

Pole Top Deterioration Study For The Electrical Utility Industry

**This research study was conducted to determine the causes
behind wood pole top deterioration**

By

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Pole Top Deterioration Study

This study is based on Distribution utility poles in the State of Florida. For this study we physically performed a field check, photographed and inspected over 5,000 distribution poles over a 5-year span, ranging from 2012 to 2017. We have documented a large number of these poles to have deteriorated pole tops in the state.

The main type of wood poles in this study and the most common in the Eastern United States is Southern Pine.

TREATMENTS

The three (3) types of wood preservatives used to treat these wood poles in this study are Creosote, Penta and CCA.

The utilities use of these chemically treated wood preservatives has changed throughout time due to costs and EPA rulings.

Most of the oldest poles in the State of Florida are Creosote which tend to have been installed up until the mid-1970's. These are the dark brown, coal tar/oil-based wood poles. Towards the mid-1970's, most likely due to economics and EPA rulings, several of the large utilities in the state switched to a Penta treated wood pole. These Penta poles from the 1970's can be found today as a beige/grey color with a large brown residual towards the bottom four feet at the base of the pole. The brown residual is caused by the oil-based treatment leaching down over time leaving the tops unprotected and in a much deteriorated state.

Around 1980, most utilities in the state had switched to the new green Chromated Copper Arsenate (CCA) poles. The chromium is used to bond the two elements of copper and arsenate to the wood. The green oxides of the copper are used to waterproof and protect the wood as a fungicide while the arsenate is used as a toxin against insects.

CCA poles are highly leach resistant and more environmentally friendly. Another big difference between CCA, Creosote and Penta poles is CCA treatment is done with a more economical waterborne pressure treatment versus Creosote and Penta using oil borne treatment.

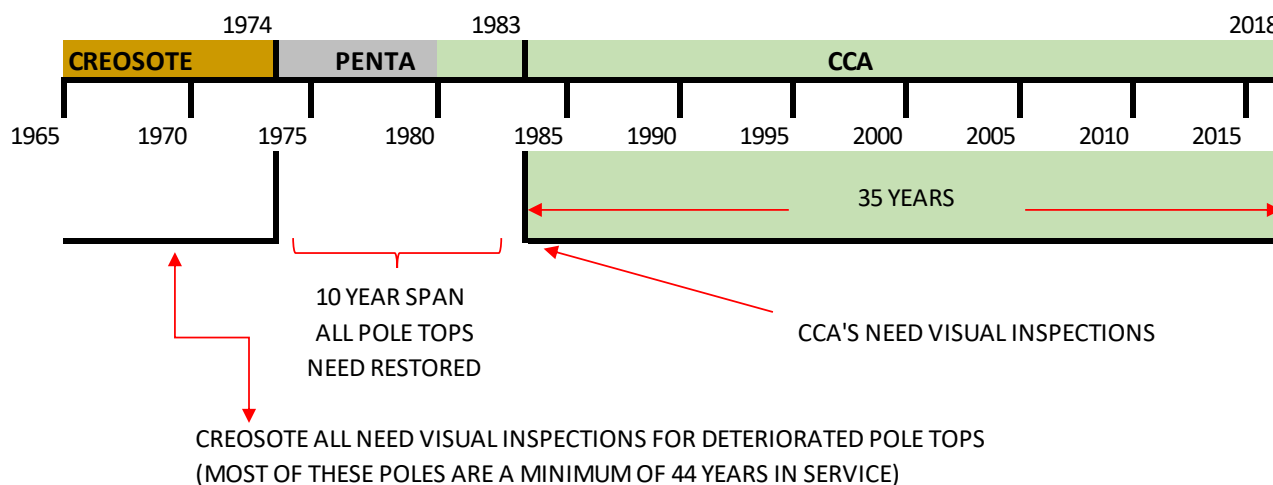
WHY POLE TOP DETERIORATION TODAY?

The utility industry did not have much of a pole top deterioration problem until 2010 when the first heavy use of Penta poles in Florida reached 35 years old (see pole time line). Today there exists wide spread pole top failure of 1970's installed Penta poles throughout the system. We are also now witnessing pole top failure with the first CCA poles installed from 1980 thru 1983. These CCA poles effectively are only lasting, on average, 35 years as far as pole top deterioration. The original Creosote poles have always weathered the best. Some Creosote poles are still in use today that were installed in the 1960's. However, we are seeing some pole top failure now with the Creosote poles that remain. Conclusion being, due to heavy tar coating treatment at the top, the failure rate was slower with Creosote.

This brings a new challenge today for the utility industry – due to economics and health concerns in the 1970's, pole treatments were changed. Today we have found, due to this change, that the pole top failure rate has begun after approximately 35 years of in service use in Florida.

There is a secondary cause that has contributed to pole top failure rate –ground line pole treatment. Although this is an excellent tool and a necessity for wood poles, ground line treatment has actually extended the useful life of the pole thus allowing additional time for pole top deterioration and failure.

POLE TOP DETERIORATION TIME LINE



POLE INSPECTIONS AND TREATMENT

Historically all pole line inspecting and treatment has been dedicated to the ground line area of poles. Typically, this has been the majority of all rot and deterioration of the poles. Some utilities have requested visual pole overall inspection and maintenance. There has been little to no documentation or studies that have identified pole top failure. Logical reasoning being, it has only recently become a serious concern and a growing liability for the utility industry.

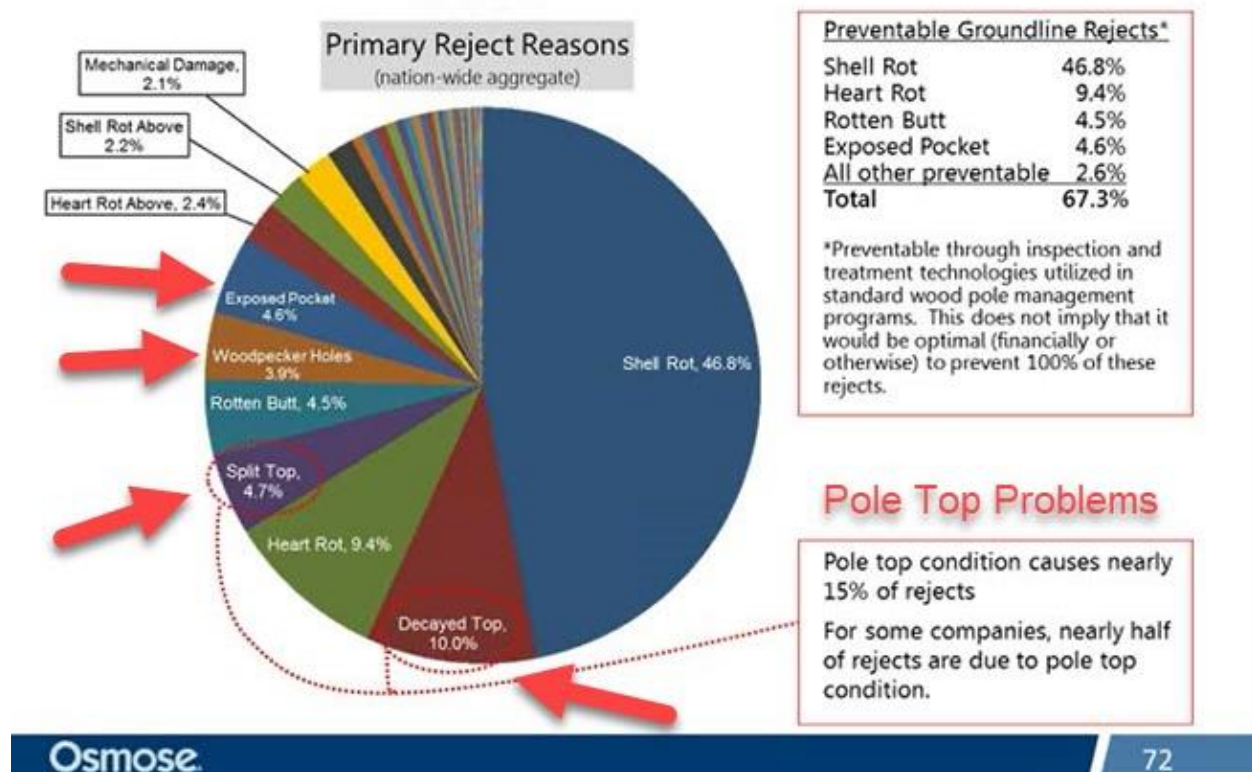
Moving forward, all utilities should begin to collect inspection data on the condition of their pole tops along with ground line data. If utilities are going to treat the base of the pole to extend the useful life, they should begin to plan on installing pole top restoration in the future to keep their pole plant in service.

Noted in an Oregon State University study, 2011, "as utilities continue to use internal and external treatments to protect the ground line zone, low development of decay above ground may threaten the long-term gains provided by ground line treatments".

POLE INSPECTION DATA

According to Osmose Utilities Services, Inc.'s. Webinar from 2015, where they conducted a 2014 nationwide industry survey on Pole Plant Management, they received over 400 responses from investor owned utilities, co-ops and municipalities. One of the areas that we should take notice is in this Primary Reject Reasons graph (see below) concerning wood pole management. This is showing that back in 2014 pole top conditions were causing between 15% - 50% of pole rejects. This should be cause for alarm to several utilities, as well as the industry as a whole.

Primary Reject Reasons



POLE TOP FIELD DETERIORATION DATA

I physically field measured fifty (50) wood power poles for this portion of the study. The data is separated by preservative treatments. The data collected – measured for age of the pole, diameter, shell rot, center rot and overall rot depth. These results are averaged by collected categories and a progression factor was determined by the average pole top rot shown at the bottom of the chart. This estimated rot factor is multiplied by existing total rot to project future pole top rot for the next 20 years.

CREOSOTE POLES

Pole Top Deterioration Study

23-Jan-18

The measurements below are based in inches

	Location	Birth mark or Est year	Age of Pole	Treatment Type	Top of Pole Diameter	Shell Rot	Center Rot	Depth of Rot
1	New Port Richey	74	43	Creosote	6.5	2	2	3
2	New Port Richey	76	41	Creosote	8	2	3	3
3	New Port Richey	75	42	Creosote	7	3	3	4
4	New Port Richey	72	45	Creosote	7.5	2	2	3
5	New Port Richey	74	43	Creosote	7	2	2	3
Average:			42.80		7.20	2.20	2.40	3.20
Progression factor based on the average pole top rot shown on this chart below:						1.12	1.12	1.12
The next 20 year additional deterioration projection for an <u>unprotected</u> pole top :						3.32	2.70	3.60
Total Maximum projected pole top rot 20 years from now with no cap protection:						5.52	5.10	6.80

According to collected data the deterioration process begins with the breakdown of the pole top protection which occurs at approximately 25 years of age.

The average pole top rot shown on this chart took place over a period of 17.80 years.

PENTA POLES

Pole Top Deterioration Study

23-Jan-18

The measurements below are based in inches

	Location	Birth mark or Est year	Age of Pole	Treatment Type	Top of Pole Diameter	Shell Rot	Center Rot	Depth of Rot
1	New Port Richey	79	38	Penta	8	2	2	8
2	New Port Richey	79	38	Penta	7.5	2	2	10
3	New Port Richey	78	39	Penta	8	1	2	3
4	New Port Richey	74	43	Penta	6.5	3	3	8
5	New Port Richey	78	39	Penta	6	2.5	3	10
6	New Port Richey	75	42	Penta	6	2	3	7
7	New Port Richey	76	41	Penta	6	3	2	8
8	Seminole	76	41	Penta	7	2	-	5
9	Largo	78	39	Penta	6.5	1	-	5
10	Largo	78	39	Penta	8	4	-	5
11	Zephyrhills	79	38	Penta	6	2	-	2
12	New Port Richey	79	38	Penta	8	2	-	5
13	New Port Richey	79	38	Penta	7.5	1	-	2
14	New Port Richey	79	38	Penta	7.5	4	4	5
15	Largo	78	39	Penta	6	3	3	5
16	Largo	75	42	Penta	6	2	5	8
17	Clearwater	78	39	Penta	7	2	3	4
18	Clearwater	78	39	Penta	8	2	3	5
19	Clearwater	78	39	Penta	7.5	2	2	5
20	Clearwater	79	38	Penta	7.5	1	2	5
21	Clearwater	77	40	Penta	8	2	3	6
22	Clearwater	79	38	Penta	7.5	2	3	5
23	Clearwater	79	38	Penta	6.5	1	0.5	3

Average:	39.26	7.07	2.11	2.68	5.61
Progression factor based on the average pole top rot shown on this chart below:			1.40	1.40	1.40
The next 20 year additional deterioration projection for an <u>unprotected</u> pole top :			3.52	4.47	9.37
Total Maximum projected pole top rot 20 years from now with no cap protection:			5.63	7.15	14.98

According to collected data the deterioration process begins with the breakdown of the pole top protection which occurs at approximately 25 years of age.

The average pole top rot shown on this chart took place over a period of **14.26** years.

Pole Top Deterioration Study

23-Jan-18

The measurements below are based in inches

	Location	Birth mark or Est year	Age of Pole	Treatment Type	Top of Pole Diameter	Shell Rot	Center Rot	Depth of Rot
1	New Port Richey	96	21	CCA	6.5	0	0	0
2	New Port Richey	81	36	CCA	7.5	2	0	6
3	New Port Richey	93	24	CCA	7	0.25	0.25	0.25
4	New Port Richey	84	33	CCA	8	3	3	4
5	New Port Richey	2001	16	CCA	7	0	0	0
6	New Port Richey	89	28	CCA	7.5	0.25	0.25	0.75
7	New Port Richey	94	23	CCA	7.5	0.25	0.25	0.25
8	St. Petersburg	83	34	CCA	8	1	-	4
9	Largo	82	35	CCA	7	2	2	4
10	Largo	82	35	CCA	7	2	2	4
11	Zephyrhills	86	31	CCA	6.5	1	2	3
12	Zephyrhills	82	35	CCA	7.5	1	-	4
13	Zephyrhills	83	34	CCA	7.5	2	2	4
14	New Port Richey	86	31	CCA	8	2	-	2
15	New Port Richey	87	30	CCA	7.5	2	-	2
16	New Port Richey	79	38	CCA	8	1	2	4
17	Largo	81	36	CCA	7	2	-	3
18	Largo	89	28	CCA	8	1	-	2
19	Largo	84	33	CCA	7	1	-	3
20	Clearwater	82	35	CCA	8	1	2	3
21	Clearwater	80	37	CCA	7.5	2	2	6
22	Clearwater	81	36	CCA	7.5	1.5	1.5	6

Average:	31.32	7.41	1.28	1.28	2.97
Progression factor based on the average pole top rot shown on this chart below:			3.17	3.17	3.17
The next 20 year additional deterioration projection for an <u>unprotected</u> pole top :			4.06	4.06	9.39
Total Maximum projected pole top rot 20 years from now with no cap protection:			5.35	5.35	12.35

According to collected data the deterioration process begins with the breakdown of the pole top protection which occurs at approximately 25 years of age.

The average pole top rot shown on this chart took place over a period of **6.32** years.

Pole Top Deterioration Study

23-Jan-18

The measurements below are based in inches

	Location	Birth mark or Est year	Age of Pole	Treatment Type	Top of Pole Diameter	Shell Rot	Center Rot	Depth of Rot
1	New Port Richey	96	21	CCA	6.5	0	0	0
2	New Port Richey	81	36	CCA	7.5	2	0	6
3	New Port Richey	93	24	CCA	7	0.25	0.25	0.25
4	New Port Richey	84	33	CCA	8	3	3	4
5	New Port Richey	2001	16	CCA	7	0	0	0
6	New Port Richey	89	28	CCA	7.5	0.25	0.25	0.75
7	New Port Richey	94	23	CCA	7.5	0.25	0.25	0.25
8	St.Petersburg	83	34	CCA	8	1	-	4
9	Largo	82	35	CCA	7	2	2	4
10	Largo	82	35	CCA	7	2	2	4
11	Zephyrhills	86	31	CCA	6.5	1	2	3
12	Zephyrhills	82	35	CCA	7.5	1	-	4
13	Zephyrhills	83	34	CCA	7.5	2	2	4
14	New Port Richey	86	31	CCA	8	2	-	2
15	New Port Richey	87	30	CCA	7.5	2	-	2
16	New Port Richey	79	38	CCA	8	1	2	4
17	Largo	81	36	CCA	7	2	-	3
18	Largo	89	28	CCA	8	1	-	2
19	Largo	84	33	CCA	7	1	-	3
20	Clearwater	82	35	CCA	8	1	2	3
21	Clearwater	80	37	CCA	7.5	2	2	6
22	Clearwater	81	36	CCA	7.5	1.5	1.5	6
23	New Port Richey	74	43	Creosote	6.5	2	2	3
24	New Port Richey	76	41	Creosote	8	2	3	3
25	New Port Richey	75	42	Creosote	7	3	3	4
26	New Port Richey	72	45	Creosote	7.5	2	2	3
27	New Port Richey	74	43	Creosote	7	2	2	3
28	New Port Richey	79	38	Penta	8	2	2	8
29	New Port Richey	79	38	Penta	7.5	2	2	10
30	New Port Richey	78	39	Penta	8	1	2	3
31	New Port Richey	74	43	Penta	6.5	3	3	8
32	New Port Richey	78	39	Penta	6	2.5	3	10
33	New Port Richey	75	42	Penta	6	2	3	7
34	New Port Richey	76	41	Penta	6	3	2	8
35	Seminole	76	41	Penta	7	2	-	5
36	Largo	78	39	Penta	6.5	1	-	5
37	Largo	78	39	Penta	8	4	-	5
38	Zephyrhills	79	38	Penta	6	2	-	2
39	New Port Richey	79	38	Penta	8	2	-	5
40	New Port Richey	79	38	Penta	7.5	1	-	2
41	New Port Richey	79	38	Penta	7.5	4	4	5
42	Largo	78	39	Penta	6	3	3	5
43	Largo	75	42	Penta	6	2	5	8
44	Clearwater	78	39	Penta	7	2	3	4
45	Clearwater	78	39	Penta	8	2	3	5
46	Clearwater	78	39	Penta	7.5	2	2	5
47	Clearwater	79	38	Penta	7.5	1	2	5
48	Clearwater	77	40	Penta	8	2	3	6
49	Clearwater	79	38	Penta	7.5	2	3	5
50	Clearwater	79	38	Penta	6.5	1	0.5	3

Average:	36.12	7.23	1.76	2.07	4.21
Progression factor based on the average pole top rot shown on this chart below:			1.80	1.80	1.80
The next 20 year additional deterioration projection for an <u>unprotected</u> pole top :			3.16	3.46	7.02
Total Maximum projected pole top rot 20 years from now with no cap protection:			4.91	5.54	11.23

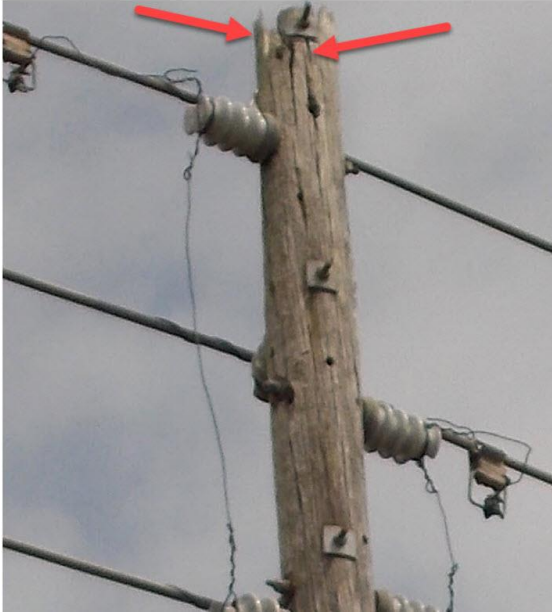
According to collected data the deterioration process begins with the breakdown of the pole top protection which occurs at approximately 25 years of age.

The average pole top rot shown on this chart took place over a period of 11.12 years.

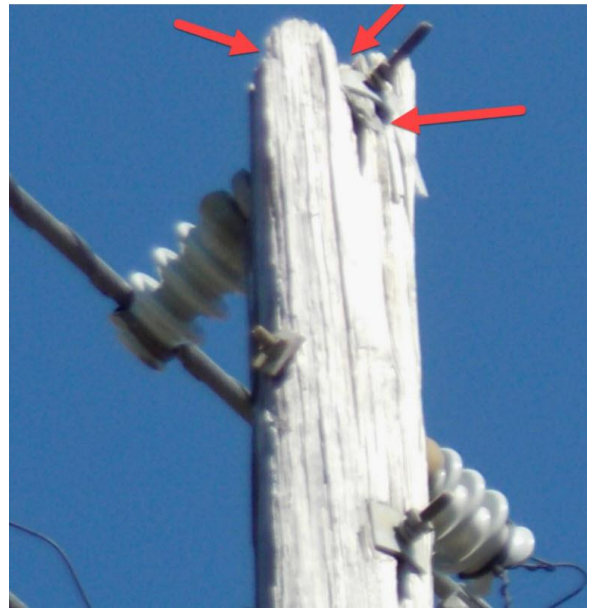
FIELD POLE TOP ISSUES

This study has found that the largest group of power pole problems identified are the Penta poles from the 1970's. Rural Utilities Service bulletin 1730B-121 was issued in 2013 stating: "Where problems have occurred with Penta treated poles, the decay can be tied to poor conditioning of the poles, to the loss of solvent due to bleeding." Examples noted below are found to be numerous though out Florida.

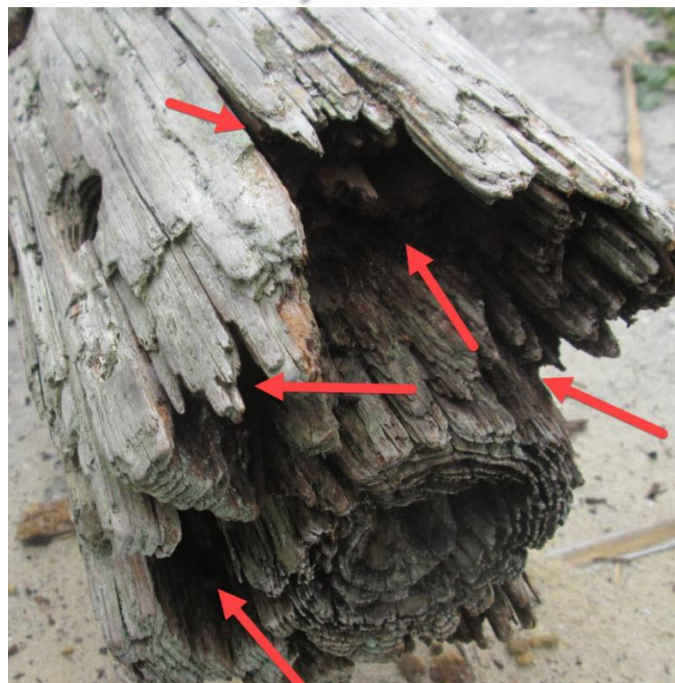
70s Penta, hollow shell gives way with conductor load.



70s Penta, hollow out until shell gets too thin, then gives way

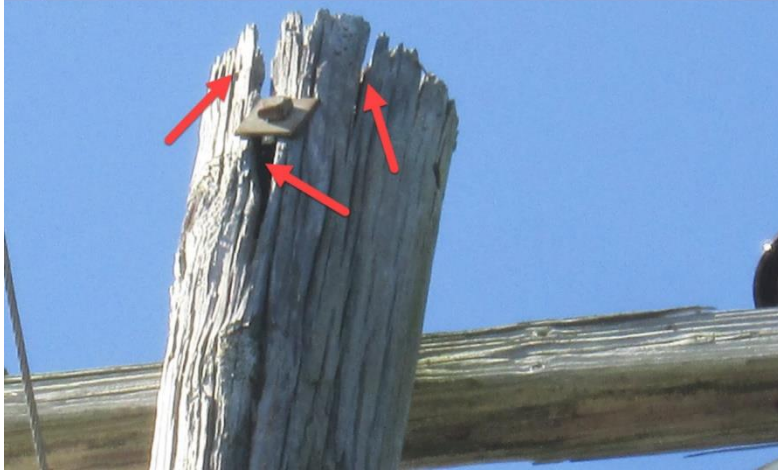


43 Yr old Penta, major damage extremely deteriorated

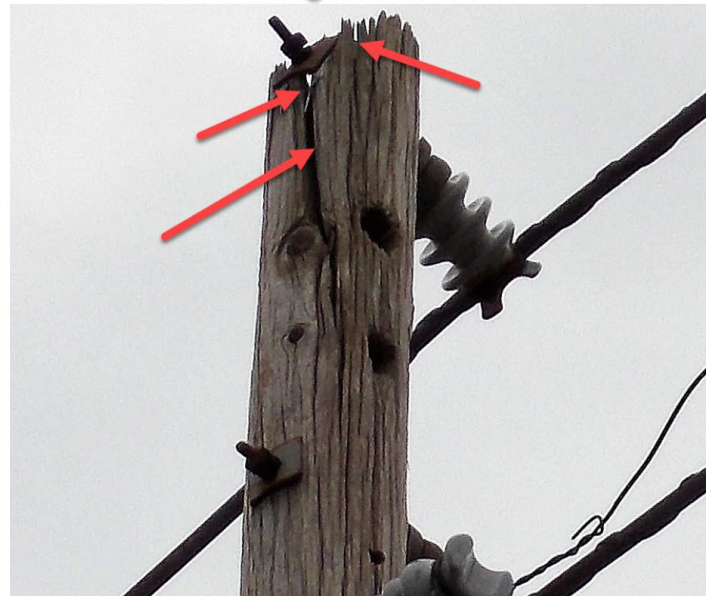


The poles in this deteriorated state exist in many locations – main thoroughfares, backyards and even several in front of schools.

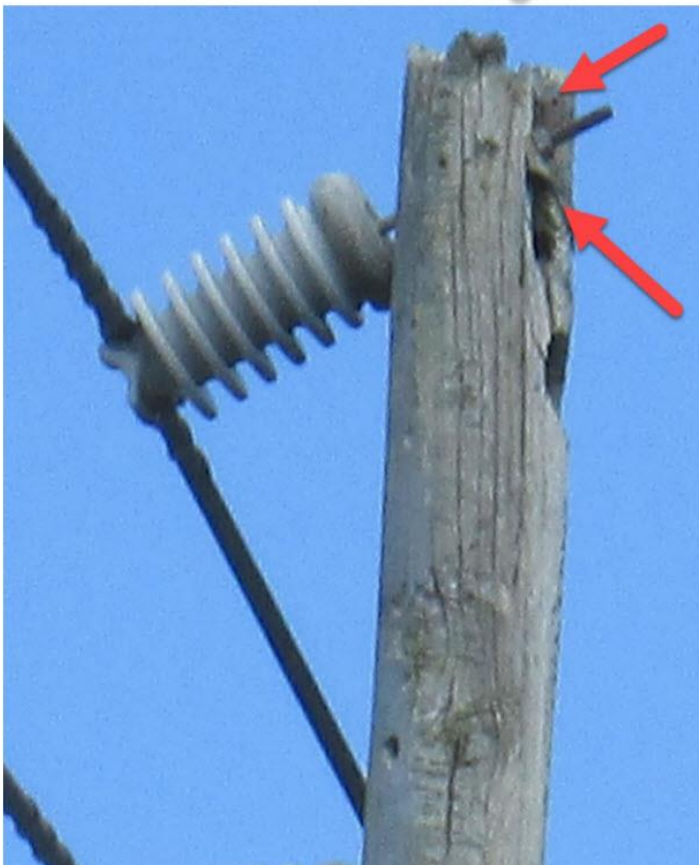
Late 70's pole in the field, Penta, major damage to crossarm pole



Late 70s Penta, not much left holding this feeder.



Late 70s Penta, soft top needs stronger top reinforcement to hold conductor weight.



The next problem poles are the aging Creosote, which have held up very well and have the longest in-service dates. However, the tops are failing through out Florida.

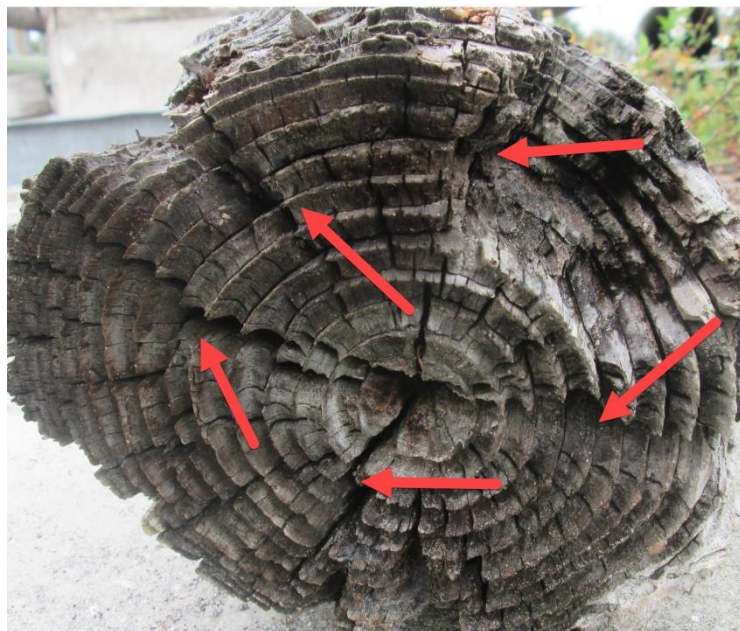
Old Creosote removed from the field, hollow top finally gave way.



Creosote older than 40 yrs will hollow out and break loose with load



45 Yr Old Creosote, major splitting, top deteriorated down 2"-3"



Lastly, the CCA pole - The CCA pole is mainly the only type being purchased today and is one to concentrate on for future asset management departments. A closer detailed look at the problems now appearing in CCA poles - At the 15 to 25 years in-service time line, the CCA pole begins to crack and split on top of the pole. This is the start of exposing tops to future deterioration. Research shows this pole top rot begins at the 25 year in service date.

16 Yr Old CCA, minor splitting starting

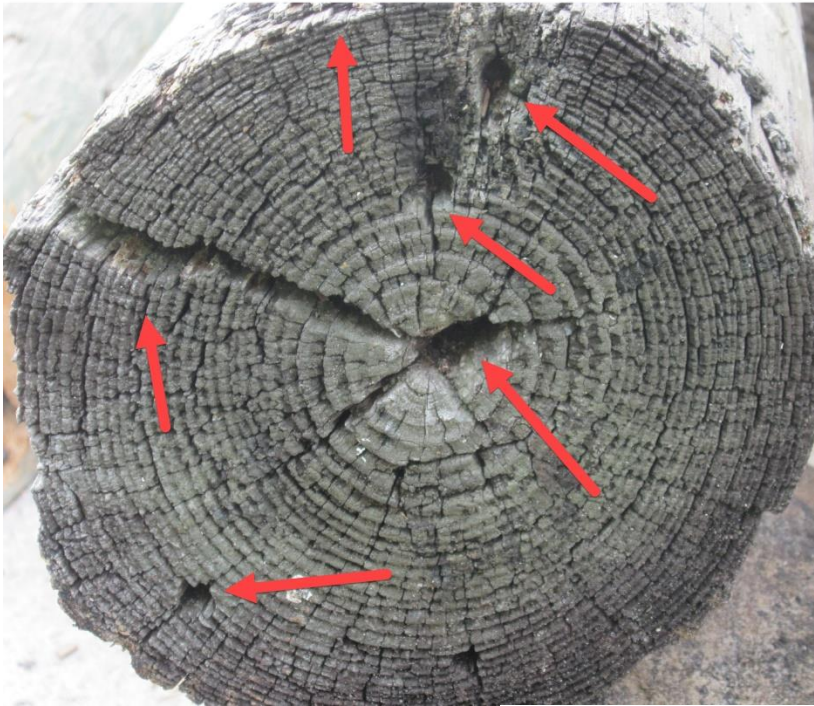


23 Yr Old CCA, minor splitting starting

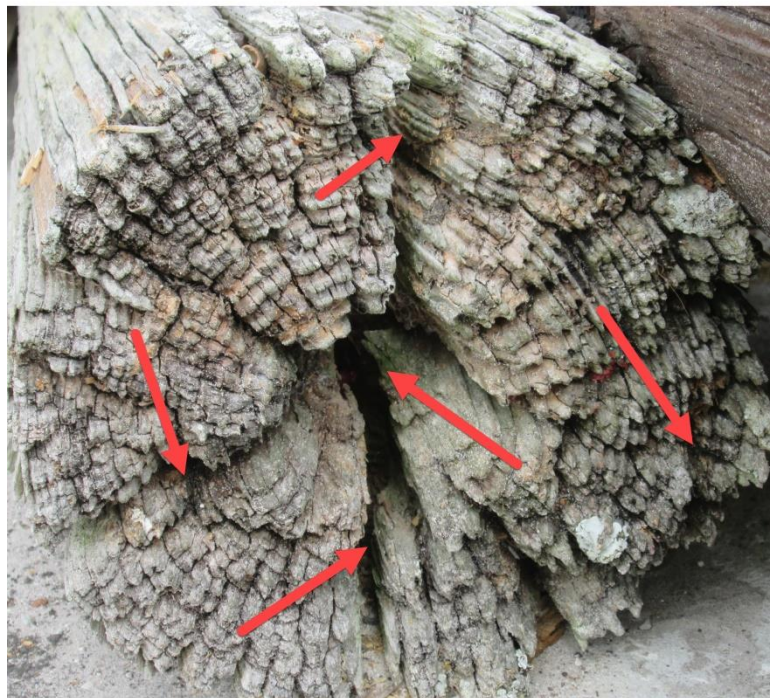


Photos noted below show progression of the in-service life cycle of a CCA pole and examples of in field poles aged 32 to 33 years. This shows how the cracks enlarge and start forming deterioration holes. CCA's also form splitting in the top shell and lose height off the top of the pole as the edges become soft and curl inward.

32 Yr Old CCA, large cracks and holes opening up



33 Yr Old CCA, several deep wide cracks, top decayed down 3"

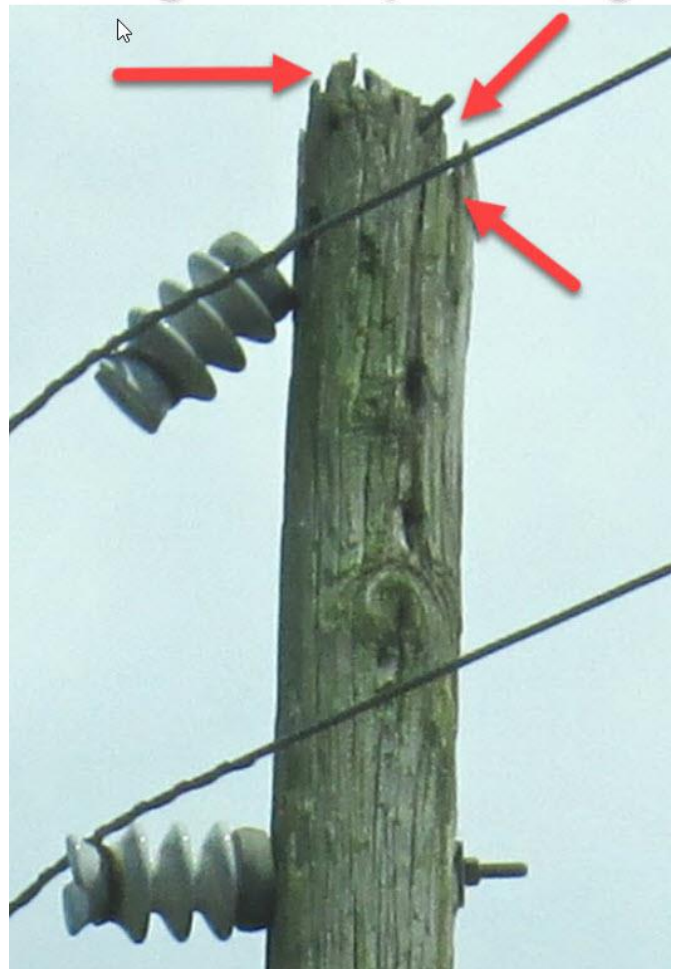


As these CCA poles age and become soft at the top, the primary insulator starts to pull through the pole and is left hanging by the remaining limited structure of the pole.

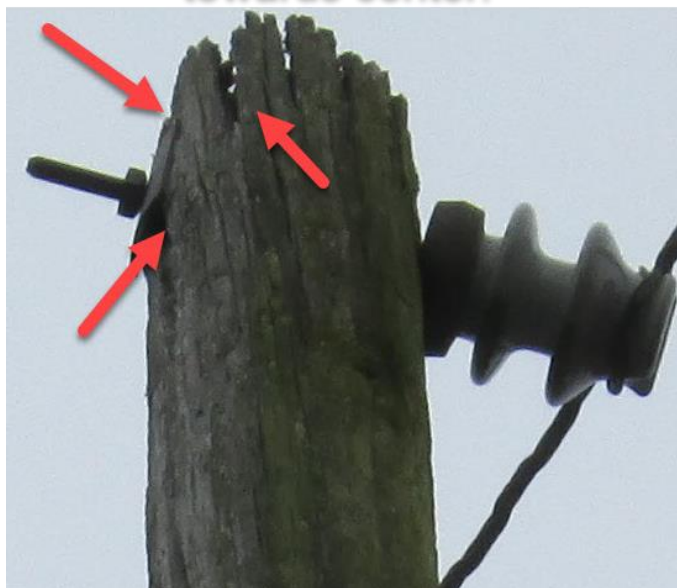
Early 80s CCA. top can not hold weight of conductor



Early 80s CCA, tops get soft causing bolts to pull through



Early 80s CCA, soft top conductor weight pulling bolt towards center.



POLE TOP INSPECTIONS

Visual inspections from the ground need to be performed on all wood pole tops more than 25 years of in service use. The aid of binoculars is recommended. This method allows the inspector to zoom in on the poles to determine the amount of deterioration that has taken place. This is the best method to date to determine a rating level for the pole top deterioration or damage. Many utilities have their ground line inspection companies doing visual inspections on the pole tops. However, it does not appear these inspectors are properly trained to determine the extent of the pole top deterioration. From gathered field data, less than 10% of the actual poles that have excessive pole top deterioration and greatly devalued structural strength are being identified. This is creating a huge liability problem and most of these poles will not last another 8 to 10 years until the next pole inspection cycle is completed. Inspection companies should be trained to look for top deterioration, splitting and hollowing out at the pole tops. Part of that training could be reviewing the data in this study which will educate the inspectors in the timelines involved.

SHORTEN SERVICE LIFE

As this study has shown, pole tops start their breakdown due to cracking and splitting. These cracks occur around the natural tree rings then begin to move their fractures to the outer edges of the pole. This deterioration becomes visible from the ground around the 23 to 25-year in service age. We have concluded from this study that the 25-year mark is the age when the pole begins its deterioration process and larger cracks open exposing bigger pockets where the forming of fungi can accelerate the decay. The life expectancy of the top of the pole is shortening due to constant moisture and fungal growth.

In a 1996 edition of “Wood Pole Newsletter”, it is stated under the heading Extending and Enhancing the life of poles – “it is likely that factors other than ground line decay will come into play in limiting life. To help ensure that extended lives can be achieved, new maintenance practices will need to be developed and implemented to address degradation mechanisms including:

- Pole Top Decay
- Decay at connections
- Splitting of Pole Tops
- Excessive weathering

WORK PLAN

Asset managers need to be aware of the new issue with pole top deterioration. There should be a plan implemented to include this type of inspection along with the current pole inspections. Also, managers need to understand that just because the top of the pole is bad and could be a liability or power quality concern, it does not necessarily need to be replaced. Pole top restoration programs exist and should be implemented by all utilities around the country. Documented life extension benefits of pole top restoration allows this option to meet the definition of a “betterment” or substantial addition to the pole plant which qualifies it as a capital expenditure.

This new pole top restoration will not only save utilities approximately 85% of the new pole cost but will be more cost effective with manpower on job sites. Crew labor is highly needed today to work more demanding deadlines and required needs. There should be a work plan that attacks this growing problem in bulk. Contract crews are very well qualified to inspect and install pole top restoration products as needed on overhead lines.

CONCLUSION

This industry is rapidly changing to better serve our customers with new technologies and better tools to do our jobs. We have to understand that the changes from the 1970's in wood preservative treatments have an impact to the current assets of all utilities. We must work safer, smarter and be able to adapt to the resources that are available today. As stated by HydroOne in Canada, "The Company's aim is to maximize the life expectancy of an asset and optimize work efficiency in order to derive the most value from its investment and to manage costs that are borne by customers. "

We now know that pole top deterioration is a fact with all utility's infrastructure and will only increase in the future. Utilities need to plan and manage the impact that this could bring to manpower needs, budget demands, power quality and liability issues. This study's estimate of bad pole tops in Florida is estimated to be at least 150,000 current wood poles in service today. Those counties that experienced large population growth in the 1970's could still have 10-15% of their current wood pole assets with existing pole top failures. Most other counties have an estimated 5% of their existing wood pole assets with failing pole tops unless they have completed extensive pole replacements or new construction. As we move to states north of Florida the decay zones decrease from 3 to 10 years according to the American Wood Protection Association. This will mean certain pole top deterioration coming to those areas soon. With the previous changes in pole preservatives, no utility will be exempt.

NOTICE

The use of trade, firm or corporation names in this study is intended as information for the reader. Any errors in citations such as lack of symbols or the misspelling of a trade name or reference is without intent and this author hereby apologizes to the reader. Such use does not establish any type of official endorsement by the author, nor does it constitute an approval by the author of this article of any product or service to exclude any other product or service that could be suitable.

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