AERIAL SNOW DEPTH MARKER CONFIGURATION AND INSTALLATION CONSIDERATIONS

By Robert W. Miller

An aerial snow depth marker is a vertical post with horizontal crossarms at known intervals.

This over-simplified definition has been taken literally by too many people in too many places. In California, for instance, aerial markers range from 10 to 24 feet in height; they are constructed of various types of wood and metal; crossarms are of various lengths; and crossarm widths or heights range from 3 to 12 inches. This was somewhat to be expected, however, since Tommy Henderson of the California Electric Power Company and the people of other agencies who started the early marker programs in California were experimenting with a system for their particular watershed and use--and at that time there were no established precedents to follow. It should be noted, however, that the three earliest programs in California--which were started by The California Electric Power Company, The Southern California Edison Company, and the City of Los Angeles--were essentially coordinated with each other. The first major conflict in configuration did not occur until the state made its first installation.

Although numerous mistakes were made, it was these early programs by the state and the above-mentioned agencies that enabled us to acquire a number of ideas about how markers should be designed, constructed, and located. Probably the greatest contribution to this field of knowledge, which was acquired on a trial and error basis, was made by the state--because the state, with its installations, made the most errors.

There are a number of points with respect to marker design and installation that are not apparent until the mistakes are made--and usually you don't learn about these mistakes until the following winter when you take your first pictures. It is then that you realize that (1) the men that you sent to install the marker must never have been in an airplane; (2) you don't know whether it is two feet to the top or the bottom or the center of the first crossarm; (3) you don't know how many crossarms there are; (4) the crossarms are oriented the wrong way and you can't read them; (5) the marker has been blown down; (6) you can't find it; (7) etc., etc.

Realizing that many of these problems are very real, and sometimes not very apparent, we felt that by passing on the results of our experiences, we might be of some help to those of you who may be just starting marker programs. What I have to say about marker design and installation is with reference to California conditions. Only you can judge whether a particular design or installation factor is applicable to your area and your problems.

First, let us consider design and fabrication. One thing that we learned the hard way is that wood is not a suitable material for marker construction. Wooden markers are not strong enough--wind and sliding or settling snow tends to break off crossarms or to take down the entire marker, and campers have been known to even use the crossarms for firewood. A further consideration is the fact that, with the expense usually involved in locating and installing a marker, it is poor economy to choose a short-lived, wooden marker buried in the ground, as against a neat, durable metal marker set in concrete.

Having decided to construct the marker of metal, the following are thought to be important considerations with regard to the metal marker construction. Pipe seems to be the most suitable material for the vertical member, and it is readily available in various diameters. Crossarms, too, should be of metal, and 1/8-inch steel plate seems to be quite suitable.

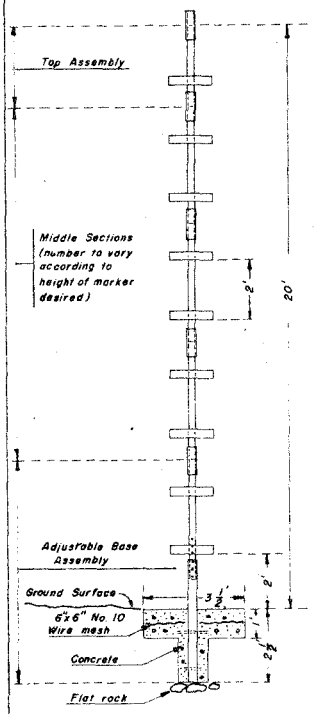
A copy of the plans of our standard marker is included in this paper. Several points regarding design features of these plans are worth mentioning. The markers are constructed in sections for ease of transportation, and by varying the number of middle sections, markers of 14-, 18-, or 22-foot heights may be obtained. The pipe sizes for the telescoping base and the coupling, and for the main parts of the marker, were chosen in the seemingly large sizes because they were the only standard pipe sizes which provided a relatively slack-free fit.

Our latest plans include an adjustable base assembly which we feel is well worth while. The 15-inch base adjustment which is possible with this design makes installation much simpler in such extremes as bedrock near the ground surface or in loose sand to a depth of about three feet. Couplings are always welded at the bottom end of a section with the weld at the top of the coupling, and the coupling is then bolted to the top end of the section below. Thus, the joints are not the water traps they would be *if* the open, bolted end were pointed up.

In general, an attempt was made to balance minimum cross-sectional area exposed to wind and drifting snow against visibility and other factors. Although blades four inches wide are adequate from a visibility standpoint, the 6-inch crossarms at 2-foot intervals provide a convenient 1:4 ratio, which is useful for estimating depths between crossarms. Crossarm lengths of 18 inches are adequate for visibility and provide a minimum cross-sectional area exposed to the wind and drifting snow.

21 Chief, Snow Surveys and Water Supply Forecast Unit, California Department of Water Resources

AERIAL SNOW MARKER WITH BASE INSTALLATION



Note: Pipe manufacturing tolerances vary greatly. Therefore, all pipe must be checked at time of purchase and those lengths selected which will allow insertion of the 2½" into the 3" pipe. (It is not necessary that complete lengths of 2½" pipe fit into the 3" size -- but sizes must be such that 12" couplings and 18" of the base section fit the 2½" pipe with a minimum of sizing operations.)

Remove all burrs and correct any other deformations caused by fabrication operations. Shop test for fit and make necessary corrections to satisfy interchangeability.

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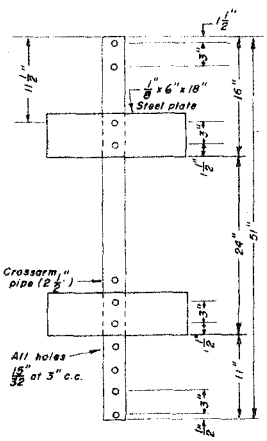
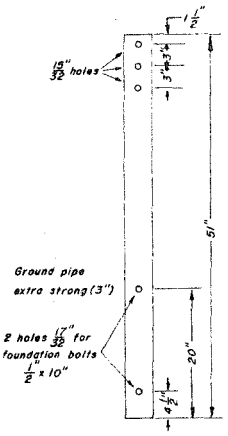
AERIAL SNOW MARKER

SCALE 1"= 3'

Sheet 1 of 4 Sheets





ADJUSTABLE BASE ASSEMBLY MATERIALS

Quan.	Description
1	51"x2½" Std. galv. I. P. (I.D. 2.469", O.D. 2.875")
1	51"x3" Extra strong galv. I.P. (I.D. 2.900", O.D. 3.500")
2	6"x18"x⅛" Steel plate
7	4½"x⅜" Hex. head bolt, 1 washer, 1 lock washer
2	10"x½" Foundation bolt

NOTES:

1. Ream end of 3" pipe deep enough to ease fit.
2. Prime and paint crossarms a bright orange.

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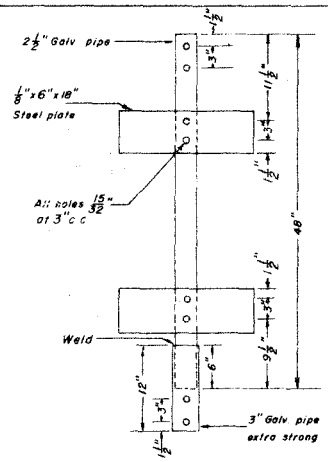
AERIAL SNOW MARKER

SCALE 1"= 1'

Sheet 2 of 4 Sheets



MIDDLE SECTIONS

MATERIALS

Quan.	Description
1	48"x2½" std. G.I.P. (I.D. 2.469", O.D. 2.875")
1	12"x3" Extra strong G.I.P. (I.D. 2.300", O.D. 3.500")
2	6"x18"x⅛" steel plate
6	4½"x⅜" Hex. head bolt, 2 washers, 1 lock washer

NOTES:

1. Ream ends of 3" pipe deep enough to ease fit.
2. Prime and paint crossarms a bright orange.

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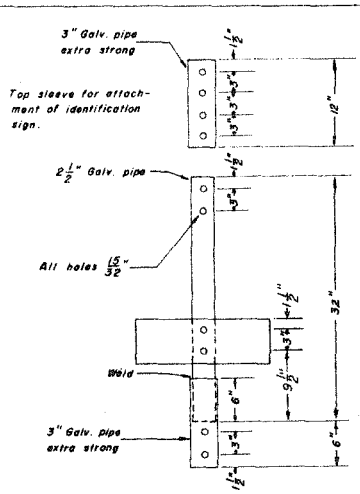
AERIAL SNOW MARKER

SCALE 1"= 1'

Sheet 3 of 4 Sheets



TOP ASSEMBLY

MATERIALS

Quan.	Description
1	32"x2½" Std. G.I.P. (I.D. 2.469", O.D. 2.875")
2	12"x3" Extra strong G.I.P. (I.D. 2.900", O.D. 3.500")
2	6"x18"x⅛" Steel plate
8	4½"x⅜" Hex. head bolt, 2 washers, 1 lock washer

NOTES:

1. Ream ends of 3" pipe deep enough to ease fit.
2. Prime and paint crossarms a bright orange

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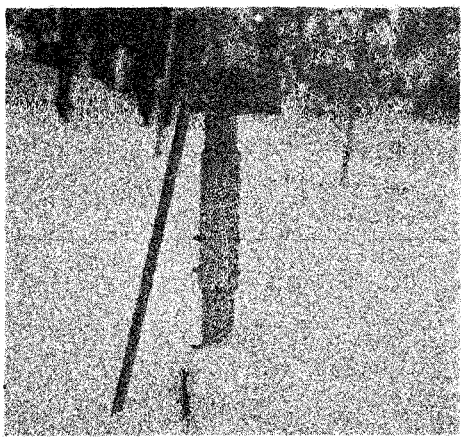
AERIAL SNOW MARKER

SCALE 1"= 1'

Sheet 4 of 4 Sheets



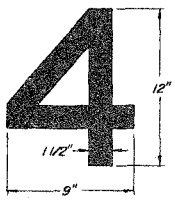
DRIFTING

MELTING

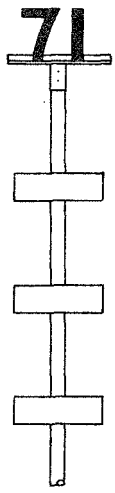
CALIFORNIA COOPERATIVE SNOW SURVEYS

AERIAL SNOW DEPTH MARKER IDENTIFICATION NUMBERS

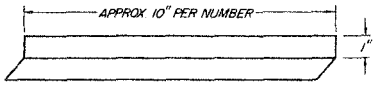
1234567890

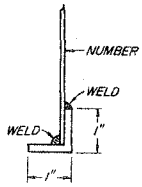


NUMBERS TO BE CUT FROM 1/8" STEEL PLATE AND EDGES FINISHED SMOOTH



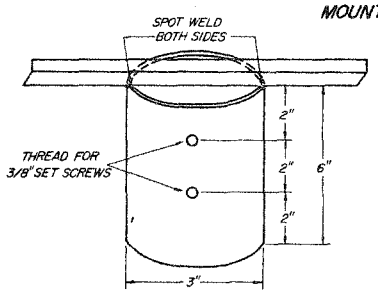
MOUNTING BAR





NUMBERS TO BE FILLET WELDED TO ANGLE IRON. SPACING WILL BE APPROX. 2" BETWEEN NUMBERS

MOUNTING SLEEVE



MOUNTING SLEEVE TO BE OF 3" DIAMETER EXTRA STRENGTH PIPE

NOTE: Numbers, mounting bar and mounting sleeve to be completely shop assembled and painted black. Provide two 1" x 3/8" square head set screws.

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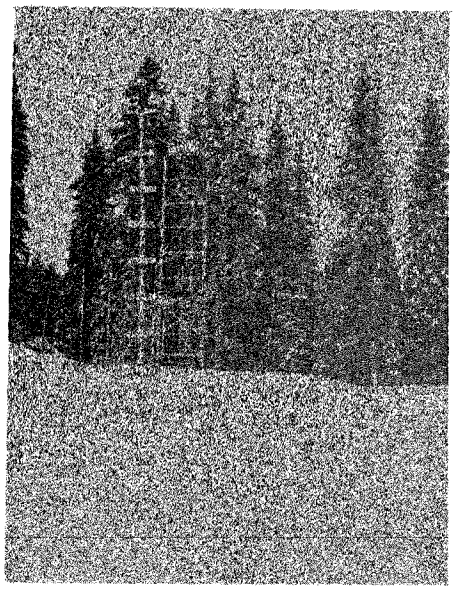
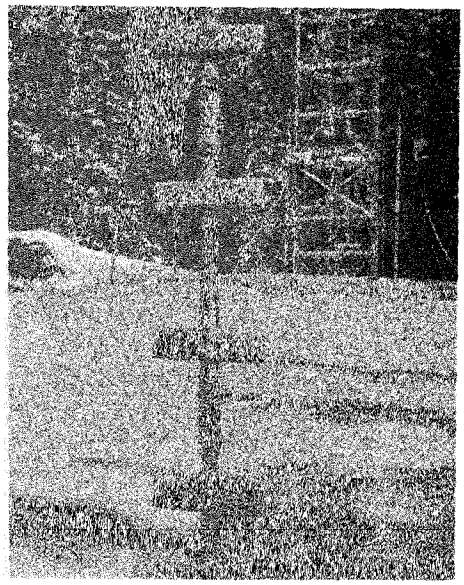
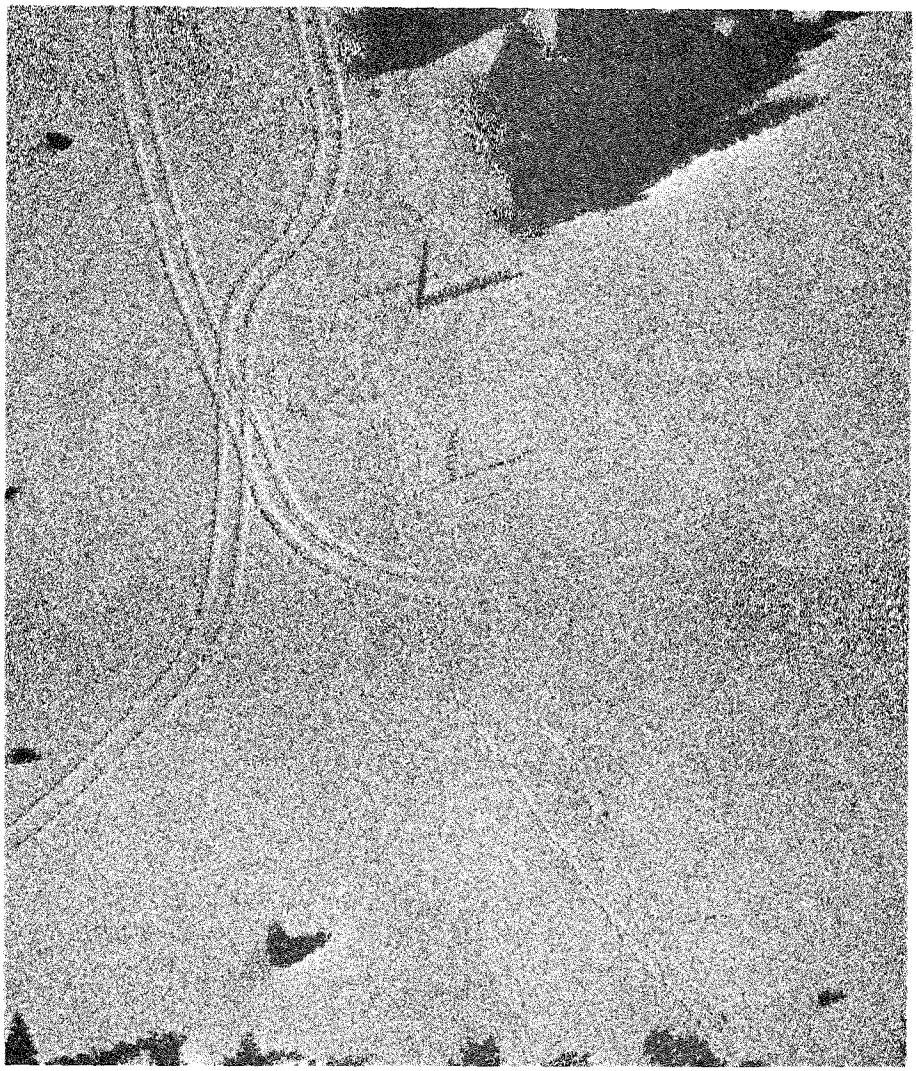


ACCUMULATION



ACCUMULATION



AERIAL VIEW

In the fall of 1960, four test aerial markers of this type were installed at the Central Sierra Snow Laboratory, where they would be under continual surveillance by the personnel of the Pacific Southwest Forest and Range Experiment Station. Ground observations and photographs of these markers were taken daily for a period which covered conditions of snow accumulation, drifting, freezing, and melt. (See illustrations following marker plans.)

These test installations and the observations confirmed our opinion that minimum cross-sectional area is desired to minimize drifting and to cause the least interference with settling and normal melting of the pack. The simplest possible crossarm configuration (single horizontal blades only) seems also to be desirable from the point of view of intercepting the least amount of falling snow. The single thin metal blade also clears more quickly when it has collected snow, ice, frost, etc.

One item which we were interested in checking at the snow laboratory was the matter of color for the marker. We felt that yellow, red, or orange paint (and particularly the fluorescent type) would increase visibility enough to be well worth the trouble and expense. It is, when you look at it from the ground, but from the air, except under ideal lighting and exposure conditions, black is just about as good. Black, incidentally, is much more acceptable to the forest service for wilderness area installations. One possible exception to the general practice of painting the marker black would be in an area with an abundance of dead snags. In this situation, yellow or orange might make close-range spotting and identification easier.

As the number of installed markers increases, it becomes apparent that some positive means of marker identification is necessary. It is desirable to have an identification system from the very beginning of any aerial marker program. As the number of markers increases, it becomes more and more important, and, eventually, imperative. We have been considering and experimenting with various imaginative, complicated, weird, and ingenious systems for several years. We now feel that a simple numbering system, using thin metal cutout numbers, is the most positive and practical method. In California, our courses are numbered from 1 to (currently) 352. If the marker is on a course, the marker number will correspond to the course number. In the case of markers not on established snow courses, one logical way to identify them is to reserve a series of numbers (500-700). These marker numbers (where no snow course is involved) may be assigned either arbitrarily or on the basis of some system. The numbers themselves are cut from 1/8 inch or 3/32 inch steel plate and welded by their base to a length of angle iron. The angle iron and number assembly is then welded in a horizontal position to a vertical sleeve, which is bolted or attached with set-screws to the top of the marker. (See identification number plans and illustration of installed marker.) Orientation of the identification number is the same as the marker crossarms. Instinctively, we realized that if the numerals comprising the identification piece on top of the marker were tipped about 30 degrees from the vertical, it would be easier to read. As if typical of many intuitive conclusions, this was wrong. The vertical numbers are just about as easy to read as the slanted numerals from even the most favorable angle for the latter. In addition, the slanted numerals have a blind spot when observed from the air, and if improperly oriented, they have a blind spot in their shadow.

A few points should be mentioned about locating the marker. Since a good installation will last for years without maintenance, every effort should be made to get a good location with good orientation. First, you should be able to fly an airplane reasonably close to the marker on a more or less routine pass. The approach should be simple and enable the pilot to get in and down to the marker without gaining excessive speed--and even more important, there should be some place to go after you have the picture and/or visual observation. Markers should not be located by ground crews with accessibility from trails as a determining factor. Probably the best method is to use aerial reconnaissance as the first step, with the selected location and blade orientation plotted on an aerial photograph. The crew which makes the subsequent ground installation should include at least one person who saw the site from the air. One significant factor in locating a marker from the air is a good shadow. Unless the flight pattern makes it impractical, blade orientation should generally be ENE by WSW.

Earlier in this paper, I mentioned California Electric Power Company, The Southern California Edison Company, and the City of Los Angeles, as having been the key agencies in starting aerial marker programs in California. These first programs were followed, in addition to the markers installed by the State, with installations by the Corps of Engineers, The Pacific Gas and Electric Company, and The East Bay Municipal Utility District. All of these agencies have contributed a great deal to our general fund of aerial marker knowledge. I would like particularly to acknowledge the work of Glenn Castle of the Corps of Engineers. Mr. Castle usually flys and photographs the State markers, and has contributed a great deal to the thoughts that I have expressed here.

Our aerial marker programs are continually expanding, and I feel this fact leads to the logical summarizing statement: "In California, we see a great future for these vertical posts with horizontal crossarms at known intervals."