Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

PUBLIC AFFAIRS

March 12, 2007

In reply refer to: DK-7

Mr. Rick Evans
High Voltage Safety Supervisor
State of Washington
Department of Labor & Industries
Division of Occupational Safety and Health
P.O. Box 44650
Olympia, WA 98504

RE: FOIA Request 07-017

Dear Mr. Evans:

This letter responds to your request for information that you made to the Bonneville Power Administration (BPA), under the Freedom of Information Act (FOIA), 5 U.S.C. 552. Your letter was received in this office on Wednesday, March 7, 2007, and was assigned a control number, 07-017.

In your request you were asking for a copy of the line maintenance safety test with the title of "Potential danger of shock to groundman while guiding the lower end of a wood pole being set with a boom truck when the top end accidentally contacts an energized conductor of an 115kv 3 phase transmission line" dated December 17, 1971. The enclosed responsive document is provided to you in its entirety.

If you are dissatisfied with our determination, you may make an appeal within thirty (30) days of receipt of this letter to Director, Office of the Hearings and Appeals, Department of Energy, 1000 Independence Avenue SW, Washington, DC 20585. Both the envelope and the letter must be clearly marked "Freedom of Information Act Appeal."

There were no charges associated with the processing of your request. I appreciate the opportunity to assist you with this matter. If you have any questions, please contact me or Laura M. Atterbury, FOIA Specialist, at (503) 230-7305.

Sincerely,

/s/ Christina J. Brannon

Christina J. Brannon
Freedom of Information Officer

Enclosure (Responsive document provided in its entirety)

original
L-1972-8

Line Maintenance Safety Tests

12-17-71

POTENTIAL DANGER OF SHOCK TO GROUNDMEN WHILE GUIDING THE LOWER END OF A WOOD POLE BEING SET WITH A BOOM TRUCK WHEN THE TOP END ACCIDENTALLY CONTACTS AN ENERGIZED CONDUCTOR OF A 115 kV 3-PHASE TRANSMISSION LINE

LR-33552

Tests By

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Branch of Laboratories

Bonneville Power Administration

Portland, Oregon

UNITED STATES GOVERNMENT

Memorandum

DATE : January 12, 1972

In reply refer to : ERH

TO : A. F. Wetsch, Head
Transmission Line & Nonelectric Plant Maintenance Section - OHT

FROM : A. L. Kinyon, Head
Electrical Laboratory Section - ERH

SUBJECT: Transmittal of Safety Test Report, LR-33552

Transmitted herewith is a report entitled "Potential Danger of Shock to Groundman While Guiding the Lower End of a Wood Pole Being Set with a Boom Truck When the Pole Top Accidentally Contacts an Energized Conductor of a 115 kV 3-phase Transmission Line".

This report combines data acquired November 14, 1971, and reported under the same heading on December 3, 1971, with additional data collected on December 17, 1971. The latter data was acquired, in part, from suggestions offered by the following personnel who witnessed the tests: D. A. Gillies, W. G. Neuschwanger, D. Ellsworth, and W. S. Acton from the Branch and Area Maintenance; J. R. Davidson from the Safety Section, and A. L. Kinyon of the Electrical Laboratory Section.

Emphasis was placed upon the results of tests conducted in a manner to represent the most hazardous conditions to be encountered during the pole changeout procedure. It is hoped that the report may provide additional guidance to field personnel where safe procedures must be judged individually on the basis of field conditions involved.

A. L. Kinyon

cc:
Official File - ERA

ALKinyon:vs

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INTERIOR--BONNEVILLE POWER ADMINISTRATION, PORTLAND, OREGON

BPA 1100 Mar. 1971

TABLE OF CONTENTS

	Page
INTRODUCTION	1
HISTORY AND PRELIMINARY TESTS	1
THE TESTS	1
EFFECTIVENESS OF BOOM GROUND RESISTANCE	3
RUBBER GLOVE TESTS	3
PEAVEY TEST	3
CONCLUSIONS	3
FIGURE 1, Wood Pole Resistance Tests	5
FIGURE 2, Circuit Arrangement for Pole	6
FIGURE 3, Circuit Arrangement for Peavey	6
FIGURE 4, Current vs Applied Voltage	7
FIGURE 5, Photo of Contact Burning	8
FIGURE 6, Photo of Glove Test Arrangement	8
FIGURE 7, Photo of Glove Puncture	8
FIGURE 8, Photo of Arc Distance to Glove	8
TABLE I, Resistance-Season Data	9
TABLE II, Moisture Data	10
TABLE III, Test Data, Cedar Pole	11
TABLE IV, Test Data, Fir Pole	13

POTENTIAL DANGER OF SHOCK TO GROUNDMEN WHILE GUIDING THE LOWER END OF A WOOD POLE BEING SET WITH A BOOM TRUCK WHEN THE TOP END ACCIDENTALLY CONTACTS AN ENERGIZED CONDUCTOR OF A 115 kV 3-PHASE TRANSMISSION LINE

INTRODUCTION

This study was made to determine the magnitude of voltage and current to which a groundman may be subjected while making a hotline pole changeout. The measurements were made under simulated conditions which, in general, would represent the most hazardous to be encountered.

Studies included the safety provided by the use of rubber gloves and the use of a peavey for guiding the pole with the lower end swinging free.

HISTORY AND PRELIMINARY TESTS

Two new 60-foot poles were selected at random from the pole yard as specimens. One was a western cedar, class 2, with Penta treatment (approx. 1/2-inch penetration) purchased in Bellingham, harvested in Canada and rafted in from Vancouver, B.C. The other was a Douglar fir from The American Timber and Trading Co., North Plains, Oregon. It was harvested in Oregon, oven dried, and given the 12 lbs. per cu. ft. Penta treatment. Both poles were trucked to the BPA pole yard.

Periodic resistance and moisture measurements were made while in the yard between August and November 1971. During the first week of November they were moved into the EHV Laboratory and kept dry until the date of test. Part of the tests were conducted November 24 and the rest on December 17, 1971. During the 11-24/12-17 time interval the building heat was turned on.

Both megger and power factor set resistance test results are shown in Table I and the monthly resistance variations from the megger readings are shown graphically in Figure 1.

As noted in Table I, measurements conducted with the power factor set indicated the resistance of both poles to be voltage sensitive. However, the resistance variation with voltage change was much greater in the cedar than the fir pole.

Moisture measurements were made with a Delmhorst Moisture Meter. The values measured, as shown in Table II, may be affected by the Penta preservative or the presence of salt which can enter during rafting in coastal waters. They were comparable to those found in past records and are considered to be average for any similar poles chosen at random in this area.

THE TESTS

The position of each pole during high voltage tests, as shown in the sketch Figure 2, consisted of placing the butt end on an insulator, suspending

the pole with a nylon strap attached just about the center, supporting it from the overhead crane (representing a boom), and lifting it to a position where the upper end made contact with a high voltage conductor. The circuit for the peavy test is shown in the sketch, Figure 3. Potential was applied in steps to the upper end of the pole and measurements were made of (1) current between the butt end and the ground with the boom ungrounded, (2) current between a choker at the boom position and ground, and the butt end and ground simultaneously, (3) potential between the butt end and ground with the boom ungrounded, (4) potential between the butt end and ground with the boom solidly grounded, (5) potential between the butt end and ground with 100 ohms inserted in the boom-to-ground circuit, (6) potential between the butt end and ground with 2 k-ohms inserted in the boom-to-ground circuit, (7) potential across rubber glove insulation by placing a finger of the glove against the ungrounded butt end with a smooth grounded electrode inserted in the finger, and (8) current at the butt end between the handle of an attached peavey and ground at positions on the handle where the hands are placed when in use.

Under condition (1) the current through the cedar pole measured at the butt end was 23 ma with only 8 kV applied at the top, and that through the fir pole about 68 ma with 69 kV applied to the top.

Burning occurred at the conductor-to-pole contacts at about 6 kV and 16 ma on the cedar pole and about 50 kV and 50 ma on the fir pole.

The results of these tests are recorded for the cedar pole in Table III, Test 1, and for the fir pole in Table IV, Test 5 and 5a. A graph showing the characteristic of the pole current vs applied voltage is shown for both poles in Figure 4.

Under condition (2) with the boom solidly grounded the current measured between the butt end and ground was over 1 ma and that at the boom 12 ma with only 3 kV applied to the cedar pole. The computed current at the butt end with 69 kV applied at the top would be about 25 ma or more. Under these conditions the fir pole conducted about 45 ma at the boom and about 25 ma at the butt end with 69 kV applied.

Data for these tests are shown for the cedar pole in Table III, Test 2, and for the fir pole in Table IV, Test 5b.

With the boom truck and the butt end ungrounded, the voltage to ground appearing at the butt of the pole was the same as that applied at the pole top. The data for this test is shown only for the cedar pole in Table III, Test 2a.

With the boom solidly grounded the voltage at the ungrounded butt of both poles was greatly diminished (3 to 4 kV). Data for these tests is recorded for the cedar pole in Table III, Test 2b, and for the fir pole in Table IV, Test 5c.

EFFECTIVENESS OF BOOM GROUND RESISTANCE

Tests with a 100 ohm resistance and a 2 k-ohm resistance in series with the boom and ground were studied to represent typical ground rod resistance values encountered in the field. The insertion of these resistances made no significant difference in the voltage appearing at the butt end of the pole. The data for these tests are also recorded for the cedar pole in Table III, Test 2c and 2d, and for the fir pole in Table IV, Tests 5d and 5e.

RUBBER GLOVE TESTS

These tests were conducted by placing one finger of a rubber glove against the ungrounded butt of the pole with a smooth grounded electrode inside the finger. The boom was ungrounded. The results for these tests are shown for the cedar pole in Table III, Test 3 and Test 4, and for the fir pole in Table IV, Test 6, 6a and 6b.

As noted, puncture occurred in each case with a voltage of 41 to 43 kV applied at the pole top. Photographs of the pole burning and of some features of the rubber glove puncture are shown in Figures 5, 6, 7, and 8.

PEAVEY TEST

This test was conducted to determine if two peaveys, one on each side, could be substituted for the rubber gloves. In effect it was conducted to determine if the peavey handles were sufficiently nonconductive to be used safely in this case. This test was conducted only on the fir pole. These tests showed that with 60 kV applied at the pole top, one peavey conducted only 0.22 ma and 0.01 ma from the middle and the end of the handle to ground respectively, while the other conducted 45 ma and 0.01 ma from the moddle and the end to ground respectively. At 80 kV the handle of one peavey began to burn and conducted 70 to 100 ma. A tabulation of test data is shown in Table IV, Test 7 and Test 7a.

CONCLUSIONS

As noted from the data, the most critical condition which could occur would be one where the boom and choker is not effectively grounded and the bottom end swings free or is insufficiently grounded to drain the pole current to ground. Under these conditions the maximum voltage appearing at the base of the pole prior to current flow would be approximately the applied line voltage. The maximum current which could be conducted through the poles under these conditions was about 1 ampere for the cedar pole and about 65 milliamps for the fir pole.

With the boom grounded the data shows the voltage at the ungrounded butt end was reduced to 3 or 4 kV. With the boom and butt both grounded, the major part of the current was conducted through the boom circuit. However, this did not provide sufficient conductivity to prevent a dangerous current flow through the bottom end even with the boom and butt connected metallically to the same ground terminals.

The glove test demonstrated the voltage level to which the isolated pole butt could rise by puncturing the glove in each case at an applied voltage of about 40 to 43 kV at the upper end. It was also demonstrated that, following puncture, the current flow through the glove to ground could be far above the danger level.

The peavey test indicated that if these tools are used for guiding the pole they should be equipped with handles made of fiberglas or other suitable hotline material.

While the report points out some of the potential dangers involved, it should be pointed out that the safety features of the work procedure would have to be judged from conditions and variables in each case, such as:

1. Condition of the pole (conductivity).

2. Effectiveness of grounding at the boom attachment.

3. Effectiveness of the boom-truck grounding.

4. Consideration of the boom operator under conditions in 3 above.

5. Soil resistivity at the base of the pole.

6. Probability of the pole swinging free.

7. Resistance of the circuit through a groundman and his contact to earth, etc.

The tests are believed to be realistic for poles and weather conditions during the major part of any given year in the Pacific Northwest region. It is possible that similar tests conducted in drier areas may yield less pessimistic results.

If there is any possibility that the boom-supported pole can contact an energized line during the setting operation, guidance of the pole butt should be provided by hotline rope and/or hotline tools. As there is a possibility that the full line voltage could appear at the pole butt and that the pole could conduct lethal currents, working distances commensurate with the voltage rating of the line should be maintained.

We do not recommend the use of rubber gloves as they, in our opinion, will not provide significant protection in case of accidental contact. In fact, they might well increase the hazard by by creating a false sense of security.

WOOD POLE RESISTANCE TESTS

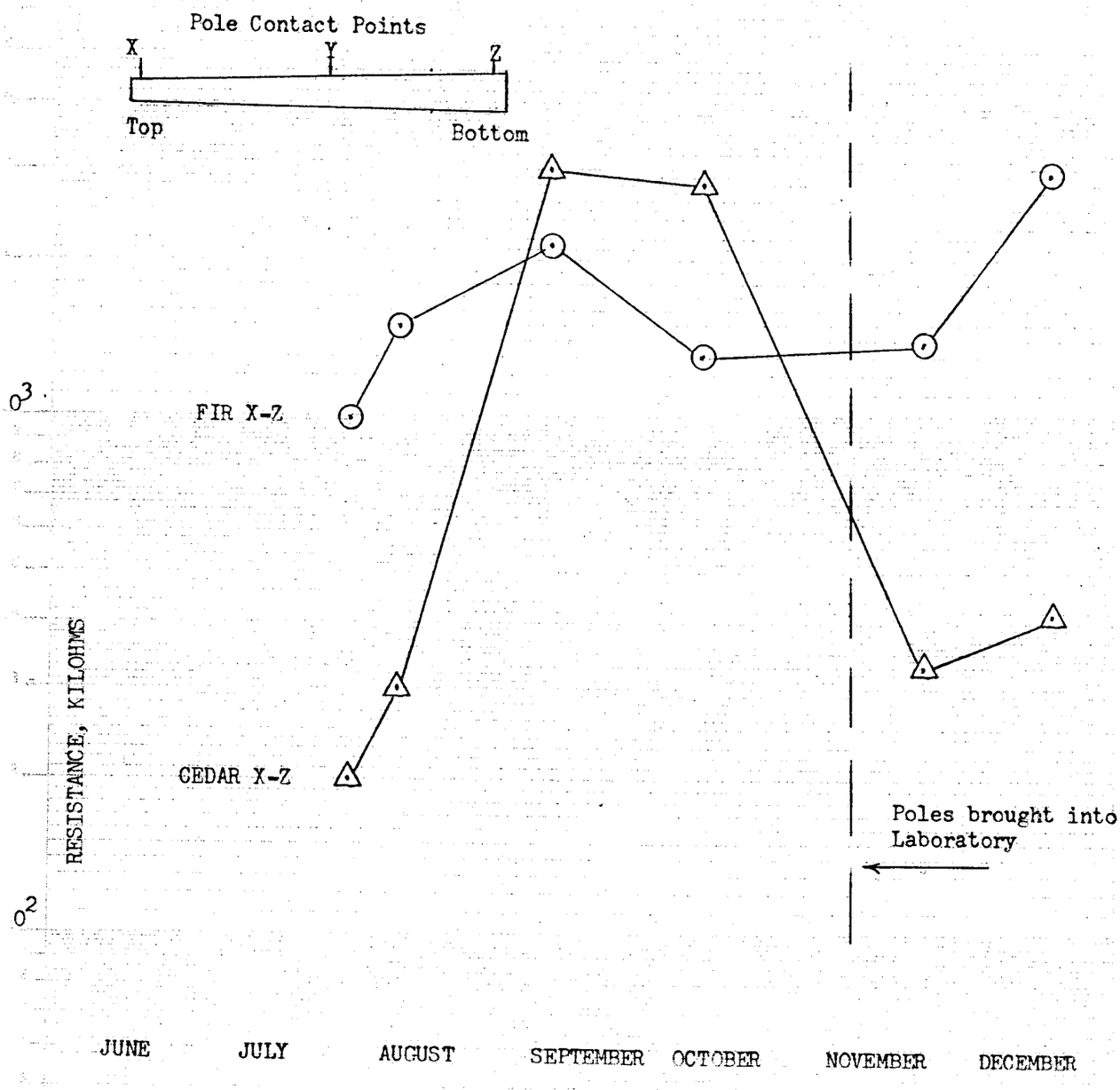

Figure 1: Resistance-Season Characteristics for Cedar and Fir Poles Picked at Random in the J. D. Ross Pole Yard.

YEAR 1971 ----→

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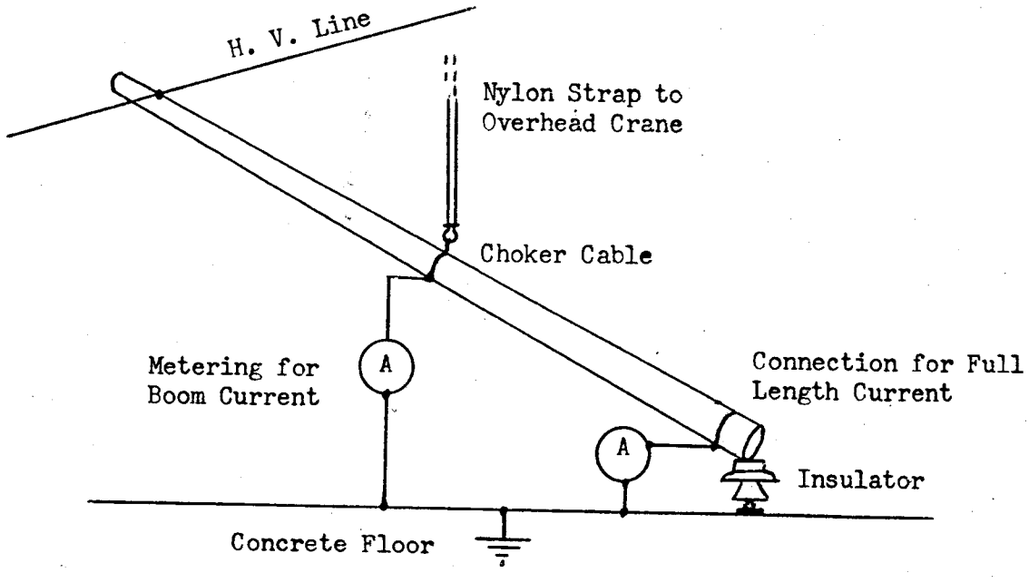


Figure 2: Pole position and circuit for measuring conduction current during simulated field conditions.

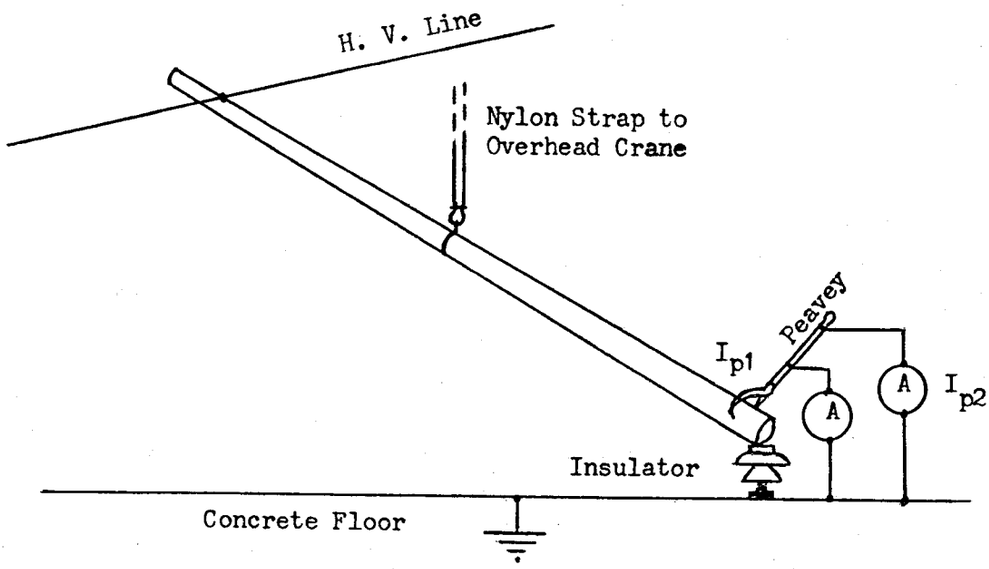


Figure 3: Arrangement for measuring conduction current through Peavey handle.

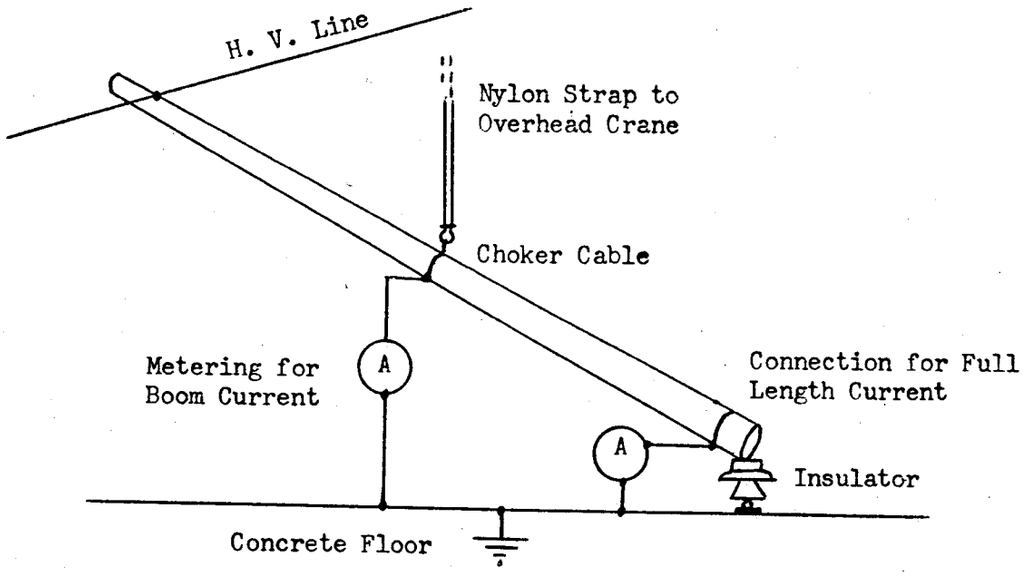


Figure 2: Pole position and circuit for measuring conduction current during simulated field conditions.

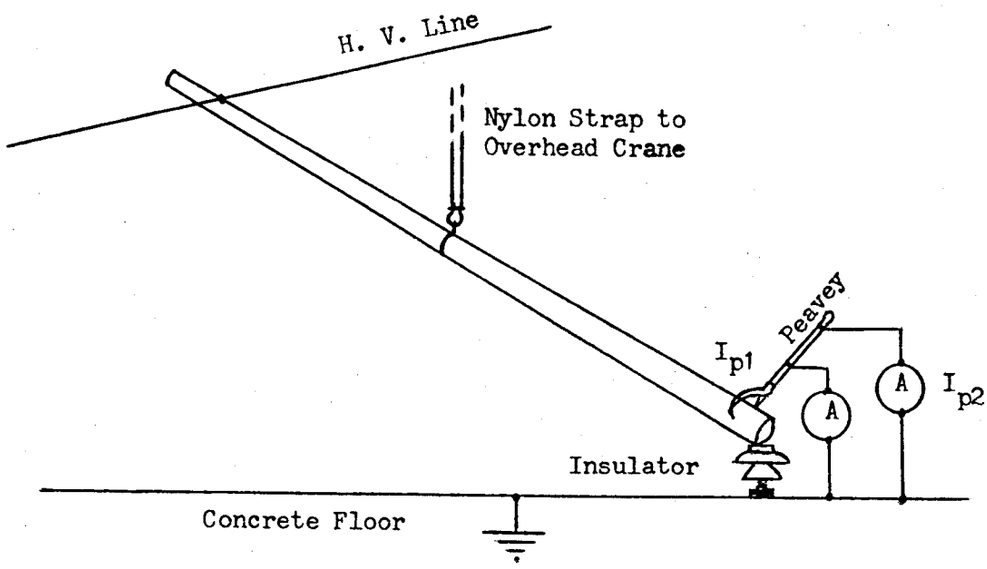


Figure 3: Arrangement for measuring conduction current through Peavey handle.

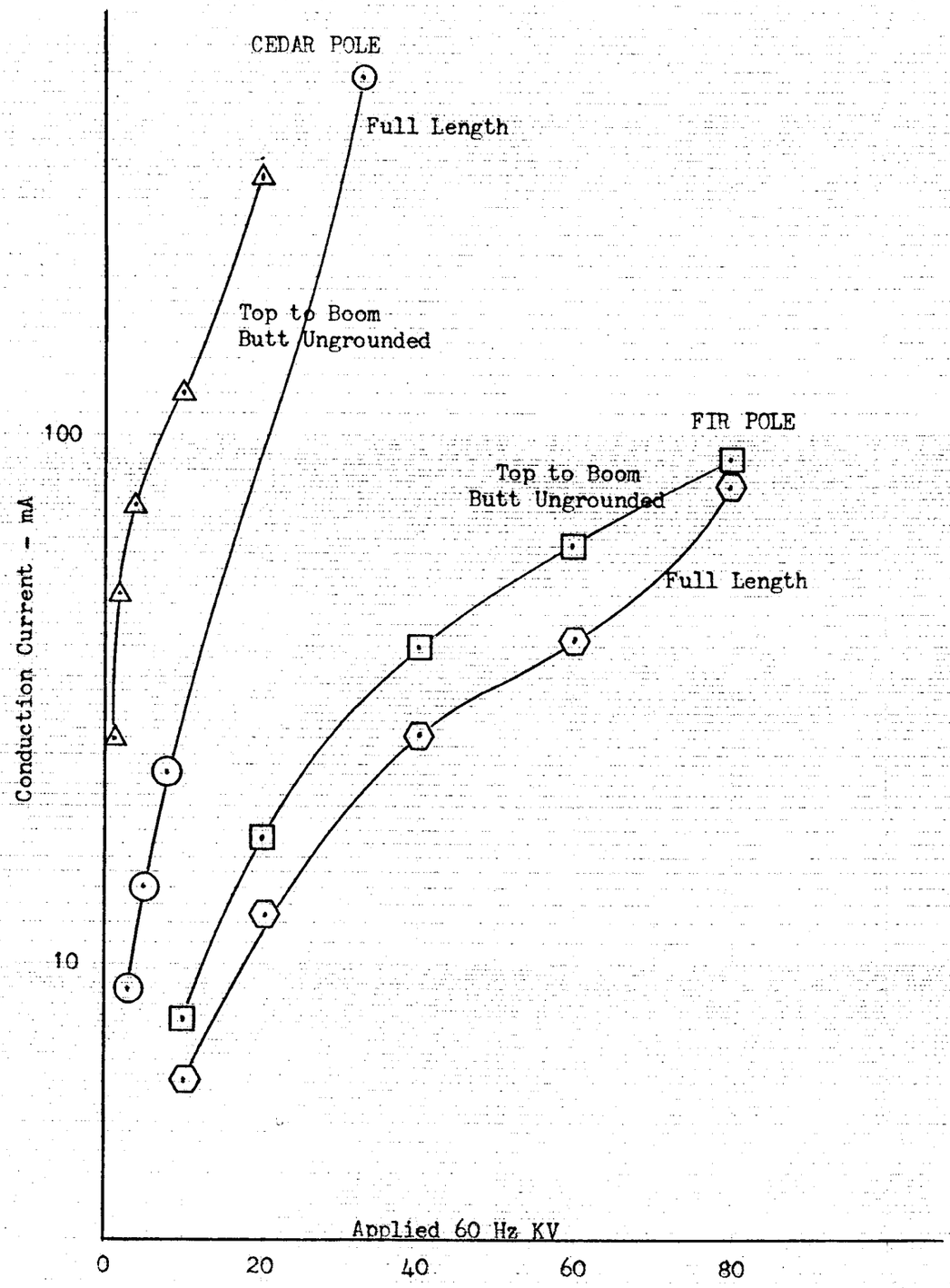


Figure 4: Conduction Current versus Applied Voltage of 60-foot Cedar and Douglas Fir Poles.

Fig. 5. Burning occurred at a conduction current of about 15 ma and above.

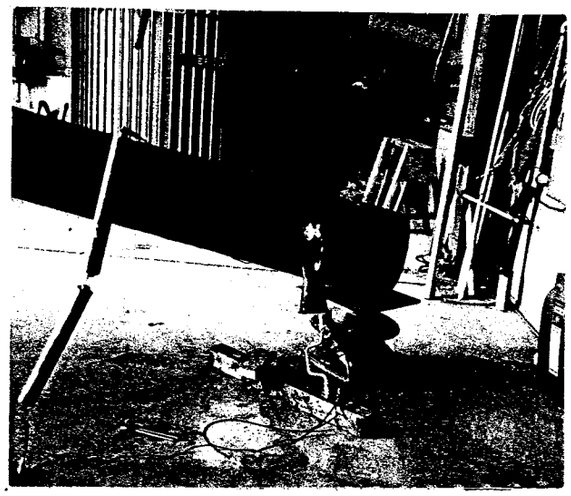


Fig. 6. Showing the method for testing with the rubber glove. Note the arc near the finger ends.

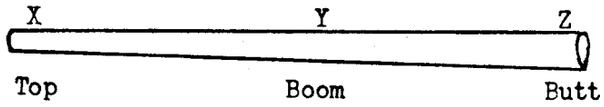
Fig. 7. Test results showing electrical puncture of glove finger.

Photo missing from original
3/7/07

Fig. 8. Showing the burn point on the pole where the arc of Fig. 7 terminated. (the distance between this point and the glove was about 1/2-inch).

TABLE I

Resistance-Season Tabulation for a
New 60-foot Cedar and a Fir Pole Taken at the J. D. Ross Pole Yard



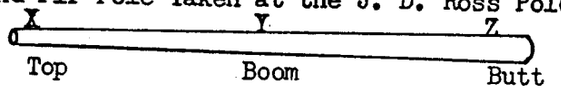
Date	Resistance by Megger K Ω X-Z	Y-Z	X-Y	Resistance by Power Factor Set A-C K _ @KV	B-C K _ @KV	A-B K @KV
Cedar						
8-8/9-71	300	600	550	455/2	465/2	87/2
				NR	84/8	59/6
9-9-71	3000	3000	1750	1960/2	3330/2	1098/2
				--		690/6
10-8-71	2800	2900	160			
11-19-71	330	390	330	260/2	200/2	870/2
				110/8	77/8	70/8
12-17-71	430	590	570	760/2	260/2	5700/2*
				117/10	190/6	240/6*

* Erratic - burning at point "B"

Fir						
8-8/9-71	1500	550	1250	1380/2	340/2	1380/2
				1390/10	455/10	1210/10
9-9-71	2115	625	1800	3410/2	896/2	1560/2
				3040/10	588/10	1380/10
10-8-71	1300	490	1050			
11-19-71	1390	590	1310	1520/2	540/2	1250/2
				1320/10	440/10	1190/10
1-17-71	2900	700	2700	2700/2	520/2	2500/2
				2000/10	500/10	1740/10

TABLE II

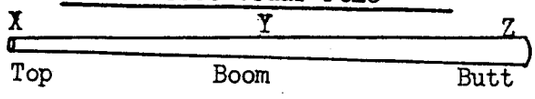
Moisture Measurements in One Each 60-foot Cedar and Fir Pole Taken at the J. D. Ross Pole Yard



Date	Position	Moisture Content - Percent (Delmhorst) Depth in Inches: Surface	1"	2"	3"	Remarks
		Cedar				
7-29-71	X	11.2	25	26	30	
	Y	12	26.5	30	30	
	Z	11	24.8	30	30	
8-9-71	X	10	29	--	--	
	Y	7	24	30	--	
	Z	7	23	30	--	
9-9-71	X	14	20.5	--	30	(3/4")
	Y	11	--	--	30	
	Z	13	18	22	30	
10-8-71	X	8	7	7	10	
	Y	7	25	30	--	
	Z	10	30	--	--	
11-19-71	X	12	27	26	30	(2-3/4")
	Y	19	30	--	--	
	Z	11.5	17	21	25	
12-17-71	X	8	--	30	--	
	Y	8	20	23	28	
	Z	9	17	19	21	
		Fir				
7-29-71		--	--	--	--	No test
8-9-71	X	9	22	20	21	
	Y	9	23	30	--	
	Z	8	23	30	--	
9-9-71	X	11	16.5	19.2	30	
	Y	12	20	20.4	30	(2-5/8")
	Z	14	19.2	25	30	
10-8-71	X	13	20	23	23	
	Y	7	22.5	22.5	30	
	Z	11.5	20.5	29	30	
11-19-71	X	12	17	19	22	
	Y	15	23	21	30	
	Z	15	21.5	30	--	
12-17-71	X	8	15	16	18	
	Y	10	17	20	22	
	Z	9	19	23	30	

TABLE III

Wood Pole Conductivity Test
60-foot Cedar Pole



Date	Applied Volts To Top Ex kV	Volts Read At Boom Ev kV	Volts Read at Butt Ez kV	Current Boom to Ground Iy ma	Current Butt to Ground Iz ma	Remarks
Test 1:	Full length with boom insulated. Butt grounded through Ammeter					
11-24-71	3				9	
	4				11	
	5				14	
	6				16	Butt and tip contact burning
	7				19	
	8				23	
	9				20-23	Burning at both ends
Test 2:	Current distribution. Boom and butt grounded through ammeters					
11-24-71	1.3			27	0.7	
	2.0			49	0.9	
	3.0			72	1.1	Burning at top end
Test 2a:	Voltage at butt end with boom and butt ungrounded					
12-17-71	10		10			
	20		20			
	40		40			
Test 2b:	Voltage at butt end with boom solidly grounded					
12-17-71	10		2.8	119		
	20		3.3	300		
Test 2c:	Same as 2b except 100 ohms in boom ground					
	10		3.5	135		
	20		4.5	306		
Test 2d:	Same as 2b except 2 k-ohm in boom ground					
12-17-71	10		3.0	126		
	20		3.0	323		
Test 3:	Rubber glove test					
11-24-71	One finger of rubber glove with a smooth grounded electrode inserted inside was placed against the butt of the pole--both the boom and butt end were ungrounded. Puncture occurred when the applied voltage at the pole top was 41 kV. No current measurement.					

TABLE III, continued

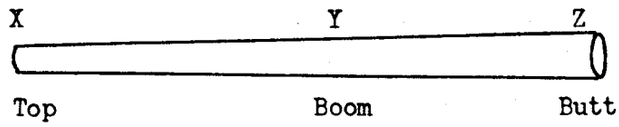
Wood Pole Conductivity Test
60-foot Cedar Pole

Test 4: Repeat of Test 3 with current measurement (different finger of glove)

11-24-71 Puncture occurred when the applied voltage at the pole top was 43 kV. When puncture occurred the applied voltage dropped to 33 kV and held. The current through the glove puncture was 470 ma.

TABLE IV

Wood Pole Conductivity Test
60-foot Fir Pole



Date	Applied Volts To Top E_X kV	Volts Read At Boom E_Y kV	Volts Read At Butt E_Z kV	Current Boom to Ground I_Y ma	Current Butt to Ground I_Z ma	Peavey Test Current Leakage Through Handle to Grnd. Middle I_{p1} ma	Top I_{p2} ma
Test 5: Full length - boom insulated - butt grounded through ammeter							
11-24-71	10				10.5		
	20				20.5		
	30				30		
	40				40		
	60				59		
	70				69		
Test 5a: Repeat of Test 5 after 22 days storage in dry bldg. (boom voltage included)							
12-17-71	10	1.42			6		
	20	2.60			12.5		
	40	7.80			27.5		
	60	13.70			41.5		
	80	19.0			59.5		
Test 5b: Current distribution - boom and butt both grounded through ammeters							
12-17-71	10			3.7	3.0		
	20			6.0	8.0		
	40			19.5	8.5		
	60			36.0	22.0		
	80			60.0	17.0		
Test 5c: Voltage at ungrounded butt end with boom solidly grounded							
12-17-71	10		2.2	8.0			
	20		2.6	17.6			
	40		3.1	39.2			
	60		4.0	62.0			
	80		3.8	89.5			

TABLE IV, continued

Wood Pole Conductivity Test
60-foot Fir Pole

Date	Applied Volts To Top E_X kV	Volts Read At Boom E_Y kV	Volts Read At Butt E_Z kV	Current Boom to Ground I_Y ma	Current Butt to Ground I_Z ma	Peavey Test Current Leakage Through Handle to Grnd. Middle I_{pi} ma	Top I_{p2} ma
Test 5d: Voltage at ungrounded butt end with boom grounded through 100-ohm resistor.							
12-17-71	10		2.7				
	20		3.4				
	40		3.7				
	60		4.0				
	80		4.0				
Test 5e: Voltage at ungrounded butt end with boom grounded through 2 k-ohm resistor							
12-17-71	10		2.8				
	20		3.1				
	40		3.8				
	60		4.0				
	80		4.3				

Test 6: Rubber glove test

One finger of rubber glove with a smooth grounded electrode inserted inside was placed against the butt of the pole. The boom and butt end were ungrounded. Puncture occurred when voltage applied at top end was 42 kV. After puncture, the applied voltage dropped to 38 kV and the current through the puncture was 38 ma.

Test 6a: Repeat of Test 6

Punctured with an applied voltage of 48.5 kV. When puncture occurred the applied voltage dropped to 48 kV and the current through the puncture was 46 ma.

Test 6b: Glove test with boom grounded and glove against the puncture butt end

No puncture with 60 kV applied to top end.

TABLE IV, continued

Wood Pole Conductivity Test
60-foot Fir Pole

Date	Applied Volts To Top E_X kV	Volts Read At Boom E_Y kV	Volts Read At Butt E_Z kV	Current Boom to Ground I_Y ma	Current Butt to Ground I_Z ma	Peavey Test Current Leakage Through Handle to Grnd. Middle I_{p1} ma	Top I_{p2} ma
12-17-71	Test 7: Peavey Test						
				Old Peavey			
	10					0	0
	20	16				.07	0
	40	34				.14	0
	60	51				.22	.01
	80	70				.31	.013
				New Peavey			
12-17-71	Test 7a:						
	10	8.2				.34	.021
	20	16				1.05	.035
	40	33				4.20	.020
	60	49				45.0	.010
	80	25				70.0	.010