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Bureau of Reclamation

INFORMATIONAL ROUTING

Memorandum

Denver, Colorado
September 2, 1954

Assistant Commissioner and Chief Engineer

Chief, Engineering Laboratories

Wind charger tests at low wind velocities

The power supply for equipment located in a remote area is critical for long term operation. The absence of commercial power imposes limitations on the instruments and many times requires an exorbitant number of batteries to give satisfactory operation. AUTHOR attached memorandum prepared by operating personnel shows that half of the failures in the radio reporting rain gage network in the Central Valley Project last season can be attributed to the discharged condition of the 2-volt storage batteries. These 2-volt batteries provide the power supply for the filaments in the standby receiver.

A 6-volt wind charger of high capacity was installed in 1951 at the Battle Creek site on an experimental basis. Wind velocities were not of sufficient magnitude for adequate length of time to keep a 6-volt battery in a charged condition. Anemometer recordings verify the results of the test, but also indicate many hours of wind velocity at lower values. Factory data on the wind charger indicates a minimum wind velocity of 9 miles per hour to produce a charging current on that generator. No data were available on voltage or current output at lower wind velocities.

A smaller capacity wind charger (Wincharger No. 617) and an anemometer with its recorder was available at Denver Federal Center. An investigation was initiated regarding the characteristics of the generator, preferably at lower wind velocities. These lower velocities should produce a proportionately lower output voltage adaptable to operation into a 2-volt storage cell. A 6-volt generator cutout was adjusted to "cut in" at about 2.2 volts merely by decreasing the spring tension. By use of two cutouts, the wind charger could be switched between 6- and 2-volt operation. A recorder was connected in the negative lead to the batteries to record the charging current for either condition.

The anemometer and wind charger were both mounted on the roof of the laboratory building. The leads were brought to the Electronics Laboratory where the recording instruments were installed. By indicating on both records the change of operation from 6 to 2 volts or vice versa and the time of change, the average charging current that corresponds to the average wind velocity could be determined. The results are demonstrated in the graph, Figure 1, where average charging current is plotted against wind velocity in knots for both 2- and 6-volt operation.

The plotted points indicate a linear relationship between current and voltage up to the governor control speed for 6-volt operation. The curve for 2-volt operation, however, is not linear, probably due to the characteristics of the shunt wound generator. It is the shunt wound connection that permits operation of the generator at 2 volts without injury.

Points were taken from the curves of Figure 1, converted to miles per hour, and replotted in Figure 2. Of the Central Valley, California, anemometer records from the 1953 season, approximately one month's record was available from each of three stations. The data were tabulated to show the number of hours during the month that the wind blew for each integral miles per hour. The summation of the product of hours at a given wind velocity and the corresponding charge current is the number of ampere hours that would probably be available for the month from the wind charger used in this test. The summation was made for both 2- and 6-volt operation for comparison. The results are shown in Tables 1, 2, and 3.

The values shown in these tables do not reflect the influence of lead-in resistance or relative charge of the batteries. No attempt was made to load the batteries or measure the lead-in resistance since the quality of results desired did not warrant such a degree of precision.

While the wind charger was mounted about 4 feet higher than the anemometer, no correction was applied to the anemometer readings since the accuracy of averaging the recordings would not warrant that refinement.

Conclusions

1. Under the conditions of the test the ampere hours of charge per month is increased appreciably when operating at 2 volts if the wind velocity is predominately below 10 miles per hour.

2. The output of the wind charger is sufficient to meet the stand by receiver requirements of the Central Valley radio reporting rain gage network at stations for which data were available. This requirement has been estimated at 455 ampere hours per month.

3. The procedures developed in the study may be applied to additional anemometer records to determine the practicability of installing a wind charger of this type.

Table 1

COW CREEK STATION--APRIL 1953--28-DAY RECORD

MPH	h	Current at 2 volts	Amp hours at 2 volts	Current at 6 volts	Amp hours at 6 volts
0-4	351	0	0	0	0
5	83	0.15	12.5	0	0
6	83	1.25	103.9	0.25	20.8
7	81	2.1	170	1.1	89.1
8	46	2.8	128.8	1.95	89.7
9	21	3.45	72.45	2.8	58.8
10	4	4.05	16.2	3.65	14.6
11	1	4.5	4.5	4.5	4.5
12	1	5.0	5	5.35	5.4
13	1	5.4	5.4	6.2	6.2
		Total	518.75		289.1
		0-4 MPH	52.23%	of Record time	
		5-9 MPH	46.87%		
		10-max	1.04%		

Table 2

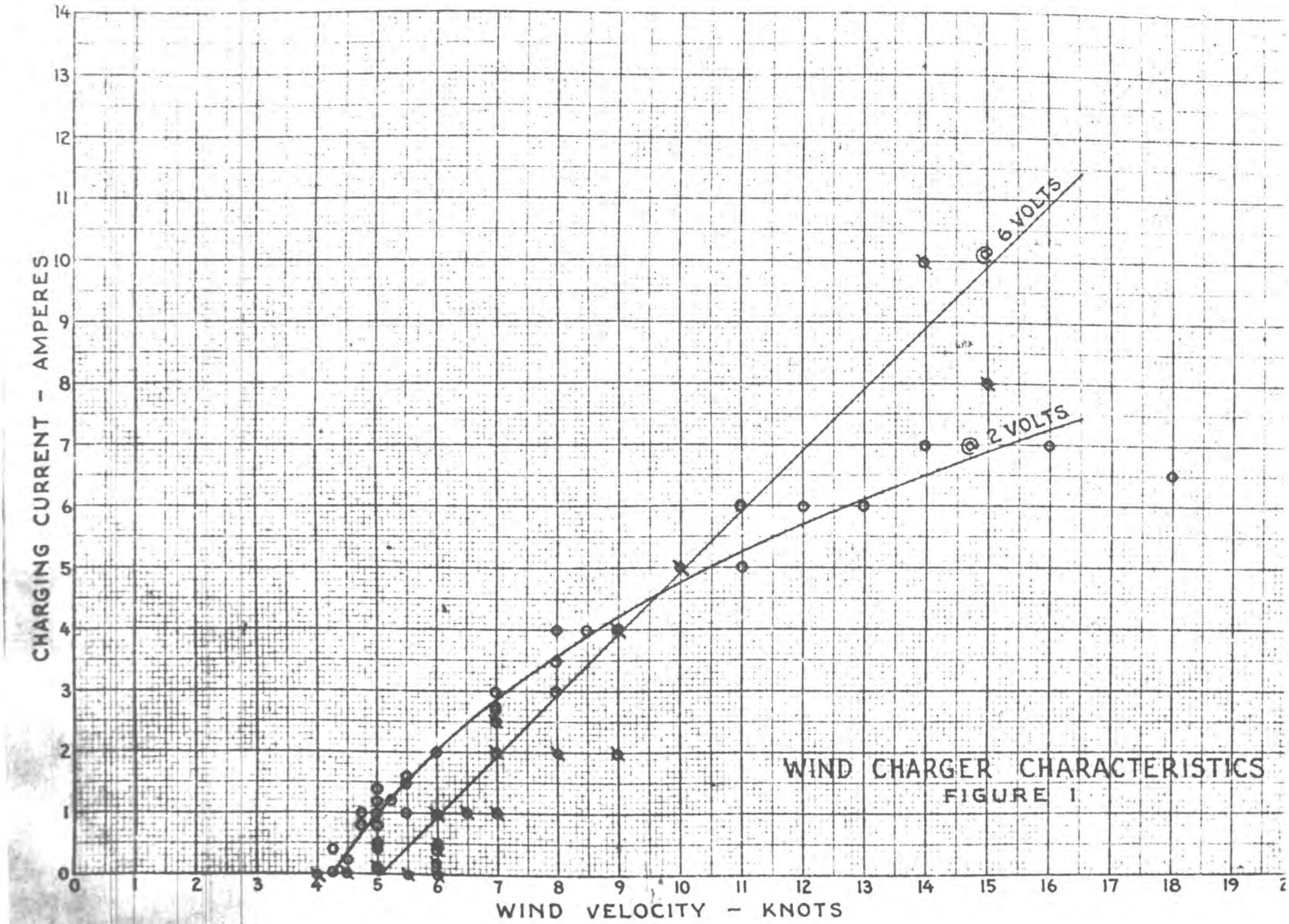
CLEAR CREEK STATION--MARCH 1953--31-DAY RECORD

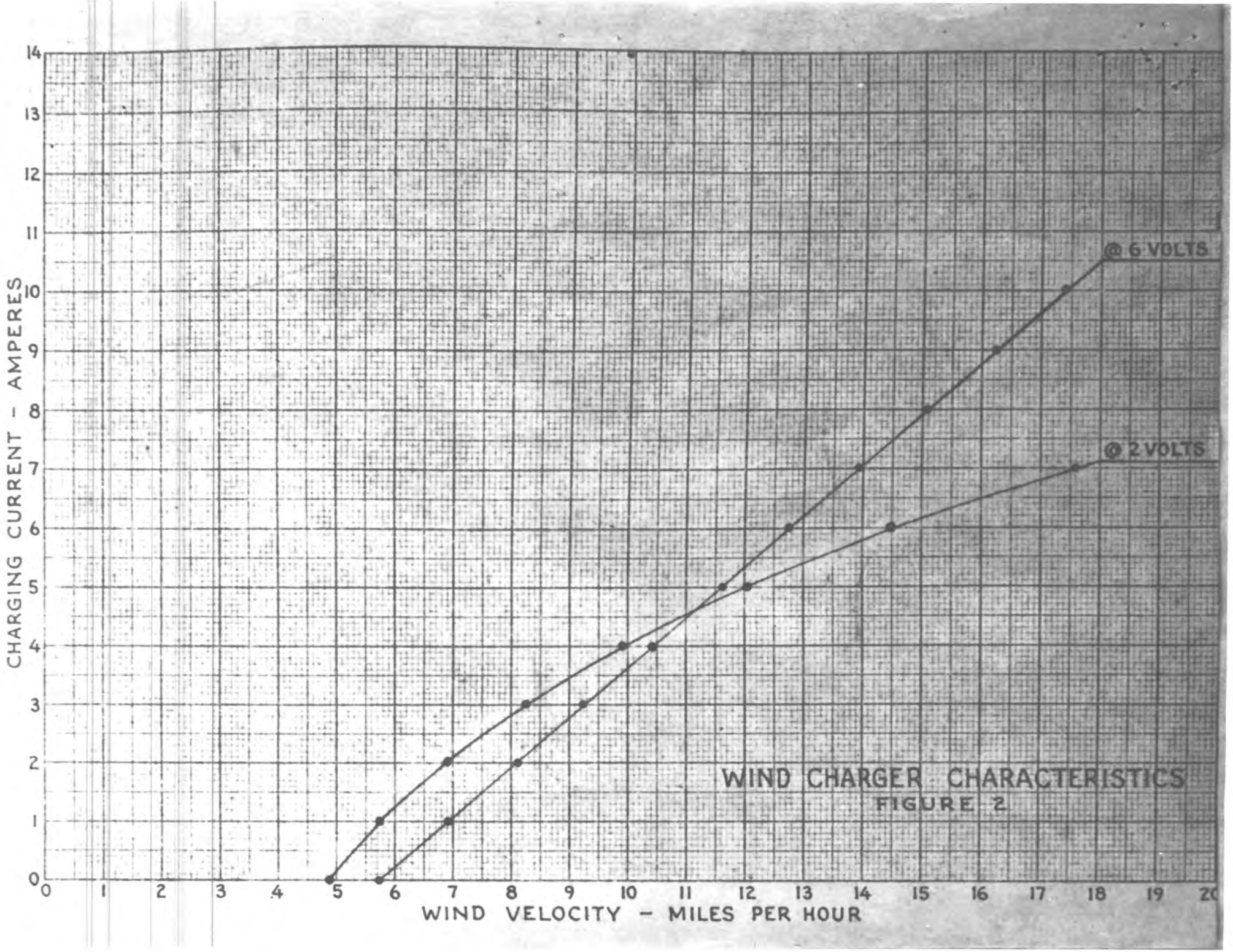
MPH	h	Current at 2 volts	Amp hours at 2 volts	Current at 6 volts	Amp hours at 6 volts
0-4	421	0	0	0	0
5	109	0.15	16.3	0	0
6	94	1.25	117.5	0.25	23.5
7	49	2.1	102.9	1.1	53.9
8	34	2.8	95.2	1.95	66.3
9	17	3.45	58	2.8	47.6
10	9	4.05	36	3.65	32.9
11	3	4.5	13.5	4.5	13.5
12	1	5.0	5	5.35	5.4
13	3	5.4	16	6.2	18.6
14	3	5.8	17	7.05	21.2
15	0	6.2	0	7.9	0
16	1	6.5	6.5	8.8	8.8
		Total	482.9		291.7
		0-4 MPH	56.6% of Record time		
		5-9 MPH	40.73%		
		10-max	2.7%		

Table 3

DEER CREEK STATION--NOVEMBER 1953--25-DAY RECORD

MPH	h	Current at 2 volts	Amp hours at 2 volts	Current at 6 volts	Amp hours at 6 volts
0-4	225	0	0	0	0
5	71	15	10.65	0	0
6	61	1.25	76.25	0.25	15.25
7	48	2.1	98.8	1.1	52.8
8	34	2.8	95.2	1.95	66.3
9	20	3.45	69	2.8	56
10	21	4.05	81	3.65	73
11	14	4.5	63	4.5	63
12	22	5	110	5.35	117.7
13	15	5.4	81	6.2	93
14	12	5.8	69.6	7.05	84.6
15	15	6.2	93	7.9	118.5
16	8	6.5	52	8.8	70.4
17	4	6.8	27.2	9.65	38.6
18 & up	31	7.1	220	10.5	325.5
	Total		1,146.7		1,174.65
		0-4 MPH	37.4% of Record time		
		5-9 MPH	38.93%		
		10-max	23.62%		


CHARGING CURRENT - AMPERES
WIND VELOCITY - KNOTS
@ 6 VOLTS
@ 2 VOLTS
WIND CHARGER CHARACTERISTICS
FIGURE 1


CHARGING CURRENT - AMPERES
WIND VELOCITY - MILES PER HOUR
@ 6 VOLTS
@ 2 VOLTS
WIND CHARGER CHARACTERISTICS
FIGURE 2

C O P Y LJE

April 5, 1954

Memorandum to Operations Supervisor
(D. B. Sturtevant, Electrical Engineer)

Subject: Operation and maintenance experience--Radio rain gage stations--1953-1954 season--Central Valley Project

I General

The six remote radio reporting rain gage stations were activated during the month of October 1953, starting with Cow station on October 9, 1953 and finishing with Deer station on October 26, 1953. The following table indicates the reporting record of each station during the period October 28, 1953 to April 1, 1954, a total of 155 days.

Station	No. days reporting
Deer	144
Battle	145
Cow	137
Elder	145
Cottonwood	134
Clear	152

Prompt attention to correct the malfunction was given to each station not reporting, resulting in a much better operating record than that obtained last season. Several modifications made to the radio rain gage installations also contributed to the improved performance.

It is to be noted that Clear station was the most reliable this season. The increased transmitter power has resulted in a consistent, well-modulated signal over this non-line-of-sight path.

II Required Maintenance

The failure of the stations to respond was found to be due to one of the four following reasons:

1. 2-volt filament storage battery discharged (16 instances)
2. Antenna feedline broken (8).
3. Tone selective reed faulty (4).
4. Handie-talkie failure (4).

Other minor malfunctions which did not result in loss of operation were found and corrected during the regular weekly visit to each station.

Referring to item (1) above, the 2-volt lead-acid batteries are the same units used during the 1952-1953 season. These batteries were maintained on a charge-discharge cycle during the summer of 1953 to keep them in as good condition as possible. After a month of operation at the rain gage sites it was found that the life of these storage cells was considerably less than during the previous season. Consequently, the cells were changed more often in an attempt to provide uninterrupted service. Use of dry cells for the filament supply would provide a more reliable source of filament supply.

The use of two-wire open feed lines to the antennas has not been satisfactory for several seasons. Wind damage has been extensive, the effects of snow and heavy rain change the characteristics of the line, and it is difficult to properly match the high impedance unbalanced input to the handie-talkie.

The tone selective reed at Cow station proved to be a source of trouble on several occasions. When removed and tested it appeared to operate properly. After repeated adjustment failed to cure the trouble, the reed was replaced.

The failure of the handie-talkie units in all cases was due to weak or open filament tubes.

III Other System Weaknesses

There still are many improvements possible in the remaining elements of the system. The call oscillator unit proved unreliable, making it necessary to revert to the use of the audio oscillator. The handie-talkie transmitter cannot be properly modulated with the present circuit arrangement. The coding devices appear to give different pulse output shape from station to station even though carefully adjusted. The scale mechanisms appear to be sluggish in some cases. During the height of a severe storm, when the system reporting is most valuable, the signal strength of some stations is poor and noise effects become troublesome.

IV Recommendations for 1954-1955 Season

The following improvements should be accomplished before reactivating the radio rain gage stations for the 1954-1955 season:

1. Discherd the 2-volt storage cells used as filament supply and use a bank of 1½ volt dry cells, changing as required.

2. Procure new high gain antennas fed with coaxial cable which are designed to be efficient under any weather conditions.

3. Procure transmitters with nominal five watt output for use at each of the stations (except Clear station).

4. Improve the stability of the present call oscillator to assure complete reliability when used in conjunction with the tone responsive reeds. If the present selective calling system cannot be made to function properly, another method should be devised and installed even if the standby battery drain is materially increased.

5. Bench test each of the coding devices to determine if improvement of pulse shape is possible.

6. Clean and readjust each scale mechanism.