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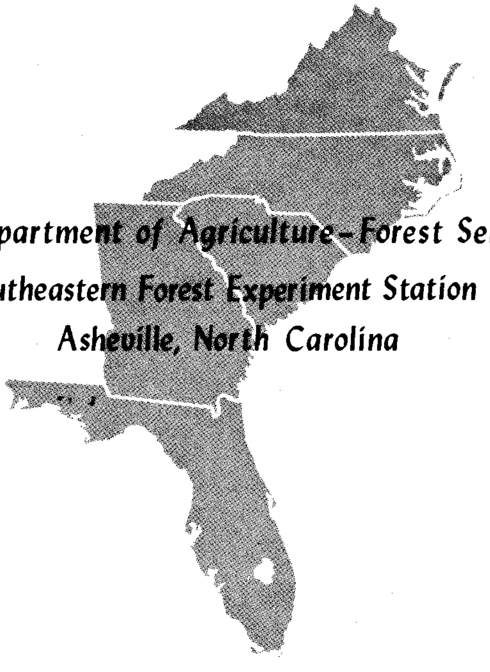
The National Fire Danger Rating System:

Derivation of Spread Index for Eastern and Southern States

by

RALPH M. NELSON

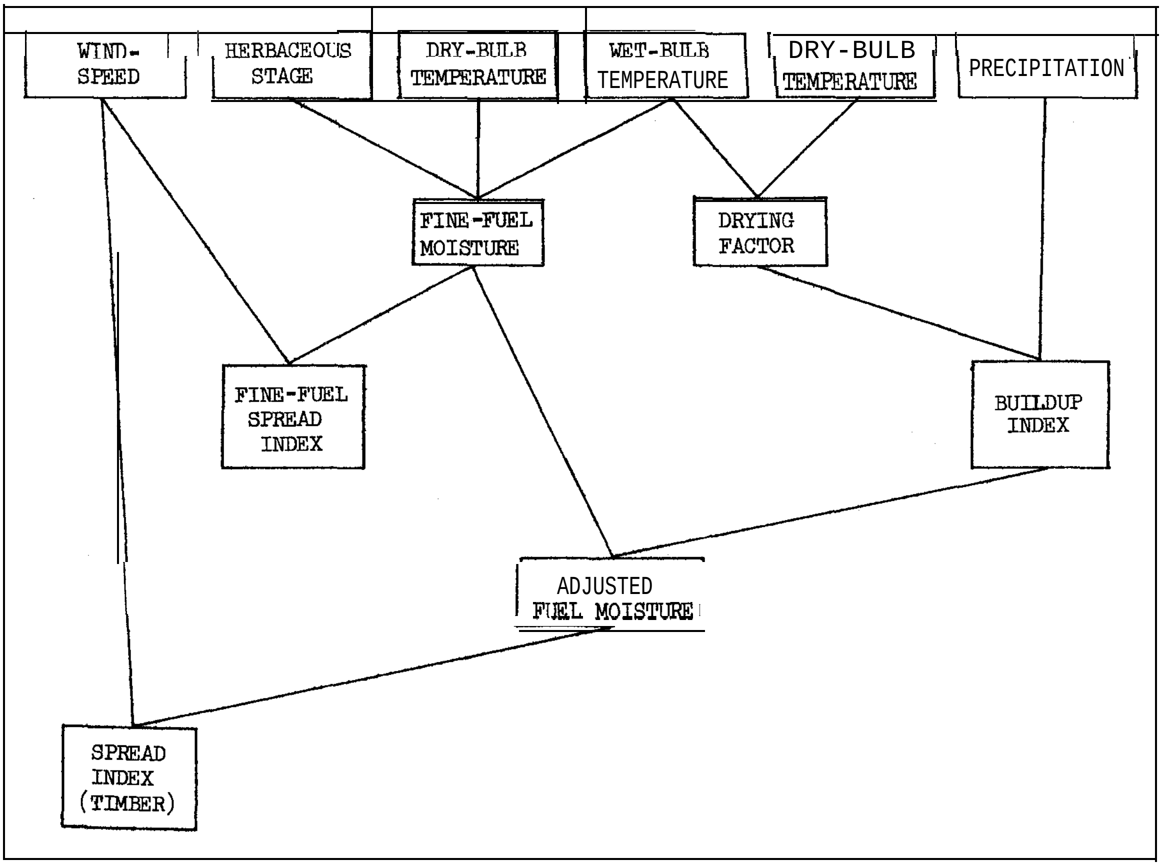


U.S. Department of Agriculture-Forest Service

Southeastern Forest Experiment Station

Asheville, North Carolina

Acknowledgment for many helpful suggestions in the preparation of this paper is made to John J. Keetch, who has played a major part in developing the Spread Phase of the National Fire-Danger Rating System.



Components of spread phase of National Fire Danger Rating System

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Introduction

The purpose of this paper is to present information that will be helpful to state and private fire control agencies in the East and South in installing and operating fire danger stations according to the National Fire Danger Rating System. This National System was adopted by the U. S. Forest Service in 1964 for use in all Regions where it has been determined it will serve satisfactorily. Accordingly, the Northeastern and the Southern Regions will place the new system in operation when arrangements can be made for danger station sites, instrumentation, and training of observers. This paper has been prepared on the assumption that most states in the two Regions will also want to convert to the National System.

Most of the material in following sections on station location and instrumentation, operation, and maintenance has been taken from the "National Fire-Danger Rating System," U. S. Forest Service Category 2 Handbook, 5123.3 (7). However, the material has been condensed or expanded as seems most applicable to Eastern and Southern States.

Why A National System

Eight systems of measuring fire danger were used in the United States in 1963. Although all were based on estimated fuel moisture and wind speed, no two systems agreed on measurement of these elements or the weights given them. Therefore, protection areas with identical burning conditions had widely differing index numbers, depending upon the system used. These differences have caused difficulty within the Forest Service and been even more troublesome to cooperating agencies. Also, it has been difficult to introduce new knowledge into existing systems. For these reasons, a decision was reached to develop a national rating system based on measurements of the same elements combined in the same way to derive an index. The effect of weather as an indicator of the severity of burning conditions could thus be more uniformly interpreted, which in turn would provide a sounder base for coordinating and evaluating fire control management at regional and national levels.

A basic consideration in the acceptance of the National System is that it must be at least as good an indicator of the severity of burning conditions in the several Regions as the systems being displaced. Reasons why the new Spread Index is believed to be better than the 8 and 8-100 Burning Indexes used in Regions 7 and 8, respectively, are discussed in the following section.

Why The Spread Index Is Believed Better Than The Burning Index

The Spread Index is a measure of the effect of weather on the relative rate of forward movement of surface fires. Actual rates of spread are, of course, influenced by factors in addition to weather, such as kinds of fuels and topography. The Spread Index is also related to the probability of fire occurrence, although more weight has been given to wind and less to buildup in the makeup of the Spread Index than in the Burning Index. They can be thought of as similar, however, in the sense that both are a measure of the severity of burning conditions.

A point is emphasized: No index can pinpoint what will happen on any given fire day. It can only indicate the fire potential; that is, what may happen in relation to past fire business on similar days.

The present Burning Index meter and earlier models have been reliable indicators of the severity of burning conditions in the East and South since 1939. A great many analyses for many areas have indicated that as the Index increased so did the number of fires and acres burned on an average day. Therefore, in the evaluation of the Spread Index, comparisons between it and the Burning Index were made to learn which of the two was superior in indicating the probability of fire occurrence and size of fires. Particular attention was paid to the amount of fire business on low index days, because some experienced fire control men have said that at times, in high risk areas, there were too many fires on such days, as measured by the Burning Index.

For example, in table 1, percent of days and fires are cumulated and grouped by 5-unit increments for both Burning and Spread Indexes. The analysis period was January, February, March, and April--usually the most severe fire months--for 1958-1960, for a Southeastern state protection district. Totals were 347 days and 1,212 fires. According to the table, 53 percent of the days, 18 percent of all fires, and 14 percent of the C, D, and E fires were in the 0- 5 Burning Index range. The same percent of days and very nearly the same percent of all fires and C, D, and E fires were distributed in the Spread Index range 0 to 15. Obviously, there was much less fire business on the lower part of the index scale when danger rating was calculated according to the Spread Index. On the higher part of the scale, values of the two Indexes tended to be more nearly equal. A point of similarity was that the highest danger rating reached during the analysis by either Index was 50.

Comparisons such as described were made for several areas in the Northeast. Although differences between the Indexes were less pronounced than for the Southeast district, trends were similar (see table 2).

Table 1. --Comparison of cumulated days, fires, and C, D, and E fires by Burning Index and Spread Index ranges for a Southeastern protection district

Index Range	Burning Index			Spread Index		
	Days	All Fires	C, D, E Fires	Days	All Fires	C, D, E Fires
	Percent					
o- 5	53	18	14	24	1	2
O-10	73	38	34	35	6	3
o-15	81	52	49	53	21	15
O-20	88	68	64	76	51	44
O-25	93	78	73	90	71	67
O-30	96	87	83	96	91	90
o-35	98	93	90	98	93	95
O-40	99	97	94	99	98	98
o-45	99	99	98	99	99	99
O-50	100	100	100	100	100	100

Table 2. --Comparison of cumulated days and fires by Burning Index and Spread Index ranges for a Northeastern protection unit[1]

Index Range	Burning Index		Spread Index	
	Days	Fires	Days	Fires
	Percent			
o- 5	29	5	17	1
O-10	40	10	32	3
o-15	52	18	46	13
O-20	69	33	64	31
O-25	76	49	70	58
O-30	84	62	78	81
o-35	88	77	95	94
O-40	91	80	100	100
o-45	94	84	--	--
O-50	100	100		

[1]The Burning Index range of O-200 used in the Northeast has been converted to a loo-point range.

As stated earlier, the Spread Index was developed as a measure of the relative rate of forward movement of surface fires. Unfortunately, enough information on rate of spread of fires in the East and South was not available so that a comparison of Indexes with spread could be made. For this reason the number of C, D, and E fires by Index ranges was used on the premise that ordinarily there should be few such fires on low Index days. Referring to table 1, 49 percent of the fires larger than 10 acres during the 347-day period occurred on days when the Burning Index was 15 or less, but only 15 percent when the Spread Index was 15 or less. Therefore, if one can assume that C, D, and E fires are a partial measure of relative rate of forward movement, then for the time and period analyzed, the Spread Index is the better indicator of spread.

A third type of analysis was made to learn which of the two Indexes seemed best in general to reflect the severity of burning conditions in the Southeastern area mentioned earlier. This was done by comparing the two Indexes by classes against no fires, number of fires, and C, D, and E fires on each of the 347 days. For example, if 10 fires occurred on a certain day, whichever of the Indexes had the highest class was considered superior on that day. Conversely, if no fires occurred on a certain day, and one Index was substantially lower than the other, the one with the lowest value was taken as best. Minor differences were ignored. For some months, depending on the weather, the two classes appeared to be about equal. For other months, when burning conditions were clearly severe, the Spread Index was decidedly better.

Based on the analyses discussed and others not mentioned, I conclude that the Spread Index is superior to the present Burning Index as an indicator of both probability of fire occurrence and rate of spread.

Similarities And Differences Between The Spread And Burning Indexes

Both Indexes are based on the same variables: fuel moisture, wind speed, precipitation, and condition of lesser vegetation. However, these variables are not given the same weight in arriving at Index values. For this reason a Spread Index of 15 does not mean the same as a Burning Index of 15.[1]

A major difference is the substitution of wet- and dry-bulb measurements for basswood slat weights in estimating fuel moisture. This does away with scales, screens, and weighing shelters, which alone, in the opinion of many, is enough to tip the scale in favor of the Spread Index.

Another difference is that only three conditions of lesser vegetation, called "Herbaceous Stages," are used in the Spread Index, whereas five must be recognized in the Burning Index system.

Two other weather elements, precipitation and wind speed, are measured much as before.

The National System Buildup Index is on an open-end scale. That is, it does not stop at 100 but continues to cumulate until rain occurs. In the 8 and 8-100 systems, it is on a loo-point scale. The Spread Index is on a loo-point scale.

Under the National System, all fire danger stations must be located in the open, which presents a problem of some difficulty in states relying on a number of woods-type stations. Well located open stations now in use can be converted with relative ease.

A set of tables is used in deriving the Spread Index. Burning Index is calculated by means of the well-known circular slide-rule type meter.

Fire Danger Classes Based On The Spread Index

Many fire control agencies in the East and South operate on the basis of 5 danger classes instead of Burning Index numbers. Adjective ratings in place of class numbers are used by many to indicate the degree of fire danger. Adjective ratings recently adopted by the U. S. Forest Service are low, moderate, high, very high, and extreme.

From experience, agencies have come to reply on class numbers or adjective ratings as highly useful guides in a variety of fire control activities. Consequently, in converting from the Burning Index to the Spread Index, a difficulty is in knowing the ranges of units on the 100-point Spread Index scale

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[1] The Burning Index meter used in the Northeast has a ZOO-point scale, whereas the one used in the Southeast has a loo-point scale.

that, on the average, best identify the same 5 classes of danger. For example, should the breaking point between very high and extreme danger come at 40, or 50, or some other number on the scale? An unqualified answer cannot now be given, but based on the best information available, the following breakdown of the 100-point Spread Index into 5 classes of danger is recommended for operational purposes: Low, O-4; moderate, 5-9; high, 10-19; very high, 20-39; extreme, 40 or more.

The fire behavior that can generally be expected according to these classes (7) follows:

(1) Low. --Fuels do not ignite readily from small firebrands, although a more intense heat source, such as lightning, may start many fires in duff or punky wood. Fire in open-cured grassland may burn freely a few hours after rain, but woods fires spread slowly by creeping or smoldering, and burn in irregular fingers. There is little danger of spotting. The color code is green.

(2) Moderate. --Fires can start from most accidental causes, but with the exception of lightning fires in some areas, the number of starts is generally low. Fires in open-cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel, especially draped fuel, may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious, and control is relatively easy. The color code is blue.

(3) High. --All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High-intensity burning may develop on slopes, or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small. The color code is yellow.

(4) Very High. --Fires start easily from all causes, and immediately after ignition spread rapidly and increase quickly in intensity. Spot fires are a constant danger. When fires burning in light fuels move into heavier fuels, they may quickly develop high-intensity characteristics such as long-distance spotting and fire whirlwinds. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes. The color code is orange.

(5) Extreme. --Fires start quickly, spread furiously, and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the very high danger class (item 4). Direct attack is rarely possible, and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks until the weather changes or the fuel supply lessens. The color code is red.

Significance Of The Buildup Index

The Buildup Index enters into the calculation of the Spread Index, but by itself provides highly useful information to the fire control manager. It reflects the dryness or wetness of fuels (other than fine flashy fuels) which have a pronounced effect on fire behavior. Where deep duff or litter layers or heavy roughs are present, fires may start and burn readily when the Spread Index is high and the Buildup Index low, but ordinarily they will be of relatively low intensity and difficulty of control. If both Indexes are high, however, fires will spread more rapidly, persist longer, burn with greater intensity, and cause more damage. As the Buildup Index increases, mopup becomes progressively more difficult.

The Buildup Index under some circumstances is a better indicator of fire-load potential than the Spread Index. For example, light rains may keep the Spread Index at a low point but have little effect on the Buildup Index. The effect of such rains on fine fuels can be quickly dissipated, sometimes in a few hours, causing fire danger to rise quickly from low to extreme if the Buildup Index is sufficiently high. The prudent fire control manager will, therefore, consider both Indexes when planning fire control activities.

Fire Danger Station And Instrument Location

Instruments needed at a fire danger station to measure weather and to derive a Burning and Spread Index are a rain gage, anemometer, and psychrometer. In selecting a site for instruments, the first consideration is to find a place that is suitable for a rain gage and psychrometer. The rain gage must be mounted at a spot at least as far from the nearest sizeable obstructions, such as buildings or a stand of trees, as the height of the obstructions. Such a place is also satisfactory for the psychrometer if there is free movement of air. A second and generally more difficult problem is to find a satisfactory location for the anemometer. In flat or rolling country, the best place for mounting anemometers is often on lookout towers.

All instruments need not be located at the same place. Sometimes a satisfactory exposure for an anemometer can be found only at some distance from the rain gage and psychrometer. With a dependable power source, a wire can be led at reasonable cost from the anemometer to some readily accessible point as far away as $\frac{1}{4}$ mile.

An ideal location for a danger station is a large flat or gently rolling area with a low vegetative cover, without buildings or other obstructions to the wind, and one that is convenient to the observers. Such sites are rare.

If possible, the station should not be nearer than 50 feet to large reflective surfaces, such as white-painted buildings, or nearer than 100 feet to extensive paved or dusty areas. A distance of at least several hundred feet from bodies of water, and from swampy or large irrigated areas is desirable, but the emphasis should be on the prevailing wind direction. Select the upwind side wherever possible.

Sharp peaks and ridges, as well as narrow valleys, should be avoided. Anemometers located on peaks and ridges are likely to register too high wind speeds. If such sites must be used, a fire danger rating expert should be consulted as to best height and exposure of the instrument.

Thought should be given to the future as well as the present; some stations, once well located, are now unsatisfactory because trees have grown up or buildings been erected nearby.

The following section of this paper describes models of instruments and their location in more detail. Mention of models by name in no way implies that others not mentioned are not satisfactory. Instrument suppliers are listed at the end of this paper.

RAIN GAGES

The Forest Service type of spun aluminum rain gage is recommended because it is accurate and relatively inexpensive. It is considered much superior to an earlier gage made of galvanized iron with soldered seams.

The gage should be securely mounted (fig. 1) so that the funnel top is level and about 3 feet above ground. It should be positioned so that an angle of 45” or less from the horizontal at the funnel top clears the top of all obstructions. This means that the distance of the gage from any obstruction should equal or exceed the height of the obstruction. The angle can be checked by setting an Abney level at 45” and sighting from the gage top in the direction of the tallest obstructions. Trees or buildings too near the gage will cause air currents and eddies and therefore interfere with free fall of precipitation.

A measuring stick made of black composition material called Lamicoid is better than the common wood stick if kept free of oily substances. Water will not creep up it, it can be easily cleaned, and markings will last longer.

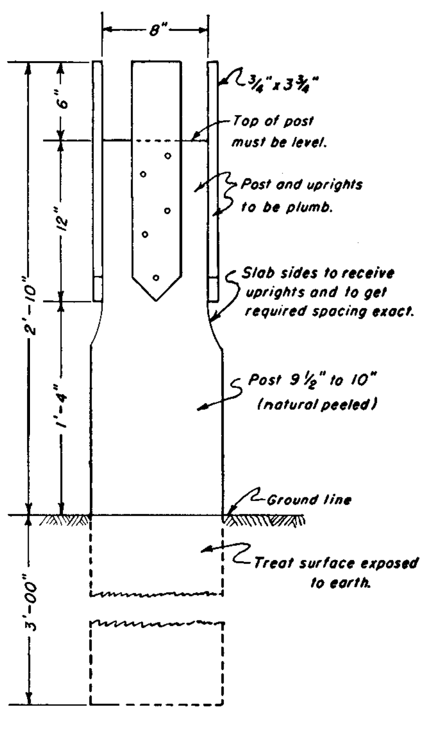


Figure 1. --Recommended mount for U. S. Forest Service-type rain gage.

ANEMOMETERS

A variety of anemometers are used at danger stations. Models that have given satisfactory service are listed under Suppliers.

Because fire spread is extremely sensitive to surface wind speed, the placement of an anemometer requires most careful attention. The standard anemometer height is 20 feet above open level ground. If supported on the ground, the average height of brush or other ground cover and a correction for wind obstruction, such as buildings or forest stands, must be added to the 20-foot basic height. An anemometer location is considered standard if it is no closer to the nearest sizeable obstruction than 7 times the height of the obstruction.

The reason corrections must be made for nonstandard locations is that obstacles and topography, such as buildings, trees, and high land masses, divert the air, split it, and create gusts and eddies, backdrafts or updrafts, thus changing its direction and speed.

Table 3. --Anemometer height, ZO-foot standard[1]

Distance to obstruction (feet)	Height of obstruction (feet)						
	10	20	30	40	50	60	70
	- - - - - - - Feet[2] - - - - - -						
10	27	--	--	--	--	--	--
20	25	34	—	--	--	--	--
30	24	32	41	--	--	--	--
40	22	30	39	48	--	--	--
50	21	29	37	46	55	--	--
60	21	27	35	44	53	62	--
70	20	26	34	42	51	60	69
80	20	24	32	40	49	58	67
90	20	23	31	38	47	56	65
100	20	22	29	37	45	54	63
120	20	21	26	34	42	50	59
140	20	20	24	31	39	47	55
160	20	20	23	28	36	44	52
180	20	20	22	26	33	41	49
200	20	20	20	24	30	38	46
220	20	20	20	23	28	35	43
240	20	20	20	22	26	32	40
260	20	20	20	21	25	30	37
280	20	20	20	20	24	28	34
300	20	20	20	20	23	26	32
350	20	20	20	20	20	23	27
400	20	20	20	20	20	21	25
450	20	20	20	20	20	20	22
500	20	20	20	20	20	20	20

[1] Note: The computed anemometer heights do not include an allowance for surface roughness, which should be added if needed.

[2] Anemometer heights have not been computed for distances less than height of obstruction. In such cases place anemometer 20 feet above the obstruction.

Principles that should be observed in locating anemometers where surface roughness and barriers influence wind movement (6) are illustrated in figures 2, 3, and 4. The amount to be added to the 20-foot standard is the average height of the surface obstruction. For example, assume a brush-covered area in the open. If the average height of brush is 3 feet, the anemometer should be mounted 23 feet above ground.

The amount by which the anemometer height must be increased because of obstructions such as buildings or trees is known as height correction, or hc. For convenience in computing hc, see table 3. For example, assume an instrument site is 100 feet from a 30-foot stand of trees. The proper anemometer height is 29 feet plus whatever needs to be added because of ground cover.

Much difficulty in finding a suitable site for an anemometer can be avoided if a danger station can be located at or fairly near a lookout tower. This will permit mounting the anemometer on the tower so as to be fully exposed to the wind. Also, a wire can be strung from the instrument to the cab for ready measurement of wind whenever the lookout chooses, and it is quickly available for servicing.

EFFECTS OF VEGETATION AND TOPOGRAPHY ON WIND

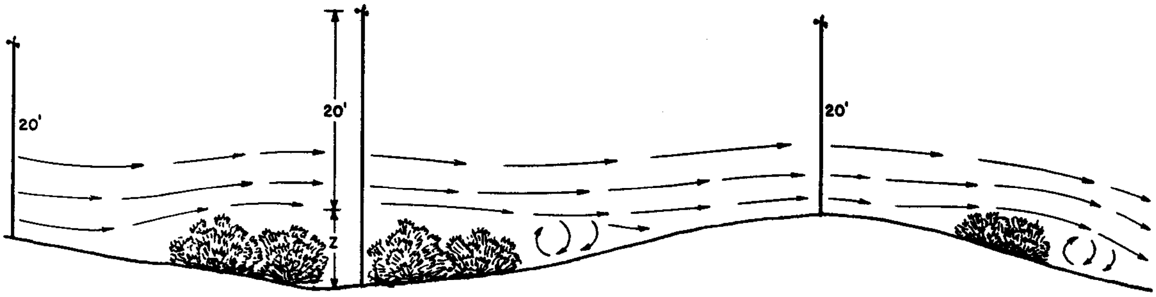


Figure 2. --Effect of surface roughness (brush and rough topography). Adjustment of anemometer height is necessary.

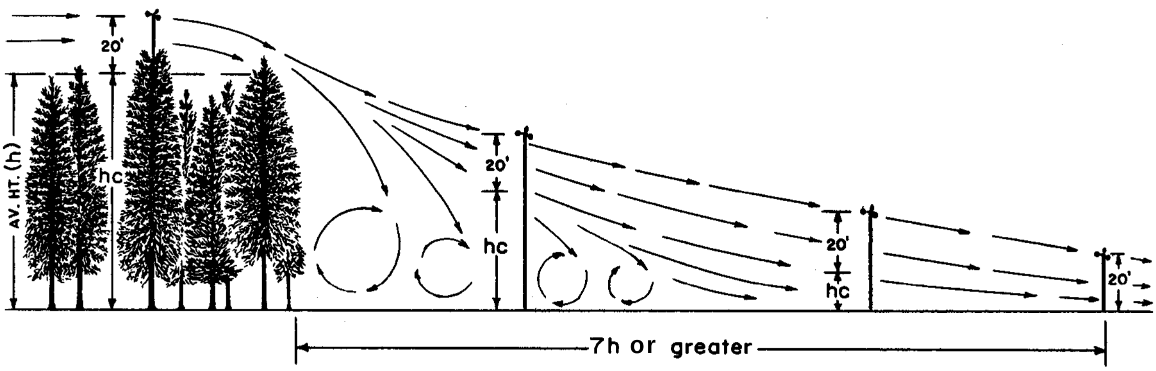


Figure 3. --Effect of wind barriers (timber and buildings). Adjustment of anemometer height is necessary.

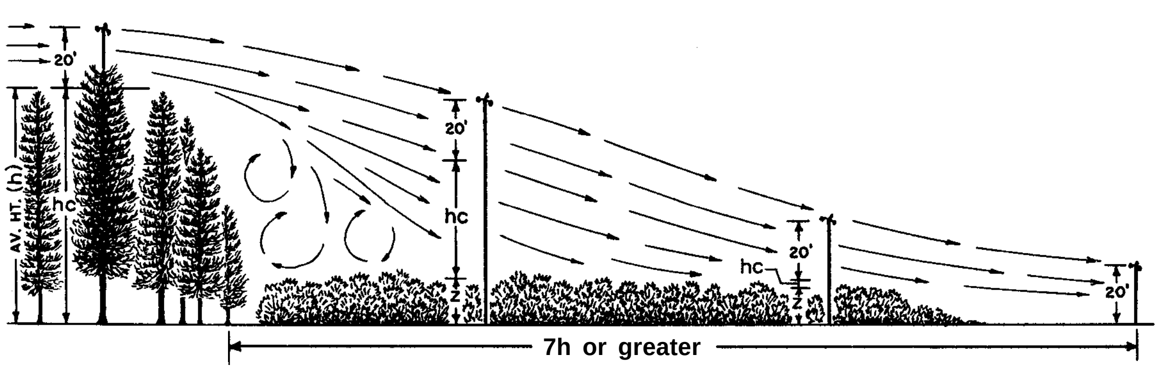


Figure 4. --Effect of wind barriers and surface roughness (trees and brush). Adjustment of anemometer height is necessary.

A previous publication (3) contained a statement that an anemometer should be attached to the guard rail or other convenient member of the tower midway between the first and second landing below the cab if this height cleared the surrounding tree canopy by 50 or more feet, and if not, the instrument should be mounted 10 feet above the cab. Based on subsequent research (2), we now recommend that the anemometer be mounted at least 10 feet above the peak of the cab. If the wind blows directly towards the anemometer when mounted on the side of the tower, correct measurements will no doubt be obtained. However, if from the opposite direction, the true speed of light winds may be reduced by almost one-half, and for winds 10 to 14 m. p. h. by nearly one-fourth. For this reason the recommended mount is at least 10 feet above the peak of the cab.

Table 4. --Conversion of wind speed measured 40 or more feet above surrounding trees to the open station standard (4)

Tower speed	Open station speed	Tower speed	Open station speed
- - - - - -	Miles per hour	- - - - - -	
1	1	26	19
2	1	27	20
3	2	28	20
4	3	29	21
5	4	30	22
6	4	31	23
7	5	32	23
8	6	33	24
9	7	34	25
10	7	35	26
11	8	36	26
12	9	37	27
13	9	38	28
14	10	39	29
15	11	40	30
16	12	41	31
17	12	42	31
18	13	43	32
19	14	44	33
20	15	45	34
21	15	46	34
22	16	47	35
23	17	48	36
24	18	49	37
25	18	50	37

Conversion of tower wind speeds to the 20-foot standard may or may not be necessary. If the height of the anemometer is 40 or more feet above the average level of surrounding tree crowns, tower speeds must be corrected by means of table 4. If substantially less than 40 feet, no correction is needed. These same general recommendations apply to anemometers mounted on masts.

Two suggested anemometer mounts are illustrated in figures 5 and 6.

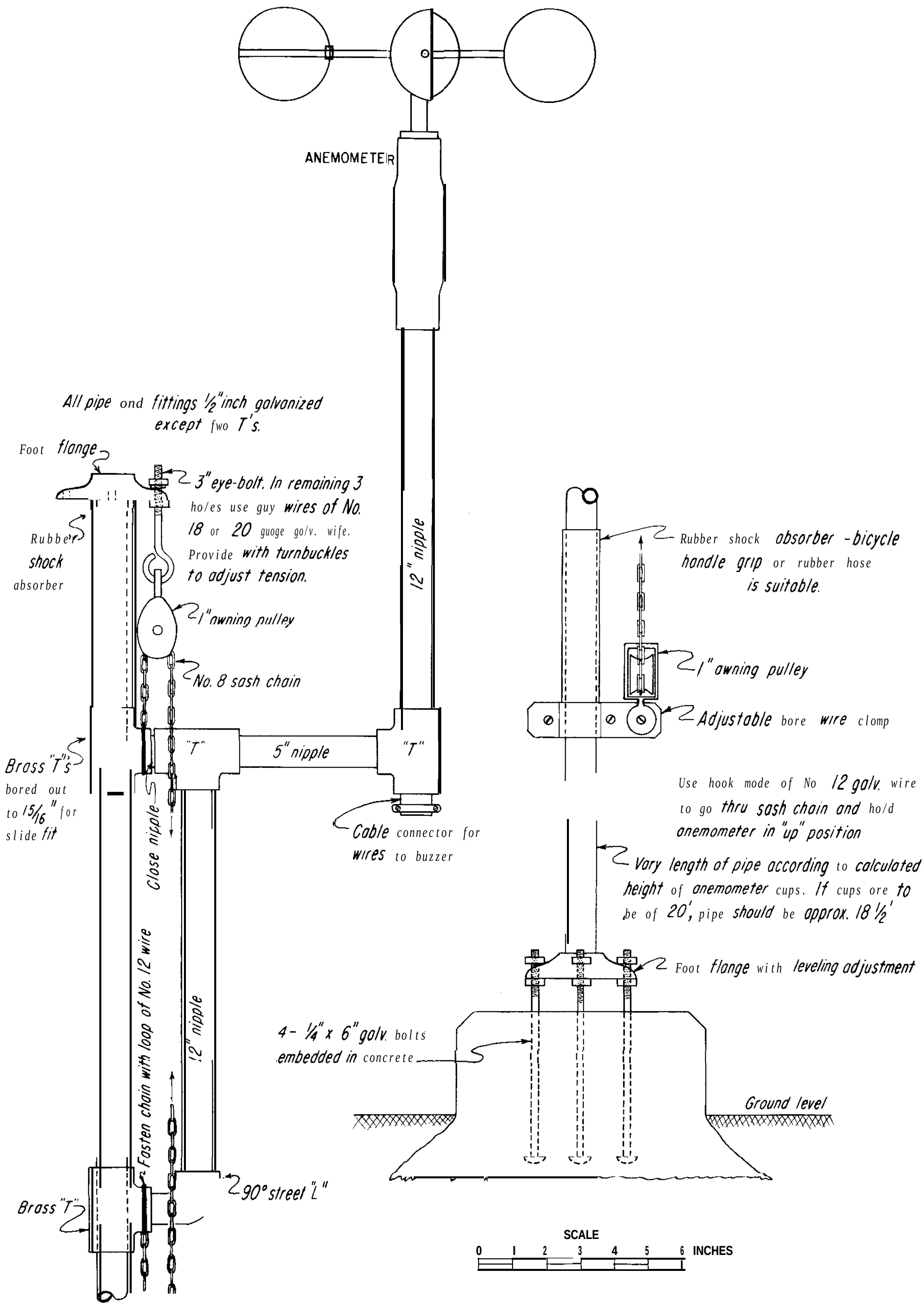


Figure 5. --A suggested anemometer mast and mounting. Instrument may readily be lowered, and is easily pulled up in position after servicing. Larger-diameter pipe and galvanized T's optional (1). Extreme care should be used in tightening guy wires to avoid bending mast.

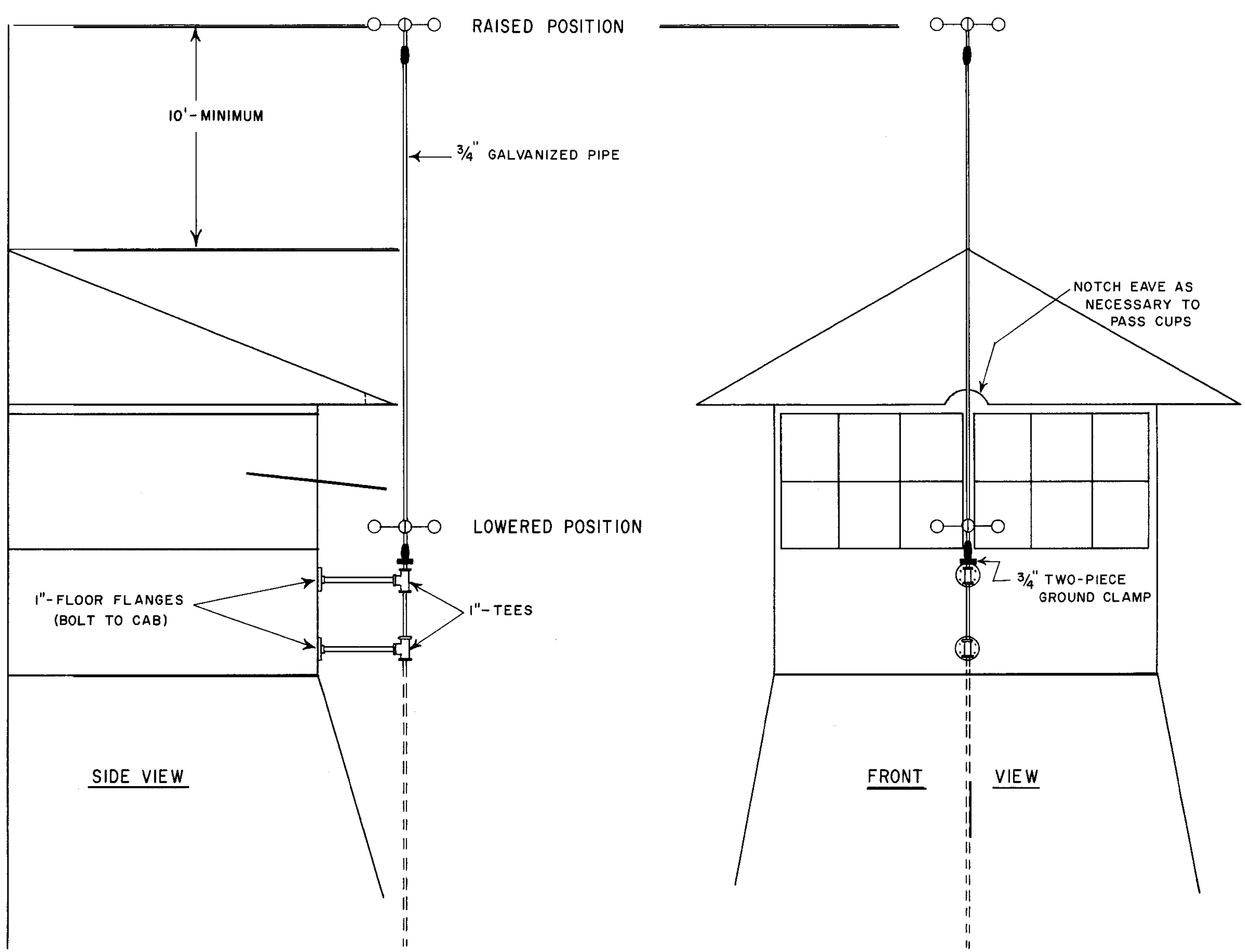


Figure 6.--A suggested anemometer mount for lookout towers.

PSYCHROMETERS

The amount of water vapor in the atmosphere, in relation to what it can hold, is used to estimate fine fuel moisture, one of the components of the Spread Index. Water vapor can be measured in a number of ways, but only psychrometers, which indicate wet- and dry-bulb temperatures, are discussed in this paper.

Fan Psychrometers

Fan psychrometers are used extensively at western fire danger stations, but they must be housed in ventilated shelters. Because shelters are expensive, a relatively inexpensive instrument called the mortarboard psychrometer (fig. 7) was devised.

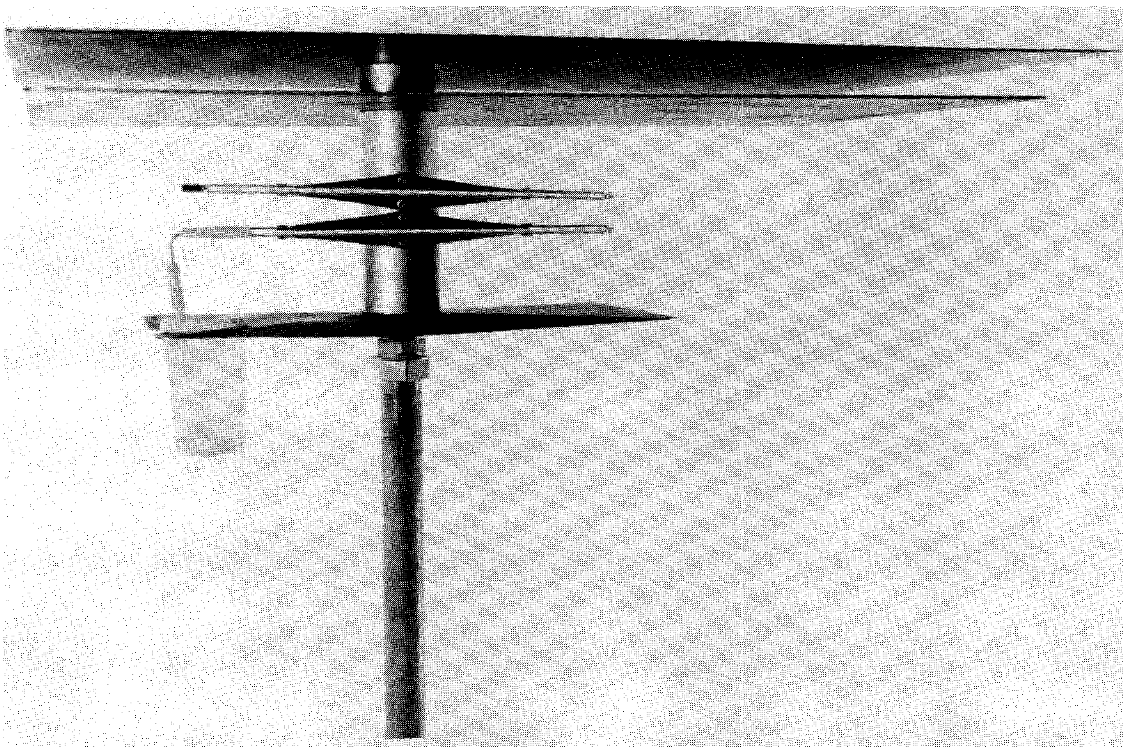


Figure 7. --Mortarboard Psychrometer.

Mortarboard Psychrometers

The mortarboard psychrometer (5) recently developed at the Southern Forest Fire Laboratory is a satisfactory and inexpensive way of measuring atmospheric moisture. It has been tested at a number of field installations and its use is recommended.

The instrument consists of a wet- and dry-bulb thermometer mounted horizontally between aluminum plates that shield the thermometers from radiation, both above and below, but permit free flow of air from all sides. A length of wicking extends from a covered plastic water container through a tube onto the wet bulb.

A site that meets the standards described for the location of a danger station will ordinarily be satisfactory for a mortarboard psychrometer. Sites where the prevailing wind blows over bodies of water or swampy areas toward the psychrometer, and pockets where air tends to stagnate, should be avoided.

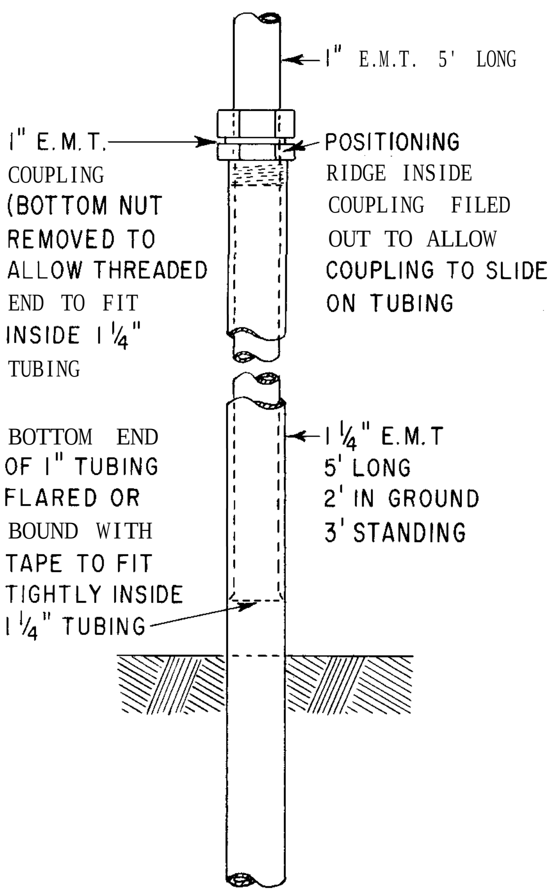


Figure 8. --Recommended ground support for mortarboard psychrometer.

A recommended method for mounting the mortarboard psychrometer according to Taylor (5) is to, ". . , set a 5-foot section of 1¼-inch electrical metallic tubing (EMT) firmly 2 feet into the ground. The l-inch electrical metallic tubing (EMT) can be slipped into the larger conduit and held at the desired height with a l-inch compression coupling from which the lower nut has been removed (fig. 8). The positioning ridge or nub in the coupling must be filed down so that the coupling will slide freely on the l-inch EMT. This permits easy adjustment of the thermometers to the eye level of the observer. If not at this height, the corners of the upper shield will be a safety hazard. "

When installing the instrument, the longest part of the upper shield must point south. In this position the thermometers will be completely shaded from the sun during the middle hours of the day. For early morning and late afternoon readings it will be necessary to reorient the psychrometer as described in the section on operation.

Mortarboard psychrometers had probably best be made in protection agency shops or procured from local manufacturers. Specifications are available from the Southern Forest Fire Laboratory, of the Southeastern Forest Experiment Station, P. 0. Box 1421, Macon, Georgia.

Matched pairs of thermometers are available to cooperating agencies from the Southern Forest Fire Laboratory on request at cost. A supply of wicking is sent with each set of thermometers. If a thermometer is broken or needs replacement, a new set should be requested. Return the old set in the shipping box. Only matched sets will be provided.

Sling Psychrometers

The well-known sling psychrometer in the hands of an experienced and conscientious observer will give accurate measurements of wet- and dry-bulb temperatures. If may be a very useful instrument in obtaining supplemental weather information in a rating area where the mortarboard psychrometer is not available. However, it is not recommended for use as standard equipment at danger stations, because it is easily broken and observers ordinarily fail to whirl the instrument long enough to obtain accurate readings.

STATION ENCLOSURE

Fire danger station equipment should be within a fenced enclosure if there is danger of molestation. Size of the fenced enclosure is immaterial so long as the fence does not interfere with free passage of air or catch of precipitation. A stout woven or mesh wire fence, not a board or picket fence, about 4 feet high is recommended. The enclosure should be neatly constructed, well maintained, and in harmony with its surroundings so far as possible.

Fire Danger Station Operation

This section deals with procedures for measuring precipitation, wind speed, wet- and dry-bulb temperatures, and identifying Herbaceous Stage.

HOW TO MEASURE PRECIPITATION

Rain is measured as follows:

1. Carefully remove the funnel top of the rain gage.

2. Lower the measuring stick down inside the measuring tube until the stick rests on the bottom.

3. Raise the measuring stick and read the top edge of the waterline (the stick is marked off in hundredths of an inch and should be read to the nearest hundredth).

4. If rain has filled the small tube and overflowed into the larger container, count the full tube as 0.50 inch (or 2.00 inches if the U. S. Weather Bureau type is used). Carefully lift tube out and empty, then pour overflow water into the small tube and measure. The sum of the measurements is the precipitation for the period.

If snow is expected, remove funnel top and measuring tube and let snow collect in the large container. To measure, melt the snow by low heat, pour the water into the small tube and proceed as in measuring rain.

HOW TO MEASURE WIND

Most anemometers at danger stations are so constructed that an electrical contact is made for every $\frac{1}{60}$ mile of wind that moves by the cups. The number of contacts per minute nearly equals the wind speed in miles per hour. Anemometer terminals are connected in series with a switch, dry cells, and a buzzer or counter, so that an electrical circuit is formed. Wind speed is measured by noting the number of signals for a specified number of minutes. For example, assume that a 4-minute measurement with a buzzer is to be made. Close the switch, listen for a signal and immediately at the end of the signal begin timing. Count the number of signals for exactly 4 minutes and divide by 4. Use a watch with a second hand to obtain correct timing. Record $\frac{1}{2}$ mile to the next higher mile. For convenience in converting number of signals to wind speed see table 5.

Anemometer manufacturers supply tables from which measured speed can be converted to true wind speed. The correction can be closely approximated by adding a mile to measured speeds that range from 1 to 9 miles per hour. Because this difference is slight and winds are variable, the use of correction tables is optional.

Table 5. --Number of anemometer signals for a 4-minute period converted to wind speed in miles per hour

Signals per 4 minutes	Wind speed	Signals per 4 minutes	Wind speed
Number	Miles per hour	Number	Miles per hour
0-1	0	78-81	20
2-5	1	82-85	21
6-9	2	86-89	22
10-13	3	90-93	23
14-17	4	94-97	24
18-21	5	98-101	25
22-25	6	102-105	26
26-29	7	106-109	27
30-33	8	110-113	28
34-37	9	114-117	29
38-41	10	118-121	30
42-45	11	122-125	31
46-49	12	126-129	32
50-53	13	130-133	33
54-57	14	134-137	34
58-61	15	138-141	35
62-65	16	142-145	36
66-69	17	146-149	37
70-73	18	150-153	38
74-77	19	154-157	39

According to meteorological studies, a 2-minute wind count is better than a l-minute count, 4 minutes are better than 2, and so on. Meteorologists agree that a lo-minute count will give a good measure of average wind speed during the period of an hour and this has been accepted as standard by the World Meteorological Organization. But lo-minute counts are impractical without automatic timers and counters. There appears to be no such device on the market except at considerable cost. A 4-minute count at each time fire danger measurements are made is strongly recommended.

HOW TO MEASURE WET- AND DRY-BULB TEMPERATURES

To obtain accurate measurements of wet- and dry-bulb temperatures with the mortarboard psychrometer, the observer must follow certain procedures. These are:

1. Be sure the wick covering the wet bulb is saturated at time of reading and that it extends at least an inch up the stem above the bulb. The thermometer with the black ring about 3 inches from the end of the bulb should be used as the wet-bulb thermometer.

2. Change the wicking every two weeks; oftener if the psychrometer is located where there is considerable dust or smoke.

3. The two thermometers should agree within ½ degree when the wet-bulb thermometer has been allowed to warm after the wet wick has been temporarily removed. Check this at the time when wicking is changed (every two weeks).

4. If the thermometers do not agree, the mercury column in one or the other may have separated. This sometimes happens in shipping or in use. If the mercury column cannot be reunited (see page 20), a new set of thermometers should be requested.

5. Distilled or clean rainwater for wetting the wick is best. However, clean mineral-free tapwater is permissible.

6. Enough air must flow over the mortarboard wet-bulb thermometer to remove the water vapor which surrounds the wick as a result of evaporation. During periods of near calm, the wet bulb must be fanned to insure a correct reading. Fanning for 2 or 3 minutes will usually be enough except during very dry weather. The wet-bulb thermometer should be watched so as to be sure it has reached its lowest temperature. Not until then should it be read. Then immediately read the dry-bulb thermometer.

7. In freezing weather the wick is usually dry. Apply cold water to obtain a thin coating of ice on the wicking over the bulb. Avoid a thick coating of ice. After the wet-bulb temperature drops below 32 degrees to a steady point, the reading is made; it may be necessary to wait for several minutes before natural ventilation or fanning brings the temperatures to this point. If a thin coating of ice does not form when the air temperature is below freezing, ice formation can be speeded by touching the bulb with a bit of ice or cold metal.

8. Temperature readings will be incorrect if thermometers are exposed to direct sunlight as in early morning or late afternoon. If readings are made at such times, the thermometers must be shaded for several minutes beforehand. This can be done by shading with an object such as a clipboard or by pivoting the mortarboard from its north and south position.

9. The possible effect of body heat on the thermometers can be avoided if the observer will stand at a slight distance to determine approximate temperatures then step in for a quick reading.

10. Temperatures should be read to the nearest degree. Record $\frac{1}{2}$ degree to the next higher degree.

Approved methods for obtaining wet- and dry-bulb temperatures with a sling psychrometer are:

1. Thoroughly wet the wick with clean water.

2. Stand in the shade and if light condition permits face into the wind so as to minimize the effect of body heat.

3. Whirl the psychrometer for about 1 minute at the rate of 3 or 4 whirls per second, then quickly read the wet bulb.

4. Repeat whirling intervals until the lowest wet-bulb reading is obtained. Read both thermometers as quickly as possible and record.

5. In freezing weather, as ice forms on the wet bulb, its temperature will rise to 32 degrees. Several minutes of moderate whirling may be necessary before the temperature drops below this point to its lowest value.

HOW TO IDENTIFY HERBACEOUS STAGE

Condition of Lesser Vegetation, one of the items set up on the type 8 or 8- 100 meters, is known as Herbaceous Stage in the National System. Instead of 5 classes, there are now 3, which are still designated as Green, Transition, and Cured. This simplification has been made because field men have had considerable trouble in identifying the 5 stages used with the meters.

Herbaceous Stage must be estimated on an observation and judgment basis. It represents the curing condition of vegetation such as grass, weeds, or ferns in the rating area, whether in the forest, or on its perimeter, or in openings. For estimating purposes, as a suggestion, vegetation is considered Cured when 75 percent or more of it is dead or dormant, in Transition when from 25 to 7 5 percent, and Green when less than 25 percent is dead or dormant.

The Cured Herbaceous Stage usually is found outside the growing season, but will also develop during the growing season if there is insufficient rainfall. The Buildup Index is a useful guide during the summer--as a preliminary estimate, shift to Transition if the new Buildup Index reaches 50 and to Cured at 100.

A comparison of the classes of Herbaceous Stage according to the Burning and Spread Indexes is as follows:

Burning Index	Spread Index
1-2	Cured
3-4	Transition
5	Green

Fire Danger Station Maintenance

ENCLOSURE

The fence and gate should be kept in good repair at all times. A low grass cover, kept neatly clipped, provides a good low-reflective surface for the mortarboard psychrometer and adds to the general appearance of the site. It should not be watered. Tall weeds, shrubby vegetation, or litter within or near the enclosure should not be tolerated. A poorly maintained area is an indicator of a poor observer.

RAIN GAGE

The rain gage needs only to be mounted firmly with its top level and round, and kept free of dents, leaks, and debris. Always remove the small tube when there is danger of freezing weather. A dirty or oily measuring stick or one that has indistinct markings should be cleaned or replaced.

MORTARBOARD PSYCHROMETER

Change the wick every 2 weeks, oftener if the psychrometer is located where there is considerable dust or smoke. To do so, cut off the wick halfway between the tube and bulb and discard. Pull up a length of fresh wicking; then slip it over the bulb and 1 inch up the stem. Be sure there is no sag between the end of the plastic tube and the end of the mercury bulb. The cap should fit tightly on the plastic cup and the tube should extend from near the bottom of the cup to 1 inch below the tip of the wet bulb. The cup and tube should be washed in clean water (no soap or detergents) whenever a fresh supply of wicking is added. A new supply is needed when that in use no longer reaches the bottom of the cup. Keep the cup at least half full of water. It will withstand repeated freezes. Polish the upper reflective surface of the top plate three or four times a year and keep it clean at all times.

THERMOMETERS

Mercury columns in thermometers sometimes become separated in use or during shipment. Manufacturers suggest several ways of reuniting columns.

1. Slight jars or shaking as one would a clinical thermometer.

2. Most thermometers have a small air chamber at the top of the stems. If the separation is near the top of the mercury column, heat the bulb carefully in very hot water until a small amount of mercury enters the air chamber. Holding this temperature, tap gently a few times. Remove bulb from water and as the mercury recedes note whether column is reunited. If not, repeat. Be very careful not to let the chamber fill with mercury because the thermometer may break.

3. If the air chamber is too small to hold the amount of mercury above the separation, cool only the bulb in dry ice until all the mercury is in the bulb. Tap bulb gently to bring all bubbles to the top, then allow bulb to warm slowly.

Markings on the thermometer can be renewed by smearing a small amount of lamp black oil color on the stem. Immediately after application, rub off the excess with a piece of hard finish paper. The lamp black can be obtained in small tubes from most paint or artist supply houses.

ANEMOMETERS

Most makes of anemometers used at danger stations will give many years of good service if given a reasonable amount of care. There are four main maintenance requirements:

1. The instrument must be mounted firmly with the spindle plumb.

2. The cups must be free of dents and tight on their shafts.

3. The electrical contact points must be smooth and free of dirt or oil.

4. Periodic lubrication is required according to maintenance specifications for the particular make and model instrument. Monthly oiling--one or two drops per bearing--is usually recommended. The tendency is to use too much rather than too little oil. Sometimes it is assumed that where one or two drops are specified, three or four will be better. The result may be a gummed and therefore inaccurate instrument. A card record of dates of oiling is recommended.

   Anemometers should be oiled with a high-grade bearing oil, such as used for typewriters, sewing machines, reels, or clocks. A silicone fluid lubricant is also recommended. Ordinary light mineral oil sold as household lubricant may become gummy or may corrode and gradually pit the bearings.

The freeness of the anemometer spindle can be checked in several ways. If mounted, remove the cups and run the side of the finger lightly along the side of the spindle. It should turn easily with only slight pressure from the finger. If the instrument is unmounted, hold it above your head in a room where there is no draft and walk rapidly. Keep the shaft vertical. The cups should begin to turn by the time you have walked about 10 feet.

Anemometers should be serviced at least once a year by trained personnel. When badly worn parts or serious adjustment problems are encountered, instrument should be sent to the manufacturer for repair. Spare anemometers should be at hand as replacements for those being repaired.

When field servicing, remove the instrument from its mount and thoroughly flush the mechanism in kerosene or other suitable solvent to remove old oil and dirt. For safety reasons, carbon tetrachloride or other highly volatile solvents should not be used. Particular attention needs to be paid to electrical contact points. These should be checked for cleanliness, proper spring tension, and clearance between points.

At danger stations that are not operated for several months each year, preferred practice is to remove the anemometer, clean, oil, and store in a safe place. Keep in mind that anemometers are precision instruments that require careful handling if they are to give accurate readings. This applies not only to assembly and maintenance, but also to transport and storage.

The Appendix contains brief instructions for the maintenance of several types of anemometers. For full details see recommendations accompanying each instrument.

INSPECTION

During the period of changeover to the National System, a fire control agency would do well to examine its entire network of danger stations. Some stations may originally have been well located but are now unsatisfactory because of tree growth, erection of buildings, or other reasons.

The need for systematic inspection of fire danger stations, their operation, and records, by experienced personnel cannot be emphasized too strongly. Unless this is done, a certain number of stations are certain to be substandard. Too often a staff man is put in charge of the danger station network but is given so many other responsibilities that he cannot give stations the required attention. Part of the inspector's job should be to:

1. Plan danger station and select station sites.

2. Train observers.

3. Thoroughly inspect each station at the beginning of the fire season and at least once during the season and make a written report.

4. Check observation procedures.

5. Check maintenance of danger station instruments and sites.

6. Check fire danger records at time of inspection and spot-check records between inspections.

7. Assist in planning action programs based on fire danger and other factors for each protection unit.

In making inspections of danger stations, a tickler list of items such as the following has been found very useful. It serves as a guide to the inspector and is helpful in training observers. Its use is strongly recommended.

Enclosure

1. Fence and gate in good repair
2. Area well maintained
3. Vegetation neatly clipped
4. In keeping with surroundings

Rain Gage

1. Firmly mounted, with top level and round
2. Free of dents, leaks, and debris
3. Measuring stick legible and in good repair
4. 45” angle from top of gage clears obstructions
5. Top approximately 3 feet above ground
6. Mount kept painted

Psvchrometers

1. Wick changed every two weeks
2. Wick extends an inch up stem
3. Wicking clean--not crusted
4. Thermometer bulbs clean
5. Thermometer markings clearly legible
6. Thermometers agree within ½ degree when read as dry-bulb thermometers
7. Clean, mineral-free water used
8. Wet bulb brought to its lowest point
9. Extra wicks on hand

Anemometers

1. Cups at proper elevation
2. Cups firmly attached to spindle
3. Cups undamaged
4. Spindle turns freely
5. Firmly mounted and plumb
6. Maintenance schedule followed
7. Protected from lightning
8. Power supply adequate

Oneration and Records

1. Precipitation measured and recorded correctly
2. Wind measured and recorded correctly
3. Wet- and dry-bulb temperatures measured and recorded correctly
4. Herbaceous stage correctly identified
5. Readings taken at scheduled time
6. Records neat and legible
7. Tables used correctly

Whenever a danger station is inspected, a written record should be made for administrative review and subsequent action where needed. An inspection form is a convenient way of summarizing the good or poor characteristics of a station and in indicating where remedial measures are needed.

How To Measure Fire Danger

This section of the Paper contains information on when to make measurements; also tables (fig. 9), and instructions for computing Buildup and Spread Indexes, and a sample form (fig. 10) for recording daily measurements.

WHEN TO MAKE MEASUREMENTS

For uniformity, observations of wet- and dry-bulb temperatures, wind speed, and 24-hour precipitation at 1 o'clock p.m. standard time each day is recommended. It should be considered the basic reading for the day.

Each U. S. Forest Service Region is required to set the time when basic reading on its National Forests will be made. This will be the time when, on the average, the highest Spread Index for the day is reached. To avoid confusion, particularly where State or privately protected lands border on federally managed lands, as well as for statistical purposes, it would be desirable to have all protection agencies within a State take the basic reading at the same hour.

Some protection agencies regularly make three readings a day, in the morning, early afternoon, and in the late afternoon during the fire season. Whether to take these additional readings depends upon administrative needs. A morning reading is often very useful in indicating the fire danger to be expected later in the day. Late afternoon readings are also recommended because high fire danger occasionally persists into the evening.

HOW TO USE THE TABLES AND FORM

Before describing how to compute the Buildup and Burning Indexes, a brief discussion of the tables and sample form follows.

Fine Fuel Moisture is estimated from wet- and dry-bulb measurements (formerly from fuel moisture slats) in either tables 1, 2, or 3 in figure 9 depending upon the existing Herbaceous Stage. (References to tables in the next several pages are to those in figure 9). Drying Factors, found in the small tables in the lower right-hand corner of tables 1, 2, and 3, are used to calculate the Buildup Index. These factors were formerly called Buildup Factors in the type 8 meters. The Buildup Index, as before, is a measure of the progressive drying of other than fast-drying fine fuels. It is adjusted for precipitation according to table 4 if the precipitation during the past 24 hours has been more than a tenth of an inch. The Buildup Index and Fine Fuel Moisture are then combined in table 5 to obtain an adjusted Fuel Moisture. With this last figure, and wind speed, the Spread Index is read from table 6.

Procedures for deriving the Buildup and Burning Indexes will be more readily understood by following through the sample calculations on the record form, figure 10, as follows:

Assume that it is October 1, and the Herbaceous Stage is in Cured. In the figure 10 form, the first day's measurements, Wet- and Dry-Bulb Temperatures, Herbaceous Stage, and Wind Speed have been recorded in columns 1, 2, 4, and 11, respectively. Note that these column headings are underscored with a heavy line.

1. Subtract wet-bulb reading, 51, from dry-bulb, 61, and enter the difference, 10, in column 3.

2. Turn to table 1 (Cured Herbaceous Stage) in figure 9. Enter the table at Wet-Bulb Depression 10 Degrees. Read across to the Dry-Bulb Temperature column headed 60-69. The estimated Fine Fuel Moisture, 8.5 percent, is recorded in column 5, figure 10.

3. Yesterday's Buildup was 40, and because there has been no precipitation during the past 24 hours, the figure recorded in column 7 of figure 10 is also 40.

4. According to the small table in the lower right-hand corner of table 1 in figure 9, a Fine Fuel Moisture of 8.5 percent has a Drying Factor of 2. This number is recorded in column 8 and added to the 40 in column 7 to give today's Buildup Index of 42 in column 9, figure 10.

5. Next, in table 5 of figure 9, go down the Buildup Index column to 40-49 and across to the Fine Fuel Moisture column headed 7.5 to 9, which gives an Adjusted Fuel Moisture of 12; this is recorded in column 10, figure 10.

6. With this last item, 12, and a wind speed of 4, the Spread Index in table 6 of figure 9 is seen to be 17. Spread Index, 17, is entered in column 12, figure 10.

7. Note that on the fourth day of the month the 24-hour precipitation has been 62 hundredths (0.62) inch. This means that the previous day's entry 49 in column 9 must be reduced according to table 4 in figure 9. Go down the left-hand column in table 4 to 46-50 and across to the Precipitation column headed 0.51 to 0.70. The number 22 now becomes the corrected Buildup Index in column 7 for the fourth day. Next add the proper Drying Factor, 1 in this instance, which makes the day's Buildup Index 23. Always adjust for precipitation before adding the Drying Factor. When snow occurs, correct the Buildup Index according to table 4, figure 9.

8. Note also, that on the sixth day the precipitation during the previous 24 hours was 10 hundredths (0.10) inch. No correction of the Buildup Index is made unless precipitation exceeds this amount.

9. When snow or ice blankets the fuels at observation time, the Spread Index is automatically zero. Therefore, temperatures need not be measured unless wanted for another purpose. Merely record the letter S in the Fine Fuel Moisture column. On such days the Drying Factor is also zero.

10. Because the Buildup Index is cumulative, a Drying Factor must be determined for all snow-free days. If a reading for one day is unavoidably missed, estimate a Drying Factor for that day. A convenient rule of thumb is to use a Drying Factor of 2 on rainless days. If a station is not operated for an extended period, compute a Buildup Index by using data from the nearest operating danger station or U. S. Weather Bureau station.

11. Only one Buildup Index is computed for a day regardless of how many measurements are made. For example, assume that measurements are made at 9, 1, and 5 o'clock and that the 1 o'clock Buildup Index today is 40. It will be the same at 5 o'clock today and 9 o'clock tomorrow. Correct for precipitation as needed, and add the Drying Factor only at the 1 o'clock reading.

12. These described sample computations of Buildup and Spread Indexes are for timbered areas. However, in some protection areas, largely in the West, there are large expanses of primarily fine fuels such as fast-drying grasses. For such areas, tables 4 and 5 need not be used. Entry into table 6 is made directly from tables 1, 2, or 3. There are no protection districts in the East and probably few in the South that are so sparsely timbered that the Fine Fuel Spread Index should be used.

Table 1. --FINE FUEL MOISTURE - CURED BERBACEOUS STAGE

WET BULB DEPRESSION (Degrees)	DRY BULB TEMPERATURE (Degrees F) 100 to 110	90 to 99	80 to 89	70 to 79	60 to 69	50 to 59	40 to 49	30 to 39	20 to 29	10 to 19
	PERCENT									
0	30+	30+	30+	30+	30+	30+	30+	30+	30+	30+
1	20	23	25	25	25	25	25	25	25	25
2	16	18	20	20	20	20	20	20	20	20
3	12	14	15	16	16	17	17	17	16	12
4	10	12	13	14	15	15	15	15	13	10
5	9	11	12	12	13	13	13	12	10	8
6	8	9.5	11	11	12	12	12	11	9	
7	7.5	9	9.5	10	10	10	10	9.5	7.5	
8	7	8.5	9	9.5	9.5	9.5	9.5	8.5		
9	6.5	8	8.5	9	9	9	9	7.5		
10	6	7.5	8	8.5	8.5	8.5	8	6		
11-12	5.5	6	7	7	7.5	7.5	6.5	6		
13-14	5	5.5	6	6	6	6	4			
15-16	4.5	5	5.5	5.5	5.5	5	4			
17-18	4	4.5	5	5	5	3				
19-20	4	4	4.5	4.5	4	2				
21-22	3.5	4	4	4	3					
23-24	3.5	3.5	3.5	3	2					
25-26	3	3	3	2.5	2					
27-28	3	3	2.5	1.5						
29-30	2.5	2.5	2	1.5						
31-32	2.5	2.5	1.5							
33-34	2	2	1							
35-36	2	1.5	1							
37-38	1.5	1								
39-40	1	1								
41+	1	1								

Fine Fuel Moisture	Drying Factor
16.0 or more	0
10.0 - 15.9	1
7.0 - 9.9	2
5.0 - 6.9	3
4.0 3.0 2.9 or 4.9 3.9 less	4 5 7

Table 2. --FINE FUEL MOISTURE - TRANSITION HERBACEOUS STAGE

WET BULB DEPRESSION (Degrees)	DRY BULB TEMPERATURE (Degrees F) 100 to 110	90 to 99	80 to 89	70 to 79	60 to 69	50 to 59	40 to 49	30 to 39	20 to 29	10 to 19
	PERCENT									
0	30+	30+	30+	30+	30+	30+	30+	30+	30+	30+
1	25	28	30	30	30	30	30	30	30	30
2	21	23	25	25	25	25	25	25	25	25
3	17	19	20	21	21	22	22	22	21	17
4	15	17	18	19	20	20	20	20	18	15
5	14	16	17	17	18	18	18	17	15	13
6	13	15	16	16	17	17	17	16	14	
7	13	14	15	15	15	15	15	15	13	
8	12	14	14	15	15	15	15	14		
9	12	13	14	14	14	14	14	13		
10	11	13	13	14	14	14	13	11		
11-12	11	11	12	12	13	13	12	11		
13-14	10	11	11	11	11	11	9			
15-16	9.5	10	11	11	11	10	9			
17-18	9	9.5	10	10	10	8				
19-20	9	9	9.5	9.5	9	7				
21-22	8.5	9	9	9	8					
23-24	8.5	8.5	8.5	8	7					
25-26	8	8	8	7.5	7					
27-28	8	8	7.5	6.5						
29-30	7.5	7.5	7	6.5						
31-32	7.5	7.5	6.5							
33-34	7	7	6							
35-36	7	6.5	6							
37-38	6.5	6								
39-40	6	6								
41+	6	6								

Fine Fuel Moisture	Drying Factor
21.0 or more	0
15.0 - 20.9	1
12.0 - 14.9	2
10.0 - 11.9	3
9.0 - 9.9	4
8.0 - 8.9	5
7.9 or less	7

Table 4. --BUILDUP INDEX RECOVERY

BUILDUP INDEX YESTERDAY	TOTAL 24-HOUR PRECIPITATION (Inches) 0.11 to 0.20	0.21 to 0.30	0.31 to 0.50	0.51 to 0.70	0.71 to 0.90	0.91 to 1.20	1.21 to 1.80	1.81 to 2.20	2.21 to 2.80	2.81 or more
	CORRECTED BUILDUP INDEX									
0	0	0	0	0	0	0	0	0	0	0
1-2	1	1	11		0	0	0	0	0	0
3-5	3	3	3	1 3	2	1	0	0	0	0
6-9	6	6	5	4		2	1	0	0	0
10-15	10	10	8	6	5	4	2	1	0	0
				9						
16-20	16	14	12	12	7	5	3	2	1	0
21-25	21	18	15		9	6	3	2	1	0
26-30	26	22	18	14	10	8	4	2	1	0
31-35	31	26	21	16	12	9	5	3	1	0
36-40	35	30	23	18	14	10	5	3	1	0
41-45	40	34	26	20	15	11	6	3	2	0
46-50	44	37	29	22	16	12	6	3	2	0
51-60	50	42	32	24	18	I.3	7	4	2	0
61-70	58	48	37	26	19	I.4	8	4	2	0
71-80	67	54	40	29	21	15	9	4	2	0
81-90	76	58	43	31	23	16	9	4	2	1
91-100	80	64	46	33	24	17	9	5	3	1
101-120	92	76	50	35	25	18	10	5	3	1
121-150	106	86	54	37	27	19	10	5	3	1
151-200	126		58	39	28	20	11	5	3	1
201-250	140	95	65	42	29	21	11	6	4	1
251-300	155	105	75	45	30	22	12	6	4	1
301-400	185	115	80	48	32	23	12	6	4	1
401+	230	135		50	35	24	13	7	4	1

Table 3. --FINE FUEL MOISTURE - GREEN RERBACEOUS STAGE

WET BULB DEPRESSION (Degrees)	DRY BULB TEMPERATURE (Degrees F) 100 to 110	90 to 99	80 to 89	70 to 79	60 to 69	50 to 59	40 to 49	30 to 39	20 to 29	10 to 19
	PERCENT									
0	30+	30+	30+	30+	30+	30+	30+	30+	30+	30+
1	30	30+	30+	30+	30+	30+	30+	30+	30+	30+
2	26	28	30	30	30	30	30	30	30	30
3	22	24	25	26	26	27	27	27	26	22
4	20	22	23	24	25	25	25	25	23	20
5	19	21	22	22	23	23	23	22	20	18
6	18	20	21	21	22	22	22	21	19	
7	18	19	20	20	20	20	20	20	18	
8	17	19	19	20	20	20	20	19		
9	17	18	19	19	19	19	19	18		
10	16	18	18	19	19	19	18	16		
11-12	16	16	17	17	18	18	17	16		
13-14	15	16	16	16	16	16	14			
15-16	15	15	16	16	16	15	14			
17-18	14	15	15	15	15	13				
19-20	14	14	15	15	14	12				
21-22	14	14	14	14	13					
23-24	14	14	14	13	12					
25-26	13	13	13	13	12					
27-28	13	13	13	12						
29-30	13	13	12	12						
31-32	13	13	12							
33-34	12	12	11							
35-36	12	12	11							
37-38	12	11								
39-40	11	11								
41+	11	11								

Fine Fuel Moisture	Drying Factor
26.0 or more	0
20.0 - 25.9	1
17.0 - 19.9	2
15.0 - 16.9	3
14.0 - 14.9	4
33.0 - 13.9	5
12.9 or less	7

Figure 9. --Spread phase tables--Wet-Bulb Depression (Form 5100-26)

Table 5. --ADJUSTED FUEL MOISTURE

BUILDUP INDEX	FINE FUEL MOISTURE (Percent)													
	1	1.5	2	2.5 or 3	3.5 or 4	4.5 or 5	5.5 to 7	7.5 to 9	9.5 to 11	12 to 14	15 to 17	18 to 20	21 to 25	26+
	PERCENT													
0	11	11	12	12	13	14	16	17	19	22	24	27	30+	30+
1-5	10	11	11	12	13	14	15	17	19	21	24	27	30	30+
6-12	9.5	10	10	11	12	13	14	16	18	20	23	26	29	30+
13-19	8.5	9	9.5	10	11	12	13	15	17	19	22	25	28	30+
20-29	7.5	8	8.5	9	10	11	12	14	16	18	21	24	27	30
30-39	6.5	7	7.5	8	9	10	11	13	15	17	20	23	26	29
40-49	5.5	6	6.5	7	8	9	10	12	14	16	19	22	25	28
50-69	4.5	5	5.5	6	7	8	9	11	13	15	18	21	24	27
70-89	3.5	4	4.5	5	6	7	8	10	12	14	17	20	23	26
90-99	3	3.5	4	4.5	5.5	6	7.5	9.5	11	14	16	19	23	26
loo-149	2	2.5	3	4	4.5	5.5	7	8.5	10	13	16	18	22	25
150-199	2	2.5	3	3.5	4	5	6.5	8	10	13	15	18	22	25
200-399	1.5	2	2.5	3	4	455	6	8	10	12	15	18	21	24
400+	1	1.5	2	3	3.5		6	7.5	9.5	12	15	17	21	24

Table 6. --SPREAD INDEX

FUEL MOISTURE (Percent)	WINDSPEED (MPH 20-foot Standard)															
	0-1	2	3	4	5	6	7	8	9	10	11-12	13-15	16-19	20-24	25-29	30+
	INDEX															
30+	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
29-30	1	1	1	1	1	1	1	1	1	1	1	2	3	4	5	6
27-28	1	1	1	1	1	1	1	1	1	2	3	4	5	6	8	9
25-26	1	1	1	1	2	2	2	3	3	4	6	7	8	9	11	13
23-24	1	2	3	3	4	4	5	6	7	7	8	10	11	13	15	17
21-22	2	3	4	5	6	7	8	8	9	10	11	13	15	17	20	22
19-20	4	5	6	7	8	9	10	11	12	13	15	17	19	22	25	29
17-18	6	8	9	10	11	12	13	14	15	16	18	21	24	28	32	36
15-16	8	10	11	12	14	15	17	18	19	20	22	26	30	34	39	44
14	9	11	12	14	16	18	20	21	22	23	26	30	34	39	44	51
13	10	12	14	16	18	20	21	23	25	26	28	33	37	43	48	56
12	11	13	15	17	19	21	23	25	27	28	31	36	41	47	53	62
11	12	15	17	19	21	23	25	27	29	31	34	39	44	51	58	68
10	13	16	18	20	22	25	27	29	31	33	37	42	48	56	63	73
9.5	14	17	19	21	23	26	28	30	33	35	38	44	50	58	66	76
9	14	17	20	22	24	27	29	32	34	36	40	46	52	60	68	79
8.5	15	18	21	23	25	28	30	33	36	38	42	47	54	63	71	83
8	15	19	22	24	26	29	31	34	37	39	43	49	56	65	74	86
7.5	16	19	22	25	28	30	33	35	38	40	45	51	58	67	76	a9
7	17	20	23	25	28	31	34	37	39	42	46	53	60	69	79	93
6.5	17	21	24	26	29	32	35	38	40	43	48	54	62	72	82	96
6	18	22	25	27	30	34	37	39	42	45	50	56	64	74	85	99
5.5	18	22	25	28	31	35	38	41	44	47	51	58	66	77	88	100
5	19	23	26	29	32	36	39	42	46	48	53	60	69	79	91	100
4.5	20	24	27	30	33	37	40	43	47	50	55	62	71	82	94	100
4	21	24	28	31	34	38	41	45	48	51	57	64	73	84	97	100
3.5	21	25	29	32	35	39	42	46	49	53	58	66	75	87	100	100
3	22	26	30	33	36	40	43	47	50	54	60	68	77	89	100	100
2.5	23	27	31	34	38	42	45	49	52	56	62	70	80	92	100	100
2	24	28	32	35	39	43	46	50	54	58	64	72	82	94	100	100
1.5	24	28	32	36	40	44	48	52	56	60	65	74	84	97	100	100
1	25	29	33	37	41	45	49	53	57	61	67	76	86	100	100	100

Figure 9. --Spread phase tables--Wet-Bulb Depression (Form 5100-26), continued.

(State or N. F.) (District) (Observer) (Danger Station Name) (Month and Year)

Observation time: A.

Day of Month	1 Dry-Bulb Temp.	2 Wet-Bulb Temp.	3 Wet-Bulb Depres.	4 Herbaceous Stage	5 Fine Fuel Moist.	9 Yesterday's BUI	10 Adj. Fuel Moist.	11 Wind Speed	12 SI (timber)	13 Fine Fuel SI
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										

Observation time: 1:00 P.M. (standard time)

Day of Month	1 Dry-Bulb Temperature	2 Wet-Bulb Temperature	3 Wet-Bulb Depression	4 Herbaceous Stage	5 Fine Fuel Moisture	6 Precipitation	7 Buildup Index yesterday, or as corrected (rain)	8 Drying Factor	9 Today's Buildup Index	10 Adjusted Fuel Moisture	11 Wind Speed	12 Spread Index (timber)	13 Class Day
1	61	51	10	1	8.5	0	40	2	42	12	4	17	III
2	74	60	14	1	6	0	42	3	45	10	12	37	IV
3	75	54	21	1	4	0	45	4	49	8	8	34	IV
4	73	69	4	1	14	.62	22	1	23	18	9	15	III
5	73	55	18	1	5	0	22	3	25	11	7	25	IV
6	62	56	6	1	12	.10	25	1	26	18	4	10	III
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													
26													
27													
28													
29													
30													
31													

Observation time: P.M.

Day of Month	1 Dry-Bulb Temp.	2 Wet-Bulb Temp.	3 Wet-Bulb Depres.	4 Herbaceous Stage	5 Fine Fuel Moist.	9 Today's BUI	10 Adj. Fuel Moist.	11 Wind Speed	12 SI (timber)	13 Fine Fuel SI
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										

Figure 10.--Sample form--National System Fire Danger Record.

An optional method of computing Fine Fuel Moisture is to substitute Relative Humidity in place of Wet-Bulb Depression (see fig. 11). This additional method is included for the convenience of agencies that consider Relative Humidity to be a more meaningful term than Wet-Bulb Depression. This is true in regions where Relative Humidity by long custom has been an element in systems of measuring fire danger.

Whichever method is used, the end result is approximately the same. However, there is some disadvantage in using Relative Humidity because an extra step in procedure is required. Its value must be found by entering wet- and dry-bulb temperatures in psychrometric tables calculated for ranges in barometric pressure. For example, from sea level to elevations of about 500 feet, a 30-inch pressure table gives the most accurate values. At elevations ranging from about 1,900 to 3,600 feet, a 27-inch pressure table should be used. Agencies that employ observers unaccustomed to the use of psychrometric tables may find this extra step an additional source of error. Proper tables for pressure ranges can be obtained from fire-weather forecasters.

At elevations up to about 3,000 feet the values based on Wet-Bulb Depression, because each degree of depression is identified, are somewhat more accurate than the ranges of values used in the Relative Humidity tables.

WB Form 612-17 revised January 1, 1964 (fig. 12) is the standard form for all National Forests where the National Fire Danger Rating System is used. The form was devised jointly by the U. S. Forest Service and the U. S. Weather Bureau to meet the needs of the two agencies. Many stations regularly report certain information in addition to fire danger elements to the Weather Bureau for use in making fire-weather forecasts and other purposes.

As will be seen, the form includes a number of items not needed to calculate the Spread or Buildup Indexes. Also, it has space for only one reading a day for a 10-day period. A number of columns have been left blank in which the predicted fire danger and other items can be entered. This provides a convenient means of comparing predicted with actual fire danger, which should be useful to forecasters in identifying localized areas that for one reason or another have aberrant weather.

For later analytical and statistical purposes it would be desirable if all fire control agencies in the East and South used the Standard Form. Pads of forms, with instructions, can be obtained from fire-weather forecasters.

Table 1.--FINE FUEL MOISTURE - CURED HERBACEOUS STAGE

RELATIVE HUMIDITY (Percent)	DRY BULB TEMPERATURE (Degrees F) 100 to 109	90 to 99	80 to 89	70 to 79	60 to 69	50 to 59	40 to 49	30 to 39	20 to 29	10 to 19
	PERCENT									
100	30+	30+	30+	30+	30+	30+	30+	30+	30+	30+
95-99	20	23	25	25	25	25	30+	30+	30+	30+
90-94	14	16	18	19	20	22	25	25	25	30+
85-89	10	13	15	16	18	19	21	23	25	25
80-84	9	10	12	14	15	17	18	21	23	25
75-79	8	9.5	11	12	14	15	17	19	21	23
70-74	7	8.5	9.5	11	12	14	15	17	19	22
65-69	6	7.5	8.5	9.5	11	13	14	16	18	21
60-64	5.5	6.5	8	9	10	11	13	14	16	20
55-59	5	6	7	8	9	10	12	13	15	18
50-54	4.5	5	6.5	7.5	8.5	9.5	10	12	14	16
45-49	4	5	6	7	8	9	9.5	11	13	15
40-44	3.5	4.5	5	6	7.5	8.5	9	10	12	14
35-39	3.5	4	5	5.5	6.5	7.5	8.5	9.5	10	13
30-34	3	3.5	4.5	5	6	7	8	9	9.5	12
25-29	3	3	4	4.5	5.5	6.5	7.5	8.5	9	10
20-24	2.5	3	3.5	4	5	5.5	6.5	7.5	8.5	9.5
15-19	2	2.5	3	3.5	4.5	5	6	7	8	9
10-14	2	2	2.5	3	4	4.5	5	6	7	8.5
5-9	1.5	1.5	2	2.5	3	3.5	4	5	6	7.5
0-4	1	1	1	1.5	2	2.5	3	4	5	6

Drying Factors for Computing Buildup Index

Fine Fuel Moisture	Drying Factor
16.0 or more	0
to 15.9	1
10.0 to 9.9	2
5.0 to 6.9	3
4.0 to 4.9	4
	5
3.9 or less	7

Table 4. --BUILDUP INDEX RECOVERY

BUILDUP INDEX YESTERDAY	TOTAL 24-HOUR PRECIPITATION (Inches) 0.11 to 0.20	0.21 to 0.30	0.31 to 0.50	0.51 to 0.70	0.71 to 0.90	0.91 to 1.20	1.21 to 1.80	1.81 to 2.20	2.21 to 2.80	2.81 or more
	CORRECTED BUILDUP INDEX									
0	0	0	0	0	0	0	0	0	0	0
1-2	1	1	1	1	0	0	0	0	0	0
3-5	3	3	3	2	2	1	0	0	0	0
6-9	6	6	5	4	3	2	1	0	0	0
10-15	10	10	8	6	5	4	2	1	0	0
16-20	16	14	12	9	7	5	3	2	1	0
21-25	21	18	15	12	9	6	3	2	1	0
26-30	26	22	18	14	10	8	4	2	1	0
31-35	31	26	21	16	12	9	5	3	1	0
36-40	35	30	23	18	14	10	5	3	1	0
41-45	40	34	26	20	15	11	6	3	2	0
46-50	44	37	29	22	16	12	6	3	2	0
51-60	50	42	32	24	18	13	7	4	2	0
61-70	58	48	37	26	19	14	8	4	2	0
71-80	67	54	40	29	21	15	9	4	2	0
81-90	76	58	43	31	23	16	9	4	2	1
91-100	80	64	46	33	24	17	9	5	3	1
101-120	92	69	50	35	25	18	10	5	3	1
121-150	106	76	54	37	27	19	10	5	3	1
151-200	126	86	58	39	28	20	11	5	3	1
201-250	140	95	65	42	29	21	11	6	4	1
251-300	155	105	70	45	30	22	12	6	4	1
301-400	185	115	75	48	32	23	12	6	4	1
401+	230	135	80	50	35	24	13	7	4	1

Table 2.--FINE FUEL MOISTURE - TRANSITION HERBACEOUS STAGE

RELATIVE HUMIDITY (Percent)	DRY BULB TEMPERATURE (Degrees F) 100 to 109	90 to 99	80 to 89	70 to 79	60 to 69	50 to 59	40 to 49	30 to 39	20 to 29	10 to 19
	PERCENT									
100	30+	30+	30+	30+	30+	30+	30+	30+	30+	30+
95-99	25	28	30	30	30	30	30+	30+	30+	30+
90-94	19	21	23	24	25	27	30	30	30	30+
85-89	15	18	20	21	23	24	26	28	30	30
80-84	14	15	17	19	20	22	23	26	28	30
75-79	13	15	16	17	19	20	22	24	26	28
70-74	12	14	15	16	17	19	20	22	24	27
65-69	11	13	14	15	16	18	19	21	23	26
60-64	11	12	13	14	15	16	18	19	21	25
55-59	10	11	12	13	14	15	17	18	20	23
50-54	9.5	10	12	13	14	15	15	17	19	21
45-49	9	10	11	12	13	14	15	16	18	20
40-44	8.5	9.5	10	11	13	14	14	15	17	19
35-39	8.5	9	10	11	12	13	14	15	15	18
30-34	8	8.5	9.5	10	11	12	13	14	15	17
25-29	8	8	9	9.5	11	12	13	14	14	15
20-24	7.5	8	8.5	9	10	11	12	13	14	15
15-19	7	7.5	8	8.5	9.5	10	11	12	13	14
10-14	7	7	7.5	8	9	9.5	10	11	12	14
5-9	6.5	6.5	7	7.5	8	8.5	9	10	11	13
0.4	6	6	6	6.5	7	7.5	8	9	10	11

Drying factors for Computing Buildup Index

Fine Fuel Moisture	Drying Factor
21.0 or more	0
15.0 to 20.9	1
12.0 to 14.9	2
10.0 to 11.9	3
9.0 to 9.9	4
8.0 to 8.9	5
7.9 or less	7

Table 3. --FINE FUEL MOISTURE - GREEN HERBACEOUS STAGE

RELATIVE HUMIDITY (Percent)	DRY BULB TEMPERATURE (Degrees F) 100 to 109	90 to 99	80 to 89	70 to 79	60 to 69	50 to 59	40 to 49	30 to 39	20 to 29	10 to 19
	PERCENT									
100	30+	30+	30+	30+	30+	30+	30+	30+	30+	30+
95-99	30	30+	30+	30+	30+	30+	30+	30+	30+	30+
90-94	24	26	28	29	30	30+	30+	30+	30+	30+
85-89	20	23	25	26	28	29	30+	30+	30+	30+
80-84	19	20	22	24	25	27	28	30+	30+	30+
75-79	18	20	21	22	24	25	27	29	30+	30+
70-74	17	19	20	21	22	24	25	27	29	30+
65-69	16	18	19	20	21	23	24	26	28	30+
60-64	16	17	18	19	20	21	23	24	26	30
55-59	15	16	17	18	19	20	22	23	25	28
50-54	15	15	17	18	19	20	20	22	24	26
45-49	14	15	16	17	18	19	20	21	23	25
40-44	14	15	15	16	18	19	19	20	22	24
35-39	14	14	15	16	17	18	19	20	20	23
30-34	13	14	15	15	16	17	18	19	20	22
25-29	13	13	14	15	16	17	18	19	19	20
20-24	13	13	14	14	15	16	17	18	19	20
15-19	12	13	13	14	15	15	16	17	18	19
10-14	12	12	13	13	14	15	15	16	17	19
5-9	12	12	12	13	13	14	14	15	16	18
0-4	11	11	11	12	12	13	13	14	15	16

Drying factors for Computing Buildup Index

Fine Fuel Moisture	Drying Factor
26.0 or more	0
20.0 - 25.9	1
17.0 - 19.9	2
15.0 - 16.9	3
14.0 - 14.9	4
13.0 - 13.9	5
12.9 or less	7

Figure 11. --Spread phase tables--Relative Humidity (Form 5100-24).

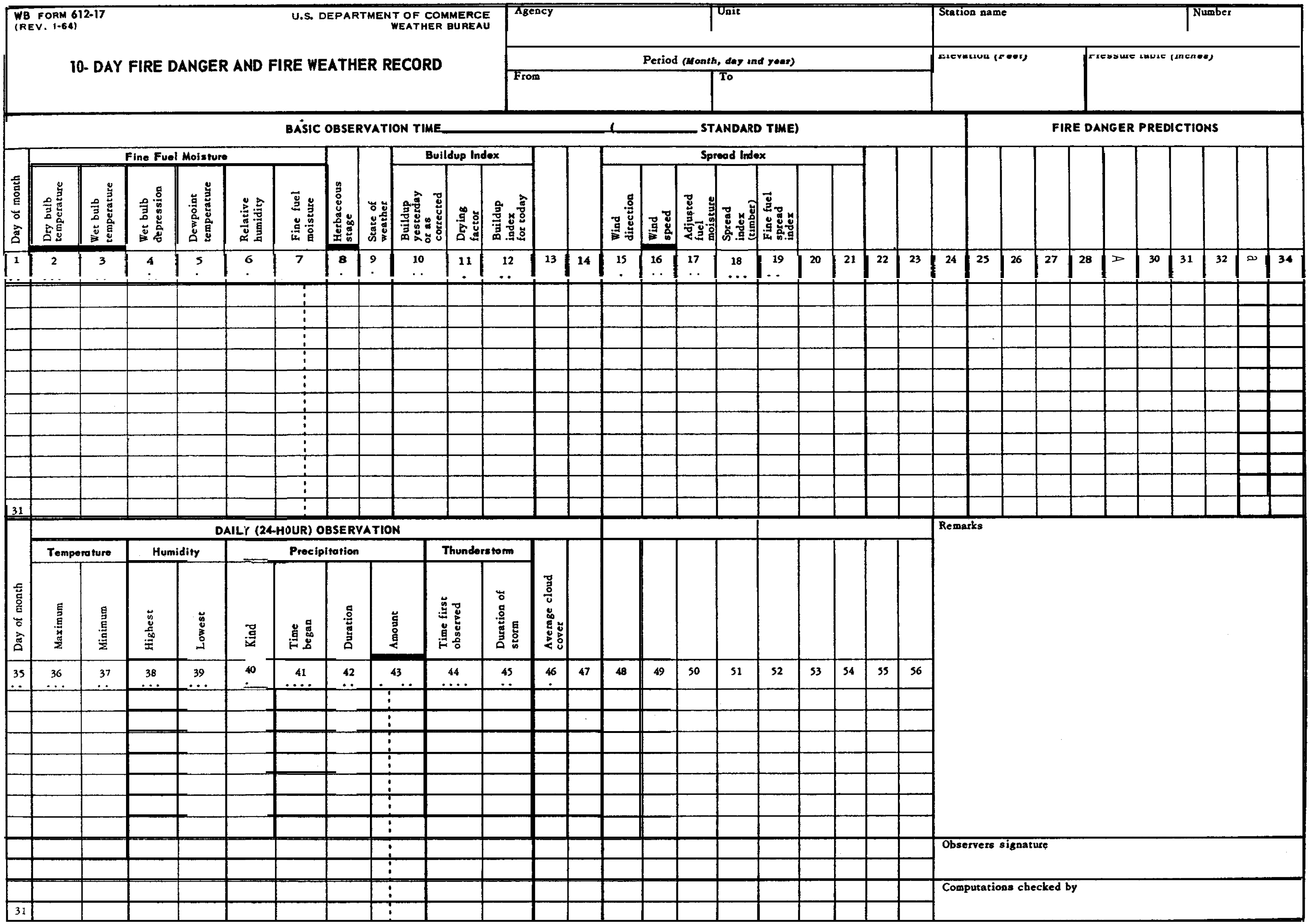
Table 5. --ADJUSTED FUEL MOISTURE

BUILDUP INDEX	FINE FUEL MOISTURE (Percent) 1	1.5	2	2.5 or 3	3.5 or 4	4.5 or 5	5.5 to 7	7.5 to 9	9.5 to 11	12 to 14	15 to 17	18 to 20	21 to 25	26+
	PERCENT													
0	11	11	12	12	13	14	16	17	19	22	24	27	30+	30+
1-5	10	11	11	12	13	14	15	17	19	21	24	27	30	30+
6-12	9.5	10	10	11	12	13	14	16	18	20	23	26	29	30+
13-19	8.5	9	9.5	10	11	12	13	15	17	19	22	25	28	30+
20-29	7.5	8	8.5	9	10	11	12	14	16	18	21	24	27	30
30-39	6.5	7	7.5	8	9	10	11	13	15	17	20	23	26	29
40-49	5.5	6	6.5	7	8	9	10	12	14	16	19	22	25	28
50-69	4.5	5	5.5	6	7	8	9	11	13	15	18	21	24	27
70-89	3.5	4	4.5	5	6	7	8	10	12	14	17	20	23	26
w-99	3	3.5	4	4.5	5.5	6	7.5	9.5	11	14	16	19	23	26
ml-149	2	2.5	3	4	4.5	5.5	7	8.5	10	13	16	18	22	25
150-199	2	2.5	3	3.5	4	5	6.5	8	10	13	15	18	22	25
200-399	1.5	2	2.5	3	4	5	6	8	10	12	15	18	21	24
400+	1	1.5	2	3	3.5	4.5	6	7.5	9.5	12	15	17	21	24

Table 6. --SPREAD INDEX

FUEL MOISTURE (Percent)	WIND SPEED (MPH 20-foot Standard) 0-1	2	3	4	5	6	7	8	9	10	11-12	13-15	16-19	20-24	25-29	30+
	INDEX															
30+	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
29-30	1	1	1	1	1	1	1	1	1	1	1	2	3	4	5	6
27-28	1	1	1	1	1	1	1	1	1	2	3	4	5	6	8	9
25-26	1	1	1	1	2	2	2	3	3	4	6	7	8	9	11	13
23-24	1	2	3	3	4	4	5	6	7	7	8	10	11	13	15	17
21-22	2	3	4	5	6	7	8	8	9	10	11	13	15	17	20	22
19-20	4	5	6	7	8	9	10	11	12	13	15	17	19	22	25	29
17-18	6	8	9	10	11	12	13	14	15	16	18	21	24	28	32	36
15-16	8	10	11	12	14	15	17	18	19	20	22	26	30	34	39	44
14	9	11	12	14	16	18	20	21	22	23	26	30	34	39	44	51
13	10	12	14	16	18	20	21	23	25	26	28	33	37	43	48	56
12	11	13	15	17	19	21	23	25	27	28	31	36	41	47	53	62
11	12	15	17	19	21	23	25	27	29	31	34	39	44	51	58	68
10	13	16	18	20	22	25	27	29	31	33	37	42	48	55	63	73
9.5	14	17	19	21	23	26	28	30	33	35	38	44	50	58	66	76
9	14	17	20	22	24	27	29	32	34	36	40	46	52	60	68	79
8.5	15	18	21	23	25	28	30	33	36	38	42	47	54	63	71	83
8	15	19	22	24	26	29	31	34	37	39	43	49	56	65	74	86
7.5	16	19	22	25	28	30	33	35	38	40	45	51	58	67	76	89
7	17	20	23	25	28	31	34	37	39	42	46	53	60	69	79	93
6.5	17	21	24	26	29	32	35	38	40	43	48	54	62	72	82	96
6	18	22	25	27	30	34	37	39	42	45	50	56	64	74	85	99
5.5	18	22	25	28	31	35	38	41	44	47	51	58	66	77	88	100
5	19	23	26	29	32	36	39	42	46	48	53	60	69	79	91	100
4.5	20	24	27	30	33	37	40	43	47	50	55	62	71	82	94	100
4	21	24	28	31	34	38	41	45	48	51	57	64	73	84	97	100
3.5	21	25	29	32	35	39	42	46	49	53	58	66	75	87	100	100
3	22	26	30	33	36	40	43	47	50	54	60	68	77	89	100	100
2.5	23	27	31	34	38	42	45	49	52	56	62	70	80	92	100	100
2	24	28	32	35	39	43	46	50	54	58	64	72	82	94	100	100
1.5	24	28	32	36	40	44	48	52	56	60	65	74	84	97	100	100
1	25	29	33	37	41	45	49	53	57	61	67	76	86	100	100	100

Figure 11. --Spread phase tables--Relative Humidity (Form 5100-24), continued.



WB FORM 612-17
(REV. 1-64)

U.S. DEPARTMENT OF COMMERCE
WEATHER BUREAU

10- DAY FIRE DANGER AND FIRE WEATHER RECORD

Agency	Unit	Station name	Number
Period (Month, day and year) From	To	Elevation (Feet)	Pressure table (Inches)

BASIC OBSERVATION TIME ______ (______ STANDARD TIME) — FIRE DANGER PREDICTIONS

Day of month	Fine Fuel Moisture: Dry bulb temperature	Wet bulb temperature	Wet bulb depression	Dewpoint temperature	Relative humidity	Fine fuel moisture	Herbaceous stage	State of weather	Buildup Index: Buildup yesterday or as corrected	Drying factor	Buildup index for today			Spread Index: Wind direction	Wind speed	Adjusted fuel moisture	Spread index (timber)	Fine fuel spread index										A				a	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	A	30	31	32	a	34
31																																	

DAILY (24-HOUR) OBSERVATION

Day of month	Temperature: Maximum	Minimum	Humidity: Highest	Lowest	Precipitation: Kind	Time began	Duration	Amount	Thunderstorm: Time first observed	Duration of storm	Average cloud cover									
35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
31																					

Remarks

Observers signature

Computations checked by

Figure 12.--Weather Bureau Form 612-17 (Rev. 1-64), 10-Day Fire Danger and Fire Weather Record.

Partial List Of Suppliers

The following list is prepared solely for the convenience of those interested in operating fire danger stations. It does not constitute an endorsement of products by the U. S. Forest Service or the Department of Agriculture to the exclusion of other equally acceptable products.

MODEL	SUPPLIER
Rain Gages	
U. S. Forest Service type gage	Standard Weather Gage Company 218 N. W. Flanders Street Portland 9, Oregon
" "	Western Fire Equipment Company 69 Main Street San Francisco 5, California
Plastic Measuring Stick	
U. S. Forest Service type gage	Standard Weather Gage Company 218 N. W. Flanders Street Portland 9, Oregon
Anemometers	
Small Airways	Belfort Instrument Company 4 North Central Avenue Baltimore 2, Maryland
" "	Science Associates, Inc. 194 Nassau Street Princeton, New Jersey
Stewart	M. C. Stewart Ashburnham, Massachusetts
"	Forestry Suppliers, Inc. Box 8397 Jackson 4, Mississippi
Forester	Western Fire Equipment Company 69 Main Street San Francisco 5, California

MODEL	SUPPLIER
	Psychrometers
Mortarboard type	Swab Wagon Company, Inc. Elizabethville, Pennsylvania
" II	Advanced Metal and Welding Co. 748 10th Street Atlanta 9, Georgia
"	Specifications available from Southern Forest Fire Laboratory Southeastern Forest Experiment Station P. 0. Box 1421 Macon, Georgia

Thermometers

W. H. Cm-tin Company
P. 0. Box 118
Houston, Texas

Available to cooperators from
Southern Forest Fire Laboratory
Southeastern Forest Experiment Station
P. 0. Box 1421
Macon, Georgia

Thermometer Wicking

Available to cooperators from
Southern Forest Fire Laboratory
Southeastern Forest Experiment Station
P. 0. Box 1421
Macon, Georgia

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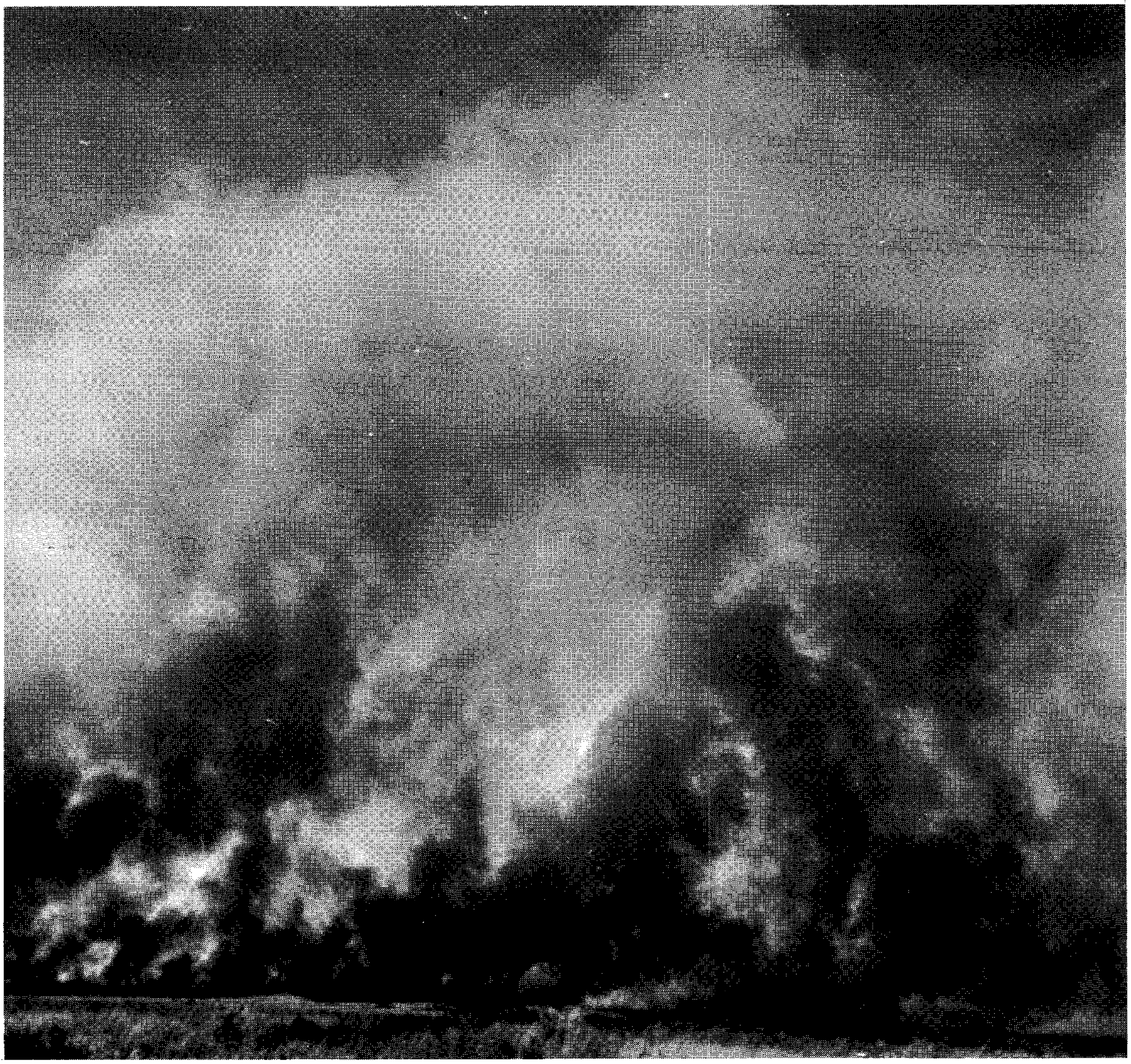

APPENDIX

ANEMOMETER MAINTENANCE

Small Airways

1. Remove the nut from the top of the cup assembly and remove cups and skirt.

2. Remove inspection plate from side of anemometer.

3. Loosen setscrew just above plate cover.

4. Slide shaft out of anemometer by lifting from the top.

5. Wash shaft in kerosene. Use deep container and plunge up and down. Allow excess kerosene to drain.

6. Replace the shaft by inserting into the housing from the top. Tighten setscrew above plate cover.

7. Oil with light oil after assembling. Place two drops on the gear part of the shaft, two drops on the bearing at the top of the shaft, and two drops on bearing at bottom of shaft.

8. Check each of the 5 contact pins to be sure that they close the contact points properly.

9. Replace inspection plate. Slip on washer at top of shaft with the beveled side face down. Replace skirt and cups so as to revolve clockwise. Replace nut securing the rotor, and the assembly is complete.

When in use, check the need for oil monthly. Loosen setscrew above inspection plate. Raise cup assembly and spindle. If oil is needed, place one to two drops on top bearing, one to two drops on the gear, and one to two drops on the bottom of the spindle.

Stewart--Models Prior to 1959

It is extremely important that the small socket in which the spindle of the instrument rests be not disturbed or removed from the housing in the cleaning process.

1. Remove small setscrew from side of cup assembly. Do not unscrew bolt in end. Remove cup assembly by sliding it off main shaft.

2. Remove inspection plate by loosening the two holding screws.

3. To remove spindle, unscrew bushing shaft from cast-alloy housing and slide over spindle.

4. Now carefully remove the spindle. It may be necessary to move it from one side or the other before it will slide out. Never turn cast housing upside down. Always keep in a standing position while cleaning. If it is turned upside down, the four small ball bearings will fall out.

5. Do not remove pinion gear or loosen the brass bearing blocks at the shaft ends, because tiny ball bearings will fall out. They are extremely difficult to replace.

6. Clean the shaft bushing and the spindle with kerosene.

7. Drop some anemometer oil on each end of the spindle, inside the top of the bushing shaft, and on the worm gear.

8. Slide spindle into place in housing and replace bushing shaft.

9. Replace cup assembly and small setscrew; also replace the inspection plate, being sure the gasket is weatherproof. The anemometer is then ready for use.

When in use, check the need for oil monthly. Remove the inspection plate for observation. If oil is needed, place one to two drops on the top and one to two drops on the bottom of the spindle. Some models provide a screw on top of the rotor which, when removed, exposes an oil duct serving the top end of the spindle. In the other models, the cup assembly must be removed and the oil placed on the spindle above the top bearing.

Stewart Aluminum Cup

Late model Stewart anemometers have Teflon bearings of low friction characteristics. According to manufacturers' instructions, maintenance is required only every 2 years unless the electrical contact points need adjustment.

1. To lubricate, remove cup wheel from spindle and with a clean soft cloth wipe off top of spindle, the spindle sleeve, and the inside of the wheel hub, and oil lightly with silicone fluid lubricant.

2. Remove the cover plate on the housing and with a medicine dropper put several drops of silicone fluid directly on the spindle just above the top bearing and just above the lower bearing.

3. Rotate the spindle clockwise several times with fingers to flush the fluid into the bearings.

4. If silicone fluid is not available, use anemometer oil, typewriter oil, sewing machine oil, or watch or clock oil.

5. Put a small dab of silicone grease or Vaseline on the gear pinion where the ground strap bears against it.

6. Do not remove the nylon pinion gear or loosen the brass bearing blocks at the shaft ends because tiny ball bearings will fall out. They are extremely difficult to replace.

In normal operation, the revolving contact screw on the gear wipes gently across the contact leaf spring in such a way that the deflection of the spring is from $\frac{1}{32}$ to $\frac{1}{16}$ inch. If adjustment is necessary, turn the screw holding the leaf spring very slightly in or out. Too much pressure will cause excessive wear and the spindle will stick in light winds. Too little pressure will result in erratic action of the indicator.

Chisholm- -Model 2B 3C

1. Disconnect wires and remove anemometer from mount.

2. Take off cap nut on top and remove cup assembly.

3. From the bottom of the anemometer remove the small bolt that goes through the main shaft. Negative contact wire is also attached to this screw when the anemometer is in use.

4. Remove electrical contact unit by sliding it carefully down over the end of the main shaft.

5. Remove small screw from revolving cylinder near the top. By turning the cylinder head to the left with one hand and holding the revolving cylinder with the other, the two pieces are separated. Remove the main shaft from the cylinder head.

6. Now wash all parts with kerosene except the electrical contact unit. Wash by plunging the parts up and down in a deep container. After washing, allow excess kerosene to drain from the parts.

7. Place about two drops of light oil around top of the two roller bearings attached to the shaft. Also add about two drops around the worm gear on the inside of the revolving cylinder near the top.

8. Check the contact mechanism before reassembling the anemometer. Slip the entire electrical contact unit on shaft and temporarily fasten it in place. Then manually turn the sprocket gear and observe whether the striking pin causes the bronze fingers to alternately make and break contact at silver contacts. The electrical circuit can be further checked by temporarily connecting the wires to the indicator circuit. The electrical contact unit will have to be removed from the shaft before reassembling the anemometer.

9. Assemble anemometer. Place cylinder head on top of roller bearings. Put revolving cylinder up over shaft onto the cylinder head. Turn it to the right until the holes match. Replace small screw. Looking in the anemometer from the bottom, rotate the revolving cylinder until the small pin on the gear wheel is face up and in line with the shaft. Hold at this point. Now replace electrical contact unit by sliding carefully up over the shaft into the revolving cylinder. When holding the top of the anemometer away from you, the contact points should be to the left of the main shaft. Replace small bolt through electrical unit and shaft. Attach cup assembly and replace cap nut. The anemometer is now ready to be remounted.

The anemometer should be oiled once each month when it is in use. To do this remove the cap nut on top of the cup assembly and place no more than three drops of oil in the hole exposed when the cap nut is removed. (On older models a clamp screw or bolt was used to fasten the cap assembly to the cylinder head.)

<u>Forester--Model 9X140</u>

1. Disconnect both electrical connections and remove anemometer from mount.

2. Unscrew the cap nut on top of rotor assembly and remove rotor assembly.

3. Remove cylinder shell screw on side of cylinder.

4. With twisting movement, remove cylinder head and stud.

5. Unscrew the slotted screw at top of main shaft which seals the oil channel to the lower bearing. (A few early instruments have a "Truarc" lockring instead of a screw at this point.)

6. Remove main shaft through bottom of cylinder shell, This is facilitated by lightly tapping the top of the main shaft.

7. Do not attempt to clean the shielded bearing with solvents because, according to manufacturers' instructions, this will do more harm than good. Merely lubricate them at least every 3 months with special anemometer oil.

8. Place two drops of oil on shield of each bearing, two drops at top of internal gear inside cylinder, and one drop on sprocket gear shaft.

9. Check the silver contact points to see that they are not burned. If necessary, they can be cleaned with a fine point file or fine sandpaper. If burned badly, they should be replaced. Burned points may be caused by too strong an electrical current.

10. Check the contact mechanism by rotating the sprocket gear and observe whether the striking pin causes the bronze fingers to make and break contact. Movement of inside contact point should be approximately $\frac{1}{32}$ to $\frac{1}{16}$ inch. Outer contact point should deflect approximately $\frac{1}{64}$ inch. The electrical circuit can be further checked by temporarily connecting the wires to the buzzer or counter circuit.

11. Check to assure that the screws holding contact arms are tight.

12. Insert main shaft into bottom of cylinder shell and up through the two bearings. The shaft is closely fitted to the bearings.

13. Install the oil channel screw at top of shaft (or Truarc lockring).

14. With a twisting motion, push on the cylinder head. Line up the hole in the side and install the screw.

15. Install the balance disc being careful to keep the side marked "top" on top.

16. Install the rotor assembly and cap nut.

17. Before replacing anemometer on support, check its operation by connecting wires to the electrical circuit and buzzer or counter. Rotate cups to see whether proper electrical contact is being made.

BUZZER MAINTENANCE

Buzzer failure or intermittent operation can occur for a number of reasons. Check possible sources of trouble in the following order. Check the battery strength by using new batteries or voltmeter. Two to four dry cells are usually enough; the number needed depends on line distance, buzzer voltage, and battery strength. Too much current will burn the buzzer contacts and the anemometer points.

In the next step, short across from the switch to buzzer. If the buzzer does not work, clean the contacts with a thin file or fine emery paper and finish by drawing a piece of rough paper between the contacts to remove dirt particles. If this fails, bend the vibrator closer to the magnet. If there is still no response, a new buzzer may be needed.

Next check the circuit by shorting across the terminals at the lightning arrester if one is used. Then check the complete wiring circuit by shorting across connections at the anemometer. If the buzzer has operated during these tests, the trouble comes from a faulty anemometer.

☆ U. S. G.P.O.: 1971 – 745-559/5016, REGION NO: 4

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Presents standards for locating, operating, and maintaining forest fire danger stations in Eastern and Southern States. Includes tables and forms for deriving the Spread Index of the new National Fire-Danger Rating System.

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