rod after preparing the PVC and logo cap.

6. Using a power auger or post hole digger, drill or dig a round hole in the ground 12 to 14-inches in diameter, and 22 inches deep. Extend the center of the bottom of the hole by drilling or digging a 3 to 6-inch diameter hole an additional 21 inches for a total depth of 43 inches. This extended area will be back-filled with washed sand around grease sleeve.

7. Glue both plastic end cap alignment bushings on a 3-foot section of the plastic extruded fin sleeve. Let glued ends dry completely. Pump food grade grease into capped sleeve until 3/4 full allowing for displacement by rod and completing the grease filled sleeve.

8. Using a standard 3/8-inch threaded stud coated with loctite (Use Loctite on all *permanent* connections), attach two 4-foot sections of stainless steel rods together. At one end of the length of rod, attach a standard spiral (fluted) rod entry point with a 3/8-inch threaded stud. On the opposite end, attach a short 4 to 5-inch piece of rod with a 3/8-inch threaded stud. Tighten all connections using two pipe wrenches a good 1/4 to 3/4 turn past the point of contact of all rod ends except the impact point which will be continually removed. This tightening requires a certain “feel” and ensures that the rod ends are seated together with greatest possible tension yet not to the point of breaking a stud. Rods tightened in this fashion should not vibrate loose when they are driven into the ground.

9. The 8-foot long connected rod is centered into the bottom of the hole and driven with a 2-pound hammer until rod is secure and as plumb as possible. A 2x4 with a 1/2" hole can be centered and braced over the hole to help guide the rod straight into the ground. Drive the section of rod to about the top of the hole with a gas powered reciprocating driver such as Whacker model BHB 25, Pionjar model 120, or another machine with an equivalent driving force.

10. Remove the short piece of rod (impact point) leaving the threaded stud in section of rod in the ground. Attach another 4-foot section of rod and, using a new threaded stud, thread on the impact point. This “cycling” of a new stud from impact point into top of rods in ground insures unweakened studs at all connections. Remember to coat threads on the permanent connections with loctite. Tighten securely utilizing pipe wrenches as described above in step 9. Always tighten rods maintaining a clockwise pressure to avoid loosening rods already in the ground. Drive the new length of rod into the ground with the reciprocating driver.

11. Repeat step 10 until the rod refuses to drive further (anchored), or until a driving rate of 60 seconds per foot is achieved. In the event that the rod will not sufficiently slow down to meet desired driving rate, terminate upon reaching 90 feet (22.5 rods). This will leave about 2 feet of rod out of the hole. If possible, let the rod set overnight, then drive the remaining 2 feet of rod to determine whether driving rate has reduced. If rod feels secure in ground, use this depth even though minimum driving rate of 60 seconds per foot has not been met. If the rod turns freely in clockwise direction, contact NGS for a decision to drive additional rods. Sometimes, all that is necessary to achieve a well anchored rod is driving it a few more feet. In other instances and additional hundred feet may be required. Indicate in the written station description the depth of rod, and whether it was driven to refusal or met the slow driving rate. Also include a description of any unusual mark setting circumstances.

12. When refusal or prescribed driving rate is reached, cut off the rod with a hacksaw or comparable tool, always removing at least the tapped and threaded portion, leaving the top of rod about 3 inches below ground surface. Shape the top of the rod to a smooth, hemispherical surface using a portable grinding machine using a grinding attachment or sanding wheels, files, and sand paper to produce a nicely finished, rounded surface. Ragged edges or grinding marks are not acceptable on top of the finished rod.

13. The datum point must then be created by center punching a dimple on top of the rod to provide a plumbing (centering) point. Place the centering sleeve over the top of the rounded rod to facilitate locating the exact center of the rod. Punch a substantial dimple, 1/16-inch deep, into the top of the rod using a punch and hammer or spring loaded center punch. Several blows may be needed to create a sufficient dimple. Remember, this is the actual survey point, so don't hesitate to spend a few extra minutes to produce a professional, finished product.

14. Insert the grease filled sleeve, produced in step 7, over the rod with the unfilled portion at the top. Upper end of sleeve will fill as rod displaces grease from the bottom. The datum point on top of rod should protrude through top of the sleeve about 3-inches with sleeve extending to the bottom of the hole. Clean the residual grease off the exposed top of the rod.

15. Back-fill and pack with washed sand the bottom 23 or more inches of the hole around the outside of grease sleeve. This fills the bottom of the hole and helps stabilize the sleeve.

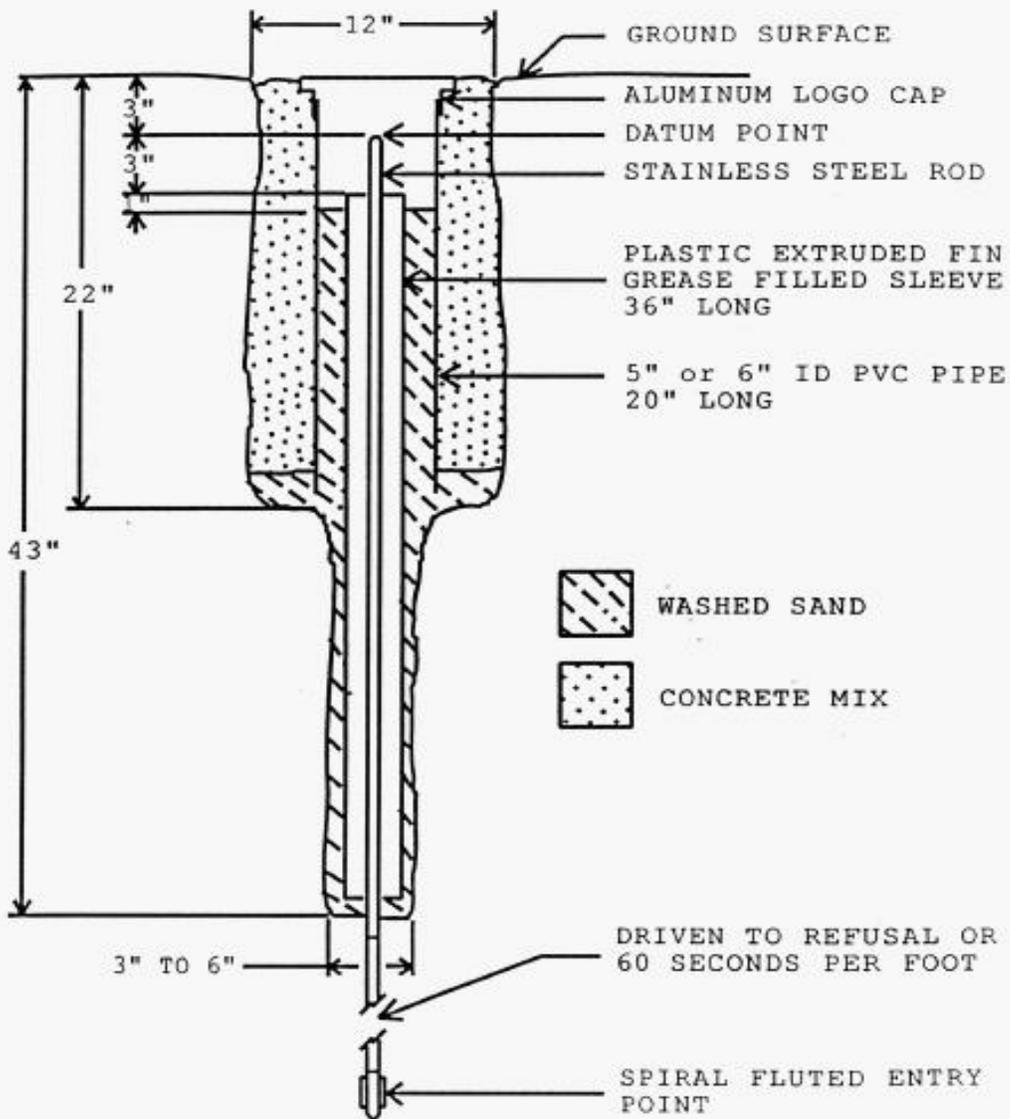
16. Place the 5 or 6-inch PVC pipe and logo cap over and around the grease sleeve and rod in the center of the hole. The bottom of the PVC pipe should extend into the top of the sand in the bottom of the hole. Leave the top of the logo cap and PVC pipe slightly higher than the top of the ground surface until the concrete is in place. Back-fill the center of the PVC pipe with washed sand around and to within 1-inch from the top of the grease filled sleeve. The rod should be centered in the PVC pipe.

17. Mix concrete in a bucket or wheel barrel to pasty, well moistened consistency like mashed potatoes. Add Portland cement, if necessary, in sufficient quantity (1 to 2 pounds) to enhance concrete mix or dry an over moistened mixture to maintain adequate consistency. A good indication of adequate consistency is that the mix neither runs nor falls off the shovel but sluggishly slides off and flattens upon hitting the ground. Pour concrete into the hole around logo cap and PVC pipe casing filling to slightly below the ground surface. To avoid frost heaving of the PVC collar, a round form should be used to ensure the outside walls of the concrete are vertical, and do not produce a [mushroom] shaped wedge at the top of the mark. Open the logo cap and grasp the PVC pipe then shake to settle concrete around the pipe to fill voids. Add concrete to within 1/2-inch of the ground surface.

18. Trowel smooth the top of concrete to a fairly finished surface. Tap alternate edges of the logo cap, using a rubber mallet or hammer and wooden block, lowering it and attached PVC pipe into surface of concrete. Finish the top of the concrete by troweling a smooth, finished surface, round in appearance, and sloped slightly outward to aid drainage of rain water.

19. Add sand to the inside of the PVC pipe to bring its level to within 1-inch of the top of the grease sleeve. Clean any overlapping concrete from the surface of the logo cap using the vegetable brush. The finished height of logo cap and access cover should be slightly lower than the surface of the ground. The logo cap should be approximately in the center of the top of the concrete. Datum point should be about 3-inches below the cover of the logo cap and centered in the 5 or 6-inch PVC pipe. The top of the grease filled sleeve should be about 3-inches below the datum point and the washed sand 1-inch below top of the sleeve. Clean any cement that may have gotten onto the exposed rod or datum point.

20. Clean all equipment and remove all debris such as extra cement, excess dirt, and trash, leaving the area in the condition it was found.



Schematic of the Revised NGS 3-D Rod Mark, Side View