Cost Effective Mitigation of Wildfire Risk Generated by Power Lines

K. Deuar*

*Kris Deuar & Associates, Inc.
Warrensburg, MO, USA, kris_deuar@hotmail.com

ABSTRACT

The recently developed extremely accurate Micro-Stress Pole Testing (MSPT) technology can save a lot of money by elimination of costly replacements of poles which are prematurely rejected by presently used inaccurate pole inspection methods. This ability of the MSPT has been consistently proven by many pilot tests and validation pole break tests. Regarding the urgent need to reduce the risk of wildfires the MSPT appears to be an ideal tool to accurately check and minimize the number of poles which must be replaced for stronger poles capable to safely support new larger and heavier insulated wires. Money saved in this way can be used for wider and faster application of insulated wires at no additional cost.

Keywords: wildfire mitigation, efficient risk management, resilience of power grid, pole inspection and testing, insulated wires

1 HOW IT WORKS

Having been extremely accurate the MSPT can uniquely identify additional amount of pole strength based on the following facts:

1. The standard values of wood fiber strength represent the 5th percentile obtained from laboratory break tests. It means that 95% of poles have the actual wood fiber strength greater than the standard value used for determining pole strength (and quite often it is twice as strong).

Table 8.--Summary of pole test values considered by ASA Committee 05,[1] 1947

Species	Number of test groups	Number of test poles	Modulus of rupture: Average	Modulus of rupture: Estimated coefficient of variation
(1)	(2)	(3)	(4)	(5)
			P.s.i.	Percent
Northern white-cedar	6	142	3,700	16
Western redcedar	9	341	6,100	20
Southern yellow pine	8	641	8,000	17
Douglas-fir	7	144	8,900	20
Lodgepole pine	10	244	6,900	20
Red pine	9	166	6,400	20
Jack pine	3	147	8,000	16
Ponderosa pine	1	5	5,400	....
Western hemlock	1	15	8,200	....
Engelmann spruce	1	20	4,400	....
Atlantic (southern) white-cedar	2	38	5,000	....
Baldcypress	1	9	8,600	....
Redwood	2	19	7,500	....

[1]Data from unpublished committee minutes.

Figure 1: Coefficient of Variation for MOR in Wood Poles

2. Many poles installed in the past are significantly oversized (stronger than need be).

2 SCIENTIFIC JUSTIFICATION

To illustrate the magnitude of unutilized additional strength of poles let us look closer at the example of Red Pine poles (see Fig. 1) [1]. Laboratory break tests of 166 poles have found that the average Modulus of Rupture of wood fibers (MOR) was 6,400 psi and corresponding Coefficient of Variation was 20% (or 0.20). Hence, the value of Standard Deviation was 1,280 psi (6,400 psi x 0.20).

From the Normal Distribution Statistical Table it can be determined the following:

- z statistics for 5th percentile of standard value of MOR is equal to 1.65
- standard value of MOR is equal to 4,288 psi (6,400psi – 1.65 x 1,280psi)
- out of 166 break tested poles approximately 8 poles (5%) had MOR less than the standard value
- the weakest pole had MOR value approximately equal to 3,174 psi (6,400psi – 2.52 x 1,280psi)
- out of 166 break tested poles approximately 158 poles (95%) had MOR greater than the standard value
- the strongest pole had MOR value approximately equal to 9,626 psi (6,400psi + 2.52 x 1,280psi)

So, the strongest pole in a relatively small sample of 166 poles had MOR value 2.24 (9,626psi / 4,288psi) times greater than than the standard MOR value.

Regarding the oversize factor of poles, a study has been carried out on a random sample of 53 relatively old poles tested at Unison Networks in New Zealand (see Fig. 2). To some surprise it has been found that the average ratio of Original Pole Strength (based on a standard value of fiber strength MOR) to Required Pole Strength was as high as 2.87.

A joint effect of additional fiber strength (well above the standard value) and significantly oversized poles has been evaluated on a large population of 7,708 poles with an average age of about 60 years. It was found that an average remaining serviceable life for these poles was 35 years.

Current Pole Strength	Original Pole Strength	Ratio of Original/Required Strength	Percentage of Original Strength	Basic Pole Status	Required Pole Strength	Working (Design) Load	Factor of Safety
30.48	88.91	1.70	34	STATUS : Reject	52.18	15.46	1.97
11.38	207.99	3.62	5	STATUS : Priority Reject	57.48	17.03	0.67
241.06	256.45	2.28	94	STATUS : Serviceable	112.51	33.34	7.23
72.56	112.34	1.62	65	STATUS : Reject Reinf	69.55	20.61	3.52
178.83	332.25	2.62	54	STATUS : Reject Reinf	126.89	37.6	4.76
301.51	274.1	5.29	110	STATUS : Serviceable	51.79	15.35	19.64
44.72	273.7	1.51	16	STATUS : Priority Reject	181.07	53.65	0.83
112.86	349.11	1.92	32	STATUS : Priority Reject	181.86	53.88	2.09
279.38	253.98	1.38	110	STATUS : Serviceable	183.84	54.47	5.13
326.11	296.46	1.72	110	STATUS : Serviceable	172.69	51.17	6.37
249.86	244.35	1.56	102	STATUS : Serviceable	156.81	46.46	5.38
270.77	320.65	3.34	84	STATUS : Serviceable	96.03	28.45	9.52
293.74	267.04	3.01	110	STATUS : Serviceable	88.67	26.27	11.18
300.6	273.27	3.38	110	STATUS : Serviceable	80.8	23.94	12.56
271.51	246.83	9.24	110	STATUS : Serviceable	26.7	7.91	34.32
257.83	234.39	5.27	110	STATUS : Serviceable	44.51	13.19	19.55
384.55	349.59	2.86	110	STATUS : Serviceable	122.24	36.22	10.62
385.73	409.33	3.26	94	STATUS : Serviceable	125.43	37.16	10.38
47.88	306.61	2.96	16	STATUS : Priority Reject	103.67	30.72	1.56
357.43	324.94	1.83	110	STATUS : Serviceable	177.66	52.64	6.79
103.94	94.49	1.42	110	STATUS : Serviceable	66.48	19.7	5.28
109.87	99.88	1.43	110	STATUS : Serviceable	69.93	20.72	5.3
65.43	59.48	1.14	110	STATUS : Serviceable	52.05	15.42	4.24
306	278.18	5.91	110	STATUS : Serviceable	47.06	13.94	21.95
90.6	82.36	1.46	110	STATUS : Serviceable	56.23	16.66	5.44
86.42	78.56	0.92	110	STATUS : Serviceable	85.3	25.27	3.42
101.63	92.39	1.82	110	STATUS : Serviceable	50.73	15.03	6.76
124.54	262.65	2.29	47	STATUS : Reject	114.69	33.98	3.67
279.38	253.98	10.59	110	STATUS : Serviceable	23.98	7.11	39.29
146.35	251.83	1.70	58	STATUS : Reject Reinf	148.49	44	3.33
327.67	405.18	2.61	81	STATUS : Serviceable	155.19	45.98	7.13
29.51	342.11	3.39	9	STATUS : Priority Reject	100.78	29.86	0.99
434.56	433.77	2.30	100	STATUS : Serviceable	188.52	55.86	7.78
299.32	383.45	2.15	78	STATUS : Serviceable	178.58	52.91	5.66
145	247.67	1.18	59	STATUS : Reject Reinf	209.82	62.17	2.33
306.77	347.37	2.10	88	STATUS : Serviceable	165.55	49.05	6.25
114.78	319.1	2.52	36	STATUS : Reject	126.4	37.45	3.06
188.31	332.25	1.38	57	STATUS : Reject Reinf	240.51	71.26	2.64
381.8	347.09	2.87	110	STATUS : Serviceable	120.78	35.79	10.67
348.62	316.93	2.89	110	STATUS : Serviceable	109.62	32.48	10.73
264.65	241.11	1.41	110	STATUS : Serviceable	171.25	50.74	5.22
377.86	343.51	3.07	110	STATUS : Serviceable	112.07	33.21	11.38
298.07	322.52	2.93	92	STATUS : Serviceable	110.2	32.65	9.13
168.46	244.35	1.77	69	STATUS : Serviceable	137.8	40.83	4.13
404.07	367.34	6.59	110	STATUS : Serviceable	55.73	16.51	24.47
313.47	284.97	2.22	110	STATUS : Serviceable	128.42	38.05	8.24
29.03	78.42	1.78	37	STATUS : Reject	44.18	13.09	2.22
17.44	78.54	0.92	22	STATUS : Priority Reject	85.58	25.36	0.69
17.9	60.24	1.39	30	STATUS : Priority Reject	43.27	12.82	1.4
72.81	138.85	2.19	52	STATUS : Reject Reinf	63.35	18.77	3.88
56.54	121.05	3.47	47	STATUS : Reject	34.85	10.32	5.48
68.58	80.35	1.69	85	STATUS : Serviceable	47.65	14.12	4.86
64.98	85.56	7.51	76	STATUS : Serviceable	11.4	3.38	19.22
		Average Ratio = 2.87					

Figure 2: Oversize Ratio of Original Pole Strength to Required Pole Strength

3 SUMMARY

It is estimated that the MSPT technology can save and leave safely in service about 50% of poles which are currently prematurely and unnecessarily replaced with stronger poles to be able to carry heavier insulated wires. Money saved in this way can be used for wider and faster installation of insulated wires at no additional cost. And importantly, it can save more people's life and their properties from devastating effects of wildfires.

REFERENCES

[1] Lyman W. Wood, E.C.O. Erickson and A.W. Dohr, "Strength and Related Properties of Wood Poles", American Society for Testing Materials, September 1960.