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Circular No. 91 - Establishing Snow Courses and Making Snow Surveys

George D. Clyde

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Establishing Snow Courses and Making Snow Surveys

George D. Clyde


Utah Agricultural Experiment Station
Utah State Agricultural College

LOGAN, UTAH
Establishing Snow Courses and Making Snow Surveys

George D. Clyde

INTRODUCTION

The major portion of the annual precipitation in the semi-arid west falls as snow. It piles up in the mountains and forms the main source of the water in the creeks and rivers draining the mountainous areas. Some of these streams flow the year around while others and intermittent, flowing only as long as the snow in the mountains lasts. The water-supply for irrigation, power development, and municipal purposes is derived largely from winter snows. A knowledge of the extent of the snow cover and its water content is, therefore, necessary for the proper utilization of this great natural resource. Forecasts of reasonable accuracy are of major importance for proper distribution of water-supplies and in flood protection.

Measurement of the accumulated snowfall at the end of the precipitation season furnishes an important index as to the probable water-supply to be derived from the snow cover. A system of snow surveying has been developed by which it is possible to measure the depth and water content of the snow cover at the end of the precipitation season. Snow surveys are now being made on the principal watersheds of Utah, California, and Nevada, as well as in parts of Idaho, Oregon, and Washington. These surveys form the basis of water-supply forecasts which are made annually at the beginning of the runoff period.

DEFINITIONS

Snow Course.—A snow course is defined as a permanently established line or series of lines over which measurements of depth and water content of the snow cover are made. Observations are made each year at fixed distances from a fixed initial starting point. The line may be straight or it may consist of a series of straight lines.

Water Content.—Water content is recorded in inches depth and is the water equivalent of the snow cover.

Snow Tube.—A light cylindrical metal tube calibrated in inches and used to sample the snow cover.

Cutter.—A short cylindrical saw-toothed steel cutting edge, the lower one-half of which is tapered from the sharp edge up to a shoulder of larger outside diameter than the snow tube. The upper one-half of the cutter is inserted in and soldered to the bottom of the snow tube. The inside diameter of the cutter is smaller than the inside diameter of the tube. The cutter cuts out the snow core to the desired diameter.

Core.—The cylindrical snow column taken out by the snow tube and cutter.

Scale.—Spring balances for weighing the core of snow cut out by the snow cutter and tube.

Slots.—Openings cut in the snow tube to enable the observer to check the height of the snow core.
Sampler.—The snow tube and cutter.
Density.—Ratio of the water equivalent of the snow core in inches depth to the depth of the snow.

SELECTION AND ESTABLISHMENT OF THE SNOW COURSES

At best, snow surveying is difficult and hazardous. Travel between courses is made on snowshoes or skis, often under extremely trying circumstances. When locating a snow course it is desirable, therefore, to keep in mind, along with the other requirements, its accessibility. Other conditions being equal, the greater the accessibility the more accurate and more continuous the record over a long period of time.

Location.—The prime requisite is a site having a uniform snow cover and which is fairly well protected from drifting winds. Such a site can usually be found in a sheltered meadow or sparsely timbered flat. Comparatively level open forests, parks, or closed basins furnish the most desirable locations. The course should be as free as possible from large irregularities, steep slopes, boulders, fallen trees, meandering streams, logs, brush, and snow slides. If a ridge location is necessary the course should extend down both sides of the ridge. The elevation of the course should be such that there is no material melting of the snow during the winter. For most Utah watersheds, the minimum elevation is about 8000 feet.

Figure 1. — An ideal location for snow courses. A protected area in the vicinity of Tony Grove Lake, Logan River Watershed.

Figure 1 shows the location of the snow course at Tony Grove Lake (elevation 8200 feet) and Figure 2 shows the Mt. Logan snow course (elevation 8700 feet). The location should be of sufficient area to accommodate a reasonably long course. Where rough and steep topography is unavoidable, old logging trails or roads are fairly satisfactory, provided they are not used after the first snow falls. Above all, only that course which is most representative of the snow cover conditions in the vicinity should be selected. If the course is located when the ground is covered with snow, an examination after the snow has melted may indicate need for a
Establishing Snow Courses and Making Snow Surveys

change of observation points or a shifting of the course. Before a course location is definitely fixed it should be examined both in winter and in summer. If the course selected does not prove to be representative of the snow cover it will be necessary to relocate it.

Length.—In general, the length of the course should not be less than 500 feet nor more than 5000 feet long. Where possible a short cross course at right angles to the main course is desirable. The topography, vegetal cover, and ground conditions will usually govern the length of the course. The course need not be straight but can angle in any direction to avoid obstructions on other difficulties. For courses 500 to 1000 feet long observations should be made every 25 feet; for courses from 1000 to 2000 feet long observations every 50 feet; and for courses over 2000 feet long observations at 100 feet should be made. This rule should not be considered fixed but should be modified to best suit the local conditions. The points of observation should be located by tape measurement from the initial starting point or from fixed markers along the line. It is highly important that the observations be made at the same point each year. The courses and cross-sections should be definitely marked with tin markers fastened to trees or posts placed at angle points. These markers should be placed high enough to be above the deepest snow. The markers should be located so that at least two of them are visible from any point on that course. A marker which has proved satisfactory in the Washington snow surveys consists of a 2-inch pipe set in concrete with a red tin sign bolted to the top.

Observation Points.—These points are located each year by measuring with a tape the proper distance from the initial point or from an angle point. The measuring should be done with sufficient accuracy that the sample may be taken within 2 feet of the same point every year. After the sampling stations have been located, the ground within a radius of 3 feet of each point should be cleared of underbrush, loose rocks, logs, etc.
Description of Courses.—After a course has been located it should be described as fully as possible. The description should include the permanent name, the U. S. Geological Survey quadrangle sheet or the Forest Service map on which it is located with the course indicated on the map, and a detailed sketch showing the

![Map showing Franklin Basin Snow Survey Course](image-url)
Establishing Snow Courses and Making Snow Surveys

field location with ties to blazed trees, posts, or any other permanent objects. The elevation and the bearings of the courses should be given. The sketch of the course should show the observation points, the distance from the initial point to

Fig. 4.—Sketch map of Franklin Basin snow course showing detailed locations of points of observation.

the first observation point and the distance between observation points. Figure 3 shows the general location of the Franklin Basin snow course and Figure 4 shows the detailed location of the points of observation.
SNOW SURVEYING EQUIPMENT

The object of a snow survey is to determine the average depth and water content of the snow cover over representative courses. Snow courses are laid out as described above, over which measurements of depth and water content are made. The depth of the snow cover can be determined by thrusting a calibrated rod through the snow to the ground and reading off the depth. The determination of the water content is not so easy. The water content can be obtained, however, either by cutting out a core of snow of known volume and melting it or by weighing it. The former was the first method used, but due to the bulky equipment required and the time necessary to secure a measurement it has now been abandoned in favor of the weight method. If the volume and weight of a core is known it can be readily converted into its water equivalent. For example: A cylinder of water 1.485 inches in diameter and 1 inch long will weigh 1 ounce; therefore, if a core of snow 1.485 inches in diameter weighs 10 ounces, the water equivalent of that snow core is 10 inches depth. There are three types of equipment now in use for measuring the depth and water content of the snow cover all based on the principle of the weight of a known volume of snow.

The first snow sampler was designed by Horton and introduced in 1905 by Dr. Frankenfield of the U. S. Weather Bureau. Later C. F. Marvin designed a sampler consisting of a cutter made from a piece of steel tubing with teeth cut in its lower edge. The inside diameter of the cutter was 2.65 inches. The cutter was fastened to the main tube which consisted of 4 feet of tinner's spout.

In 1908 J. E. Church, Jr., of the University of Nevada, developed the Mt. Rose sampler and scales. The Mt. Rose sampler consists of a 1.75-inch outside diameter seamless drawn steel tube of the desired length with alternate slots 1-16 inch wide cut throughout its entire length. The purpose of these slots is to permit checking the length of the core and to facilitate cleaning the tube. Inserted in the lower end of the tube is a special milled steel cutter whose inside diameter is 1.5 inches. The tube is graduated on the outside in inches. The scales on which this tube is weighed are also especially calibrated to fit this tube. Each division on the scale represents 1 inch depth of water. This scale is so constructed that the pointer may be set at zero with the tube on the scales so that the reading of the tube and core is equal to the water equivalent of the snow cover in inches depth.

In 1915 Kadel of the U. S. Weather Bureau introduced an improved design of a snow sampler and scales. The sampler tube consists of a slotted drawn steel tube 3 inches in diameter to the end of which is fastened a special steel cylindrical shaped cutter whose inside diameter is 2.655 inches. With a cutter of this diameter one-fifth of a pound of snow is equivalent to 1 inch depth of water. The scales on which this tube is weighed are so calibrated that one-fifth pound equals one division; therefore, the weight of the tube and core minus the weight of the tube equals the water content of the snow in inches depth.

The third type is similar to the Mt. Rose sampler the only difference being that the diameter of the cutter is made 1.485 inches instead of 1.5 so that standard commercial scales accurate to 0.5 ounce may be used to weigh the core. (A cylinder of water 1.485 inches in diameter and 1 inch long weighs 1 ounce.) The standard commercial dial scale accurate to 0.5 ounce or the special tubular scale

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Clyde, G.D. A new spring balance for measuring the water content of snow. In press (Science).
Fig. 5.—Various types of snow-surveying equipment used in the Utah cooperative snow surveys.
developed by the writer at the Utah Agricultural Experiment Station may be used with this modified Mt. Rose sampler. Figure 5 shows the three different types of equipment. The Mt. Rose sampler has been adopted as standard in California, while in Utah the modified Mt. Rose sampler is most widely used.

In addition to the sampler, miscellaneous equipment needed on the survey consists of a tape for locating the observation points, an alpenstock or forked stick upon which the scales may be hung, a field book for recording notes, map, cloth for cleaning tube, sling for supporting tube on scales, hatchet, thong leather for repairs to snowshoes, barometer, thermometer, compass, and first-aid kit. A list of equipment should be made and kept in the notebook and checked before leaving each station; the omission of any item may cause considerable inconvenience when in the field.

CARE OF EQUIPMENT

Due to its lightness, snow-surveying equipment is fragile and must be handled with care.

1. In transporting the snow sampler, extreme care should be used to guard against injury; it can be easily dented or bent.

2. When climbing steep slopes sampler should not be used as alpenstock.

3. When sampling on steep slopes care should be taken not to cling to the sampler.

4. Sampler should be kept covered inside and out with a thin coating of shellac. The inside coating can be applied by pulling through a swab soaked or wet with shellac. This coating prevents rust and tends to keep snow from adhering to the tube.

5. Ice and rock sound and feel alike when struck by the sampler; therefore, care must be taken to determine the substance before forcing the cutter into it. Ice will not blunt the cutter while rock will.

6. The cutter must be kept sharp and the orifice true to its original diameter. To replace a damaged or worn cutter, the tube is heated sufficiently to melt the solder that holds the cutter and then a new cutter is sweated into place.

7. The scales must be protected. Oil should not be used. The pointers must not be jammed. The scales should be carried in a light canvas case or wrapped in the cloth used to clean the tube.

8. If the tube is dented, a steel torpedo, turned so that its maximum diameter equals the inside diameter of the tube, should be driven through the tube.

MAKING MEASUREMENTS OF DEPTH AND WATER CONTENT

Samples should be taken at observation points located by measurement from the initial point of the course. Station 1, where sample 1 is taken, is usually located a few feet from the initial point, or Station 0+00. Great care should be used to follow the regular snow course starting from the same point each year, lining up the observation points in a straight line between the angle points. Careful measurements of distance and angles are necessary in order that the samples may be taken at the proper points.

The outside of the tube is calibrated in inches between the rows of narrow slots. Before taking a sample the empty tube is weighed. In taking a sample, the tube is thrust vertically downward through the snow until the cutter comes in contact with the soil. (If the soil is soft the cutter should be pushed about 0.5 inch into it. The mud on the end of the cutter must be carefully removed before weighing; in recording the depth, that depth to which the cutter is pushed into the
mud is deducted.) In driving, a steady downward thrust is preferable to twisting; twisting allows a small amount of snow to enter the slots. However, where ice crusts are encountered, twisting is necessary to cut through. Plunging the tube is entirely unnecessary and should be avoided. If the sampler sticks a slight twist will usually release it.

With the cutter in contact with the soil a slight twist will break the snow from the ground; since the cutter is slightly smaller than the tube, the shoulder in the cutter will prevent the snow core from sliding out while the tube is being withdrawn. The depth of the snow should be recorded before the tube is withdrawn. After withdrawing the tube the length of the core through the slots in the tube is checked. The length of the core should not vary from the depth of the snow by more than 10 per cent; if the difference is greater than this, another sample should be taken.

To determine the water content of the snow core, the core is weighed by suspending the tube and core in a horizontal position in the sling attached to the scales.

The field procedure for making a measurement of depth and water content of the snow cover may be stated as follows:

1. The survey party should never consist of less than two men. On long trips a third man is necessary. More than three men in a party is of no advantage.
2. Before leaving for the field, fill in Column 1 of the field notes from the location sketch, as shown in sample notes given below.
3. Beginning at the initial point, measure the distance to the first observation point, as shown in the sketch. (Station 1 where Sample 1 is taken is usually a few feet from the beginning point or 0+00.)
4. Stick an alpenstock or a forked stick into the snow and suspend the scales therefrom.
5. Fill in completely all data called for at the top of the page of field notes. (Do not forget the date, the time of day, and the temperature and weather conditions.)
6. Weigh the tube empty and record in Column 3 of field notes.

7. Hold the tube vertically with the cutter against the snow and force downward with a steady thrust, twisting only when ice crusts are encountered. The operator can tell when the bottom is reached by the feel. Care must be used, however, when working over rocky ground since the rock and the ice feel about the same. If the bottom is soft push the cutter into the mud about 0.5 inch before withdrawing tube.

8. Record depth of snow.

9. Twist tube to break snow core loose from ground.

10. Withdraw tube by pulling vertically upward with a steady motion. Jerking will dislodge core. If tube sticks, twist it slightly backwards (to the left).

11. Check length of core. If core length varies from the depth by more than 6 inches, take another sample. 6

12. Hold tube in horizontal position and examine cutter end. If there is mud in cutter clean out carefully and record its depth. To determine true depth mud must be deducted from depth of snow.

13. Lay the tube in the sling attached to the scales, care being taken to keep it in a horizontal position so that the core will not slide out. Figure 6 shows the tube in position for weighing.

14. When the spring has come to rest with its load, shake it slightly to prevent it from sticking. Record the scale reading in Column 4.

15. To dislodge the core invert the tube and shake slightly. Hold the tube off the snow so that the core will not lodge in the end of the tube as it comes out. If the core sticks, jar the end of the tube on the framework of snow shoe or ski. If the core freezes in the tube, as is the case under certain conditions of temperature and density of snow, it may be necessary to burn a few newspapers around the cutter end of the tube has been found effective. Wipe the tube dry and take another sample. A stout string, at least twice the length of the tube with a small heavy weight attached to one end, will serve as a ramrod for cleaning the tube. Keep the tube clean. Do not allow mud to freeze on the cutter.

Best results are obtained from sampling when the temperature of the snow is about 32 degrees F. and the temperature of the air at freezing or only slightly above. Sampling is most easy and rapid when done in the morning or evening instead of during the warm part of the day. If it is impossible to get a satisfactory core record the length of core obtained in the column under "Remarks".

For forest samplings, the tube is kept in the shade to keep it cool. This will help to prevent sticking and clogging.

In Utah at present (1930) there are three different scales being used to weigh the snow samples. These are all spring scales and differ only in their calibration.

The diameter of the cutter in the Utah snow tube is 1.485 inches, or such that 1 inch depth of water weighs 1 ounce. This calibration permits the use of any standard commercial scale accurate to 0.5 ounce to be used to determine the water content of the snow core. The scales being used in Utah are as follows:

(a) Commercial dial spring balance accurate to 0.5 ounce.
(b) Utah tubular spring balance calibrated to read the water content directly in inches depth.
(c) U.S. Weather Bureau spring scale which records the depth of water in inches directly when used with the Weather Bureau tube (2.65 inches diameter).

In using any of the three scales, the empty tube should always be weighed first. This weight in ounces subtracted from the weight of the tube and core in ounces on the commercial scale is equal to the water content of the snow core in inches depth. The weight of the empty tube subtracted from the weight of tube and core on either the Utah or the Weather Bureau scales is equal to the water content of the snow core in inches depth.

6Difficulty may be encountered in getting a complete core. This may be due to:

(1) Presence of thick underbrush which prevents the snow from settling. To avoid this condition, move the observation point, making a record of the distance moved.

(2) The presence of temperatures may be below 32 degrees F. in the snow while the temperature of the air is above freezing. This condition often causes the snow to adhere to the orifice of the cutter, forming a solid ice plug. This difficulty may be overcome by removing tube and cleaning it thoroughly with a dry cloth. It may be necessary to melt the ice plug. In removing the ice, a small handful of newspapers burned around the cutter end of the tube has been found effective. Wipe the tube dry and take another sample. A stout string, at least twice the length of the tube with a small heavy weight attached to one end, will serve as a ramrod for cleaning the tube. Keep the tube clean. Do not allow mud to freeze on the cutter.

Best results are obtained from sampling when the temperature of the snow is about 32 degrees F. and the temperature of the air at freezing or only slightly above. Sampling is most easy and rapid when done in the morning or evening instead of during the warm part of the day. If it is impossible to get a satisfactory core record the length of core obtained in the column under "Remarks".

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Establishing Snow Courses and Making Snow Surveys

U. S. DEPARTMENT OF AGRICULTURE
WEATHER BUREAU, FOREST SERVICE AND
UTAH AGRICULTURAL EXPERIMENT STATION

UTAH COOPERATIVE SNOW SURVEYS

Drainage basin .................................................................

Snow course ........................................................................

Signature ..............................................................................

Address .......................................................... Date ..............

Equipment used: Snow sampling tube No. ......; length, (50, 60, 72, 84, 96, 108 or 120 inches*); diameter, (1.485 or 2.65 inches*). Weighing scales*, U.S.W.B. No. ......; Utah Exp. Sta. No. ......; Commercial, No. ......

<table>
<thead>
<tr>
<th>Station** (interval ft)</th>
<th>Snow depth, inches</th>
<th>Weight,*** tube and core.</th>
<th>Weight,*** tube only, before sampling</th>
<th>Water content of snow core****</th>
<th>Remarks</th>
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* Strike out ones not needed, and give serial numbers.
** Enter measurement interval or distance apart at top of first column; number the measurement stations consecutively from No. 1, as shown on the sketch map.
*** Record all weights as indicated by the scales. U.S.W.B. and Utah Exp. Sta. scales are graduated in inches; ordinary commercial scales in pounds and ounces. Convert pounds to ounces for recording; 1 pound equals 16 ounces; 2-32; 3-48; 4-64; 5-80; 6-96; 7-112; 8-128; 9-144; 10-160; etc.
**** Water content of snow layer is obtained by subtracting weight of tube (col. 4), from combined weight of tube and snow core (col. 3).

Mail promptly, one full report to Weather Bureau Office, Salt Lake City, Utah, one to District Forester, Ogden, Utah, and one to Director, Utah Agricultural Experiment Station, Logan, Utah.

(WBO-SLC-11-10-30-1000)

Fig. 7.—Sample field notes, Utah cooperative snow surveys.
Examples

<table>
<thead>
<tr>
<th></th>
<th>Wgt. Empty Tube</th>
<th>Wgt. Tube and Core</th>
<th>Water Content in Inches Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utah scales and tube</td>
<td>17</td>
<td>30</td>
<td>13</td>
</tr>
<tr>
<td>U. S. W. B. scales and tube</td>
<td>17</td>
<td>30</td>
<td>13</td>
</tr>
<tr>
<td>Commercial scales with Utah tube</td>
<td>17 oz.</td>
<td>30 oz.</td>
<td>13</td>
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</table>

**RECORDING DATA**

Forms for recording data are made up and punched to fit the standard 3-ring field book. Dates called for are filled in completely at the top of the forms as well as under equipment used. **Record the time of day, temperature, and weather conditions before and after survey of course.** Begin taking samples from the initial end of the course, recording the first sample as Sample No. 1. Fill in completely Columns 1-4, inclusive; Column 5 may be filled in at the office.

If depth of core varies from the depth of snow by more than 6 inches and it is impossible to get the core to check within that length, the reason for the discrepancy must be determined if possible and recorded in the "Remarks" column. (Any unusual condition is always recorded in the "Remarks" column.)

Make notes on the general condition of snow cover on the back of the field notes. Note the extent of drifting, amount of snow on trees, general condition of the snow (whether hard or soft, wet or dry), moisture condition of the soil under the snow cover, and the condition of any streams in the vicinity as to whether they are running clear or muddy. Weather conditions shortly before and during survey, together with any unusual difficulties encountered, should also be noted on the back of the field notes. A sample of field notes is given in Figure 7.

**SUGGESTIONS COVERING CLOTHING, SHELTER, FOOD, AND MISCELLANEOUS EQUIPMENT**

These suggestions are intended primarily for those observers who have had little experience in the mountains during the winter. Tight-fitting garments should be avoided, as they have a tendency to decrease circulation and do not keep out the cold as well as those that fit loosely. Clothes that fit loosely and that give maximum protection for least weight should be chosen. Loose-fitting woollen garments are the best.

The following list is suggested because of their warmth, lightness, and looseness.

1. **Underwear.**—Wool underwear only is recommended, as the wool retains its warmth even after wet by perspiration.

2. **Trousers.**—Medium-weight wool trousers or breeches can be used. Trousers are preferable because of their looseness at the knees. Instead of wool, some prefer a waterproofed canvas trouser which keeps the knees dry and affords wind protection. They are quite stiff, however, and for this reason are not generally used.

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Items 1-17, inclusive.

3. **Socks.**—A light-weight wool sock is generally used next to the foot, together with one or two more of heavier weight. If rubber pack boots are used, an all-felt shoe worn over the light-weight wool sock is satisfactory for absorbing the perspiration and for keeping the feet warm. In lieu of the felt shoe, heavy blotting paper or a pad felt may be used as an inner sole.

4. **Boots.**—To insure dry feet, rubber snow packs (boots with rubber feet and high leather tops) are generally worn when the snow is wet. A pair of moccasins (for use with snowshoes) is excellent in dry snow or in an emergency. Ordinary leather boots are all right in dry snow, but they are not particularly satisfactory for wet snow because they lose their waterproof qualities quickly. Frost penetrates leather boots quickly, making them unsatisfactory in cold weather.

5. **Shirt.**—A medium-weight wool shirt has been found to be most satisfactory.

6. **Sweater.**—A light-weight wool sweater, loosely knitted, is useful both for field trips and in camp. The loose weave tends to trap the air and keep it between the body and outer garments.

7. **Coat.**—A light, short, wind- and rainproof coat similar to a waterproof stag shirt or a cruising coat is good for wear in windy or rainy weather.

8. **Parka.**—A parka is a loose-fitting over-garment fashioned after the style of the Eskimo outer garment. It slips over the head, has a hood usually trimmed with fur, is loose and roomy about the body and knees, and is easily slipped on or off. It affords great protection against cold wind.

9. **Mittens.**—Leather-faced, fur-lined mittens or a combination of leather and woollen mittens usually keep the hands sufficiently warm. Sheep fleece is not satisfactory as it tends to crack when once wet. Mittens should always be tied to the wearer to prevent loss in a fall.

10. **Cap.**—A leather fur-lined cap with visor and with ear and neck flaps is most satisfactory. A knitted wool cap is often used, but it lacks the waterproof qualities of the leather cap.

11. **Goggles.**—Amber or green goggles with leather dust shields on the sides prevent snow blindness and afford wind protection. Goggles should always be tied to the wearer and an extra pair carried for emergencies.

12. **Overcoat.**—A heavy fleece-lined overcoat affords good protection when riding in a machine. It is also useful around camp.

13. **Pack or Knapsack.**—A non-sweat frame pack or knapsack is recommended for carrying clothing and equipment.

14. **Repair Equipment.**—Thongs and a few small nails, for repairing skis and snowshoes away from camp, should be carried as part of the equipment.

15. **First-Aid Kit.**—A medium-sized first-aid kit containing equipment for breaks, sprains, burns, and cuts is recommended: Chloranodyne and alkaline elixir for flux caused by snow water, remedies for ptomaine poisoning, and a good cathartic.

16. **Food.**—It is well to carry a small supply of food for emergencies. Canned beans and soup, chocolate, raisins, bacon, beef cubes, etc. are recommended.

17. **Matches.**—A supply of matches in a waterproof container should be carried for emergency use only.

18. **Face Veil.**—For the protection of the face a thin black veil fastened to the hatband and dropped over the neck and shoulders has been found satisfactory. This does not interfere with breathing or sight and affords good protection from the reflected rays of the sun.
SHELTERS AND FOOD SUPPLIES

Shelters for snow surveyors should be supplied at intervals of not over ten to twelve miles. These shelters should be stocked with blankets and provisions. Where surveys are made on National forests with the U. S. Forest Service cooperating, ranger stations offer first-class shelter. Areas not on National forests may have private cabins which can be used, or cabins may have to be built especially for the purpose. In any event, shelters stocked with provisions should be available at intervals of distance not to exceed one day's hike under adverse weather conditions.

Supplies should be kept in tight metal cans to protect them from mice and should be kept locked. An assortment of canned goods, together with salt, sugar, flour, etc., in glass jars, makes up the provisions. The survey party usually carries some fresh provisions with them. The amount of provisions stored in the cabins will be determined by the length of the stop at that point.

Snow surveying in high, rough, inaccessible areas is hazardous at best, and the surveyor should avoid undue exposure, travel during blizzards, and be continually on the alert for snow slides. **In case of doubt remain in the shelters.**