Report on Collaborative Research for Hurricane Hardening

Provided by

The Public Utility Research Center
University of Florida

To the

Utility Sponsor Steering Committee

February 2016

I. Introduction

The Florida Public Service Commission (FPSC) issued Order No. PSC-06-00351-PAA-EI on April 25, 2006 (Order 06-0351) directing each investor-owned electric utility (IOU) to establish a plan that increases collaborative research to further the development of storm resilient electric utility infrastructure and technologies that reduce storm restoration costs and outages to customers. This order directed IOUs to solicit participation from municipal electric utilities and rural electric cooperatives in addition to available educational and research organizations. As a means of accomplishing this task, the IOUs joined with the municipal electric utilities and rural electric cooperatives in the state (collectively referred to as the Project Sponsors) to form a Steering Committee of representatives from each utility and entered into a Memorandum of Understanding (MOU) with the University of Florida's Public Utility Research Center (PURC). The third extension of this MOU was recently approved by the Research Collaboration Partners and now extends through December 31, 2018.

PURC manages the work flow and communications, develops work plans, serves as a subject matter expert, conducts research, facilitates the hiring of experts, coordinates with research vendors, advises the Project Sponsors, and provides reports for Project activities. The collaborative research has focused on undergrounding, vegetation management, hurricane-wind speeds at granular levels, and improved materials for distribution facilities.

This report provides an update on the activities of the Steering Committee since the previous report dated February 2015.

II. Undergrounding

The collaborative research on undergrounding has been focused on understanding the existing research on the economics and effects of hardening strategies, including undergrounding, so that informed decisions can be made about undergrounding policies and specific undergrounding projects.

The collaborative has refined the computer model developed by Quanta Technologies and there has been a collective effort to learn more about the function and functionality of the computer code. PURC and the Project Sponsors have worked to fill information gaps for model inputs and significant efforts have been invested in the area of forensics data collection. Since the state has not been affected by any hurricanes since the database software was completed, there is currently no data. Therefore, future efforts to refine the undergrounding model will occur when such data becomes available.

In addition, PURC has worked with doctoral and master's candidates in the University of Florida Department of Civil and Coastal Engineering to assess some of the inter-relationships between wind speed and other environmental factors on utility equipment damage. PURC has also been contacted by engineering researchers at the University of Wisconsin and North Carolina State University with an interest in the model, though no additional relationships have been established. In addition to universities, PURC was contacted by researchers at the Argonne National Laboratory who expressed interest in modeling the effects of storm damage. The researchers developed a deterministic model, rather than a probabilistic one, but did use many of the factors that the Collaborative have attempted to quantify. Every researcher that contacts PURC cites the model as the only non-proprietary model of its kind.

The research discussed in last year's report on the relationship between wind speed and rainfall is still under review by the engineering press. Further results of this and related research can likely be used to further refine the model.

III. Wind Data Collection

The Project Sponsors entered into a wind monitoring agreement with WeatherFlow, Inc., in 2007. Under the agreement, Florida Sponsors agreed to provide WeatherFlow with access to their properties and to allow WeatherFlow to install, maintain and operate portions of their wind monitoring network facilities on utility-owned properties under certain conditions in exchange for access to wind monitoring data generated by WeatherFlow's wind monitoring network in Florida. WeatherFlow's Florida wind monitoring network includes 50 permanent wind monitoring stations around the coast of Florida, including one or more stations located on utility-owned property. The wind monitoring agreement expired in early 2012; however, the wind, temperature, and barometric pressure data being collected at these stations is being made available to the Project Sponsors on a complimentary basis.

IV. Public Outreach

In last year's report we discussed the impact of increasingly severe storms on greater interest in storm preparedness. PURC researchers discussed the collaborative effort in Florida with the engineering departments of the state regulators in Connecticut, New York, and New Jersey, and regulators in Jamaica, Grenada, Curacao, Samoa, and the Philippines. While all of the regulators and policymakers showed great interest in the genesis of the collaborative effort, and the results of that effort, they have not, at this point, shown further interest in participating in the research effort.

PURC researchers continue to utilize the insight gained through the hurricane hardening research to contribute to the debate on undergrounding in the popular press, and reinforce the state of Florida as a thought leader in this area. PURC Director of Energy Studies Ted Kury was asked to contribute an article to the second quarter issue of *Utility Horizons* describing the modeling methodology for assessing the undergrounding of power lines. The essay also provided a link to an *Electricity Journal* article by Kury and Lynne Holt, another PURC researcher, which discusses Florida's cooperative approach and holds it up as a "best practice" in regulation. In addition, Kury has conducted interviews for the general press on the costs and benefits of underground power lines.

V. Conclusion

In response to the FPSC's Order 06-0351, IOUs, municipal electric utilities, and rural electric cooperatives joined together and retained PURC to coordinate research on electric infrastructure hardening. The steering committee has taken steps to extend the research collaboration MOU so that the industry will be in a position to focus its research efforts on undergrounding research, granular wind research and vegetation management when significant storm activity affects the state.

Your Touchstone Energy® Partner

WITHLACOOCHEE RIVER ELECTRIC COOPERATIVE, INC.

Monday, February 22, 2016

PSC 25 – 6.0343
Municipal Electric Utility and Rural Electric Cooperative Reporting Requirements

Withlacoochee River Electric Cooperative, Inc.
P.O. Box 278
Dade City, FL 33526-0278
352-567-5133
Billy E. Brown, Executive V.P. & General Manager

1) Number of meters served in calendar year 2015

221,678 (Services in place - December 2015)

2) Standards of Construction

a) National Electric Safety Code Compliance

All electrical facilities constructed by Withlacoochee River Electric Cooperative, Inc. on or after January 1, 2012, will comply with the 2012 edition of the NESC; facilities constructed prior to this date comply with the edition in effect at the time of the initial construction.

Withlacoochee River Electric Cooperative's (WREC) Specifications and Drawings for 14.2/24.9 KV Overhead and Underground Distribution Line Construction are based on RUS bulletins, drawings and engineering specifications. All of those specifications meet or exceed the requirements of the National Electrical Safety Code (ANSI C-2) [NESC]. Due to the nature of capital funding from the Department of Agriculture (RUS), WREC is held accountable to a very comprehensive set of Federal guidelines (including the NESC). A Construction and Operations Manual was created and distributed to all line crews, supervisors, and

other affected employees. Lines, cables and related equipment are installed and maintained according to these manuals, and both are used in the training program registered with the State of Florida. All field staking technicians have been trained in, and have access to, software that verifies NESC construction compliance. This Pole Foreman software is based on specific WREC design templates that include framing guides and corresponding material specifications. The program will calculate strength capabilities and clearances of specified spans, and compare results to the minimum NESC requirements (Grade C, B and Extreme Wind Loading).

b) Extreme Wind Loading Standards

WREC facilities are not designed to be guided by the "extreme wind loading standards" on a system wide basis. However, most new construction, major planned work assigned on or after December 10, 2006 and targeted critical infrastructure meets design criterion that comply with standards of construction for the wind loading projections in our service area. The NESC extreme wind loading standards are being considered for major distribution feeders. The difficulty in this consideration is the impact of joint use facilities. The concept of allowing joint use of overhead electrical distribution facilities is beneficial to all concerned, including the resulting pricing efficiencies for all affected Customers. Allowing multiple or large diameter cable attachments makes compliance with the extreme wind loading standards economically and aesthetically impractical due to the drastic reduction of span lengths.

c) Flooding and Storm Surges

Storm surge effects on WREC's underground distribution facilities and supporting structures have been evaluated and for several years all pad mounted equipment, transformers, switchgear, etc., is specified with stainless steel construction. This requirement helps mitigate the need for premature replacement due to coastal erosion and high surge salt water intrusion.

We will continue to monitor all relative studies through the Florida Electric Cooperative Association and we will adjust our design standards accordingly. We strongly believe that it is essential to maintain current practices until we are able to thoroughly evaluate the results of current studies so that a cost/benefit can be established for conversion of overhead to underground.

All underground system designs include conduit installation for all primary and secondary cables, to both lengthen the life of the cable and shorten replacement times.

Additionally, WREC was the first Cooperative in the U.S. to receive RUS approval for

cost capitalization of the rehabilitative "cable-cure" process. This process prolongs the useful life of the cable and drastically reduces outages associated with cable failures. EPR (Ethylene-Propylene-Rubber) insulated cable is used exclusively for all underground primary distribution installations. Compared to standard cross-linked polyethylene insulation, EPR has a proven superior life span. All primary cables are also fully jacketed and strand-filled for additional long term reliability.

d) Safe and Efficient Access of New and Replacement Distribution Facilities

In 2015 WREC relocated approximately 15 miles of overhead primary lines from rear lot lines to the street, changing out hundreds of older poles and facilities. This practice will continue until all of the older areas have been upgraded.

e) *Attachments by Others*

All joint use attachment requests are evaluated on a case by case basis. Joint use companies send a written request to attach to WREC's poles. Each request is evaluated as to loading and clearance requirements per the NESC and Pole Foreman software (referenced in 3(a) above). WREC has extensive written and signed joint use agreements on file with each joint use company that specify compliance with the NESC and Rural Utilities Services (RUS) requirements, specifications and drawings. Such items as placing, transferring, or rearranging attachments, erecting, replacing, or relocating poles are specifically addressed to meet all requirements as per the NESC and RUS.

4. *Facility Inspections*

a) *Description of policies, guidelines, practices and procedures for inspection transmission and distribution lines, poles and structures including pole inspection cycles and pole selection process.*

WREC utilizes well over 250 full time personnel to constantly monitor conditions and we are continuously developing realistic practices to evaluate the integrity and condition of our system as a whole. The group mentioned here consists of a combination of Operations and Engineering employees who are charged with the duty of line patrols while in the normal course of their daily work. Additionally, circuits and line segments having decreased performance are identified through data obtained with our Outage Management System and specific inspections are assigned accordingly. Annually, thousands of Service Orders are completed, processed, and the appropriate corrective action is taken.

With over 7,100 miles of overhead distribution lines, a considerable portion of WREC's system is physically checked annually according to the following methods:

Line Patrol	**2,325 Miles**
Voltage Conversion	**76 Miles**
Right-of-Way	**2,504 Miles**
S.T.A.R. [1]	**1,270 Miles**
Total	**6,175 Miles (Approximate numbers for year 2015)**

b) *Transmission and distribution inspections planned and completed*

WREC owns and maintains sixty-eight miles of transmission line with voltages of 69KV and 115KV.

All of the transmission feeders are patrolled annually by walking, riding or aerial patrol. An intense aerial patrol that included detailed infra-red inspections of every pole, switch, and connection on the system was conducted after it was exposed to tropical storm and hurricane force winds in 2004.

Distribution lines inclusive of lateral taps and services are annually inspected according to procedures described in the response to question (4. a) above.

[1] Strategic Targeted Action and Repair. Selected areas of our system are targeted for intense line maintenance and repair according to information obtained by various methods including customer service issues, service interruption data, etc.

c.) *Number and percentage of transmission poles and structures and distribution poles failing inspection and the reason for the failure.*

Distribution poles are visually inspected at the time line inspections are performed. Additionally, poles are visually inspected, including sounding and checking below ground level, during voltage conversion and maintenance programs; subsequently changed out as necessary.

WREC utilized a contractor (OSMOSE) for pole inspection and treatment during 2003-2004. They found 6.2% pole rot and 1.0% pole rejection. A decision was made at that time to discontinue that type of inspection/treatment plan, due to the fact that the majority of our wooden poles are CCA, having a life expectancy well in excess of 20 years, with no known instances of ground line decay. The poles with older treatments are being systematically changed out.

Data is unavailable on exact failure rates. WREC is systematically changing out all of the wood poles treated with anything other than CCA through an aggressive voltage conversion program, relocation of rear lot line facilities and routine system maintenance. Many polymer and steel distribution poles have been installed throughout the system in an effort to test what appears to be emerging changes to the wood pole philosophy.

d) *Number and percentage of transmission poles and structures and distribution poles, by pole type and class of structure, replaced or for which remediation was taken after inspection, including a description of the remediation taken.*

Attached is a summary of size/class of distribution/transmission poles installed and removed in 2015. (Detailed data is not available, but WREC is exploring options to capture requested data for 2016 and future years)

5. *Vegetation Management*

a) *Utility's policies, guidelines, practices, and procedures for vegetation management, including programs addressing appropriate planting, landscaping, and problem tree removal practices for vegetation management outside of road right-of-ways or easements, and an explanation as to why the utility believes its vegetation management practices are sufficient.*

A very aggressive Vegetation Management Program (VMP) was adopted in 2004 which is inclusive of problem tree removal, increased horizontal and vertical clearances and under-brushing to ground level. Our goal has been obtained of having the entire system on a well documented trim cycle with problem circuits/areas clearly identified enabling a proactive right of way program.

WREC fully understands the objectives of the PSC with respect to a three year trim cycle, but WREC has in fact implemented measures to extend trim cycles; *not shorten trim cycles*. The ultimate objective is to control vegetation growth before it causes line related problems. WREC has accomplished this through the VMP and by well documenting vegetation growth/trim cycles for every transmission and distribution line segment. The thought process is by extending clearances, trim periods are extended. Certainly, desired clearances are not always obtainable, but these problem areas are being identified, monitored and addressed as needed. The VMP was implemented in early 2004 as a five-six year program with respect to addressing the entire system and our goal was achieved in summer of 2010.

WREC maintains over 150 overhead feeder circuits (over 7,100 miles of line). The current trim cycle is between three and four years. A few feeders, due to the type of soil conditions, have been cut more often because of a faster growth rate in those particular areas. Specific areas, according to customer service issues, outage reports and other statistics are trimmed in spots (Hot Spotted) which addresses "cycle busters".

Data relevant to right of way issues is extracted from our outage management system (OMS) for prioritizing circuit trimming. When circuit trimming is performed all lateral taps and services are trimmed. Additional right of way issues are identified by line patrols, employees, contractors and consumers. Whenever the company is notified of any right of way issue a "service order" is initiated. During 2015 WREC addressed 1,934 right of way service orders ranging from trimming a single account to trimming an entire subdivision/area.

b) *Quantity, level, and scope of vegetation management planned and completed for transmission and distribution facilities.*

All transmission lines are inspected annually and associated right of way issues are considered top priority and addressed immediately (2015 = 11.5 miles of right of way trimmed).

PSC Data Request to Florida Municipal Electric Utilities and Rural Electric Cooperative Utilities

(Subject: 2015 Electric Distribution and Transmission Service Reliability)

Withlacoochee River Electric Cooperative, Inc.

For the data requests appearing below, please use the following definitions for the measure of reliability performance at the distribution system or the transmission system level. If your company uses a different definition, please specify.

(a) Service Interruptions (CI) - the loss of service to retail customers that lasts one minute or greater due to unplanned events within the distribution system or the transmission system.

(b) Customers (C) – The total number of retail customers (meters) served by the utility at the end of the reporting period (2015).

(c) Customer Minutes of Interruption (CMI) - The total number of minutes of interruption of retail customers within the total system.

(d) CAIDI (Customer Average Interruption Duration Index) - The average time to restore the service interruptions to interrupted retail customers within a system for 2015. CAIDI is calculated by dividing the customer minutes of interruption by the number of interrupted customers.

(e) SAIFI (System Average Interruption Frequency Index) - The average number of service interruptions per retail customer within a system for 2015. It is calculated by dividing the Service Interruptions (CI) by Customers (C).

(f) SAIDI (System Average Interruption Duration Index) - The average minutes of service interruption duration per retail customer served within a system for 2015. Mathematically, SAIDI is CMI divided by C.

(g) CEMI (Customers Experiencing Multiple Interruptions) - The percentage of customers (C) that have experienced more than a specified number of interruptions. For example, CEMI5 reports the percentage of customers experiencing more than 5 interruptions.

(h) MAIFIe (Momentary Average Interruption Event Frequency Index) - The average number of Momentary Interruption events (loss of continuity of less than one minute) recorded at substation breakers. A momentary interruption event is one or more momentary interruptions recorded within a five-minute period.

I. Data Requests Regarding Distribution Reliability (1 through 6) – For utilities which do not own distribution infrastructure, please respond "Not Applicable" or "N/A".

1. Please provide C, CAIDI, SAIDI, and SAIFI for your company's distribution system in 2015.
   C = 208,761
   CAIDI = 76.36
   SAIDI = 86.84
   SAIFI = 1.14

2. Please provide CAIDI, SAIDI, and SAIFI for each named storm that was excluded from the calculation of the system reliability indices provided in response to Question 1.

   No named storms but there were events that exceeded the T-Med threshold (SAIDI=7.8118) and were considered Major Event days.

   CAIDI = 97.10
   SAIDI = 13.87
   SAIFI = 0.14

3. Please provide CAIDI, SAIDI, and SAIFI for those events other than named storms that were excluded from the calculation of the system reliability indices provided in response to Question 1. Please describe the types of events and reasons for exclusion.

   POWER SUPPLIER – Outages caused by Progress Energy/ Substations excluded.

   CAIDI = 66.99
   SAIDI = 20.39
   SAIFI = 0.30

   SCHEDULED MAINTENANCE & CONSTRUCTION – Planned outages are excluded.

   CAIDI = 97.60
   SAIDI = 2.42
   SAIFI = 0.02

4. Please provide MAIFIe for your company's distribution system in 2015.

   Not Available, WREC does not track MAIFIe.

5. Please provide MAIFIe for all events that were excluded from the calculation of the MAIFIe provided in response to Question 4. Please describe the types of events and reasons for exclusion.

   Not Available, WREC does not track MAIFIe.

6. Please provide any other measures that your company uses in tracking outage trends and system reliability goals, including any type of CEMI (such as CEMI5) for 2015.

   Not Available, WREC does not track other outage trends beyond those described above.

II. Data Requests Regarding Transmission Reliability (7 through 9) – For utilities which do not own transmission infrastructure, please respond "Not Applicable" or "N/A".

7. Please provide SAIDI, SAIFI, and CAIDI for your company's transmission system in 2015.

   NO outages were experienced on WREC owned radial transmission in 2015. WREC does not own Any "looped" or grid configured transmission.

8. Please provide SAIDI, SAIFI, and CAIDI for each named storm that was excluded from the calculation of the system reliability indices provided in response to question 7.

   N/A

9. Please provide SAIDI, SAIFI, and CAIDI for those events other than named storms that were excluded from the calculation of the system reliability indices provided in response to question 7. Please describe the types of events and reasons for exclusion.

   NO planned outages were experienced on WREC's transmission in 2015. Power supplier (Progress Energy) outages are spread across the distribution circuits affected.

III. Overhead (OH) vs. Underground (UG) Questions (10 through 12)

10. Please provide the number of Overhead (OH) and Underground (UG) retail customers for your company at year-end 2015. How does your company determine whether a retail customer is served by OH or UG system?

    Not Available, WREC does not categorize retail customers by OH or UG.

11. Please provide an estimate of the number of customer interruptions for OH and UG systems in 2015 and, if available, show the breakout of such data for named storms event periods (combined) and non-named storm periods.

    Not Available.

12. Please provide an estimate of the minutes of customer interruptions for OH and UG systems in 2015 and, if available, show the breakout of such data for named storms event periods (in sum for all such periods) and non-named storm periods.

    Not Available.

END

Record Unit	Description	Added	Retired
F105	POLES,CONCRETE,65'	0	0
F120	POLES,WOOD,75'	0	0
F130	POLES,WOOD 80'	0	0
F140	POLES,WOOD,85'	0	6
F225	POLE, STEEL 90' TANG 0-5D	4	0
F310	POLES, CONCRETE 95' TANG 0-5D	1	0
Y119	POLES, CONCRETE 40'	1	0
Y120	POLES, WOOD, 40 FT.	2	0
1065	POLES, FIBERGLS/COMPOSITE 40FT	8	0
1066	POLES, FIBERGLS/COMPOSITE 50FT	15	2
1070	POLES,WOOD,35'& UNDER	756	1588
1080	POLES,WOOD,40'& 45'	1736	1050
1090	POLES,WOOD,50'& OVER	713	235
1100	POLES,CEMENT,35'& UNDER	4	2
1110	POLES,CEMENT,40'& 45'	2	7
1114	POLES, DUCTILE IRON 50' C1	3	0
1115	POLES, DUCTILE IRON 60' H3	1	0
1116	POLES, DUCTILE IRON 55' H3	3	0
1117	POLES,STEEL 60-65" LGHT DTY H2	67	1
1118	POLES,STEEL 50' RD &LD H1 GALV	82	2
1120	POLES,CEMENT 50FT.	3	0
1121	POLES,CONCRETE 65 FT	4	0
1122	POLES,WOOD 60FT	7	6
1124	POLES,WOOD 65 FT	2	1
1125	POLES,CONCRETE 55FT	8	0
1135	POLE, STEEL 75' LT DUTY H5	2	0
8085	POLES,FIBERGLASS	29	29
8090	POLES,WOOD,35'& UNDER	240	209
8100	POLES,CONCRETE,35'& UNDER	125	46
8105	POLES,CONCRETE,35' & UNDER (B)	36	0
8117	POLES,ALUMINUM, 14'	1	1
8118	POLES, ALUMINUM 12'	322	19
8119	POLES,ALUMINUM, 15'	0	3
8130	POLES,WOOD,40'& 45'	2	0
8135	POLES,CEMENT,40'& 45'	37	0

Type	TR	TS
Done	799	416
In Progress	719	
Total	1518	416