NELSON RESEARCH

Storm Report
for
The City of Seattle

following
The Storm on East Marginal Way South
April 5, 2019

prepared by

Nelson G. Bingel, III – Mechanical/Structural Engineer
Wood Pole Strength & Loading Expert
Chairman – National Electrical Safety Code (NESC)

David J. Marne – Electrical Engineer
National Electrical Safety Code (NESC) Expert

Jerrold E. Winandy – Wood Scientist
Expert on Properties and Durability of Wood

Nicholas Bond – Research Meteorologist
Climatologist for the State of Washington

September 30, 2019

TABLE OF CONTENTS

1. Details of the Incident……3
2. Materials Relied On……3
3. Qualifications and Forensic Steps Taken……3
4. Weather Analysis Findings……5
5. Findings for Pole Loading Designs……5
6. Findings for Pole Remaining Strengths……6
7. Causation……7
8. Conclusion……7

9. Appendix A – Map of Failed Pole Locations……1
10. Appendix B – Bingel CV……3
11. Appendix C – Marne CV……11
12. Appendix D - Winandy CV……18
13. Appendix E – Bond CV……37
14. Appendix F – Weather Conditions Report ……50
15. Appendix G – Wood Pole Loading Report……55
16. Appendix H – Rule 250B Pole Loading Analysis Reports……76
17. Appendix I – Rule 250C Pole Loading Analysis Reports……162
18. Appendix J – Expected Storm Pole Loading Analysis Reports….177
19. Appendix K – Forensic Analysis of Failed Poles……263
20. Appendix L – Wood Pole Strength Report ……289

1. Details of the Incident

On Friday, April 5, 2019 an afternoon summer storm occurred in the Seattle area with high winds and rain. At approximately 3:50 PM, Seattle City Light experienced a downed section of power line consisting of 26 poles located north and south of the Museum of Flight at 9404 E. Marginal Way South in Tukwila, WA. The map in Appendix A shows the location of the 26 poles. Security camera footage and news reports showed that one pole landed on a moving vehicle with two occupants inside. The vehicle passengers were treated and released shortly afterward from a local hospital.

Seattle City Light quickly responded with 7 crews and about 40 workers to assist with the safety of people near the scene. Subsequent efforts were focused on clearing debris and restoring power to approximately 16,500 customers impacted by the outage. By 6:00 pm all but 300 customers had power restored and all, but 13 customers were restored by Saturday morning.

The Seattle City Light called for a third-party review of the incident and asked the City Attorney's Office for assistance in contracting with multiple experts and overseeing the on-site inspection. The results of that expert review are contained in this report.

2. Materials Relied On

A. Seattle City Light Design Standard 9620.01 – Properties of Wood Poles (June 2015)
B. Seattle City Light Design Standard 9130.01 – 26.4 kV Overhead Design
C. Seattle City Light Construction Guide D9-51 – 26 KV Construction for 954 Rail
D. Seattle City Light Material Standard 5082.00 – Wood Poles, Pressure Treated, Douglas Fir
E. Seattle City Light Material Standard 5054.10 – Crossarms, Douglas Fir
F. Seattle City Light: Douglas Fir Wood Pole Material Standards History File Review
G. Seattle City Light Standard 160812 – Inspection Procedures for Wood Pole Assessment
H. Seattle City Light 2016 Pole Inspection Reports for the 26 poles involved in the incident
I. National Electrical Safety Code (NESC) 2017 edition
J. Google Earth views of previous pole construction

3. Qualifications and Forensic Steps Taken

The Seattle City Attorney's Office contacted the following experts to form the team to investigate the incident:

- Nelson G. Bingel, III - Mechanical/Structural Engineer
  Wood Pole Loading and Strength Expert
  Chairman - National Electrical Safety Code (NESC)
- David J. Marne - Electrical Engineer
  National Electrical Safety Code (NESC) Expert
- Jerrold E. Winandy - Wood Scientist
  Expert on Properties and Durability of Wood
- Nicholas Bond - Research Meteorologist
  Climatologist for the State of Washington

The Curriculum Vitae of the experts are attached as Appendices B, C, D, and E.

As the investigation progressed, it was determined that the investigation team should be led by Nelson Bingel as the focus was on the wood pole failures. This report has been authored by Nelson Bingel with input from all the team members.

The following personnel with Seattle City Light and the Seattle City Attorney's Office have worked with the experts to provide documents, additional information, and a field visit:

- Jeff Wolf and Engel Lee – Seattle City Attorney's Office
- Paul Larson – Seattle City Light - Engineering and Operations Manager
- Alan Hall – Seattle City Light - CL Team D Engineering Manager
- Tom Caddy – Seattle City Light - Supervisor South Operations

A field visit was organized for May 6 where Nelson Bingel, David Marne and Jerry Winandy were hosted by Jeff Wolf, Paul Larsen, Engle Lee, Alan Hall, and Tom Caddy. The group first visited each of the 26 poles of the rebuilt section of line on East Marginal Way South by the Museum of Aviation.

In addition to the Seattle City Light pole numbers, the poles that failed were numbered 1 through 26 for easier reference during the analysis. Pole number 1 was the farthest north pole to fail and 26 was at the southern end (Appendix A – Map).

Pole species, length and class details were collected from the replacement poles along with measured groundline circumferences and span lengths. Not all poles were reset in the location of the previous poles. Wire types and specific pole construction were also recorded along with all guying configurations. The terrain and nearby buildings and foliage that may deflect or accelerate wind loading were also noted.

The next visit was to the pole yard where all remaining pole sections that Seattle City Light could identify had been sequentially positioned for inspection in the same order as they existed when in service. The 2016 inspection reports provided the pole species, length and class and most of those could be validated from the remaining pole sections.

The setting depth of each pole was measured from the butt of each pole to the perceived groundline. The distance from groundline to the breakpoint was also recorded. The span lengths of the original construction were provided by Seattle City Light and the pre-storm pole construction would later be confirmed using Google Earth.

The pole sections were also closely evaluated for the condition of the pole near the groundline and near the breakpoint. The groundline and the breakpoint were often the same location. This analysis was to determine the amounts of decay-induced void volume, the extent of decayed wood showing some physical evidence of weakened strength, and/or sound wood near the groundline or point of pole failure. The measurements would be used to estimate the remaining bending strength at the groundline of poles with decay.

An additional forensic analysis was conducted by Nicholas Bond to determine the best estimation of the actual wind conditions that occurred during the storm. The weather data was largely obtained from the Boeing Field station (KBFI) and a private weather station in the Highland Park neighborhood. The videos provided by the Seattle City Attorney's Office were reviewed by Nicolas and a site visit occurred on June 9, 2019. The full report is attached as Appendix F, Weather Conditions Report.

4. Weather Analysis Findings

The maximum observed gust speeds at the Boeing Field station occurred at 3:50 pm and reached 29 mph. The atmospheric conditions resembled a wet microburst where heavy downpours of rain result in stronger surface winds over small areas. Fitting atmospheric soundings to the observed wind gust magnitudes resulted in an expected gust speed of 39 mph.

Another mechanism that can contribute to locally enhanced wind speeds in low-level terrain is having higher-level terrain located nearby. Although the actual resulting wind speed increases are difficult to calculate, the expert opinion is that an increased wind speed of roughly 10 mph would be reasonable in this case.

Given all the factors related to the weather conditions that occurred at the accident site, a reasonable upper bound for the wind speeds was concluded to be approximately 50-mph.

5. Findings for Pole Loading Designs

Each pole of the original construction was modeled in the pole loading software program, O-Calc Pro, using the field data, Google Earth views of the construction, and conductor types and span lengths provided by Seattle City Light. The loading requirements of this line are found in the National Electrical Safety Code: Rule 250B and 250C.

This line is in the Medium Loading District which calls for adding a radial ice thickness of ¼ inch to all conductors which adds ½ inch to the diameter of each wire. The wind is applied at a pressure of 4-lb/sq-ft of surface area; most of the surface area consists of the wires with the additional ice and the pole. Some poles had streetlights, other equipment and telecom attachments which were also added to the pole models.

A wind pressure of 4-lb/sq-ft is approximately equal to a 40 mph wind speed. The NESC requires Grade C construction for this line so the strength and load factors for Grade C were also applied.

To account for construction tolerances, a 1° line angle was added to each pole. This created some additional transverse load on each pole caused by the wire tension in the spans not directly opposing each other.

The design capacity for these poles when new exceeded the loading requirements of Rule 250B in the NESC. In most cases the design significantly exceeded the code loading requirements as shown in the pole loading summary in Appendix G, Wood Pole Loading Report.

The NESC Extreme Wind Load Case, Rule 250 C, also needs to be considered when poles extend more than 60 feet above ground. This case is intended to represent an extreme summer wind event using a wind speed of 85 mph and a wood strength factor of 0.75. Only poles 17 through 20 are tall enough to require evaluation using the Rule 250C criteria. the new pole capacity of these poles exceeded the Extreme Wind load case for Grade C construction. The capacity of the shorter poles in the line also exceeded the Extreme Wind load case.

The individual pole loading analyses are included in Appendices H through J.

Another benchmark for loading can be established by calculating the equivalent wind speed without ice on the wires that causes the same load as the Medium District load case. In this analysis, the equivalent “no-ice” wind speed was greater than the 50 mph upper limit that is expected to have occurred. Thereby, the design capacity of the poles exceeded the capacity required to support the upper limit wind speed that was expected during the storm.

6. Findings for Pole Remaining Strengths

The requirements for categorizing poles following groundline inspection are specified in Seattle City Light Standard 160812 – Inspection Procedures for Wood Pole Assessment. Table 2-1: Priority Rating (below), explains how poles are to be classified depending on the remaining strength results during the "Inspect & Treat" program.

Table 2-1: Priority Rating

Priority Rating	Maintenance Required	Description
P1	Replace	RSM is 25% or less – Pole requires Replacement – **Immediate Action Required** – Notify CITY LIGHT if pole poses an imminent public safety hazard
P2	Replace	RSM is 75% or less than and greater than 25% – Pole requires Replacement – Maintenance Required within Practical Timeframe – Not a candidate for truss reinforcement.
P3	Reinforce	RSM is 75% or less and greater than 40% – Maintenance Action Required within Scheduled Timeframe. Candidate for truss reinforcement.
P4	None	RSM is greater than 75% – Pole is Serviceable based on an above ground level sound and bore inspection only (non-excavatable). No Remedial Maintenance Required – Inspect next cycle.
P5	None	RSM is greater than 75% – Pole is Serviceable – No Remedial Maintenance Required – Inspect next cycle.

During the inspections, two sections of the 26 failed poles were found to have several adjacent poles which were severely weakened by decay at the groundline as shown in Appendices K and L, Forensic Analysis of the Failed Poles and Pole Strength Report; poles numbered 8 to 13 (6 poles) in the midsection and poles 22-24 and 26 (4 of 5 poles) at the southern end. The condition of these poles was classified as P2 during the 2016 inspection.

However, a P2 pole, per the Seattle City Light specification, may have a remaining strength ranging from 75% down to a value greater than 25% remaining strength. This range is conservative on the high end as the NESC allows pole strength to be reduced to 67% before restoration or replacement is required. The greater than 25% remaining strength is non-conservative for the P2 description in Table 2-1:

> "Pole requires replacement – Maintenance Required within Practical Timeframe – Not a candidate for truss reinforcement."

The phrase "Maintenance Required within Practical Timeframe" is completely vague and provides no level of urgency for remediation. Seattle City Light will need to revamp Table 2.1 with tighter remaining strength ranges and more specific requirements for replacement or restoration.

It was also noted that three of the poles in the line also had damage from the presence of Golden Buprestid beetles (see Appendix H, pg 2). These beetles usually only survive in a tree converted to a utility pole if the pole was not properly sterilized during manufacturing. The larvae bore holes on the inside of a pole which by themselves do not cause a significant strength reduction. However, boring larvae do spread fungal spores throughout these bore holes causing significantly more rapid fungal inoculation of the untreated heartwood. Where such beetle larvae boring holes are found, wood decay was generally more noticeable than in un-bored heartwood.

7. Causation

Poles categorized in the P2 classification may have a remaining strength ranging anywhere from 75% down to just greater than 25%. Within this 26-pole line segment there were two groups of P2 classified poles that were sequential and were in the lower portion of the strength range. Six such P2 classified poles, 8 to 13, were near the middle range of the failed poles.

The remaining strength of a pole cross section is typically calculated based on the pole failing in bending. These six poles had advanced internal decay that created a thin-walled cylinder. Instead of failing in a bending mode, these poles are likely to fail due to localized buckling of the thin wall as explained in the Conclusions of the Wood Pole Loading Report, Appendix H.

It is known that when hollow poles fail due to local buckling, the actual remaining strength is less than what is calculated as a remaining bending strength. However, it is difficult to calculate with any precision because local buckling depends on multiple shell measurements of the cross section and it varies with the height of the internal decay within the pole. The greater the height that the decay extends in a pole, the lower the expected buckling strength.

The estimated remaining strength values in Table 1 of Appendix H for poles 12 and 13 are 57% and 33% respectively. These values are based on a pole failing in bending so the actual remaining strength was likely to be less when buckling is considered.

Poles 12 and 13 were exposed in open ground as opposed to neighboring poles which had some level of sheltering or disruption of the wind from buildings and vegetation. The wind speed exposure for these poles was likely greater than most of the other poles (Figures 5 and 10 of Appendix G).

Video BOE_4_5_2019 shows that poles 12 and 13 failed first. It also shows the northward sequential failures of poles 11 through 6. The dynamic loads created by wire tension and falling poles is very significant and explains the continued failure of several poles; even poles with no decay at the north end of the line. The propagation of failures eventually ended at pole 1.

The Museum of Flight video (MOF 04.05.19 power lines and poles fall) shows pole 18 and 19 failing sequentially by a longitudinal line tension coming from north of their location. A validation of the significant additional dynamic loading created by poles falling and that the failures also propagated southward from poles 12 and 13 to pole 26. Pole 26 was the last pole in the line on that side of the street so there were no neighboring inline poles that were affected by the failure of pole 26.

8. Conclusion

The original designs of the 26 poles when installed surpassed the requirements of the National Electrical Safety Code (NESC). The weather report provided by Dr. Bond projected an upper limit of actual wind speed to be 50 mph during the storm. When these poles were initially installed, the new pole bending capacity of all poles in the line exceeded the loading that a 50-mph wind would cause.

The main issue for this line turned out to be a group of sequential poles that had significantly reduced strength due to internal groundline decay. The poles were classified as P2's during the 2016 inspection but that Seattle City Light designation covers a remaining strength ranging from 75% down to greater than 25%. Poles 8 through 13 were near the middle of the failed poles and all were in the lower range for P2's. Poles 12 and 13 failed first which created significant additional dynamic loading for poles to the north and south causing sequential failures of an additional 13 poles to the south and 11 poles to the north including 9 poles with no groundline decay.

This report and appendices are based on a reasonable degree of engineering and wood science certainty, based on forensic review in the Seattle City Light pole yard, based on my expertise in the National Electrical Safety Code (NESC), based on the documents reviewed and cited in this report, and based on my experience with wood utility pole inspection and maintenance.

I reserve the right to add, amend, or change details or opinions should further information be made available for my review or come to my attention.

Respectfully submitted,

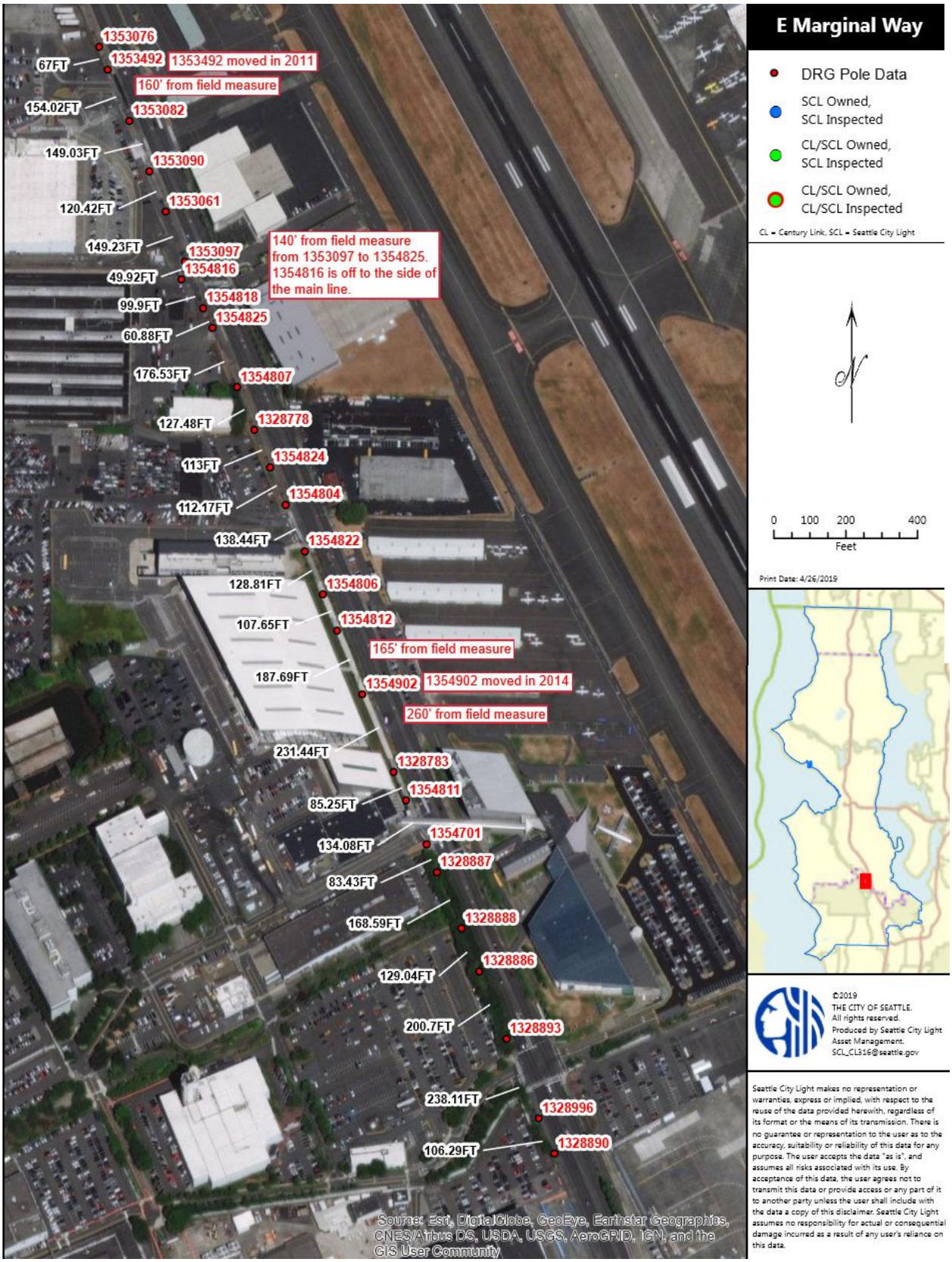


Nelson G Bingel III
Chairman – NESC

207 Marcie Ct
Senoia, GA 30276
nbingel@nelsonresearch.net
(678) 850-1461

APPENDIX A

Map of Failed Poles


1353076
67FT
1353492
1353492 moved in 2011
160' from field measure
154.02FT
1353082
149.03FT
1353090
120.42FT
1353061
149.23FT
1353097
140' from field measure from 1353097 to 1354825. 1354816 is off to the side of the main line.
49.92FT
1354816
99.9FT
1354818
1354825
60.88FT
176.53FT
1354807
127.48FT
1328778
113FT
1354824
112.17FT
1354804
138.44FT
1354822
128.81FT
1354806
107.65FT
1354812
165' from field measure
187.69FT
1354902
1354902 moved in 2014
260' from field measure
231.44FT
1328783
85.25FT
1354811
134.08FT
1354701
83.43FT
1328887
168.59FT
1328888
129.04FT
1328886
200.7FT
1328893
238.11FT
1328996
106.29FT
1328890
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
E Marginal Way
DRG Pole Data
SCL Owned, SCL Inspected
CL/SCL Owned, SCL Inspected
CL/SCL Owned, CL/SCL Inspected
CL = Century Link, SCL = Seattle City Light
N
0 100 200 400
Feet
Print Date: 4/26/2019
©2019 THE CITY OF SEATTLE. All rights reserved. Produced by Seattle City Light Asset Management. SCL_CL316@seattle.gov
Seattle City Light makes no representation or warranties, express or implied, with respect to the reuse of the data provided herewith, regardless of its format or the means of its transmission. There is no guarantee or representation to the user as to the accuracy, suitability or reliability of this data for any purpose. The user accepts the data "as is", and assumes all risks associated with its use. By acceptance of this data, the user agrees not to transmit this data or provide access or any part of it to another party unless the user shall include with the data a copy of this disclaimer. Seattle City Light assumes no responsibility for actual or consequential damage incurred as a result of any user's reliance on this data.

APPENDIX B

Nelson G. Bingel, III Curriculum Vitae

CURRICULUM VITAE

Nelson G. Bingel III

Subject Matter Expert
Expert Witness
Electric & Telecom Overhead Lines
Utility structures
Wood, Steel, Concrete, Fiberglass
Original Structure Strength
Wood Decay and Steel Deterioration
Inspection Techniques
Remaining Strength Analysis
Structure Loading Analysis
Clearance Analysis
Third Party Attachments
Industry Best Practices

March 5, 2019



Marital Status: Married

Date of Birth: 9/13/1951
Place of Birth: Buffalo, NY
Business: Near Atlanta, GA

Nelson Research, LLC
207 Marcie Ct.
Senoia, GA 30276
(678) 850-1461
nbingel@nelsonresearch.net

Chairman
National Electrical Safety Code
The premiere safety standard for overhead and underground electric and telecom lines

Chairman
Accredited Standards Committee O5
Publishing standards for the manufacture of wood poles and crossarms

Osmose Utilities Services, Inc.
30-year career researching, developing and testing tools, products and methods for inspection, analysis and repair or restoration of utility structures.

Purdue University 1969-1973
BS Mechanical Engineering

Four US Patents

Other Technical Society Memberships

IEEE
Institute of Electrical and Electronics Engineers

ASCE
American Society of Civil Engineers

AWPA
American Wood Protection Association

CURRICULUM VITAE

Patents obtained while with Osmose

June 27, 2000

US Patent 6,079,165: Apparatus and method for bracing vertical structures

April 29, 2008

US Patent 7,363,752 B2: Pole Reinforcement Truss

August 26, 2008

US Patent 7,415,808 B2: Pole Reinforcement Truss

January 16, 2018

US Patent 9,869,622: Automated profiling of the hardness of wood

Products developed while with Osmose

1987

Re-design of existing Osmo-C-Truss wood pole restoration system. Steel truss design was optimized for efficiency in correlating with the requirements of the National Electrical Safety Code.

1999/2010

O-Calc®/O-Calc Pro™- Comprehensive Pole Loading Software

Software used by Osmose and companies across the country to model in-service utility poles and evaluate loading per the National Electrical Safety Code or GO 95 in California.

2000

C2-Truss™ - Wood Pole Restoration System – 3 Patents Awarded

This unique, computer-aided design enabled using very high strength steel to produce steel trusses for restoring wood poles that are lighter, stronger and lower in cost.

2005

StrengthCalc® - Electronic Wood Pole Strength Calculator

This software tool provides greatly enhanced precision for determining the remaining strength of in-service wood poles that have some level of deterioration in the zones just below and above the groundline. StrengthCalc is utilized during inspection of millions of wood poles annually and helps insure proper classification of their condition for optimum asset management.

2006

LoadCalc® - Electronic Pole Loading Estimating Tool

This software tool enables users to estimate the loading of in-service poles as a low-cost screening tool that can be incorporated with regular pole inspection programs. This can save a majority of poles from requiring a comprehensive pole loading analysis which incurs a is significantly higher cost.

Industry Association Activities

National Electrical Safety Code (NESC) – the standard that establishes safety requirements for the construction, operation and maintenance of overhead and underground electrical and communication lines.

NESC Committee

Chairman: Aug 2016 forward

NESC Strength & Loading Subcommittee

Chairman: 2009 – 2016

Member: 1990 – 2016

NESC Main Committee

Member: 2009 – present

NESC Executive Subcommittee

Member: 2013 – present

American Standards Committee O5 (ASC O5) – this committee publishes standards for the manufacturing of wood poles and crossarms.

Chairman: 2006 – present

Member: 1990 - present

ASC O5 Fiber Strength Subcommittee

Chairman: 1998 – 2015

Member: 1990 - present

American Society of Civil Engineers (ASCE)

Member: 1996 - present

ASCE Committee on Recommended Practice for the **Design and Use of Wood Pole Structures** for Electrical Transmission Lines

Member: 2014 – present

Reliability-based Design Committee of the Structural Engineering Institute of ASCE

Member during the development through publishing in 2006

Task Committee on **Fiber-Reinforced Polymer Products for Overhead Utility Line Structures**; the Structural Engineering Institute of ASCE

Member during the development through publishing in 2003

Institute of Electrical and Electronics Engineers (IEEE)

Overhead Lines Working Group on the NESC

Chairman: 1996 – present

Member: 1988 - present

American Wood Protection Association (AWPA) – publishes standards for preservative treatment of all wood groups, including wood poles.

Member: 1988 - present

Articles, Manuals, Publications

1994 Electric Perspectives Magazine – Nov/Dec – Edison Electric Institute
"Restore, Don't Replace"

1998 Wood Design Focus
- A Journal of Contemporary Wood Engineering; Forest Products Society
"Computer-Aided Design of Fiber Composite Wraps for Wood Pole Restoration"

2003 – *Manual of Recommended Practice for Fiber-Reinforced Polymer Products for Overhead Line Structures*; Edited by Jim Davidson; ASCE MOP-104

2006 – *Manual of Practice for Reliability-Based Design of Utility Pole Structures*; Edited by Habib Dagher; ASCE MOP-111

2007 – *Transmission and Distribution World Magazine*
"Extreme Winds Test Wood Pole Strength"

2016 – *Electric Energy Online*
"Guest Editorial | 2017 Revisions and Review Underway to the National Electrical Safety Code (NESC)"

2016- *Energy Central*
"Highlights, Changes and New User Elements of the 2017 National Electrical Safety Code

2017 – *Power Grid International*
"The Pole Express
– Road to System Resiliency Varies, but all Benefit from Taking a Closer Look"

2017 – *Natural Gas & Electricity*
"Wood Pole Strength & Loading - Key to Resiliency, Require Programs"

Conference Presentations

1999 Utility Pole Structures Conference – Reno, NV –
Northwest Public Power Association (NWPPA), Western Electric Power Institute (WEPI) Utility Structure Conference
"Proposed Code Changes: American Standards Committee O5/National Electrical Safety Code"

2000 Northeast Utility Pole Conference – October 17-18, Binghamton, NY
"Product Design in the new Electric Utility Environment"

2000 American Society of Civil Engineers (ASCE) Structures Congress – Philadelphia, PA
"Code Issues and Applications for Fiber Reinforced Composite Utility Poles"

2000 International Conference on Utility Line Structures – March 20-22, Ft. Collins, CO
"Product Design in the New Electric Utility Environment"

2000 Southern Pressure Treaters Association (SPTA) Winter Conference – January 23-25, Key Largo, FL
"Update on ANSI O5.1 New Wood Pole Standard"

2000 Geospatial Information and Technology Association (GITA) Conference
"Utility Pole GIS Data Systems"

2001 Power Transmission & Distribution Asset Management Conference – Oct 27-28, Atlanta, GA
"Building a Data Strategy to Improve Reliability Planning"

2001 Institute of Electrical and Electronics Engineers (IEEE) Transmission and Distribution Conference – October 28-November 1, Atlanta, GA
"2002 National Electrical Safety Code (NESC) Update"

2001 National Joint Use Educational Conference – October 22-23, Phoenix, AZ
"2002 National Electrical Safety Code (NESC) Update"

2001 Southeast Electrical Exchange (SEE) Joint Use Committee Meeting – March 4-6, Orlando, FL
"Utility Pole Strength and Loading for Joint Use Applications"

2001 Edison Electric Institute (EEI) Transmission Committee Meeting – October 7-10
"2002 National Electrical Safety Code (NESC) Update"

2001 Western Energy Institute (WEI) Overhead Electric Distribution Workshop –Sep 10-12
"2002 National Electrical Safety Code (NESC) Update"

2002 Southeast Electrical Exchange (SEE) Joint Use Committee Meeting – May 19-21, Atlanta, GA
"Options for Overloaded Poles"

2002 Northeast Utility Structure Conference – October 22-23, Binghamton, NY
"Update on ANSI O5.1 – New Wood Pole Specification"

2002 SBC/Ameritech Technical Training Symposium - Chicago, IL
"Utility Pole Loading and Clearances"

2003 Southeastern Electric Exchange (SEE) Annual Conference – June 11-13
"Transmission Structure Asset Management"

2003 Northwest Public Power Association (NWPPA) Utility Structure Conference - Reno, NV
"ANSI O5.1-2002 – The Inside Story", "2002 NESC Update"

2005 Western Electric Institute (WEI) Utility Pole Conference, October 26-27, Reno, NV
"Code Update: ANSI O5.1-2005, Upcoming NESC 2007"

2005 Institute of Electrical and Electronics Engineers (IEEE) Winter Power Meeting – Jan 23-25, Albuquerque, NM
"NESC and ANSI O5 Overview"

2006 International Conference on Overhead Lines – March 27-31, Ft. Collins, CO
"Code Update: NESC and ANSI O5"

2006 Edison Electric Institute (EEI) Transmission & Distribution Conference – April 2-5, Houston, TX
"Code Update: NESC and ANSI O5"

2006 American Wood Preservers' Association (AWPA) 102nd Annual Meeting – April 9-12, Austin, TX
"Code Update: NESC and ANSI O5"

2006 Florida Public Service Commission Workshop – April 17, Tallahassee, FL
"Wood Pole Strength & Loading"

2006 Municipal Electric Authority of Georgia (MEAG) – October 6, Cordele, GA
"Breakthroughs in Steel Restoration Truss Design"

2006 Northeast Utility Pole Conference – October 24-25, Binghamton, NY
"Code Update: NESC and ANSI O5"

2007 Institute of Electrical and Electronics Engineers (IEEE) Towers, Poles and Conductors Panel Session – Orlando, FL, January 9
"Significant Rejected Change Proposals to the 2007 NESC"

2007 Southeastern Utility Pole Conference – February 11-13, Tunica, MS
"ANSI & NESC – What's New for Your Poles"

2007 Florida Electric Cooperatives Association (FECA) Engineers Conference – May 30-June 1, Clearwater, FL
"New Technology – Managing Wood Pole Strength and Load"

2007 Western Electric Institute (WEI) Utility Pole Conference – Oct 10-11, Vancouver, WA
"ANSI & NESC Update"

2008 International Conference on Overhead Lines – March 31-April 3, Ft. Collins, CO
"Code Updates – ANSI O5 & NESC"

2008 Northeast Utility Pole Conference – October 22-23, Binghamton, NY
"Steel and Concrete Utility Structure Corrosion"

2010 Utility Reliability Conference – February 10, Columbus, OH
"Reliability from the Ground Up"

2010 International Overhead Utility Conference, March 29-April 1, Ft. Collins, CO
"Code Update – ANSI O5.1 & NESC Safety"

2011 Eastern Utility Pole Conference – October 18-19, Baltimore, MD
"ASC O5 Committee – Wood Poles, Crossarms, Laminated Poles" – "NESC Update"

2012 International Overhead Utility Conference, March 28-April1, Ft. Collins, CO
"NESC Update"

2012 Spring Heartland Joint Use Conference – May 9-10, Pittsburgh, PA
"ANSI / NESC Code Review"

2012 Fall Heartland Joint Use Conference – October 24-25, Dayton, OH
"ANSI/NESC Code Review"

2016 National Electrical Safety Code (NESC) Workshop: Changes for the Future - October 18-19, 2016, San Antonio, TX
Workshop Host and Presenter

2017 National Association of Regulatory Utility Commissioners (NARUC)
Summer Policy Meeting – July 16-19, 2017, San Diego, CA
"Technology Developments & Challenges for Building 5G Small Cell Networks"
"Distributed Solar: Jurisdiction between NESC and NEC"

2018 National Association of Regulatory Utility Commissioners (NARUC)
Winter Policy Summit – February 11-14, 2018, Washington, D.C.
"Utility Distribution Poles and Lines – How Strong is Strong Enough?

2018 National Electrical Safety Code (NESC) Change Proposal Development Workshop – April 10-11, 2018, Savannah, GA
Host and Presenter

Training

2017 EUCI Seminar
Best Practices for Wood Utility Poles
Presented: "ANSI O5.1 and National Electrical Safety Code Review and Updates

2017 EUCI Symposium
"Best Practices for Wood Utility Pole Strength and Loading" Santa Clara, CA
Instructed: The full day and a half symposium
- "Wood Pole Management"
- "Wood Pole Manufacturing and Strength"
- "Pole Loading Basics"
- "NESC Loading & Strength Requirements"
- "California GO 95 Loading & Strength Requirements"
- "Wood Pole Decay & Strength Loss"
- "NESC / GO 95 Strength & Loading Comparisons"
- "Clearance Basics"
- "Pole Loading Examples"
- "Third Party Attachment Processes"
- "Adding Attachments to Existing Poles"

2018 EUCI Symposium
Chicago, IL
"Best Practices for Wood Utility Pole Strength and Loading"
Updated Presentations: The full day and a half symposium
- "Wood Pole Management"
- "Wood Pole Manufacturing and Strength"
- "Pole Loading Basics"
- "NESC Loading & Strength Requirements"
- "California GO 95 Loading & Strength Requirements"
- "Wood Pole Decay & Strength Loss"
- "NESC / GO 95 Strength & Loading Comparisons"
- "Clearance Basics"
- "Pole Loading Examples"
- "Third Party Attachment Processes"

APPENDIX C

David J. Marne Curriculum Vitae

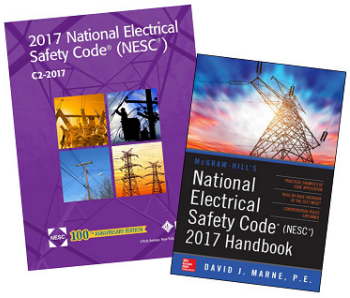
David J. Marne, P.E.

Marne and Associates, Inc.
945 Wyoming St., Suite 150
Missoula, MT 59801
Phone: (406) 544-8997
Email: davem@marneassociates.com
Web: www.marneassociates.com



David J. Marne, P.E.

David J. Marne, P.E. is a registered professional electrical engineer. Mr. Marne is the author of *McGraw-Hill's National Electrical Safety Code® (NESC®) Handbook* and is a nationally recognized speaker on the NESC®. He serves on NESC Subcommittee 4 Overhead Lines Clearances, NESC Subcommittee 7 Underground Lines, and the NESC Interpretations Subcommittee. He is company president and senior electrical engineer for Marne and Associates, Inc. in Missoula, Montana where he specializes in National Electrical Safety Code® (NESC®) training, OSHA training for power and communication workers, engineering design training, and expert witness services related to the NESC®, the OSHA Standards for Power and Communication workers, and California's General Order 95, 128, and 165. Mr. Marne has over 35 years of experience in the utility industry engineering and managing transmission and distribution line projects, substation projects, electrical system planning studies, joint use (power and communication) projects, and providing training and expert witness services.



The 2017 National Electrical Safety Code® (NESC®) (above left) and McGraw-Hill's 2017 NESC® Handbook authored by David J. Marne, PE (above right)

Education

Montana State University, Bozeman, Montana
Bachelor of Science in Electrical Engineering (BSEE)
Graduation Date: June 1983

Various Continuing Education Courses, 1983-present
Transmission and Distribution Line Design and Staking, Substation Design, System Protection and Coordination, System Over-voltage Design, Engineering and Operations Conferences, Pole Conferences, Joint Use (Power and Communications) Conferences, Electromagnetic Fields (EMF), Corrosion Control, Project Management, Finance and Accounting, OSHA Compliance and Workplace Safety, OSHA 1910.269 Qualified Worker, National Electrical Safety Code® (NESC®) Sub-Committee Meetings, and California General Order 95 (GO95) Rule Making Sessions.

Experience

Transmission and Distribution Line Engineering

Responsible for the engineering management and/or engineering design of over 40 transmission line related projects and over 225 distribution line related projects. Projects have involved a variety of voltage levels, conductor sizes, structure types, terrain types, right-of-way constraints, and environmental issues. Designs for transmission and distribution lines include both overhead and underground circuits (including underwater locations) in both urban and rural settings. Engineering services provided for transmission and distribution engineering projects include planning, cost estimating, design, bidding, construction administration, construction observation, right-of-way, and permitting.

Substation Engineering

Responsible for the engineering management and/or engineering design of over 60 substation related projects. Projects have involved a variety of voltage levels, transformer ratings, bus sizes, structure types, site plans, grounding issues, protection schemes, metering types, communication systems, ownership, and environmental issues. Designs for substations include both live front and dead front equipment in both urban and rural settings. Engineering services for substation projects include planning, cost estimating, design, bidding, construction administration, construction observation, site work, and permitting.

Electrical System Planning Studies

Responsible for the engineering management and/or engineering design of over 95 electrical system planning related studies. Projects have involved a variety of studies including long range plans, construction work plans, sectionalizing and coordination studies, voltage drop studies, fault current studies, motor starting studies, power factor analysis, electromagnetic field (EMF) reports, and environmental studies.

Joint Use (Power and Communication) Engineering

Responsible for the engineering management and/or engineering design of over 25 joint use (power and communication) related projects. Projects have involved a variety of power line voltage levels and communication line (phone, CATV, fiber) cable types. Engineering services include calculating and reviewing clearance, and strength and loading issues in accordance with the National Electrical Safety Code® (NESC®) and Joint Use Agreements. Services also include field data gathering, determining make-ready requirements, and field construction observation.

National Electrical Safety Code® (NESC®), OSHA, and California's GO95

Nationally recognized expert on the National Electrical Safety Code® (NESC®). Author of *McGraw-Hill's NESC® Handbook* and presenter of NESC® seminars around the United States. Expert in the Occupational Safety and Health (OSHA) Standards that apply to power and communication utilities including OSHA Standards 1910.269 and 1910.268. Expert in the California General Orders related to the electrical power and communication utility industries (GO95, GO128, and GO165). Expert in the National Electrical Code® (NEC®) rules that relate to the utility service point. (See Publications and Presentations for additional information.)

Expert Witness Services

Expert witness services and electrical investigations for cases involving power line contacts, electrocution, pole strength and loading, guy wire contacts, lineman work rules, roadway clearances, building clearances, power failure, fires, and electrical service failures resulting in loss of life, injury, and/or property damage. Electrical investigations related to power theft and stray voltage complaints. Electrical investigations related to electromagnetic field (EMF) concerns. Services for defense and plaintiff attorneys and insurance companies. (Expert witness testimony list provided separately).

Management Experience

President and CEO of Marne and Associates, Inc. Responsible for all aspects of corporate management and company direction.

Branch Manager of SSR Engineers, Inc., Missoula, Montana office. Responsibilities included administration, marketing, and engineering. Reported directly to the company president of an 80+ employee firm spread across five offices. Elected to SSR Engineers, Inc. Board of Directors in 1998 and served as a trustee on the Board of Directors until SSR Engineers was purchased by HDR Engineering in 2003.

Department Manager of the Transmission and Distribution (T&D) group of HDR Engineering in Missoula, Montana. Similar management duties as described above in addition to maintaining relationships with other managers and corporate personnel throughout a 3200+ employee firm with over 80 offices.

Work History

Marne and Associates, Inc.

Missoula, Montana 2005-Present
President
President of Marne and Associates, Inc. which provides National Electrical Safety Code® (NESC®) training (public seminars, in-house seminars, and web based training), OSHA training, training aids (books, manuals, etc.), accident investigation, expert witness services, and engineering design.

HDR Engineering, Inc.

Missoula, Montana 2003-2005
Transmission and Distribution Department Manager/Senior Electrical Engineer
(HDR Engineering purchased SSR Engineers on 8/1/03)

Department manager and senior electrical engineer in charge of electrical engineering design for electric utility clients and National Electrical Safety Code® (NESC®) presentations.

SSR Engineers, Inc.

Missoula, Montana 1988-2003

Branch Manager/Senior Electrical Engineer

Branch manager and senior electrical engineer in charge of electrical engineering design for electric utility clients and National Electrical Safety Code® (NESC®) presentations.

Project Engineer 1988-1990

(SSR Engineers purchased General Engineers on 3/1/88)

Project electrical engineer involved with electrical power, lighting, and communication projects for utility, industrial, and commercial clients.

General Engineers, Inc.

Missoula, Montana 1985-1988

Design Engineer

Design electrical engineer involved with electrical power, lighting, and communication projects for utility, industrial, and commercial clients.

Mare Island Naval Shipyard

Vallejo, California 1983-1985
Design Engineer
Design electrical engineer involved with electrical power, lighting, and communication projects for the public works department of a naval shipyard.

Presentations

- Applying the National Electrical Safety Code® (NESC®) to Day-to-Day Utility Work
  Presented at various utility companies and utility associations across the United States.
- Applying the National Electrical Safety Code® (NESC®) to Day-to-Day Utility Work – Transmission Voltage Focus
  Presented at various utility companies across the United States.
- Applying the National Electrical Safety Code® (NESC®) to Day-to-Day Utility Work – Substation Focus
  Presented web seminar for utility company substation department.
- National Electrical Safety Code® (NESC®) Rules for Joint Use Construction
  Presented at various utility companies and utility associations across the United States.
- Major Changes and General Overview of the 2017 National Electrical Safety Code® (NESC®)
  Presented at various utility companies and utility associations across the United States.
- Major Changes and General Overview of the 2012, 2007, 2002, and 1997 National Electrical Safety Code® (NESC®)
  Presented at various utility companies and utility associations across the United States.
- OSHA 1910.269: Electric Power Generation, Transmission, and Distribution
  Presented web seminars and provided eLearning for various utility companies across the US and presented in-house on a special request basis.
- OSHA 1910.268: Telecommunications
  Presented web seminars and provided eLearning for various utility companies across the US and presented in-house on a special request basis.
- Distribution Line Design
  Presented web seminars and provided eLearning for various utility companies across the US and presented in-house on a special request basis.
- Arc Flash Hazards and Arc Rated Clothing
  Presented web seminars and developed eLearning for various utility companies across the US.
- NESC and OSHA Rules for Street Light and Traffic Signal Workers (A custom seminar consisting of approximately ½ day of NESC Rules and ½ day of OSHA 1910.269 power lineman standards.)

  Presented for the City of Portland and the City of Seattle.
- CA GO95
  Presentation at California Public Utilities Commission rule making session in San Francisco, CA regarding mounting communication antennas on power poles.
- CA GO95, GO128, and GO165 compared to the NESC
  Presentation at Western Energy Institute conference in Long Beach, CA and for various in-house training classes.

Publications

Marne, David J., *McGraw-Hill's National Electrical Safety Code® (NESC®) 2017 Handbook*, Conforms to the 2017 NESC®, McGraw-Hill Publishing, New York, NY

Marne, David J., *McGraw-Hill's National Electrical Safety Code® (NESC®) 2012 Handbook*, Conforms to the 2012 NESC®, McGraw-Hill Publishing, New York, NY

Marne, David J., *McGraw-Hill's National Electrical Safety Code® (NESC®) 2007 Handbook*, Conforms to the 2007 NESC®, McGraw-Hill Publishing, New York, NY

Marne, David J., *McGraw-Hill's National Electrical Safety Code® (NESC®) 2002 Handbook*, Conforms to the 2002 NESC®, McGraw-Hill Publishing, New York, NY

National Electrical Safety Code® and NESC® are registered trademarks of the Institute of Electrical and Electronics Engineers (IEEE).

Awards

IEEE Senior Engineer Membership Award

SSR Engineers, Inc. 15-year service award

HDR Engineering, Inc. Professional Associates and Pathfinders Award

Professional Affiliations

Institute of Electrical and Electronics Engineers (IEEE), Senior Member Status and Power Engineering Society (PES) Member

IEEE/NESC Subcommittee 4 (Overhead Lines- Clearances), NESC Subcommittee 7 (Underground Lines), and the NESC Interpretations Subcommittee

National Society of Professional Engineers (NSPE)

Manager of LinkedIn NESC – Power and Communications Group

Manager of LinkedIn GO95, GO128, and GO165 Group

Licensure

Professional Engineer, State of Montana, License Number 9428PE

Professional Engineer, State of Idaho, License Number 6426

Professional Engineer, State of Washington, License Number 39601

Professional Engineer, State of Texas, License Number 1106

Professional Engineer, State of California, License Number E 20771

Professional Engineer, State of New York, License Number 095448

Professional Engineer, State of New Jersey, License Number 24GE05395500

APPENDIX D

Dr. Jerrold E. Winandy Curriculum Vitae



VITAE

Jerrold Everett Winandy, Principal Partner & CTO

Winandy & Associates LLC
960 157th Ave.. NE
Ham Lake, MN 55304 USA
http://www.winandyassociates.com/

608-234-8060 (Cell)
email=jerry@winandyassociates.com
http://bbe.umn.edu/adjunct-faculty/jerroldwinandy

Education

BSF, 1976. Wood Utilization, Dept. of Forestry, Purdue University, West Lafayette, IN.
MS, 1978. Wood Science, Dept. of Forestry, Purdue University, West Lafayette, IN.
Ph.D., 1993. Wood Science & Engineering, Dept. of Wood Science & Engineering, Oregon State University, Corvallis, OR.

Experience

2008-present	Principal Partner, Winandy & Associates LLC, Ham Lake, MN 55304
2008-2009	Interim Executive Vice-president, Forest Products Society, Madison WI
2005-2015	Adjunct Professor, College of Forest Resources, Mississippi State University.
2001-2008	Project Leader & Principal Wood Scientist, Performance Engineered Composites--RWU 4706, USDA, Forest Products Laboratory, Madison, WI
1998-present	Adjunct Professor, Department of Bioproducts and Biosystems Engineering, University of Minnesota.
1994-2001	Principal Wood Scientist, Engineering Properties of Wood--RWU 4714, USDA, Forest Products Laboratory
1989-1994	Research Wood Scientist, Engineering Properties of Wood--RWU 4714, USDA, Forest Products Laboratory
1988-1989	Visiting Scientist, Forest Products Research Laboratory, Oregon State University, Corvallis, OR 97331
1979-1988	Research Forest Products Technologist, Engineering Properties of Wood--RWU 4714, USDA Forest Products Laboratory
1978-1979	Forest Products Technologist, National Furniture Engineering Center, General Services Administration, Washington, DC

Society and Committee Participation

1. Membership in professional societies

American Society for Testing and Materials, ASTM
American Wood Protection Association, AWPA
Forest Products Society, FPS
International Academy of Wood Science, IAWS (Fellow, elected 2004)
International Research Group for Wood Preservation, IRG/WP
International Union of Forest Research Organizations (IUFRO)
Society of Wood Science and Technology, SWST

2. Committee assignments

ASTM D7.06--Chairman, Subcommittee on preservative treatment of wood (1999-2003).
ASTM D7.07--Vice-Chairman, Subcommittee on fire-performance of wood (1996-1999).
ASTM D7.06.04--Chairman, Section on fire-retardant treatments of wood (1992-1996).
ASTM D7.06.04.02 Task group (Chairman) developing Standard Test Methods (D-5516 and D-5664) to assess effects of elevated temperatures on FR-treated plywood and lumber (1990-1995) and develop Standard Practice (D6305) to estimate adjustments to allowable design properties of FR-treated plywood (1995-1998).
ASTM D7.02--Committee on lumber.
ASTM D7.03--Committee on engineered wood composites.

AWPA General Treatments--Chairman, oversee activities of nine AWPA T-subcommittees for writing and maintaining standards on preservative and fire retardant treatments for lumber, poles, pilings, posts, ties, structural composites, and plywood (1999-2003).
AWPA T1--Chairman, Committee on committees for establishing standards on preservative treatment of lumber, timbers, poles, and piling (1999-2003).
AWPA T9--Chairman, Subcommittee on fire-retardant treatments for wood products (1996-1999).
AWPA T2--Committee for identifying requirements and establishing standards on preservative treatment of lumber and timbers (1986-1999).
AWPA T8--Committee for identifying requirements and establishing standards on preservative treatment of composite materials (1988-1999, 2008).
AWPA P6--Chairman, Committee on evaluation and test methods (2006-2011).

FPS Wood Engineering Division--Division Coordinator (1992-1995).
FPS Treated Wood Products Section--Vice-chairman (1989-1992).
FPS Treated Wood Products Section--Secretary (1986-1989).
FPS Treated Wood Products Tech. Newsletter--Contrib. Editor (1986-1996).

IUFRO, Member of Organizing Committee for October/November IUFRO Division 5 Forest Products conference in Taipai, Taiwan
IUFRO, Vice-chair of the Division 5.05 Composites Research Group for enhancing performance, durability & long-term sustainability of bio-based composites.

SWST President (2008-2009).
SWST Member of Executive Board (2004-2006).

Research Leadership and Accomplishments

Dr Winandy started his own consulting firm specializing in forensic wood science, wood durability and bioresource sustainability in 2008.

He served as Project Leader from 2001 to 2008, of the Engineered Composites Science Research Work Unit (RWU4706) at FPL. He had primary responsibility for the processing and serviceability of wood-based and wood-plastic composite products. This research group is recognized by the building codes, the wood industry, and standard organizations as having a leadership role in providing unbiased technical information on manufacturing of and serviceability requirements of wood-based and wood-plastic composite products.

He is internationally recognized for his research and technological development of the concepts of using engineered biocomposites as a value-added tool to promote and to fund sustainable forest management. He formerly led this emerging approach through his long-work with the International Union of Forest Research Organizations (IUFRO) Division 5 Forest Products. From 2003-2012, he was the vice-chair of the Division 5.05 Composites Research Group of IUFRO in which he focused on enhancing the performance and durability of engineered biocomposites and the long-term sustainability of bio-based composites.

He is internationally recognized for his research on the effects of chemicals and chemical processing on the structural performance of wood and wood-composites. This research has resulted in over two dozen peer-reviewed publications on the effects of preservatives and preservative treatment on the physical and mechanical properties of wood. This research has been resulted in several new design adjustments or process limitations in National Codes and Standards in the US and Canada.

The multidisciplinary FRT-Serviceability Team received national recognition by the building codes, the wood industry, and standard organizations for having taken a leadership role in providing unbiased technical information on serviceability assessment of fire-retardant treated plywood roof sheathing. The team also pioneered mechanical- and chemical-based techniques for residual serviceability assessment and predictive models to estimate residual serviceability of wood products in-service. This research resulted in over another two dozen peer-reviewed publications. It has also resulted in four National Standards (ASTM D5516-94, D-5664-95, D-6305-98, and D-6841-02) and major revisions to FR-Treating Standards (AWPA C20 & C27, now AWPA U-1 & T-1).

His work on the very early stages of biological decay showed that changes in the chemical composition of the wood cause significant reductions in wood strength before measurable weight loss occurs. From an engineering perspective, estimating strength loss and residual strength is the critical element in assessing wood serviceability/durability for structures in-service as affected by wood decay. Collaborative studies have shown close a relationship between the degradation of hemicellulose and wood strength losses. Residual strength of degraded wood can be predicted using models developed by this collaborative team. The changes in chemical composition appear to be similar in both the biological and chemical systems. Understanding the relationship between chemical composition and strength loss is critical in developing models to estimate strength loss caused by biological, chemical or thermal agents.

Awards/Honors

Outstanding Alumni Award, College of Forestry, Oregon State University, May 2019

Distinguished Service Award, Society of Wood Science and Technology, June 2015

Elected as a Fellow, Society of Wood Science and Technology, June 2014

President of the Society of Wood Science and Technology (2008-2009)

Interim Executive Vice President of the Forest Products Society (2008-2009)

Elected as a Fellow, International Academy of Wood Science, July 2004

Forest Products Society (FPS). 2002 L. J. Markwardt Engineering Research Award for distinguished contribution to knowledge of wood as an engineering material and its efficient utilization:

Winandy, J. E.. Lebow, P. K., 2001. Modeling strength loss in wood by chemical composition. Part I. An individual component model for Southern pine. Wood and Fiber Science 33(2):239-254.

Forest Products Society (FPS). 2000 L. J. Markwardt Engineering Research Award for distinguished contribution to knowledge of wood as an engineering material and its efficient utilization:

Lebow, P. K., J. E. Winandy. 1999. Verification of a kinetic model for the effects of FR on bending strength at elevated temperatures. Wood and Fiber Science 31(1):49-61.

Society of Wood Science and Technology (SWST). 2018 George C. Marra Award for excellence in research and writing as exhibited in:

Winandy, J. E. 2017. Relating wood chemistry and strength. Part II. Fundamental relationships between changes in wood chemistry and strength of wood. Wood and Fibers Science 49(1):2-11.

American Wood Preservers' Association "Award of Merit" for lifetime service to Association for strategic and technical advancements in National Standards for durable engineered wood materials, April 2006.

Named Adjunct Professor of Wood Science (February 1998-present), Department of Bioproducts and Biosystems Engineering, University of Minnesota, St. Paul, MN.

Named Adjunct Professor of Wood Science (2004-2013), College of Forest Resources, Mississippi State University, Starkville, MS.

USDA Superior Service Award (June 92) for fundamental research defining the interaction between mechanical properties and fire-retardant treated wood exposed at elevated temperatures.

Society of Wood Science and Technology (SWST). 1994 George C. Marra Award (2nd Place). For excellence in research and writing as exhibited in:

Winandy, J. E., J. J. Morrell. 1993. Relationship between incipient decay, chemical composition, and properties of Douglas-fir. Wood and Fiber Science 25(3):278-288.

Reporting of Research Results

1. Publications: (J.Winandy has authored or co-authored over 185 Technical Publications)
2. Patents:
    - Apparatus to nondestructively estimate the density of contiguous segments of lumber (U.S. Patent No. 4747308) May 31, 1988.
    - Method of making medium density fiberboard (U.S. Patent No. 8123904) Feb 28, 2012.

List of Publications: Dr. Jerrold E. Winandy

Wood & Wood Science

W1. Winandy, Jerrold E. 2017. Relating wood chemistry and strength. Part II. Fundamental relationships between changes in wood chemistry and strength of wood. Wood and Fibers Science 49(1):2-11.

W2. Winandy, Jerrold E. 2016. Relating wood chemistry and strength. Part I. Wood structure and chemistry. Proc. Soc. of Wood Science and Technology. Levan SM (ed). Pg.92-102. (*swst.org*) Monona WI. 277pg.

W3. Winandy, Jerrold E.; Rowell, Roger M. 2013. Chemistry of wood strength. In: Rowell, Roger M. ed. Handbook of wood chemistry and wood composites, 2nd Ed.. Boca Raton FL: CRC Press LLC: 415-455, Chapter 11.

W4. Piao, C., Winandy, J.E., Shupe.T.F. 2010. From hydrophilicity to hydrophobicity: A critical review. Wood and Fibers Science 42(4):490-510.

W5. Sabo, R., Clausen, C.A., Winandy, J.E., Basta, A. 2008. Remediation and recycling of WBP-treated lumber for use as flakeboard. Proc. American Wood Protection Association. Vol. 104:256-266. AWPA Birmingham, AL. (http://www.fpl.fs.fed.us/documnts/pdf2008/fpl_2008_sabo002.pdf)

W6. Sabo, R., Clausen, C., Winandy, J.E. 2008. Thermochemical Remediation of Preservative-Treated Wood. IRG/WP- 50524. Stockholm, Sweden. http://www.fpl.fs.fed.us/documnts/pdf2008/fpl_2008_sabo001.pdf

W7. Winandy, J.E., Hatfield, C.H., 2007. Analysis of three-year Wisconsin temperature histories for roof systems using wood, wood-thermoplastic composite, and fiberglass shingles. Forest Products Journal. 57(9):87-96. http://www.fpl.fs.fed.us/documnts/pdf2007/fpl_2007_winandy004.pdf

W8. Kretschmann, D.E., J.Winandy, C.Clausen, M.Wiemann, R.Bergmann, R.Rowell, J.Zerbe, J.Beecher, R.White, D.McKeever, J.Howard. 2007. Wood. In: Kirk-Othmer Encyclopedia of Chemical Technology. New York : John Wiley & Sons, pg 59 (Online posting July 13, 2007.). http://www.fpl.fs.fed.us/documnts/pdf2007/fpl_2007_kretschmann001.pdf

W9. Winandy, Jerrold E.; Rowell, Roger M. 2005. Chemistry of wood strength. In: Rowell, Roger M. ed. Handbook of wood chemistry and wood composites. Boca Raton FL: CRC Press LLC: 303-347, Chapter 11. http://www.fpl.fs.fed.us/documnts/pdf2005/fpl_2005_winandy004.pdf

W10. Wegner, T.H., Winandy, J.E., Ritter, M.A. 2005. Nanotechnology opportunities in residential and non-residential construction. IN: 2nd International Symposium on Nanotechnology in Construction. Held 13-16 Nov2005, Bilbao, Spain. RILEM, Bagneuz, France 9p. (http://www.fpl.fs.fed.us/documnts/pdf2005/fpl_2005_wegner003.pdf)

W11. Winandy, J. E., Grambsch, M., Hatfield C. 2005. Two-year Wisconsin thermal loads for roof assemblies and wood, wood-plastic composite, and fiberglass shingles. Research Note FPL-RN-0301. Madison, WI: United States Department of Agriculture, Forest Service, Forest Products Laboratory: 13p. http://www.fpl.fs.fed.us/documnts/fplrn/fpl_rn301.pdf

W12. Winandy, Jerrold E.; Barnes, H. Michael, Falk, Robert H. 2004. Summer roof temperatures of western red cedar, wood-plastic composite, and black- and white-fiberglass shingles. Forest Products Journal 54(11):27-33. (refereed) http://www.fpl.fs.fed.us/documnts/pdf2004/fpl_2004_winandy002.pdf

W13. Laufenberg, Theodore L.; Winandy, Jerrold E. 2004. Stabilized Engineered Wood Fiber (SEWF) Surfaces for Accessible Playground Areas: Field testing at Governor Nelson State Park in Wisconsin. In: Gen. Tech. Rep. FPL-GTR-154; U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 13p. (refereed) http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr154.pdf

W14. Williams, R.S., Lacher, S., Winandy, J. E., White, C. 2004. Comparison of traditional methods for testing paint service life with new methods for service life prediction. In: Proceedings of 3rd International Symposium on Surfacing and Finishing of Wood. Sponsored by IUFRO Division 5: Working Group 5.04.12 and held on November 24-26, 2004 in Kyoto, Japan. Pg. 167-190. http://www.fpl.fs.fed.us/documnts/pdf2004/fpl_2004_williams005.pdf

W15. Laufenberg, T., A.Krzysik, J.E.Winandy. 2003. Improving engineered wood fiber (EWF) surfaces for ADA-accessible playgrounds. USDA, For. Serv. Gen. Tech. Report FPL-GTR-135, Madison, WI. (refereed). http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr135.pdf

W16. Laufenberg, Theodore L.; Winandy, Jerrold E. 2003. Field Performance Testing of Improved Engineered Wood Fiber (EWF) Surfaces for Accessible Playground Areas. In: Gen. Tech. Rep. FPL-GTR-138; U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 14p. (refereed) http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr138.pdf

W17. Williams, R.S., J. E. Winandy, W. Feist. 2002. Correlation of adhesive strength with service life of paint applied to weathered wood. Proc. of 9th Durability of Building Materials Conference, held March 17-21, 2002 in Brisbane, Queensland, Australia. Vol II. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2002/willi02a.pdf

W18. Winandy, J. E., TenWolde, A., Falk, R.H., Barnes, H.M. 2002. Temperature histories of plywood roof sheathing and roof rafters as used in North American light-framed. In: Proc. of the 7th World Conference on Timber Engineering, Vol. 3:114-121. August 6-10,2002, Malaysia. http://www.fpl.fs.fed.us/documnts/pdf2002/winan02b.pdf

W19. Winandy, J. E., H.M. Barnes, C.Hatfield.. 2000. Temperatures of Wood Roof Materials and Attics in Mississippi and Wisconsin. USDA, For. Serv. Res. Paper FPL-RP-589, Madison, WI. 24 pgs. (refereed). http://www.fpl.fs.fed.us/documnts/fplrp/fplrp589.pdf

W20. Durbak, I., Green, D. W., Highley, T. L., Howard, J. L., McKeever, D. B., Miller, R. B., Pettersen, R. C., Rowell, R. M., Simpson, W. T., Skog, K. E., White, R. H., Winandy, J. E., Zerbe, J. I. 1998. Wood. In: Kirk-Othmer Encyclopedia of chemical technology, 4th Ed. Vol. 25:627-664. J.Wiley & Sons, NY, NY.

W21. Green, D. W., J.E. Winandy, D. E. Kretschmann. 1999. Chapter 4: Mechanical Properties of Wood, USDA Gen. Tech. Report 113, Wood Handbook: Wood as an Engineering Material, Madison, WI. (refereed).

W22. Stoker, D.L., J. E. Winandy, E. K. Achi. 1996. Engineering properties of two underutilized Cote de' Ivoire species: Adjouaba and Aniouketti. J. of Tropical Forest Science 2(1):114-124. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1996/stoke96a.pdf

W23. Falk, R. H., K. A. McDonald, J. E. Winandy. 1995. Controlling Moisture in Deck Lumber. Fine Homebuilding. August/September 1995. p.70-71. http://www.fpl.fs.fed.us/documnts/pdf1997/falk97c.pdf

W24. Larsen, M. J., J. E. Winandy, F. Green. 1995. A proposed model of the tracheid cell wall having an inherent radial ultrastructure in the S_2 layer. Materials und Organism 29(3):197-210. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1995/larse95a.pdf

W25. McDonald, K. A., R. H. Falk, R. S. Williams, J. E. Winandy. 1995. Residential Wood Decks: Materials, Construction, & Finishing. Forest Products Society.Madison,WI. 93pg.

W26. Winandy, J. E., R.Beaumont. 1995. Roof Temperatures in Simulated Attics. USDA, For. Serv. Res. Paper FPL-RP-543, Madison, WI. pg. 14. (refereed). http://www.fpl.fs.fed.us/documnts/fplrp/fplrp543.pdf

W27. Winandy, J. E. 199**4**. Wood Properties. In: Encyclopedia of Agricultural Science, C.J. Arntzen, ED. Academic Press. San Diego, CA. V4:549-561. http://www.fpl.fs.fed.us/documnts/pdf1994/winan94a.pdf

W28. Winandy, J. E., McDonald, K. A. 1993. Material Selection and Preservative Treatment for Outdoor Wooden Structures. Wood Design Focus 4(3):8-13. http://www.fpl.fs.fed.us/documnts/pdf1993/winan93b.pdf

W29. Ritter, M. and J. E. Winandy. 1990. Chapter 3: The properties of wood and structural wood products IN: U.S. Forest Serv. Timber Bridge Manual. M. Ritter, ed., USDA, Washington, DC.

W30. Williams, R. S., J. E. Winandy, and W. C. Feist. 1987. Adhesion of paint to weathered wood. For. Prod. J. 37(11/12):29-31. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1987/willi87b.pdf

W31. Williams, R. S., J. E. Winandy, and W. C. Feist. 1987. Paint adhesion to weathered wood. J. of Paint and Coatings Technology 59(749):43-49. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1987/willi87a.pdf

W32. Bendtsen, B.A., W.J. James, C.C. Gerhards, J.E. Winandy, D.W. Green, M. Chudnoff, P.J. Giese. 1987. Chapter 4: Mechanical Properties of Wood, USDA Ag. Hdbk. #72, Wood Handbook: Wood as an Engineering Material, Madison, WI. (refereed).

W33. Boone, R. S., J. E. Winandy, and B. A. Bendtsen. 1985. A technique for simulating lumber drying using small clear specimens. Forest Prod. J. 35(11/12):49-51. (refereed).

W34. Winandy, J. E. 1984. Evaluation of live oak submerged underwater for 50 years and proposed for use in rebuilding the USS Constitution. Forest Prod. J. 34(51):61-63. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1984/winan84a.pdf

W35. Winandy, J. E., and R. M. Rowell. 1984. The chemistry of wood strength, Chapter 5 in The Chemistry of Solid Wood. R. M. Rowell, ed., Advances in Chemistry Series No. 207, American Chemical Society, Washington, DC.

W36. Winandy, J. E. 1979. The feasibility of using FPL Press-Lam as upholstered furniture dimension stock, Part I. Furniture Manufacturing Management 25(3):29-32.

W37. Winandy, J. E. 1979. The feasibility of using FPL Press-Lam as upholstered furniture dimension stock, Part II. Furniture Manufacturing Management 25(4):35-36.

W38. Eckelman, C. A. and J. E. Winandy. 1979. Performance test for upholstered furniture frames. Furniture Manufacturing Management, 25(6):17-20.

Durability& Decay

D1. Winandy JE, Morrell JJ. 2017. Improving the utility, performance and durability of wood- and bio-based composites. Annals of Forest Science. 74(1):Article 25. 11pg. doi:10.1007/s13595-017-0625-2. https://medcraveonline.com/FREIJ/FREIJ-02-00027.pdf

D2. Aro, M., Donahue, P., and Winandy, J. 2014. Thermal Modification: Current Developments in the U.S. and Canada. In: *Proceedings of the 8th European TMT Workshop*. Dresden, Germany. 147-158.

D3. Kirker, G., Winandy, J. 2014. Chapter 6: Above ground deterioration of wood and wood-based materials. In: Schultz,T., Goodell,B., Nicholas,D. (Ed.). Deterioration and Protection of Sustainable Biomaterials. ACS Symposium Series, Vol. 1158. American Chemical Society Press. Wash.DC. p113-129 https://global.oup.com/academic/product/deterioration-and-protection-of-sustainable-biomaterials-9780841230040?cc=us&lang=en&#)

D4. Winandy, J.E., Donahue, P. 2014. Development and use of AWPA/ANSI Guidance Document N—Data requirements for listing thermally modified wood in AWPA Standards. Proc. of 7th European Conference on Wood Modification. Held March 10-12, 2014 in Lisbon, Portugal. 8pg.

D5. Curling, S., Winandy, J.E. 2008. Comparison of the effects of gamma irradiation and steam sterilization on southern pine sapwood. Forest Products Journal 58(1/2):87-90. (refereed). (http://www.fpl.fs.fed.us/documnts/pdf2008/fpl_2008_curling001.pdf)

D6. Kamke, F.A., Winandy, J.E. 2008. Issues and concepts for making durable composites. Proc. American Wood Protection Association. Vol. 104. (In-Press). AWPA Birmingham, AL.(http://www.fpl.fs.fed.us/documnts/pdf2008/fpl_2008_kamke001.pdf)

D7. Winandy, Jerrold E.; Curling, Simon F.; Lebow, Patricia K. 2005. Controlling the moisture content of wood samples using the modified FPL soil-pan decay method. Forest Products Journal 55(6): 80-85. http://www.fpl.fs.fed.us/documnts/pdf2005/fpl_2005_winandy002.pdf

D8. Curling, S.F., J. E. Winandy, C. Carll, J. A. Micales, A. Tenwolde. 2003. How variability in OSB mechanical properties affects biological durability testing. Holzforschung 57 (2003): 8-12 (refereed). http://www.fpl.fs.fed.us/documnts/pdf2003/curli03a.pdf

D9. Smith, W. R., A. Rapp, J. E. Winandy. 2003. Resistance of heat-treated wood to Formosan subterranean termites. International Research Group on Wood Preservation, Document No. IRG/WP 03-40264. Stockholm, SWEDEN. http://www.fpl.fs.fed.us/documnts/pdf2003/smith03a.pdf

D10. Curling, S.F., C.A. Clausen, J. E. Winandy. 2002. Relationship between mechanical properties, weight loss and chemical composition of wood during incipient brown rot decay of southern pine sapwood. Forest Products Journal 52(7/8):34-39. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2002/curli02b.pdf

D11. Curling, S.F., J. E. Winandy, C.A. Clausen. 2002. Experimental method to quantify progressive stages of decay of wood by basidiomycete fungi. International Biodeterioration and Biodegradation 49 (2002) 13-19. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2002/curli02a.pdf

D12. Morris, P.I., Winandy, J. E. 2002. Limiting conditions for decay in wood systems. International Research Group on Wood Preservation, Document No. IRG/WP 02-10421, Stockholm, SWEDEN. http://www.fpl.fs.fed.us/documnts/pdf2002/morri02a.pdf

D13. Curling, S.F., J. E. Winandy, C. A. Clausen. 2001. Effect of hemicellulose degradation on mechanical properties during brown rot decay. International Research Group on Wood Preservation, Document No. IRG/WP 01-20219, Stockholm, SWEDEN. http://www.fpl.fs.fed.us/documnts/pdf2001/curli01a.pdf

D14. Winandy, J. E., C. A. Clausen, Curling, S.F. 2001. Predicting the effects of decay on wood properties and modeling residual service-life. Proc. of 2nd annual conference on Durability and Disaster Mitigation in Wood-Frame Housing. Held Nov 6-8, 2000 in Madison, WI. Published by Forest Products society October 5, 2001. p.261-263. http://www.fpl.fs.fed.us/documnts/pdf2000/winan00b.pdf

D15. Curling, S.F., J. E. Winandy, C. A. Clausen. 2000. An experimental method to simulate incipient decay of wood by basidiomycete fungi. International Research Group on Wood Preservation Document No. IRG/WP 00-20200, Stockholm, SWEDEN. 12pg. http://www.fpl.fs.fed.us/documnts/pdf2000/curli00a.pdf

D16. Winandy, J. E., J. J. Morrell. 1993. Relationship between incipient decay, chemical composition, and physical properties of Douglas-fir heartwood. Wood and Fiber Science 25(3):278-288. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1993/winan93a.pdf

D17. Green, F., M. J. Larsen, J. E. Winandy, T. L. Highley. 1991. The role of oxalic acid in brown rot decay. Materials und Organism 26(3):191-213. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1991/green91b.pdf

D18. Winandy, J. E., J. J. Morrell. 1990. Protection of wood designs in adverse environments. In: Suprenant, Bruce S. ed. Serviceability and durability of construction materials. Proc. of the 1st Material Engineering Congress, August 13-15, 1990. Denver, CO. New York, NY. American Society of Civil Engineers, Vol 1:303-313. https://www.fpl.fs.fed.us/documnts/pdf1990/winan90b.pdf

Engineered Composites

C1. Winandy JE, Morrell JJ. 2017. Improving the utility, performance and durability of wood- and bio-based composites. Annals of Forest Science. 74(1):Article-25. 11pg. doi:10.1007/s13595-017-0625-2. https://medcraveonline.com/FREIJ/FREIJ-02-00027.pdf

C2. Basta AH, El-Saied H, Winandy JE. 2017. Chapter 7: Comparative evaluation of rice bran- and corn starch-modified urea formaldehyde adhesives on improvements of environmental performance of agro-based composites. IN: Bio-based Wood Adhesives: Preparation, Characterization, and Testing. Ed: He Z, CRC Press/Taylor & Francis, 326p. ISBN 9781498740746. Pg179-196.

C3. Sabo, R., Basta, A.H., Winandy, J.E. 2013. Integrated study of the potential application of remediated CCA-treated Spruce Wood to MDF production. Ind. Eng. Chem. Res. 52:8962-8968. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2013/fpl_2013_sabo002.pdf

C4. Li, X., Cai, Z., Horn, E., Winandy, J.E., 2011. Effect of oxalic acid pretreatment of wood chips on manufacturing medium-density fiberboard. Holzforschung 65:737-741. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2011/fpl_2011_li005.pdf

C5. Li, X., Cai, Z., Horn, E., Winandy, J.E., 2011. Oxalic acid pretreatment of rice straw particles and loblolly pine chips: Release of hemicellulosic carbohydrates. Tappi Journal, May 2011 pp. 41-45.(refereed). http://www.fpl.fs.fed.us/documnts/pdf2011/fpl_2011_li004.pdf

C6. Li, X., Cai, Z., Winandy, J.E., Basta, A. 2010. Effect of oxalic acid and steam pretreatment on the primary properties of UF-bonded rice straw particleboards. Industrial Crops and Products 33(2011):665-669. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2011/fpl_2011_li002.pdf

C7. Basta, A.H., El-Saied, H., Winandy, J.E., Sabo, R. 2011. Preformed amide-containing biopolymer for improving the environmental performance of synthesized urea-formaldehyde in agro-fiber composites. J. Polymers and the Environment (2011) 19:405-412. (refereed). DOI 10.1007/s10924-011-0286-4. http://www.fpl.fs.fed.us/documnts/pdf2011/fpl_2011_basta001.pdf

C8. Moya, L., Tze, W.T.Z., Winandy, J.E. 2010. Predicting bending strength of randomly oriented hybrid panels. Wood and Fiber Science 42(4):536-549. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2010/fpl_2010_moya001.pdf

C9. Li, X., Cai, Z., Winandy, J.E., Basta, A. 2010. Selected properties of particleboard panels manufactured for rice straws of different geometries. Bioresource Technology 101 (2010) pg 4662-4666. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2010/fpl_2010_li003.pdf

C10. Moya, L., Tze, W.T.Z., Winandy, J.E. 2009. The effect of cyclic relative humidity changes on moisture content and thickness swelling behavior of oriented strandboards. Wood and Fiber Science 41(4):447-460. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2009/fpl_2009_moya001.pdf

C11. Ayrilmis, N., Laufenberg, T.L., Winandy, J. E. 2009. Dimensional stability and creep behavior of heat-treated exterior medium density fiberboard. Eur. J. Wood Prod. 67:287-295. DOI 10.1007/s00107-009-0311-7. Springer-Verlag. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2009/fpl_2009_ayrilmis002.pdf

C12. Ayrilmis, N., Winandy, J. E. 2009. Effects of post heat-treatments on surface characteristics and adhesive bonding performance of medium density fiberboard. Materials and Manufacturing Processes 24:594-599. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2009/fpl_2009_ayrilmis001.pdf

C13. Cai, Z., Birkeland, M., Wescott, J.M., O'Dell, J., and Winandy, J.E. 2009. Effects of press sizes on internal steam pressure during particleboard hot-pressing process. Forest Prod. J. 59(4):40-44. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2009/fpl_2009_cai001.pdf

C14. Winandy, J.E.; Stark, N.M.; Horn, E. 2008. Wood-plastic composites using thermomechanical pulp made from oxalic-acid-pretreated red pine chips. In: Proceedings of the 7th Global WPC and Natural Fibre Composites Congress; 2008, June 18-19; University of Kassel, Germany: A16-1-A16-7. http://www.fpl.fs.fed.us/documnts/pdf2008/fpl_2008_winandy002.pdf

C15. Sabo, R., Clausen, C.A., Winandy, J.E., Basta, A. 2008. Remediation and recycling of WBP-treated lumber for use as flakeboard. Proc. American Wood Protection Association. Vol. 104. (In-Press). AWPA Birmingham, AL. (http://www.fpl.fs.fed.us/documnts/pdf2008/fpl_2008_sabo002.pdf)

C16. Williams, R.S, Winandy, J.E. 2008. Effect of flakeboard manufacturing variables on composite properties: Part 1. Effect of resin content, wax content, pressing conditions, and edge treatments on paint performance. Proc. American Wood Protection Association. Vol. 104:146-160. AWPA Birmingham, AL. (http://www.fpl.fs.fed.us/documnts/pdf2008/fpl_2008_williams001.pdf)

C17. Winandy, Jerrold E.; Krzysik, Andrzej M. 2007. Thermal degradation of wood fibers during hot-pressing of MDF composites: Part I. Relative effects and benefits of thermal exposure. Wood and Fiber Science. 39(3): 450-461. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2007/fpl_2007_winandy002.pdf

C18. Winandy, Jerrold E.; Smith, W. Ramsay. 2007. Enhancing composite durability: Using thermal treatments. Forest Products Society, Publication No. 7229 ISBN 1-892529-48-3. pg195-199. http://www.fpl.fs.fed.us/documnts/pdf2007/fpl_2007_winandy001.pdf

C19. Hughes, Mark; Winandy, Jerrold E. 2007. Issues related to durability and protection affecting the acceptance and use of engineered wood composites in Europe. Forest Products Society, Publication No. 7229 ISBN 1-892529-48-3. pg. 173-178. http://www.fpl.fs.fed.us/documnts/pdf2007/fpl_2007_hughes001.pdf

C20. Ayrilmis, N., Korkut, S., Tanritanir, E., Winandy, J.E., Hiziroglu, S. 2007. Effect of various fire retardants on plate shear and five-point flexural shear strength of plywood. Forest Products Journal 57(4):44-49. http://www.fpl.fs.fed.us/documnts/pdf2007/fpl_2007_ayrilmis001.pdf

C21. Winandy, J.E. 2006. Thermal load histories for North American roof assemblies using various cladding materials including wood-thermoplastic composite shingles. In: Proceedings of the 6th global wood and natural fibre composites symposium; 2006 April 5-6; Kassel, Germany. Kassel, Germany: B13-1-B13-8. http://www.fpl.fs.fed.us/documnts/pdf2006/fpl_2006_winandy001.pdf

C22. Ayrilmis, N., Korkut, S., Tanritanir, E., Winandy, J.E., Hiziroglu, S. 2006. Effect of various fire retardants on surface roughness of plywood. Building and Environment 41 (2006):887-892. http://www.fpl.fs.fed.us/documnts/pdf2006/fpl_2006_ayrilmis001.pdf

C23. Winandy, J. E., Hunt, J.F., Turk, C., Anderson, J.R. 2006. Emergency housing systems for three-dimensional engineered fiberboard: Temporary building systems for lightweight, portable, easy-to-assemble, reusable, recyclable, and biodegradable structures. General Technical Report FPL-GTR-166. Madison, WI: United States Department of Agriculture, Forest Service, Forest Products Laboratory: 10p. http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr166.pdf

C24. Cai, Z., Muehl, J. H., Winandy, J.E. 2006. Effects of panel density and mat moisture content on processing medium density fiberboard. Forest Products Journal 56(10):20-25. http://www.fpl.fs.fed.us/documnts/pdf2005/fpl_2005_wang003.pdf

C25. Cai, Zhiyong; Wescott, James M.; Winandy, Jerrold E. 2006. Strandboard made from soy-based adhesive with high soy content. In: Proceedings of Wood Adhesives. 2005 November 2-4; San Diego, California: Forest Products Society Proceedings No. 7230: 531-537. http://www.fpl.fs.fed.us/documnts/pdf2006/fpl_2006_cai006.pdf

C26. Cai, Zhiyong; Muehl, James H.; Winandy, Jerrold E. 2006. Effects of pressing schedule on formation of vertical density profile for MDF panels. IN: Proc. of International Wood Composites Sysmposium. Washington State University. http://www.fpl.fs.fed.us/documnts/pdf2006/fpl_2006_cai003.pdf

C27. Winandy, J.E., Wellwood, R.W., Hiziroglu, S. 2005. *Using wood composites as a tool for sustainable forestry:* Proceedings of Scientific Session 90, XXII IUFRO World Congress. Gen. Tech. Rep. FPL-GTR-163. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 91 pg. https://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr163.pdf

C28. Ayrilmis, Nadir; Kartal, S. Nami; Laufenberg, Theodore L.; Winandy, Jerrold E.; White, Robert H. 2005. Physical and mechanical properties and fire, decay, and termite resistance of treated oriented strandboard. Forest Products Journal 55(5): 74-81. http://www.fpl.fs.fed.us/documnts/pdf2005/fpl_2005_ayrilmis001.pdf

C29. Winandy, J.E.; Stark, N.M.; Clemons, C.M. 2004. Considerations in recycling of wood-plastic composites. In: Proceedings of the 5th global wood and natural fibre composites symposium; 2004 April 27-28; Kassel, Germany. Kassel, Germany: A6-1-A6-9. http://www.fpl.fs.fed.us/documnts/pdf2004/fpl_2004_winandy001.pdf

C30. Winandy, Jerrold E.; Kamke, Frederick A. 2004. Fundamentals of composite processing: proceedings of a workshop. General Technical Report FPL-GTR-149. Madison, WI: United States Department of Agriculture, Forest Service, Forest Products Laboratory: 118 p. http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr149.pdf

C31. Hunt, John F.; Winandy, Jerrold E. 2003. 3D Engineered Fiberboard: Engineering Analysis of an Innovative New Building Product. In: Proceedings of the 2nd Eco-Composites Conference, Paper 8.02. European Society for Composite Materials. London UK, 1-2 Sept 2003. http://www.fpl.fs.fed.us/documnts/pdf2003/hunt03a.pdf

C32. Hunt, John F.; Winandy, Jerrold E. 2003, Lam I-joists: A New Structural Building Product From Small-diameter, Fire-prone Timber. USDA Forest Service Forest Products Laboratory, Res. Note FPL-RN-0291 http://www.fpl.fs.fed.us/documnts/fplrn/fplrn291.pdf

C33. Hunt, J.F., Winandy, J.E. 2002. 3D Engineered Fiberboard: A new structural product. Proc. of 6th European Panel Products Symposium. Held Oct 8-11, 2002. University of Wales, Bangor-Gwynedd, Wales. October 2002. Pg. 106-117. http://www.fpl.fs.fed.us/documnts/pdf2002/hunt02a.pdf

C34. Winandy, J. E. 2002. Emerging Materials: What will durable materials look like in 2020. Proc. of the Forest Products Society Conference on "Enhancing the durability of lumber and engineered wood products". Held in Kissimmee, FL on February 11-13, 2002. Forest Products Society Publ No. 7249. September 2002. pg. 13-18. http://www.fpl.fs.fed.us/documnts/pdf2002/winan02c.pdf

C35. Hunt, J.F., Winandy, J.E. 2002. Using wood-based structural products as forest management tools to improve forest health, sustainability and reduce forest fuel: A research program of the USDA Forest Service under the National Fire Plan. Proc. of the 6th Pacific Rim Bio-based Composites Symposium. Held Nov 10-13, 2002. Portland OR. Vol. 1: 316-322. http://www.fpl.fs.fed.us/documnts/pdf2002/hunt02c.pdf

FRT & Modeling Thermal Degradation

F1. Winandy, J. E., H. M. Barnes, J.M Hill. 2016. Effect of specimen width when evaluating laboratory-manufactured fire retardant-treated strandboard. Wood and Fiber Science 48(1):2-12. (refereed).

F2. Barnes, H.M., J.E.Winandy, J.M Hill. 2015. Development of a testing protocol for effects on strength of laboratory-manufactured fire retardant-treated strandboard. Wood and Fiber Science 47(1):50-55. (refereed).

F3. Winandy, J. E., H. M. Barnes, P. D. Jones, and C. R. McIntyre. 2014. Laboratory and field exposures of fire retardant-treated plywood: Part 3—modeling exposure relationships. 46(4):563-572. (refereed).

F4. Winandy, J.E., Barnes, H.M., Jones, P.D. 2014. Modeling the relationship between laboratory and field exposure of FRT plywood. IN: *Proc. of 57th International Convention of the Society of Wood Science and Technology*, June 23-27, 2014, Zvolen, Slovakia. Ed: H.M.Barnes & V.H Herian. Monona, WI.

F5. Winandy, J. E., 2013.. Effects of Fire-retardant-treatments on chemistry and engineering properties of wood. Wood and Fiber Science. 45(2):131-148. (refereed).

F6. Barnes, H.M., Winandy, J.E., McIntryre, C.M. 2010. Laboratory and field exposures of FRT plywood: Part 2 – Mechanical properties. Wood and Fiber Science. 42(1):30-45. (refereed).

F7. Barnes, H.M., Winandy, J.E., McIntryre, C.M. 2008. Laboratory and field exposures of FRT plywood: Part 1 – Physical test data. IRG-WP 08-40426, Int. Res. Group on Wood Protection. IRG Secretariat, Stockholm, SWEDEN.

F8. Winandy, J. E., Wang, Q., White, R. H.. Fire-retardant-treated strandboard: Properties and fire performance. Wood and Fiber Science. 40(1):62-71. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2008/fpl_2008_winandy001.pdf

F9. White, R. H., Winandy, J. E. 2006. Fire performance of oriented strandboard. Proc. of the conference on recent advances in flame retardancy of polymeric materials. BCC Research Norwalk, CT. ISBN: 1-59623-221-8. Vol 17. Pg 297-309. http://www.fpl.fs.fed.us/documnts/pdf2006/fpl_2006_white001.pdf

F10. Wang, Q., Wang, W., Winandy, J.E. 2005. Effects of a new GUP-B fire retardant on mechanical properties of Korean pine when exposed to elevated temperature. Forest Products Journal 55(12)214-220. (refereed) http://www.fpl.fs.fed.us/documnts/pdf2005/fpl_2005_wang003.pdf

F11. Wang; Qingwen; Li, Jian; Winandy, Jerrold. 2004. Chemical mechanism of fire retardance of boric acid on wood. Wood Science and Technology 38(2004):375-389. (refereed) http://www.fpl.fs.fed.us/documnts/pdf2004/fpl_2004_wang002.pdf

F12. Winandy, J. E., M. J. Richards. 2003. Evaluation of boron-nitrogen, phosphate-free fire-retardant: Part I. Evaluation of Douglas-fir plywood according to ASTM D5516-96. ASTM Journal of Testing and Evaluation 31(2): 133-139. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2003/winan03a.pdf

F13. Winandy, J. E., D. Herdman. 2003. Evaluation of boron-nitrogen, phosphate-free fire-retardant: Part II. Evaluation of small, clear specimens according to Methods A and B of ASTM D5664-95. ASTM Journal of Testing and Evaluation 31(2): 140-147. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2003/winan03b.pdf

F14. Winandy, J. E., W. McNamara. 2003. Evaluation of boron-nitrogen, phosphate-free fire-retardant: Part III. Evaluation of full-size 2 by 4 lumber according to Method C of ASTM D5664-95. ASTM Journal of Testing and Evaluation 31(2): 148-153. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2003/winan03c.pdf

F15. Lebow, P. K.; Winandy, J.E. 2003. Using Kinetic Models to Predict Thermal Degradation in Fire-Retardant Treated Plywood Roof Sheathing. In: Proc. of 31st Conf. of the North American Thermal Analysis Society. Albuquerque NM. Paper#048. http://www.fpl.fs.fed.us/documnts/pdf2003/lebow03b.pdf

F16. Winandy, J. E., P. K. Lebow, J. F. Murphy. 2002. Predicting the current serviceability and residual service-life of plywood roof sheathing using kinetics-based models. Proc. of 9th Durability of Building Materials Conference, held March 17-21, 2002 in Brisbane, Queensland, Australia. Vol. II (refereed). http://www.fpl.fs.fed.us/documnts/pdf2002/winan02a.pdf

F17. Winandy, J. E. 2001. Thermal degradation of fire-retardant-treated wood: Predicting residual service-life. Forest Products Journal 51(2):47-54. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2001/winan01a.pdf

F18. Winandy, J. E., P. K. Lebow. 2001. Modeling strength loss in wood by chemical composition: I. An individual component model for Southern Pine. Wood and Fiber Science. 33(2):239-254. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2001/winan01c.pdf

F19. Winandy, J. E. 2000. Serviceability modeling—Predicting and extending the useful service life of FRT-plywood roof sheathing. International Research Group on Wood Preservation Document No. IRG/WP 00-20210, Stockholm, SWEDEN. 10 pg. http://www.fpl.fs.fed.us/documnts/pdf2000/winan00a.pdf

F20. Lebow, S. T., J. E. Winandy. 1999. The effect of FRT on plywood pH and relationship of pH to strength properties. Wood Science and Technology 33 (1999) 285-298. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1999/lebow99c.pdf

F21. Lebow, P. K., J. E. Winandy. 1999. Verification of a kinetic model for the effects of FR on bending strength at elevated temperatures. Wood and Fiber Science 31(1):49-61. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1999/lebow99a.pdf

F22. Sweet, M. S., J. E. Winandy. Influence of degree of polymerization (DP) of cellulose and hemicellulose content on strength loss in fire-retardant-treated Southern pine. Holzforschung 53(3):311-317. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1999/sweet99a.pdf

F23. Winandy, J. E., P. K. Lebow, and W. Nelson. 1998. Development of models to predict bending strength from screw-withdrawal test of FRT-plywood. USDA, For. Serv. Res. Paper FPL-RP-568, Madison, WI. (refereed). http://www.fpl.fs.fed.us/documnts/fplrp/fplrp568.pdf

F24. Lebow, S. T., J. E. Winandy. 1998. The role of grade and thickness in the degradation of fire-retardant-treated plywood. Forest Products Journal 48(6):88-94. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1998/lebow98a.pdf

F25. Winandy, J. E. 1998. Using kinetics-based models to address serviceability concerns for fire retardant treated wood exposed at elevated in-service temperatures. In: Proc. of the 5th World Conference on Timber Engineering, August 17-22,1998, Lausanne, Switzerland. Vol 1:794-795. Swiss Federal Laboratories. http://www.fpl.fs.fed.us/documnts/pdf1998/winan98c.pdf

F26. Winandy, J. E. 1997. Effects of fire retardant retention, borate buffers, and redrying temperature after treatment on thermal-induced degradation. Forest Products Journal 47(6): 79-86. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1997/winan97a.pdf

F27. Winandy, J. E., P. K. Lebow. 1996. Kinetic model of the effects of fire-retardants at elevated temperatures. Wood and Fiber Science 28(1):39-52. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1996/winan96a.pdf

F28. Winandy, J. E. 1996. Serviceability Modeling of Fire-retardant Treated Plywood Roof Sheathing. IN: Proc. of the Third Wood Building/Architecture Technical Conference. Seoul, Korea Nov 14, 1996. Korean Forest Research Institute, Seoul, Korea. pg. 47-63. http://www.fpl.fs.fed.us/documnts/pdf1996/winan96d.pdf

F29. Winandy, J. E., E. L. Schmidt 1995. Remedial treatments for thermally-degraded fire-retardant-treated lumber. Forest Products Journal 45(2):51-52. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1995/winan95a.pdf

F30. Winandy, J. E. 1995. The effects of fire-retardant treatments after 18-months exposure at 150 F (66 C). USDA, For. Serv. Res. Note FPL-0264, Madison, WI. (refereed). http://www.fpl.fs.fed.us/documnts/fplrn/fplrn264.pdf

F31. Winandy, J. E. 1994. Serviceability Modeling of Fire-retardant treated plywood roof sheathing. IN: Proc. of the Pacific Timber Engineering Conference. Gold Coast, Queensland, AUSTRALIA. July 11-15, 1994. Vol.2:292-297.

F32. Winandy, J. E. 1991. Impact of preservative and fire-retardant treatments on allowable design stresses for wood. Wood Design Focus 2(1):8-10.

F33. Winandy, J. E., S. L. LeVan, R. J. Ross, S. P. Hoffman, C. R. McIntyre. 1991. Thermal degradation of fire retardant treated plywood: development and evaluation of a test protocol. USDA, For. Serv. Res. Paper FPL-501, Madison, WI. (refereed). http://www.fpl.fs.fed.us/documnts/fplrp/fplrp501.pdf

F34. Winandy, J. E., R. J. Ross., S. L. LeVan. 1991. Fire retardant-treated wood: Research at USDA Forest Products Laboratory. Proc. of the 2nd International Timber Engineering Conference V4:69-74. London, UK. http://www.fpl.fs.fed.us/documnts/pdf1991/winan91a.pdf

F35. LeVan, S. L., J. E. Winandy. 1990. Effects of fire retardant treatments on wood strength: A review. Wood and Fiber Science 22(1):113-131. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1990/levan90b.pdf

F36. LeVan, S. L., R. J. Ross, J. E. Winandy. 1990. Effect of fire retardant chemicals on the bending properties of wood exposed to elevated temperatures. USDA, For. Serv. Res. Paper FPL-498, Madison, WI. (refereed). http://www.fpl.fs.fed.us/documnts/fplrp/fplrp498.pdf

F37. Winandy, J. E. 1990. Fire-retardant treated wood: Effects of elevated temperature and guidelines for design. Wood Design Focus 1(2):8-10. http://www.fpl.fs.fed.us/documnts/pdf1990/winan90a.pdf

F38. Winandy, J. E., S. L. LeVan, E. L. Schaffer, and P. W. Lee. 1988. Effect of fire retardant treatment and redrying on the mechanical properties of Douglas-fir and Aspen plywood. USDA, For. Serv. Res. Paper FPL-485, Madison, WI. (refereed). http://www.fpl.fs.fed.us/documnts/fplrp/fplrp485.pdf

Preservative & Treatment Processing Effects

P1. Winandy JE, Morrell JJ, Cheung K. 2018. Review of Revisions to Incising-Effect Adjustment Factors (C_i) in the 2018 National Design Specification for Wood Construction. Wood Design Focus 28(1):11-17.

P2. Winandy JE, Cheung K. 2017. Update on revisions to 2018 National Design Specification for incising-effect adjustment factors for strength and stiffness. Proc. of American Wood Preservers' Association. Birmingham, AL. Vol. 115:141-146.

P3. Hernandez, Roland; Winandy, Jerrold E. 2005. Evaluation of a reduced section modulus model for determining the effects of incising on bending strength and stiffness of structural lumber. Forest Products Journal 55(9):57-65. http://www.fpl.fs.fed.us/documnts/pdf2005/fpl_2005_hernandez001.pdf

P4. Lebow, Stan; Winandy, Jerrold; Bender, Donald. 2003. Treated wood in transition: a look at CCA and the candidates to replace it. Frame Building News. 15(5): 32-38. http://www.fpl.fs.fed.us/documnts/pdf2004/fpl_2004_lebow005.pdf

P5. Winandy, J. E., F.Green III, D.Keefe. 2001. Treatability problems—Relationship between anatomy, chemical composition and treatability. International Research Group on Wood Preservation, Document No. IRG/WP 01-40213, Stockholm, SWEDEN. http://www.fpl.fs.fed.us/documnts/pdf2001/winan01b.pdf

P6. Barnes, H. M., J. E. Winandy. 2001. Bending properties of wooden crossarms. Proc. of American Wood Preservers' Association. Granbury, TX. Vol. 105:30-37. http://www.fpl.fs.fed.us/documnts/pdf2001/barne01a.pdf

P7. Winandy, J. E., J. J. Morrell. 1998. Effects of incising on lumber strength and stiffness: Relationship between incision density and depth, species and MSR-grade. Wood and Fiber Science 30(2):185-197. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1998/winan98a.pdf

P8. Morrell, J. J., R. Gupta, J. E. Winandy, and D. S. Riyanto. 1998. Effects of incising on torsional shear strength of lumber. Wood and Fiber Science 30(4):374-381. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1998/morre98a.pdf

P9. Winandy, J. E., R. Hernandez. 1998. An analytical approach to determining the effects of incising on bending strength and stiffness of glue-laminated beams. Proceedings of the American Wood Preservers' Association. Vol. 94:98-115. Granbury,TX. http://www.fpl.fs.fed.us/documnts/pdf1998/winan98b.pdf

P10. Winandy, J. E., S. T. Lebow. 1997. Effects of ammoniacal copper citrate preservative treatment and redrying on bending properties of two grades of Southern pine 2 by 4 lumber. Forest Products Journal 47(7/8):91-99. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1997/winan97b.pdf

P11. Anderson, M., J. J. Morrell, and J. E. Winandy. 1997. Effect of incising depth and density on treatability of Douglas-fir, Hem-Fir, and Spruce-Pine-Fir lumber with ACZA, CCA, and ACQ. International Research Group on Wood Preservation, Doc. No. IRG/WP/97-40093. Stockholm, Sweden. 8 pg.

P12. Winandy, J. E. 1996. Effects of Treatments, Incising, and Drying on Mechanical properties of Timber. In: Proc. of National Conf. on Wood Transportation Structures. USDA, For. Serv. Gen. Tech. Report FPL-GTR-94, Madison, WI. pg. 178-185. http://www.fpl.fs.fed.us/documnts/pdf1996/winan96b.pdf

P13. Winandy, J. E. 1996. Treatment-processing effects model for WBP-treated lumber. In: Proc. of the International Wood Engineering Conference V3:125-133. New Orleans, LA. http://www.fpl.fs.fed.us/documnts/pdf1996/winan96c.pdf

P14. Winandy, J. E. 1995. Influence of time-to-failure on strength of CCA-treated lumber. Forest Products Journal 45(2):82-85. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1995/winan95d.pdf

P15. Winandy, J. E. 1995. Effect of moisture content on strength of CCA-treated lumber. Wood and Fiber Science 27(2):25-34. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1995/winan95c.pdf

P16. Winandy, J. E., J. J. Morrell, and S. T. Lebow. 1995. Review of Effects of Incising on Treatability and Strength. IN: Proc. of Wood Preservation in the 90's and beyond. Savannah, GA. Sept 26-28, 1994. Forest Products Society. Madison, WI. p.65-69.

P17. Boone, R. S., J. E. Winandy, J. J. Fuller. 1995. Effects of redrying schedule on preservative fixation and strength of CCA-treated lumber. Forest Products Journal 45(9):65-73. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1995/boone95a.pdf

P18. Winandy, J. E. 1995. Effects of waterborne preservative treatment on mechanical properties: A review. Proc. of American Wood Preservers' Association. Granbury, TX. Vol. 91:17-33. http://www.fpl.fs.fed.us/documnts/pdf1995/winan95b.pdf

P19. Winandy, J. E. 1995. The effects of drying and treatment on mechanical properties of wood. In Proc. of DRY-CON: Wood Technology magazine's drying management conference. November 29-December 1, 1995. pg. 57-63. Charlotte, NC.

P20. Winandy, J. E. 199**4**. The effects of long-term elevated temperature on CCA-treated Southern Pine lumber. Forest Products Journal 44(6):49-55. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1994/winan94c.pdf

P21. Winandy, J. E. 1994. Influence of short-term load duration and moisture content on the strength of CCA-treated lumber. In: Systems approach to wood structures. Editors: K.J. Fridley and J.D. Dolan. Forest Products Society. FPS Proceedings #7312. Madison, WI. pg 97-99. http://www.fpl.fs.fed.us/documnts/pdf1994/winan94b.pdf

P22. Winandy, J. E., H. M. Barnes, Technical Editors. 1993. Chromium-containing Waterborne Wood Preservatives: Fixation and Environmental Issues. Proceedings of a 1991 Plenary Session on Chemical Fixation of Waterborne-preservative Treated Wood and related 1991 & 1992 Technical Forums. Forest Products Society, Madison,WI. 55 pp.

P23. Winandy, J. E., H. M. Barnes, P. H. Mitchell. 1992. Effects of CCA treatment and drying on tensile strength of lumber. J. of Materials in Civil Engineering 4(3):240-251. (refereed). https://www.fpl.fs.fed.us/documnts/pdf1992/winan92a.pdf

P24. Winandy, J. E., D. A. Bender. 1992. Treat Wood Right. Framebuilders News. May/June 1992 p.8-11.

P25. Winandy, J. E., H. M. Barnes. 1991. Influence of initial kiln drying on CCA-treatment effects on strength. Proc. of the American Wood Preservers' Assoc. V87:147-152. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1991/winan91b.pdf

P26. Morrell, J. J., S. M. Smith, J. J. Winandy. 1991. Effects of incising on preservative treatment of Douglas-fir lumber. Proc of the Canadian Wood Preservers' Assoc. 12:263-276.

P27. Barnes, H. M., J. E. Winandy, P. H. Mitchell. 1990. Effect of initial and post-treatment drying temperatures on the bending properties of CCA-treated Southern Pine. J. of the Institute of Wood Science 11(6):222-230. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1990/barne90a.pdf

P28. Winandy, J. E. and D. E. Kretschmann. 1989. The effect of CCA preservative treatment and redrying on the fracture toughness of loblolly pine. Proc. of the Int'l. Conf. on Timber Engineering, R. Y. Itani, ed. Seattle, WA., Sept. 19-22, 1988, by FPS, Madison, WI. ,Vol. 2 pg 576-583. http://www.fpl.fs.fed.us/documnts/pdf1988/winan88b.pdf

P29. Winandy, J. E. 1989. CCA preservative treatment and redrying effects on the bending properties of Southern Pine 2 by 4's. Forest Products Journal 39(9):14-21. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1989/winan89a.pdf

P30. Winandy, J. E., R. S. Boone, L. R. Gjovik, P. L. Plantinga. 1989. The effects of ACA and CCA preservative treatment and kiln-redrying after treatment on the mechanical properties of Douglas-fir. Proc. of the American Wood Preservers Assoc. 85:106-118. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1989/winan89b.pdf

P31. L. A. Soltis, J. E. Winandy. 1989. Long-term strength of CCA-treated lumber. Forest Products Journal 39(5):64-68. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1989/solti89a.pdf

P32. Ostmeyer, J. G., T. J. Elder, J. E. Winandy. 1989. Spectroscopic analysis of southern pine treated with chromated copper arsenate: Part 2. Diffuse reflectance Fourier transform infrared spectroscopy. J. of Wood Chemistry and Technology 9(1):105-122.

P33. Barnes, H. M., J. E. Winandy. 1989. Mechanical properties of CCA-treated Southern Pine after post-treatment kiln drying. International Research Group on Wood Preservation Document No. IRG/WP/3543, Stockholm, SWEDEN.

P34. Smith, S. M., J. J. Morrell, and J. E. Winandy. 1989. Measuring retention of chromated copper arsenate using x-ray densitometry. J. of Wood Chemistry and Technology 10(1):21-38.

P35. Winandy, J. E., and R. W. Boone. 1988. The effects of CCA preservative treatment and redrying on the bending properties of 2 x 6 southern pine dimension lumber. Wood and Fiber Science 20(3):350-364. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1988/winan88c.pdf

P36. Ostmeyer, J. G., T. J. Elder, D. M. Littrell, B. J. Tatarchuk, and J. E. Winandy. 1988. Spectroscopic analysis of southern pine treated with chromated copper arsenate: Part 1. X-ray photoelectron spectroscopy. J. of Wood Chemistry and Technology 8(3):413-439.

P37. Winandy, J. E. 1988. Effects of treatment and redrying on mechanical properties. In Proc. of Conf. on Wood Protection and the Use of Treated Wood in Construction. M.Hamel, ed. Memphis, TN, Oct 28-30, 1987 by Forest Prod. Res. Soc., Madison, WI. pg. 54-62.

P38. Morrell, J. J. and J. E. Winandy. 1987. Incising practices used to improve preservative treatment in western species: A preliminary survey. Amer. Wood Pres. Assoc. Proc. 83:400-404.

P39. Winandy, J. E., and B. H. River. 1986. Evaluation of a method for testing adhesive-preservative compatibility. Forest Prod. J. 36(1):27-32. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1986/winan86a.pdf

P40. Barnes, H. M., and J. E. Winandy. 1986. Effects of seasoning and preservatives on the properties of treated wood. Amer. Wood Pres. Assoc. Proc. 82:95-104. (refereed).

P41. Winandy, J. E., R. S. Boone, and B. A. Bendtsen. 1985. Interaction of CCA preservative treatment and redrying on the mechanical properties of Southern Pine. Forest Prod.J. 35(10):62-68. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1985/winan85a.pdf

P42. Winandy, J. E. 1983. Precipitation of CCA solutions for waste disposal. International Journal of Wood Preservation. V3(2):83-88. (refereed).

P43. Winandy, J. E., B. A. Bendtsen, and R. S. Boone. 1983. Effect of delay between treatment and drying on the toughness of CCA-treated southern pine. Forest Prod. J. 33(6):53-58. (refereed). http://www.fpl.fs.fed.us/documnts/pdf1983/winan83a.pdf

Sustainability and Alternative Technology

S1. Winandy J. 2018. Enhancing sustainability by integrated use of wood and natural fibers for energy, chemical feedstock and advanced materials. Forest Res Eng Int J. 2018:2(2):64–68. DOI: 10.15406/freij.2018.02.00027. https://medcraveonline.com/FREIJ/FREIJ-02-00027.pdf

S2. Winandy, J.E., Rudie, A.W., Williams, R.S., Ross, R.J. 2008. Chapter 10: Opportunities for using wood and biofibers for energy, chemical feedstocks, and structural applications. IN: Properties and performance of natural-fibre composites. K.L. Pickering, Editor. Woodhead Publishing. Cambridge, England. http://www.fpl.fs.fed.us/documnts/pdf2008/fpl_2008_winandy004.pdf

S3. Winandy, J.E., Rudie, A.W., Williams, R.S., Wegner, T.H. 2008. Integrated Biomass Technologies: A future vision for optimally using wood and biomass. Forest Products Journal 58(6):6-16. http://www.fpl.fs.fed.us/documnts/pdf2008/fpl_2008_winandy003.pdf

S4. Winandy, J., and Cai, Z. 2008. Potential of using anaerobically digested bovine biofiber as a fiber source for wood composites. BioResources 3(4):1244-1255. http://www.ncsu.edu/bioresources/BioRes_03/BioRes_03_4_1244_WinandyCai_Using_Anaerob_Dig_Bovine_Fiber_Compos_332.pdf

S5. Spelter, H., Winandy, J., and Zauche, T. 2008. Anaerobically digested bovine biofiber as a source of fiber for particleboard manufacturing: An economic analysis. BioResources 3(4):1256-1266. http://www.fpl.fs.fed.us/documnts/pdf2008/fpl_2008_spelter002.pdf

S6. Moya, L., Winandy, J.E., Tze, W.T.Z., Ramaswamy, S. 2008. Use of fire-impacted trees for oriented strandboards. Forest Products Journal 58(6):45-52. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2008/fpl_2008_moya001.pdf

S7. Rockwood, D.L., Rudie, A.W., Ralph, S.A., Zhu, J.Y., Winandy, J.E. 2008. Energy product options for Eucalyptus species grown as short rotation woody crops. Int. J. Molecular Sciences 2008(9):1361-1378. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2008/fpl_2008_rockwood001.pdf

S8. Winandy, J.E., Muehl, J.H., Glaeser, J.A., Schmidt, W. 2007. Chicken feather fiber as an additive in MDF composites. J. Natural Fibers 4(1):35-49. (refereed). http://www.fpl.fs.fed.us/documnts/pdf2007/fpl_2007_winandy003.pdf

S9. Winandy, J. E. 2006. Advanced wood- and bio-composites: Enhanced performance and sustainability. Proc. of 4th International conference on advanced materials and processes. University of Waikato, Hamilton, New Zealand. December 10-13, 2006. Keynote Paper. http://www.fpl.fs.fed.us/documnts/pdf2006/fpl_2006_winandy002.pdf

S10. Hunt, John R.; Gu, Hongmei; Walsh, Philip; Winandy, Jerrold E. 2005. Development of new microwave-drying and straightening technology for low-value curved timber. Research Note FPL-RN-0296. Madison, WI: United States Department of Agriculture, Forest Service, Forest Products Laboratory: 4p. http://www.fpl.fs.fed.us/documnts/fplrn/fpl_rn296.pdf

S11. Winandy, Jerrold E; Clemons, Craig M.; Stark, Nicole M.; Muehl, James H.; Williams, R. Sam. 2005. Evaluation and process development of salt cedar and juniper bio-composites as tools to utilize exotic and invasive species and restore native eco-systems. In: Proceedings of third international workshop on green composites, IWGC-3; 2005 March 16-17; Kyoto, Japan. Kyoto, Japan: 56-60. http://www.fpl.fs.fed.us/documnts/pdf2005/fpl_2005_winandy001.pdf

S12. Winandy, J.E., Wellwood, R., Hiziroglu, S.. 2005. Using wood composites as a tool for sustainable forestry. Proceedings of IUFRO XXII World Forestry Congress; August 8-13, 2005; Brisbane, Australia. In: Gen. Tech. Rep. FPL-GTR-163; U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 100p. http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr163.pdf

S13. Winandy, J.E. 2005. Advancing sustainable forestry by using engineered wood or bio-composites. IN: Proc. of IAWPS International Symposium on Wood Science and technology. Held November 27-30, 2005 in Yokahama, Japan. Japanese Wood Research Society. p104-105. http://www.fpl.fs.fed.us/documnts/pdf2005/fpl_2005_winandy003.pdf

S14. Winandy, J.E. 2005. Achieving resource sustainability and enhancing economic development through biomass utilization. IN: Proc. of International Workshop on Prefabricated Housing from Bamboo-based Panels. Held November 24-25, 2005 in Beijing, China. International Network for Bamboo and Rattan. http://www.fpl.fs.fed.us/documnts/pdf2005/fpl_2005_winandy005.pdf

S15. Winandy, J.E., Hiziroglu, S.. 2005. North American perspective on using wood composites as a tool for sustainable forestry. In: Gen. Tech. Rep. FPL-GTR-163; U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. Pg2-8p. http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr163.pdf

S16. Winandy, J E., Muehl, J. H., Micales, J.A., Raina, A., Schmidt, W.; Potential of Chicken Feather Fiber in Wood MDF Composites. In: Proceedings of the 2nd Eco-Composites Conference, Paper P.20. European Society for Composite Materials. London UK. 1-2 Sept 2003. http://www.fpl.fs.fed.us/documnts/pdf2003/winan03d.pdf

S17. Hamilton, T. E., Winandy, J. E. 1998. Focusing on environmental sensitivity in wood products research. In: Proc. Forestry towards the 21st Century—Forestry science and technology under the global strategy of sustainable development. Chinese Academy of Forestry. pg. 541-552. October 27-29, 1998. Beijing, China. http://www.fpl.fs.fed.us/documnts/pdf1998/hamil98a.pdf

APPENDIX E

Dr. Nicholas Bond Curriculum Vitae

Curriculum Vitae - Nicholas A. Bond 1 September 2019

Research Meteorologist
Joint Institute for the Study of the Atmosphere and Ocean (JISAO)
University of Washington, Seattle, WA

Mailing Address:
1520 NE 90th Street
Seattle, WA 98115

ph:206-526-6459, fax:206-526-6485, e-mail:nab3met@u.washington.edu; nicholas.bond@noaa.gov

A. BIOGRAPHICAL DATA

Education:
PhD (1986) Dept. of Atmospheric Sciences, University of Washington, Seattle, WA
Thesis title - Boundary layer structure and processes in mid-latitude ocean storms (R.G. Fleagle, Advisor)
BS (1976) Dept. of Physics, University of California, Riverside, CA

Professional Employment:
Washington State Climatologist (2010 – present)
Deputy Director of JISAO (2009 – present)
Affiliate Associate Professor, Dept. of Atmos. Sci., Univ. of Washington (1998 - present)
Research Meteorologist, JISAO and NOAA Pacific Marine Environmental Laboratory
(1990 - present)
Post-Doctoral Research Associate, University of Washington (1986-1989)
Research Assistant, University of Washington (1980-1986)

Honors and Awards:
Phi Beta Kappa, 1976
Achievement Rewards for College Scientists, 1985
Editor's Citation for Excellence in Refereeing, Journal of Geophysical Research, 2007

Teaching Experience:
Department of Atmospheric Sciences, University of Washington
ATMS 101 (Introduction to Atmospheric Science), Summer 1985
ATMS 370 (Atmospheric Structure and Analysis), Winter 1996
ATMS 452 (Weather Forecasting and Advanced Synoptic Meteorology; co-taught with
Prof. Clifford Mass), Spring 1994-2018

Field Program Experience:
Co-Chief Scientist, Arctic Flux, Air-ice-sea interactions in the marginal ice zone from a NOAA P-3 Oct-Nov 2013 and Oct 2014.
Chief Scientist, SARJET, Low-level wind jets in the coastal Gulf of Alaska from the
University of Wyoming King Air, Sep-Oct, 2004.
Principal Investigator, IMPROVE, Surveys of landfalling storms from the Univeristy of
Washington Convair-580 and a NOAA P-3, Nov-Dec, 2001.
Principal Investigator, PACS/EPIC, Marine atmospheric boundary layer structure over the
cold tongue in the eastern equatorial Pacific from the NCAR C-130, Sep-Oct 2001.

Research Topics and Interests:

Past and current work encompasses a range of topics, with a common theme. Much of the past research involved the collection and analysis of low-level atmospheric observations over the ocean, based on special field measurements from research ships and aircraft. Notable examples have involved documenting the effects of the terrain along the U.S. West Coast on landfalling storms during the winter and boundary layer phenomena during the summer. Considerable recent effort has been under the broad umbrella of the Fisheries-Oceanography Coordinated Investigation (FOCI). Here the focus has been on the variability in climate and atmospheric forcing of the Bering Sea, and topographical effects on coastal winds in Alaska. Finally, topics related to the weather and climate of the Pacific Northwest have been an ongoing subject of research.

Professional Service:
Co-Chair, Phenomena, Observations and Synthesis Panel of U.S. Climate Variability and Predictability Program (CLIVAR), 2009 - 2013
Chair, Executive Committee of Northeast Pacific Component of the U.S. Global Ocean Ecosystems Dynamics Program (GLOBEC), 2005 -2011
Member, U.S. GLOBEC Scientific Steering Committee, 2001-2011
Member, AMS Committee on Meteorology and Oceanography in the Coastal Zone, 1997-2001
Session co-chair, Eastern Pacific Ocean Conference, Stanford Camp, CA, 24-26 Sep., 2008.
Session co-chair, Ocean Sciences Meeting, Orlando, FL, Mar 2008.
Co-convener, Third AMS Conference on Coastal Atmospheric and Oceanic Processes, New Orleans, LA, 3-5 Nov.,1999
Member, Coastal Ocean Processes (CoOP) Scientific Steering Committee, 1995 - 1999
Associate Editor, Weather and Forecasting, 1993 - 1998

Professional Society Membership:
American Geophysical Union (since 1994)
American Meteorological Society (since 1982)
Sigma Xi (since 1986)

B. REFEREED PUBLICATIONS (previous 10 years)

Yang, Q., E.D. Cokelet, P.J. Stabeno, L. Li, A.B. Hollowed, W.A. Palsson, N.A. Bond, and S.J. Barbeaux (2019): How "The Blob" affected groundfish distributions in the Gulf of Alaska. Fish. Oceanogr., doi: 10.1111/fog.12422

Li, S., M. Wang, N.A. Bond, W. Huang, Y. Wang, S. Xu, J. Liu, B. Wang, and Y. Bai (2018): Precursors of September Arctic sea-ice extent based on causal effect networks. Atmosphere, 9(11), 437, doi: 10.3390/atmos9110437

Bond, N.A., P.J. Stabeno and J.M. Napp (2018): Characteristics of the flow of the Chukchi Sea during June through October 1979-2014 based on an ocean reanalysis. Deep-Sea Res. II, 152, SOAR II, 35–47, doi: 10.1016/j.dsr2.2018.02.009.

Wood, K.R., S.R. Jayne, C.W. Mordy, N. Bond, J.E. Overland, C. Ladd, P.J. Stabeno, A.K. Ekholm, P.E. Robbins, M.-B. Schreck, R. Heim, and J. Intrieri (2018): Results of the first Arctic Heat Open Science Experiment. Bull. Am. Meteorol. Soc., doi: 10.1175/BAMS-D-16-0323.1.

Hermann, A.J., G.A. Gibson, N.A. Bond, E.N. Curchitser, K. Hedstrom, W. Cheng, M. Wang, E.D. Cokelet, and P.J. Stabeno (2016): Projected future biophysical states of the Bering Sea. Deep-Sea Res. II, 134, 30–47, doi: 10.1016/j.dsr2.2015.11.001, Understanding Ecosystem Processes in the Eastern Bering Sea IV.

Ortiz, I., K. Aydin, A.J. Hermann, G.A. Gibson, A.E. Punt, F.K. Wiese, L.B. Eisner, N. Ferm, T.W. Buckley, E.A. Moffitt, J.N. Ianelli, J. Murphy, M. Dalton, W. Cheng, M. Wang, K. Hedstrom, N.A. Bond, E.N. Curchitser, and C. Boyd (2016): Climate to fish: Synthesizing field work, data and models in a 39-year retrospective analysis of seasonal processes in the eastern Bering Sea shelf and slope. Deep-Sea Res. II, 134, 390–412, doi: 10.1016/j.dsr2.2016.07.009, Understanding Ecosystem Processes in the Eastern Bering Sea IV.

Chiodi, A.M., N.A. Bond, N.K. Larkin, and J. Barbour (2016): Summertime rainfall events in eastern Washington and Oregon. Weather Forecast., 31(5), 1465–1480, doi: 10.1175/WAF-D-16-0024.1.

Siedlecki, S.A., I.C. Kaplan, A.J. Hermann, T.T. Nguyen, N.A. Bond, J.A. Newton, G.D. Williams, W.T. Peterson, S. Alin, and R.A. Feely (2016): Experiments with seasonal forecasts of ocean conditions for the northern region of the California Current upwelling system. Scientific Reports, 6, 27203, doi: 10.1038/srep27203.

Spencer, P.D., K.K. Holsman, S. Zador, N.A. Bond, F.J. Mueter, A.B. Hollowed, and J.N. Ianelli (2016): Modelling spatially dependent predation mortality of eastern Bering Sea walleye pollock, and its implications for stock dynamics under future climate scenarios. ICES J. Mar. Sci., 73, 1330–1342, doi: 10.1093/icesjms/fsw040.

Kaplan, I.C., G.D. Williams, N.A. Bond, A.J. Hermann, and S.A. Siedlecki (2016): Cloudy with a chance of sardines: Forecasting sardine distributions using regional climate models. Fish. Oceanogr., 25(1), 15–27, doi: 10.1111/fog.12131.

Stabeno, P.J., N.A. Bond, N.B. Kachel, C. Ladd, C.W. Mordy, and S.L. Strom (2016): Southeast Alaskan shelf from the southern tip of Baranof Island to Kayak Island: Currents, mixing and chlorphyll-a. Deep-Sea Res. II, 132, 6–23, doi: 10.1016/j.dsr2.2015.06.018, Understanding Ecosystem Processes in the Gulf of Alaska: Volume 1.

Wood, K.R., N.A. Bond, J.E. Overland, S.A. Salo, P. Stabeno, and J. Whitefield (2015): A decade of environmental change in the Pacific Arctic region. Prog. Oceanogr., 136, 12–31, doi: 10.1016/j.pocean.2015.05.005.

Bond, N.A., M.F. Cronin, and H. Freeland (2015): The Blob: An extreme warm anomaly in the northeast Pacific. In *State of the Climate in 2014,* Global Oceans. Bull. Am. Meteorol. Soc., 96(7), S62–S63.

Stock, C.A., K. Pegion, G.A. Vecchi, M.A. Alexander, D. Tommasi, N.A. Bond, P.S. Fratantoni, R.G. Gudgel, T. Kristiansen, T.D. O'Brien, Y. Xue, and X. Yang (2015): Seasonal sea surface temperature anomaly prediction for coastal ecosystems. Prog. Oceanogr., 137A, 219–236, doi: 10.1016/j.pocean.2015.06.007.

Bond, N.A., M.F. Cronin, H. Freeland, and N. Mantua (2015): Causes and impacts of the 2014 warm anomaly in the NE Pacific. Geophys. Res. Lett., 42(9), 3414–3420, doi: 10.1002/2015GL063306.

Bond, N.A. and K.A. Bumbaco, (2015): Summertime Potential Evapotranspiration in Eastern Washington State. *J. Appl. Meteor. Climatol.*, **54**, 1090–1101.doi: http://dx.doi.org/10.1175/JAMC-D-14-0228.1

Punt, A.E., T. A'mar, N.A. Bond, D.S. Butterworth, C.L. de Moor, J.A.A. Oliveira, M.A. Haltuch, A.B. Hollowed, and C. Szuwalski (2014): Fisheries management under climate and environmental uncertainty: control rules and performance simulation. ICES J. Mar. Sci., 71(8), 2208–2220, doi: 10.1093/icesjms/fst057.

Harrison, D.E., N. Bond, L. Goddard, R. Martinez, and T. Yamagata (2014): TPOS White Paper #2 - Some Societal Impacts of ENSO. In Proceedings of the Tropical Pacific Observing System 2020 Workshop, A Future Sustained Tropical Pacific Ocean Observing System for Research and Forecasting, WMO and Intergovernmental Oceanographic Commission, La Jolla, CA, 27–30 January 2014.

Kawai, Y., H. Tomita, M.F. Cronin, and N.A. Bond (2014): Atmospheric pressure response to mesoscale sea surface temperature variations in the Kuroshio Extension region: In situ evidence. J. Geophys. Res., 119(13), doi: 10.1002/2013JD021126, 8015–8031

Pelland, N.A., J.T. Sterling, M.A. Lea, N.A. Bond, R.R. Ream, C.M. Lee, and C.C. Eriksen (2014): Fortuitous encounters between Seagliders and adult female northern fur seals (*Callorhinus ursinus*) off the Washington (USA) coast: Upper ocean variability and links to top predator behavior. PLoS ONE, 9(8), e101268, doi: 10.1371/journal.pone.0101268.

Sterling, J.T., A.M. Springer, S.J. Iverson, S.P. Johnson, N.A. Pelland, D.S. Johnson, M.A. Lea, and N.A. Bond (2014): The sun, moon, wind, and biological imperative—Shaping contrasting wintertime migration and foraging strategies of adult male and female northern fur seals (Callorhinus ursinus). PLoS ONE, 9(4), e93068, doi: 10.1371/journal.pone.0093068.

Wood, K.R., J.E. Overland, S.A. Salo, N.A. Bond, W.J. Williams, and X. Dong (2013): Is there a "new normal" climate in the Beaufort Sea? Polar Res., 32, 19552, doi: 10.3402/polar.v32i0.19552

Di Lorenzo, E., D. Mountain, H.P. Batchelder, N. Bond, and E.E. Hofmann (2013): Advances in marine ecosystem dynamics from US GLOBEC: The horizontal-advection bottom-up forcing paradigm. Oceanography, 26(4), doi: 10.5670/oceanog.2013.73, 22–33.

Wilderbuer, T., W. Stockhausen, and N.A. Bond (2013): Updated analysis of flatfish recruitment response to climate variability and ocean conditions in the Eastern Bering Sea. Deep-Sea Res. II, 94, doi: 10.1016/j.dsr2.2013.03.021, 157–164.

Bumbaco, K.A., K. Dello and N.A. Bond, 2013: History of Pacific Northwest heat waves: Synoptic pattern and trends. J. Appl. Meteorol. Clim. 52, 1618-1631. doi:http://dx.doi.org/10.1175/JAMC-D-12-094.1

Hermann, A.J., G.A. Gibson, N.A. Bond, E.N. Curchitser, K. Hedstrom, W. Cheng, M. Wang, P.J. Stabeno, L. Eisner, and K.D. Cieciel (2013): A multivariate analysis of observed and modeled biophysical variability on the Bering Sea shelf: Multidecadal hindcasts (1970-2009) and forecasts (2010-2040). Deep-Sea Res. II, doi: 10.1016/j.dsr2.2013.04.007.

Huntington, H.P., G. Noongwook, N.A. Bond, B. Benter, J.A. Snyder, and J. Zhang (2013): The influence of wind and ice on spring walrus hunting success on St. Lawrence Island, Alaska. Deep-Sea Res. II, doi: 10.1016/j.dsr2.2013.03.016.

Cronin, M.F., N.A. Bond, J.T. Farrar, H. Ichikawa, S.R. Jayne, Y. Kawai, M. Konda, B. Qiu, L. Rainville, and H. Tomita (2013): Formation and erosion of the seasonal thermocline in the Kuroshio Extension Recirculation Gyre. Deep-Sea Res. II, 85, doi: 10.1016/j.dsr2.2012.07.018, 62–74.

Punt, A.E., T. A'Mar, N.A. Bond, D.S. Butterworth, C.L. deMoor, J.A.A. De Oliveira, M.A. Haltuch, A.B. Hollowed, and C. Szuwalski (2013): Fisheries management under climate and environmental uncertainty: Control rules and performance simulation. ICES J. Mar. Sci., doi: 10.1093/icesjms/fst057.

Capotondi, A., M.A. Alexander, N.A. Bond, E.N. Curchitser, and J.D. Scott (2012): Enhanced upper ocean stratification with climate change in the CMIP3 models. J. Geophys. Res., 117(C4), C04031, doi: 10.1029/2011JC007409.

Overland, J.E., M. Wang, K.R. Wood, D.B. Percival, and N.A. Bond (2012): Recent Bering Sea warm and cold events in a 95-year context. Deep-Sea Res. II, 65–70, doi: 10.1016/j.dsr2.2012.02.013, 6–13.

Furtado J., E. Di Lorenzo, N. Schneider, and N. Bond , 2011: North Pacific Decadal Variability and Climate Change in the IPCC AR4 Models. Journal of Climate, doi: 10.1175/2010JCLI3584.1.

King, J.R., V.N. Agostini, C.J. Harvey, G.A. McFarlane, M.G.G. Foreman, J.E. Overland, E. Di Lorenzo, N.A. Bond, and K.Y. Aydin (2011): Climate forcing and the California Current ecosystem. ICES J. Mar. Sci., 68(6), doi: 10.1093/icesjms/fsr009, 1199–1216.

Mueter, F., N. Bond, J. Ianelli, and A. Hollowed (2011): Expected declines in recruitment of walleye pollock (Theragra chalcogramma) in the eastern Bering Sea under future climate change. ICES J. Mar. Sci., 68(6), doi: 10.1093/icesjms/fsr022, 1284–1296.

Ianelli, J.N., A.B. Hollowed, A.C. Haynie, F.J. Mueter, and N.A. Bond (2011): Evaluating management strategies for eastern Bering Sea walleye pollock (Theragra chalcogramma) in a changing environment. ICES J. Mar. Sci., 68(6), doi: 10.1093/icesjms/fsr010, 1297–1304.

Overland, J.E., M. Wang, N.A. Bond, J.E. Walsh, V.M. Kattsov, and W.L. Chapman (2011): Considerations in the selection of global climate models for regional climate projections: The Arctic as a case study. J. Climate, 24(6), doi: 10.1175/2010JCLI3462.1, 1583–1597.

Bond, N.A., 2011: The Coastal Gulf of Alaska Program: Progress and perplexity. Current, 27, 15-18.

Bond, N.A., M.F. Cronin, C. Sabine, Y. Kawai, H. Ichikawa, P. Freitag, and K. Ronnholm (2011): Upper-ocean response to Typhoon Choi-Wan as measured by the Kuroshio Extension Observatory (KEO) mooring. J. Geophys. Res., 116, C02031, doi: 10.1029/2010JC006548

Stock, C. A., M. A. Alexander, N. A. Bond, K. Brander, W. W. L. Cheung, E. N. Curchitser, T. L. Delworth, J. P. Dunne, S. M. Griffies, M. A. Haltuch, J. A. Hare, A. B.. Hollowed, P. Lehodey, S. A. Levin, J. S. Link, K. A. Rose, R. R. Rykaczewski, J. L. Sarmiento. R. J. Stouffer, F. B. Schwing, G. A. Vecchi, F. E. Werner (2010): On the use of IPCC class models to assess the impact of climate on living marine resources. Progr. Oceanogr., doi:10.1016/j.pocean.2010.09.001.

Bond, N.A., M.F. Cronin, and M. Garvert (2010): Atmospheric sensitivity to SST near the Kuroshio Extension during the extratropical transition of Typhoon Tokage. Mon. Weather Rev., 138(7), 2644–2663.

Kwon, Y.-O., M.A. Alexander, N.A. Bond, C. Frankignoul, H. Nakamura, B. Qiu, and L. Thompson (2010): Role of the Gulf Stream and Kuroshio-Oyashio systems in large-scale atmosphere-ocean interaction: A review. J. Climate, 23(12), 3249–3281.

Wang, M., J.E. Overland, and N.A. Bond (2010): Climate projections for selected large marine ecosystems. J. Mar. Syst., 2(3–4), 258–266.

Bond, N., M. Cronin, and M. Garvert (2009): Atmospheric sensitivity to SST near the Kuroshio Extension: A case study of the extratropical transition of Typhoon Tokage. U.S. CLIVAR Variations, 7(1), 8–11.

Bond, N.A., and C.F. Mass (2009): Development of skill by students enrolled in a weather forecasting laboratory. Weather Forecast., 24, 1141–1148.

Hollowed, A.B., N.A. Bond, T.K. Wilderbuer, W.T. Stockhausen, Z.T. A'mar, R.J. Beamish, J.E. Overland, and M.J. Schirripa (2009): A framework for modelling fish and shellfish responses to future climate change. ICES J. Mar. Sci., 66, 1584–1594.

Dobbins, E. L., A. J. Hermann, P. J. Stabeno, N. A. Bond and R. C. Steed (2009): Modeled transport of freshwater from a line-source in the coastal Gulf of Alaska. Deep-Sea Res. II, 10.1016/j/dsr2.2009.02.004

Hermann, A.J., S. Hinckley, E. L. Dobbins, D. B. Haidvogel, N. A. Bond, C. Mordy, N. Kachel and P. J. Stabeno (2009): Quantifying cross-shelf and vertical nutrient flux in the Gulf of Alaska with a spatially nested, coupled biophysical mode. Deep-Sea Res. II, 10.1016/j.dsr2.2009.02.008.

Bond, N.A., H.P. Batchelder, and S.J. Bograd (2008): Forecasting northeastern Pacific ecosystem responses to La Niña. Eos, Trans. AGU, 89, 321–322.

Bond, N.A., and M.F. Cronin (2008): Regional weather patterns during anomalous air-sea fluxes at the Kuroshio Extension Observatory (KEO). J. Climate, 21(8), 1680–1697.

C. RECENT COLLABORATORS

Karin Bumbaco University of Washington
Wei Cheng, University of Washington
Andrew Chiodi, University of Washington
Meghan Cronin NOAA/PMEL
Manu DiLorenzo Georgia Tech
Al Hermann University of Washington
Anne Hollowed NOAA/AFSC
Mary Hunsicker NOAA/NWFSC
Isaac Kaplan NOAA/NWFSC
Calvin Mordy University of Washington
Jim Overland NOAA/PMEL
Samantha Siedlecki University of Washington
Phyllis Stabeno NOAA/PMEL
Jeremy Sterling NOAA/AFSC
Charles Stock NOAA/GFDL
Muyin Wang, University of Washington
Kevin Wood, University of Washington

D. FORENSIC METEOROLOGY EXPERIENCE (Cases for which retained by counsel representing the plaintiffs and defendants indicated with a P and D, respectively)

Retained by Schroeter Goldmark & Bender (2019, ongoing). On behalf of claimant the family of Andrew Yoder conducting analysis of weather conditions related to a collapse of a crane in the south Lake Union district of Seattle on 27 April 2019. (P)

Retained by Seattle City Attorney's Office (2019, ongoing). Conducted analysis of winds associated with the failure of utility poles along East Marginal Way South on 5 April 2019. (D)

Retained by Boyle Martin Thoeny (2019). Conducted analysis of weather and forecasts related to a slip and fall on ice in Lynnwood, WA on 9 January 2017. (P)

Heko v. ChemTrack (2019). Retained by Nicoll Black & Feig PLLC. Conducted analysis of weather and ocean conditions related to a maritime accident in the vicinity of Unimak Pass, Alaska on 2 June 2018. (P)

Steadfast Insurance v. Marine Co. dba HDB Marine (2018, ongoing). Retained by Gaspich Law Office PLLC. Conducting analysis of weather and waves related to a dock failure on the Spokane River on 17 November 2015. (D)

Dustin Mork v. F/V Bristol Leader and Bristol Leader Fisheries LLC (2018). Retained by Johnson Beard & Trueb, PC. Conducted analysis of weather and wave conditions related to a maritime accident in the Bering Sea on 17 April 2016. (P)

Opara, Nicholas v. EQC Operating Trust fka HUB Properties Trust, et al. (2018) Retained by Preg O'Donnell & Gillett PLLC. Conducted analysis of weather conditions related to a slip and fall accident in Bellevue, WA on 14 February 2014. (D)

Eric Tolliver v. Icicle Seafoods (2018, ongoing) Retained by LeGros Buchanan & Paul. Conducting analysis of weather and sea state conditions related to a marine accident in the Bering Sea. (D)

Danton DeMarr v. Martin Torres (2017, ongoing) Retained by Ressler & Tesh, PLLC. Conducting analysis of weather conditions related to an automobile accident in Kent, WA on 17 July 2015. (P)

Broetje Orchards v. Allied Potato & Eagle Spraying (2017, ongoing) Retained by Preg O'Donnell & Gillett PLLC. Conducting analysis of weather conditions pertaining to a potential overspray of herbicide in Walla Walla county during September 2015. (D)

Soto v. Woodmark Apartments (2017) Retained by Law Offices of David S. Roth. Conducted analysis of weather conditions related to a slip and fall on ice in Tacoma, WA on 6 February 2017. (P)

Crabtree v. Buoys-R-Us et al. (2017, ongoing) Retained by Beard, Stacey & Jacobsen, LLP. Conducting analysis of weather conditions related to a marine accident in Elliott Bay on 27 February 2017. (P)

Tyler Holmes v. Olympic Tug & Barge, Inc. (2017) Retained by Beard, Stacey & Jacobsen, LLP. Conducted analysis of weather conditions related to a marine accident in San Francisco Bay on 8 February 2015; provided report. (P)

Stewart Riding & Terry Riding v. Spokane County (2017) Retained by Spokane County Prosecutor Office. Conducted analysis of rainfall and snowmelt related to flooding near Elk, WA during February and March 2014. (D)

Pestka v. Icicle Seafoods, Inc. (2017, ongoing) Retained by LeGros Buchanan & Paul, P.S. Conducting analysis of winds and sea state related to an accident on a vessel in the vicinity of Unimak Pass, AK (D)

Coty B. Cook v. Pacific Storm Fisheries, LLC (2016) Retained by Stacey & Jacobsen, LLP. Conducted analysis of winds related to an accident on a vessel in the vicinity of Kodiak, AK; provided report. **Provided deposition on 19 April 2017**. (P)

Newell Brands, Inc. v. Expeditors International Ocean, Inc. (2016) Retained by Nicoll Black & Feig PLLC. Conducted analysis of weather and sea state in the North Pacific related to damages to cargo suffered by the M/V Eternity in January 2016. (P)

Paulina Lujan v. Laurier Enterprises (2016) Retained by Preg O'Donnell & Gillett PLLC. Conducted analysis of weather conditions pertaining to a slip and fall on ice in Port Orchard, WA in February 2013; provided report. (D)

On behalf of Dunlap Towing Co. (2016, ongoing) Retained by Nicoll Black & Fegi PLLC. Conducted analysis of weather and tidal conditions on the Naknek River related to an accident that occurred in June 2016; provided report (P).

Arctic Sea Mining v. Atlantic Specialty et al. (2016, ongoing) Retained by Bauer Moynihan & Johnson LLP. Conducted analysis of weather and wave conditions in the Bering Sea and Gulf of Alaska from a climatological perspective pertaining to a potential towing operation. (D)

Robert & Barbara Cline v State of Washington Department of Transportation (2016) Retained by WA State Department of Transportation. Conducted analysis of weather and streamflow data with respect to floods in Yakima County; provided report. (D)

Glassman v. State of Washington (2016) Retained by Dearie Law Group, P.S. Conducted analysis of weather related to a slip and fall on ice in Cheney, WA; provided report. (P)

George Koss v. Capitol Square, LLC (2015) Retained by Hollenbeck Lancaster & Miller. Conducted analysis of weather related to a slip and fall on ice in Federal Way, WA; provided report. (D)

Stella Farms v. Eagle Rigid Span, Inc. (2015) Retained by Brassey & Crawford, PLLC. Conducted analysis of weather conditions related to the collapse of a barn after heavy snow in the vicinity of Coeur D'Alene ID; provided report. (D)

Debra Hope and Albert Stefurak v. Wedge 2, LLC (2015) Retained by Anderson Law, PLLC Conducted analysis related to a slip and fall on ice in Tacoma, WA; provided report. (P)

Doucoure v. Unied States Seafoods (2015) Retained by Holmes Weddle & Barcott. Conducted analysis of weather and sea state in the Bering Sea related to an accident on a fishing vessel; provided report. (D)

Snapp v. Citadel Marine Services (2015,ongoing) Retained by Gosselin Law Office, PLLC. Conducted analysis of winds related to the toppling of a sailboat in dry dock. (P)

Gray v. American Seafoods, LLC (2015,ongoing) Retained by the Law Offices of George H. Luhrs. Conducted analysis of winds and waves related to an accident on a vessel in the Bering Sea; provided report. (P)

Cosio v. United States (2014) Retained by Myers & Company, P.L.L.C. Conducted analysis of weather conditions related to a slip and fall in Longview, WA; provided report. (D)

Wishtoyo Foundation et al. v. Magic Mountain, LLC et al. (2014) Retained by Earthwise Law Center. Conducted climatological analysis of heavy rain events in the vicinity of Six Flags/Magic Mountain facility; provided rebuttal to expert witness report. (P)

State Farm v. City of Seattle (2014, ongoing) Retained by Office of Seattle City Attorney. Conducted analysis of wind conditions related to tree and utility damage during a storm in Seattle on 25 September 2011; provided data and report. (D)

Larson v. Skyview Medical Park (2014) Retained by Kirkpatrick & Startzel, P.S. Conducted analysis of weather conditions related to a slip and fall on ice in Coeur D'Alene, Idaho in January 2012; provided report. (D)

Kirsten Kennedy v. Bayside Gardens Apartments (2014) Retained by Law Offices Sloan Bobrick, P.S. Conducted analysis of rainfall related to a slip and fall in Tacoma, WA; provided report. (D)

Danuta Jakubowsa v. American Seafoods, LLC (2014) Retained by Beard, Stacey & Jacobsen, LLP. Conducting analysis of winds and waves related to an accident on a vessel in the Bering Sea; provided report. **Provided deposition on 16 June 2015**. (P)

Matter concerning damage caused by a tree on property owned by H.F. D'Annunzio (2014). Conducted analysis of wind and other weather data associated with the storm on 17-18 December 2010 in the vicinity of Covington, WA; **provided declaration and phone testimony for arbitration**. (D)

Tug Barney et al. v. Ridge Contracting, Inc. (2013) Retained by Nicoll Black & Fegi PLLC. Conducted analysis of weather and sea state in the Bering Sea from a climatological perspective pertaining to the recovery of the Tug Aries; provided report and supplementary report. (D)

Port of Bellingham v. Estate of Langei et al. (2013, ongoing) Retained by Preg O'Donnell & Gillett PLLC. Conducting analysis of winds and other conditions related to a case involving a fire at the Squalicum Boathouse in Bellingham Bay during March 2012; provided report. (D)

Erik D. Allen v. Kittitas County and State of Washington (2013) Retained by AAG Ian Northrip. Conducting analysis of precipitation and snowpack related to flooding along the lower Teanaway River in January 2009; provided report. (D)

Owen v. Sate of Washington (2013) Retained by Stritmatter Kessler Whelan. Conducted analysis of snowfall, wind and other aspects of the weather in the vicinity of a vehicle accident on US 2; provided report. (P)

Kimberly Collins v. Ballard Marine Construction (2013). Retained by Nicoll Black & Feig PLLC. Carried out analysis of winds and waves, and forecast information, relevant to an accident on 15 November 2013 in Puget Sound near Alki Point; provided report. (D)
Marshall Taylor v. Joshua Green Corp. and Trugreen Landcare, LLC (2013). Retained by Steven Sitcov. Carried out analysis of snowfall and other aspects of the weather at Bride Trails Shopping Center in Kirkland, WA relevant to a fall; provided report. (P)

Erickson v. Kitsap County and Washington State Department of Transportation (2013) Retained by AAG Ian Northrip. Carried out analysis of rainfall intensity, and sea level related to flooding near the mouth of Chico Creek, Kitsap County in December 2007; provided report. (D)

Tug Blarney LLC v. Ridge Contracting Inc. (2013, ongoing) Retained by Nicoll Black & Feig PLLC. Carried out analysis of weather and sea state related to the salvage of a barge in the Bering Sea during June 2011; provided report. (D)

Crenna v. Safeco Insurance Co. (2013) Retained by Bricklin & Newman, LLP. Carried out analysis and provided a report on rainfall in March 2011 pertaining to landslide on Whidbey Island, WA; **deposition provided on 1 July 2013**. (P)

Masauo Jacob v. American Seafoods. Retained by Edward F. Boyer. Carried out analysis of a Bering Sea storm related to an accident at sea; provided report. (P)

On behalf of Holden-McDaniel (2013) Retained by Bricklin & Newman, LLP. Carried out analysis of rainfall pertaining to flooding in Arlington, WA on 7 January 2009; provided report.

International Marine Underwriters v. Expeditors International Inc. (2012) Retained by Foster Pepper PLLC. Carried out analysis of weather and sea state associated with the storm of 4-5 January 2012 in the Northwest Pacific Ocean; provided report. (P)

Hurley et al. v. The Campbell Group et al. (2012) Retained by Bricklin & Newman, LLP. Carried out analysis of rainfall and snowpack pertaining to landslides in southwest Washington state associated with the storm of 7 January 2009; **provided deposition on 21 August 2012 and testimony in Lewis County Superior Court on 7 November 2012**. (P)

APL v. MMI (2012) Retained by Keesal, Young & Logan. Conducted analysis and provided report on the winds associated with a collapse of a crane at the terminal in Dutch Harbor, Alaska; **provided deposition on 15 November 2012**. (D)

Bonanza Fuel v. Delta Western (2012) Retained by Bauer Moynihan & Johnson LLP. Carried out analysis of weather conditions during the summer of 2011 related to the lack of fuel deliveries to Nome, Alaska; **provided deposition on 28 October 2013**. (P)

Rebecca Patterson v. Pasco School District (2012). Retained by Preg O'Donnell & Gillett PLLC. Provided weather summary related to a fall on ice in Pasco, WA. (D)

Trevor Reynolds v. Early Dawn LLC (2012). Retained by Beard Stacey & Jacobsen, LLP. Provided a report on weather and wave conditions related to an accident aboard a vessel in the Bering Sea. (P)

Conkling Park Boaters Assoc. v. Scottsdale Insurance Co. (2011). Retained by Adams & Gaffaney LLP. Provided report and deposition on weather related to the collapse of a marina on the shore of Lake Coeur D'Alene in late December 2008. (D)

Nolf et al. v. Huntington, et al. (2011), Retained by City of Bremerton and WA State Department of Transportation. Provided report on flooding in Bremerton, WA in association with the storm of 3 December 2007. (D)

Watt v. State Farm Insurance (2010), Retained by Evezich Law Offices, P.L.L.C., Provided expert analysis of the weather in Seattle associated with the Hannukah Eve Storm of 14 Dec. 2006. (D)

Western and Clay LLC v. Landmark American Insurance Co. (2010), Retained by Bennett Bigelow & Leedom, P.S., Provided report reviewing the weather of the winter of 2006-07 in Seattle related to damages and construction delays. (P)

Case of Hyundai Kingdom (Ongoing; lawsuit not yet filed). Retained by Cozen O'Connor regarding the loss of containers related to winds and waves in the Gulf of Alaska.

Olsen v. Fred Meyer (2009). Retained by Merrick, Hofstedt & Lindsey, P.S., Provided report and **testimony (arbitration)** on weather related to a fall on ice in Sumner, WA. (D)

State of Washington v. James Lee Walters (2008). Testified in Pierce County Superior Court regarding weather conditions during a criminal incident in Pierce County, Washington. (P)

Morgan v. Homestead and KZ Landscaping (2007). Retained by Kirkpatrick & Startzel, P.S., Provided report on weather related to flooding at a residence in Spokane Valley, WA. (D)

Mabrey v. Wizard Fisheries (2006). Retained by Myers & Company, P.L.L.C.. Provided report on weather and forecasts related to marine accident in the southern Bering Sea. (P)

Gus Blanco v. American Seafoods (2004), Retained by Le Gros, Buchanan & Paul, Provided report on weather situation related to an accident on the Dutch Harbor dock. (D)

Taniella Takai, Claimant (2003), Retained by Le Gros, Buchanan & Paul, Provided report on climatological wind chill conditions in the Bering Sea. (P)

Mel Debrum v. M & F Fishing Co. Inc. (2002), Retained by Le Gros Buchanan & Paul, Provided report and a **deposition** on a marine accident involving winds and waves in the vicinity of American Samoa. (P)

The Sinking of the Arctic Rose (2001), Retained by Mikkelborg Law Firm, in collaboration with Dr. Cliff Mass provided report on the meteorological and sea state conditions before and at the time of the accident, and **provided expert testimony at a hearing** held by the U.S. Coast Guard.

John Berger v. Seldovia Fisheries Inc. (2000), Retained by Le Gros Buchanan and Paul, in collaboration with Dr. Cliff Mass provided report on a case of storm-forced waves just north of Unimak Pass, Alaska. (P)

Martin v. City of Seattle (1999), Retained by Law Office of Groff & Murphy, Provided report on a case involving storm-induced flooding. (D)

Broadview v. City of Seattle (1998-99), Retained by Law Offices of Michael Myers, Provided report on a case involving storm-induced flooding. (D)

Alaska Corp. v. Arctic Tug (1996-97), Retained by Craig Smith & Associates, Provided report on a case involving storm winds and waves in Lower Cook Inlet, Alaska.

Newman v. Kitsap County (1996-97), Retained by Lee, Smart, Cook, Martin & Patterson, P.S., Inc., Provided report on a case involving road flooding and subsequent ice formation. (P)

Brorby v. Grays Harbor County (1996-97), Retained by Lee, Smart, Cook, Martin & Patterson, P.S., Inc., Provided report and **court testimony** on a case involving fog in Grays Harbor County. (D)

Wily v. Mason County (1995), Retained by Law Offices of Stritmatter Kessler, Provided report and **deposition** on a case involving snow and ice on a roadway. (P)

Mohseni v. Panayitou (1992), Retained by Hackett, Beecher & Hart, Provided report on a case involving black ice. (D)

APPENDIX F

Weather Conditions Report



Report on Weather Pertaining to Pole Failures on East Marginal Way South on 5 April 2019

This report represents an analysis of the winds in the vicinity of Boeing Field during the failure of poles along East Marginal Way South on 5 April 2019.

Data

This report considers meteorological data from primarily two weather stations: the Boeing Field station (KBFI) located at 47.55 N, 122.31 W (elev. 16') with historical data available via the following website: https://mesowest.utah.edu/cgbin/droman/hourly_trend_monitor.cgi?state=WA, and a private weather station (KWASEATT1860) in the Highland Park neighborhood at 47.53 N, 122.35 W (elev. 400') with historical data available via the following website: https://www.wunderground.com/dashboard/pws/KWASEATT1860. It also considers the upper air measurements at Quillayute, WA from the atmospheric sounding collected at 0000 UTC 6 April 2019 (late afternoon on 5 April local time) available from the following website: weather.uwyo.edu/upperair/sounding.html. Videos from cameras in the vicinity of the accident provided by Jeff Wolf of the Seattle City Attorney's office were reviewed. A blog post by Prof. Cliff Mass: https://cliffmass.blogspot.com/2019/04/what-knocked-down-24-city-light-power.html was reviewed. A visit of the accident site was made on 9 June 2019.

Description of Wind Event on the Afternoon of 5 April 2019

The storm of 5 April 2019 featured an unusually intense band of heavy rain and wind that moved through Seattle, WA. The weather at 5 minute intervals between 3 PM and 4 PM local time at KBFI is itemized in Table 1; this station is located at the north end of Boeing Field about 1.5 miles to the north-northwest of the pole failures. The weather during the first 45 minutes of this hour included moderate winds from the south (7-13 MPH sustained winds, and gusts up to about 18 MPH) and mostly light rain. Greater rain rates, cooler air temperatures and stronger wind speeds began with the report at 03:50 PM. During the three minutes between 03:50 and 03:53 KBI received 0.04" of rain; this equates to a rain rate of 0.80" per hour, which constitutes an unusually large value for the Puget Sound lowlands. The short period near the end of the hour also featured wind gust speeds of about 29 MPH and an abrupt rise in surface pressure. The band of heavy rain and strong winds extended from near the border of King and Snohomish counties to the north to just past the southern tip of Lake Washington to the south. Its strength was greatest in the region of south Seattle based on radar reflectivities observed from the Camano Island radar (not shown). Based on the two radar reflectivity patterns presented by Prof. Mass in his blog post, the southern end of the heavier rain with this band moved from just offshore of Des Moines to Tukwila in 9 minutes, which equates to a northeastward propagation of about 40-45 MPH.

Local Effects and Processes Related to the Winds at the Site of the Pole Failures

There are no weather station observations in the immediate vicinity of the location of interest for directly gauging the strength of the winds during the 5 April 2019 event. There are two mechanisms that could have produced wind speeds at the site of the pole failures that were considerably greater than those measured to the north at KBFI. The first of these mechanisms is simply the intrinsic variability in the winds on small length scales. While this event did not include any lightning in the area, the heaviest rain was very localized in nature such as occurs in thunderstorms, whose accompanying winds typically also vary substantially over distances of a mile or less. In many ways this event resembles that of a wet microburst, through which heavy downpours can effectively transport momentum from aloft resulting in strong surface winds over small areas. The study by Geerts (2001) provides a means for estimating probable maximum surface winds for this case. Using the vertical sounding data from Quillayute, WA during the afternoon of 5 April, and the relationship found through fitting atmospheric soundings to observed wind gust magnitudes, yields a value for the expected maximum wind gust of about 39 MPH. This value is 10 MPH higher than the maximum gust of 29 MPH observed at KBFI; deviations in maximum gust speeds from one place to another of this magnitude are not uncommon in situations such as the 5 April 2019 storm. The second mechanism that could have contributed to locally enhanced winds at the location of the pole failure relates to the effects of the higher terrain of Burien upwind. In some lowlevel atmospheric flows there can be enhanced winds downstream of terrain in a manner similar to the acceleration of the currents on the downstream sides of rocks in fastmoving streams. The hilltops in Burien reach elevations of about 280 feet a bit over a mile away to the south (Fig.1). Based on this height, and the temperature profile that afternoon, the low-level flow would be expected to have been in the supercritical regime from a hydrodynamic point of view (Durran 1986), resulting in a tendency for some acceleration from Burien to the accident site. The amount of this change could only be estimated through a sophisticated numerical model study. Such an exercise is well outside of the scope of the present analysis and is prone to its own uncertainties. Considering previous work on this mechanism, in my professional opinion a potential enhancement of wind speeds of very roughly 10 MPH would be reasonable. It is emphasized that this is merely an estimate. A peak gust of 28 MPH was observed at the Highland Park weather station (KWASEATT1860) at 400 feet elevation, and it is reasonable to expect that some stronger winds occurred downwind of the higher terrain of West Seattle and Burien. It bears mentioning that the winds with downslope windstorms are by no means steady, with intermittent eddies/vortices resulting in decidedly higher (and lower) speeds accompanied by variations in wind direction.

An additional factor is noted here, but not quantified in any way. Specifically, the poles that failed immediately north of the pedestrian bridge were in close proximity to a large building associated with the Museum of Flight. Such structures produce substantial and erratic small-scale eddies and vortices during strong winds. It is likely that such a feature helped cause the failure of the pole partway up, leading to its connecting wires causing subsequent pole failures. But the magnitude(s) of such features during the 5 April event are unknown.

Table 1 Weather at Boeing Field (KBFI) during the Afternoon of 5 April 2019

Time	Temp.	Wind Dir.	Speed	Gust Speed	Weather	Pressure
3:00	53.6	S	9.2		Lgt Rain	29.66
3:05	53.6	S	9.2		Lgt Rain	29.67
3:10	53.6	S	9.2		Lgt Rain	29.67
3:15	53.6	S	11.5	18.4	Lgt Rain	29.67
3:20	53.6	S	16.1		Lgt Rain	29.67
3:25	53.6	S	10.4	16.1	Lgt Rain	29.67
3:30	53.6	SSW	12.7	18.4	Lgt Rain	29.67
3:35	53.6	S	11.5	18.4	Overcast	29.67
3:40	53.6	SSW	8.1		Overcast	29.67
3:45	53.6	WSW	6.9		Lgt Rain	29.67
3:50	53.6	SSW	17.3	28.8	Rain	29.70
3:53	51.1	S	20.7	28.8	Hvy Rain	29.70
4:00	50.0	S	15.0		Lgt Rain	29.69

Note: Times are in local time during the afternoon (PM) of 5 April 2019; temperatures are in degrees F; wind directions are from true north; sustained and gust speeds are in miles per hour, and pressure is in mm of Hg.

Note: Times are in local time during the afternoon (PM) of 5 April 2019; temperatures are in degrees F; wind directions are from true north; sustained and gust speeds are in miles per hour, and pressure is in mm of Hg.

Summary

This report reviews aspects of the weather relevant to the failure of power poles along East Marginal Way in Seattle, WA during the afternoon of 5 April 2019. My professional opinions relevant to this case are summarized below. 1. A band of heavy rain accompanied by strong winds moved through the southern portion of Seattle, WA from 3:45 to 4 PM local time on 5 April 2019. 2. The winds were generally from between the south and south-southwest with a peak wind speed of 29 MPH observed at the Boeing Field weather station (KBFI). 3. An empirical relationship developed for these kinds of weather situations yields expected maximum gust speeds of approximately 39 MPH. 4. The presence of prominent terrain upwind of the accident site suggests the possibility of topographically-enhanced flow or eddies that could have enhanced wind speeds at the location of the accident by very roughly 10 MPH. 5. Given all the factors related to the weather conditions that occurred at the accident site, a reasonable upper bound for the wind speeds is approximately 50 MPH.

Reference:

Durran, D.R. (1986): Another look at downslope windstorms. Part I: The development of analogs to supercritical flow in an infinitely deep, continuously stratified fluid. Monthly Weather Review, 43, 2527-2543.

Geerts, B., (2001): Estimating Downburst-Related Maximum Surface Wind Speeds by Means of Proximity Soundings in New South Wales, Australia. Weather and Forecasting, 16, 261-269, https://doi.org/10.1175/15200434(2001)016<0261:EDRMSW>2.0.CO;2

Additional Information

This report was prepared by Nicholas Bond, PhD, Research Meteorologist and Climatologist for the State of Washington. Dr. Bond's fee for this service is $200. per hour. Dr. Bond's CV has also been provided to the counsel representing the defendants. Inquiries can be directed to the following address: Box 355672, University of Washington, Seattle, WA 98195 (ph: 206-526-6459)

Dr. Nicholas Bond, Research Meteorologist & Climatologist for the State of Washington

11 June 2019

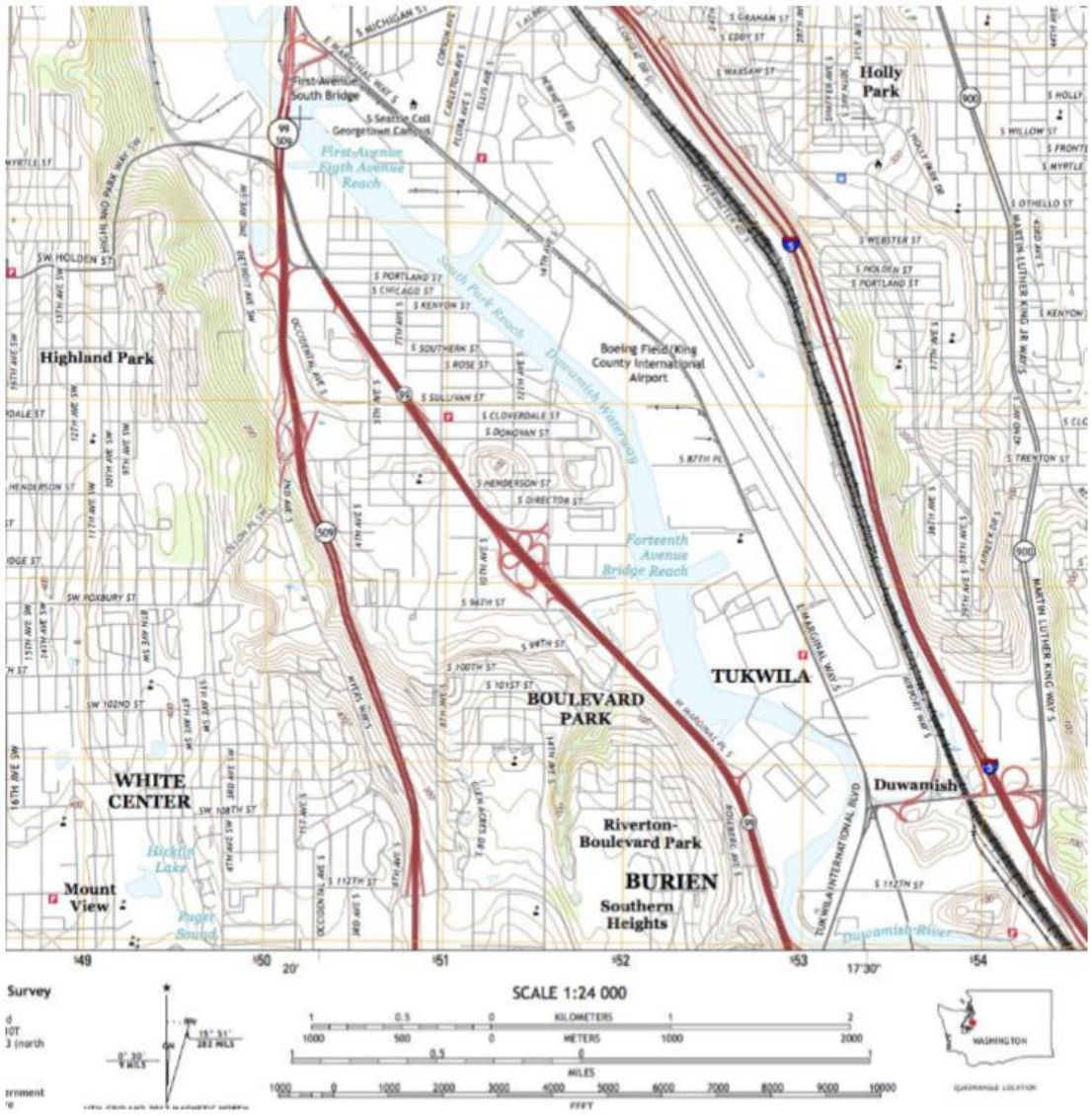


Figure 1 Topographic Map of Region of Accident.

APPENDIX G

Wood Pole Loading Report

Wood Pole Loading Report
for
The City of Seattle

following
The Storm on East Marginal Way South
April 5, 2019

prepared by

Nelson G. Bingel, III – Principal, Nelson Research, LLC

Mechanical/Structural Engineer

Wood Pole Strength & Loading Expert

Chairman – National Electrical Safety Code (NESC)

September 30, 2019

TABLE OF CONTENTS

1. Scope……4
2. Forensic Data Collection……4
3. Wood Pole Modeling……4
4. Wood Pole Load Cases……6
5. Wood Pole Design Load Findings……6
6. Actual Storm Loading Analysis……8
7. Video Analysis……9
   A. Poles 4 through 13……9
   B. Poles 18 and 19……11
   C. Pole 20……15
8. Map Showing the Timing of the Pole Failures……18
9. Conclusions……19

1. Scope

The scope of this report is to determine if the poles that failed along East Marginal Way South during a storm on April 5, 2019 had been designed in accordance with the strength and loading requirements of the National Electrical Safety Code. Additionally, to analyze specific poles that appear to be the starting point of the pole failures.

2. Forensic Data Collection

The species, length and class of the poles damaged during the storm were provided from the SCL 2016 pole inspection reports and the span lengths were also provided by SCL. Each pole was modeled in O-Calc Pro pole loading software. The setting depths were measured during a field visit to the damaged pole sections that were stored in a single yard and positioned in the same sequence as their order when in service.

This line was a double three-phase circuit with 954 kcmil ACSR "Rail" conductors modeled with 2,000 lb. tension. The neutral is 4/0 AAC Covered "Olive" conductor with 1,000 lb. tension. The spacing between the crossarms was modeled using the minimum 5 ft spacing per the SCL spec (5 to 7 ft) to be conservative.

3. Wood Pole Modeling

Figure 1 shows the user interface for pole loading models of wood poles. The Catalogs include the specifications for pole elements like crossarms, insulators, wires and of course poles. The Pole Inventory panel is where items from the catalogs can be dragged to create a specific pole model. As items are added they create the inventory tree and the resulting model can be seen in the 3-D View. Spans can be "gang edited" for length and line angle using the Top View and other specifics of attached items can be edited in Data Entry.

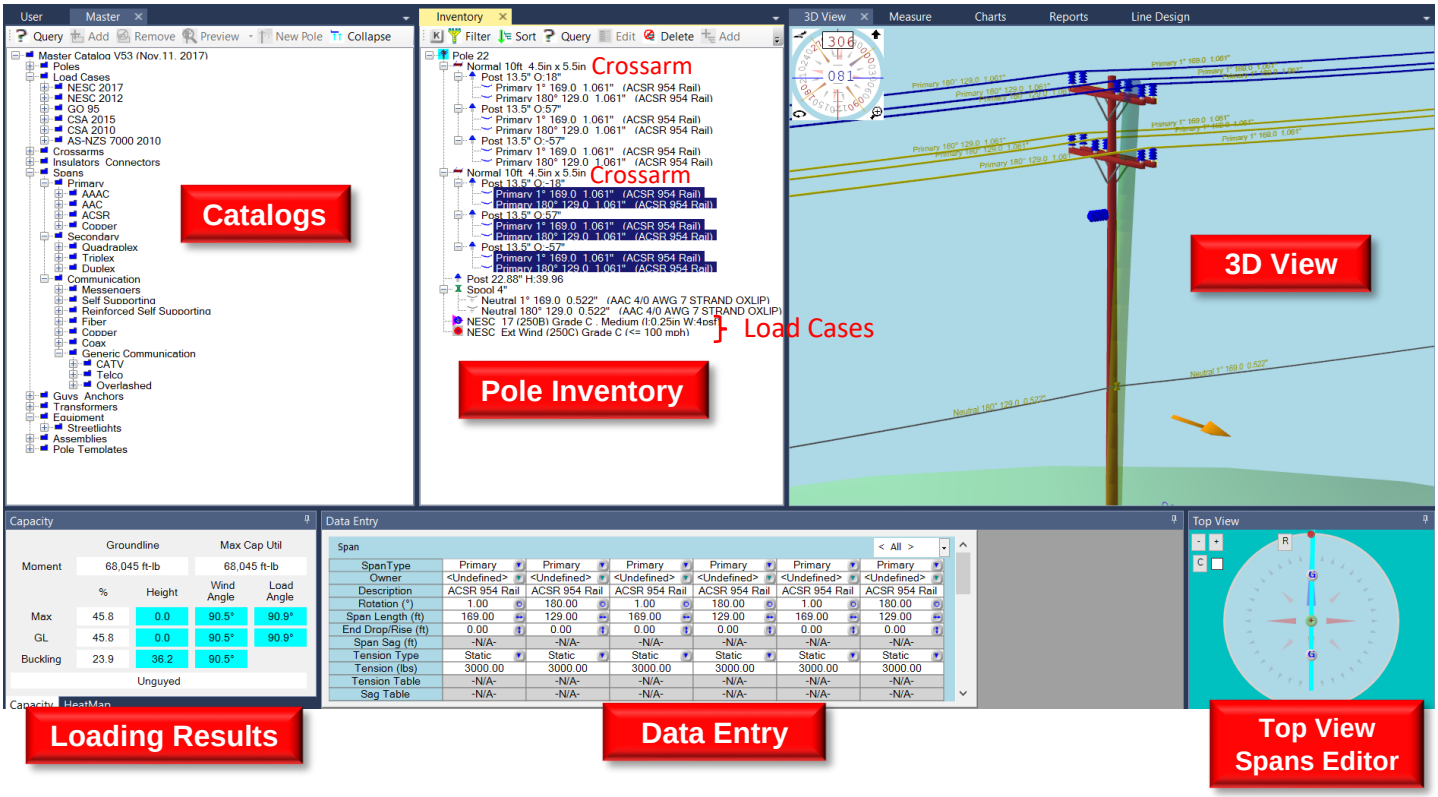


Figure 1. O-Calc Pro Pole Loading Software User

The direction of the wind is swept completely around the structure and settles on the direction that creates maximum loading. The bending load as a percent of pole capacity is shown in the Loading Results. Separate values are shown for the groundline and for the maximum loading above ground in case the maximum is not at the groundline.

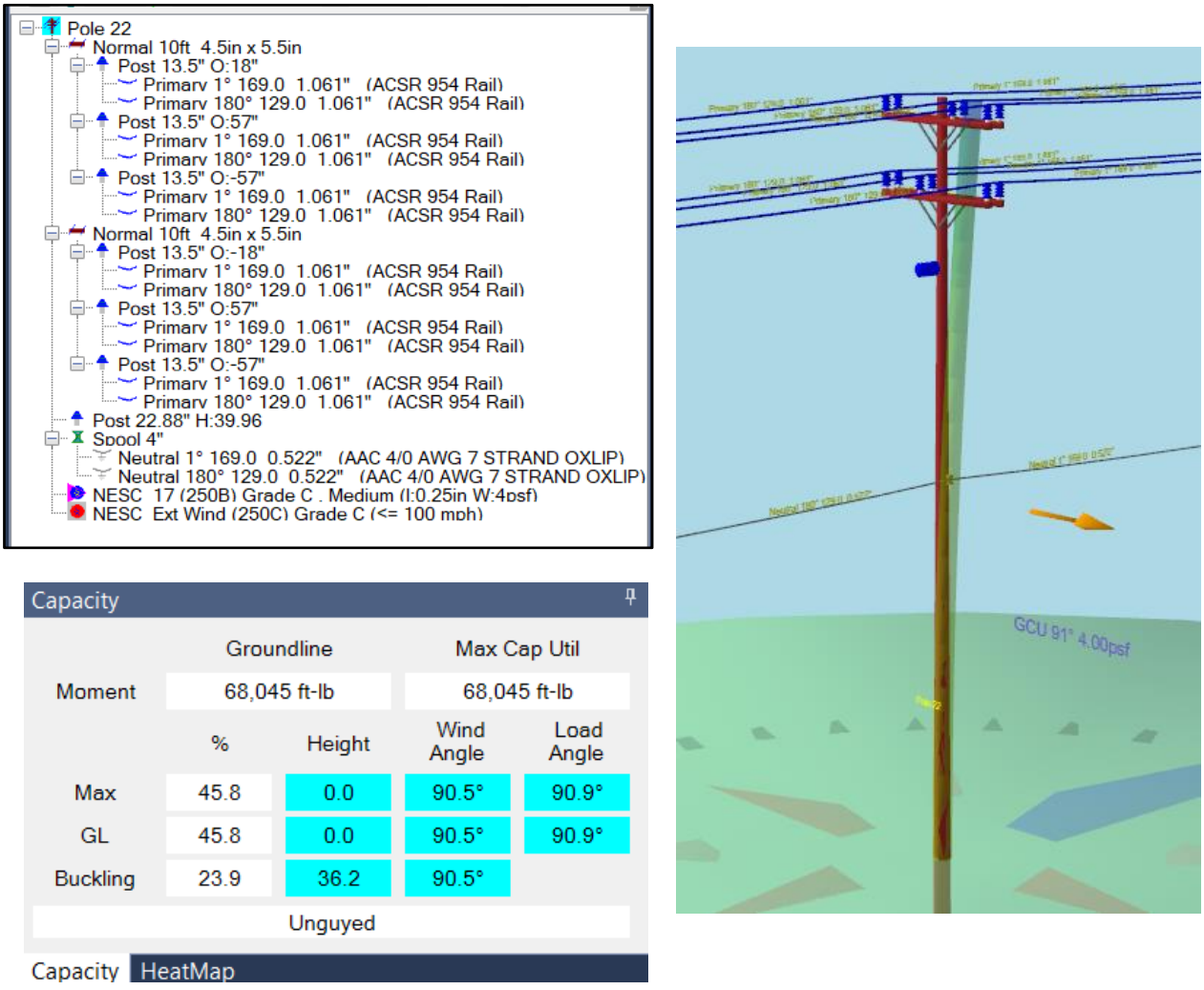


Figure 2. Pole "6" Pole Inventory, Output Summary, and 3-D

4. Wood Pole Load Cases

The National Electrical Safety Code (NESC) specifies loading criteria that are necessary to provide basic safety for overhead lines. Rule 250B District Loading represents a reasonably expected winter storm. Since Seattle is in the Medium Loading District, adding a ¼" of radial ice on each conductor is required (increasing the diameter by ½"). The wind pressure specified is 4-lb/sq-ft of surface area and is approximately equal to a 40-mph wind speed. Rule 250B must be considered for all structures regardless of the height they extend above ground.

There are two Grades of Construction that can be applied to Rule 250B loading, Grade C or B. However, the NESC only requires Grade B construction for lines that cross over railroads, limited access highways and waterways that require crossing permits. The required grade of construction for the line along East Marginal Way is Grade C.

Since the wind and ice loading in Rule 250B are deterministic, the resulting load must be increased by a factor of 1.75 for Grade C. The corresponding strength factor for wood poles is 0.85 for Grade C. This means that only 85% of the pole capacity is "allowed" to be used with the design loading.

Four of the 26 failed poles, 17 through 20, extended more than 60 feet above ground so a second NESC load case had to be considered to determine which load case is more severe. Rule 250C represents an extreme summer wind event using extreme wind speeds from maps published by the American Society of Civil Engineers in standard ASCE 7-10. These wind speeds have a 50-to-90 year mean recurrence interval so there is a known probability of occurrence as opposed to the deterministic wind pressures in Rule 250B. No load factor is applied, and ice is not added to the wire diameters.

The extreme wind speed in the Seattle area is 85 mph. For Grade C a load factor of 0.87 is applied and the wood strength factor is 0.75. Once again, this means that only 75% of the wood pole capacity is "allowed" to be used with the design loading.

A line angle of 1° was added to each structure to account for construction tolerances in the field. This causes the wire tension of opposing spans to be at a slight angle which adds some additional transverse loading.

5. Wood Pole Design Load Findings

The design of all 26 poles exceeded the loading requirements of Rule 250B in the NESC. Thirteen of the poles had a design load ranging from 26% to 45% of pole capacity while 11 poles were within the range from 46% to 65%. Pole 7 was not analyzed as it was an inaccessible, lightly loaded tap pole nor was pole 26 as it is unclear how it was guyed.

In addition, poles 17 through 20 needed to be evaluated for Rule 250C Extreme Wind loading as they extended more than 60 feet above ground. All four pole capacities exceeded the loading requirements of Rule 250C using an 85 mph wind speed. The range of capacity utilization was 60% to 96% and pole 17 was loaded to the greatest amount of its capacity at 96%. The range of loading for the other three poles was 60% to 74%.

Figure 3 is a summary of the design loading for all poles.

NESC Design Loading of Original East Marginal Way Wood Poles

Pole	SCL Pole No.	Original Spans South	Original Spans North	Spans Combined	Length	Class	Species	Rule 250B Grade C	85 mph Rule 250C Grade C	Maximum Stress Point
1	1353076	67	114	181	60	1	WRC	43%		Groundline
2	1353492	154	67	221	60	1	DF	48%		Groundline
3	1353082	149	154	303	65	1	DF	43%		Groundline
4	1353090	120	149	269	65	1	DF	53%		Groundline
5	1353061	149	120	269	65	1	DF	41%		Groundline
6	1353097	100	149	249	65	1	DF	36%		Groundline
7	1354816	103	none		55	2	DF	--		Tap Pole
8**	1354818	61	100	161	65	1	DF	26%		Groundline
9**	1354825	177	61	238	65	1	DF	37%		Groundline
10**	1354807	127	177	304	65	1	DF	43%		Groundline
11**	1358778	113	127	240	65	1	DF	35%	Guyed-29 ft	@ 29 ft AGL
12**	1354824	112	113	225	65	1	DF	58%		Groundline
13**	1354804	138	112	250	65	1	DF	45%		Groundline
14	1354822	129	138	267	65	1	DF	44%		Groundline
15	1354806	108	129	237	65	1	DF	42%		Groundline
16	1354812	188	108	296	65	1	DF	52%		Groundline
17	1354902	231	188	419	85	1	DF	60%	96%	@ 20 ft AGL
18	1328783	85	231	316	75	1	WRC	51%	74%	@ 25 ft AGL
19	1354811	134	85	219	80	1	DF	38%	63%	Groundline
20	1354701	83	134	217	85	H1	DF	37%	60%	Groundline
21	1328887	169	83	252	65	3	DF	51%		Groundline
22**	2496259	129	169	298	60	2	DF	46%		Groundline
23**	1328886	201	129	330	60	2	WRC	51%		Groundline
24**	1328893	238	201	439	65	2	WRC	65%		@ 19 ft AGL
25**	1328996	107	238	345	60	1	WRC	53%		@ 19 ft AGL
26**	1328890	137	107	244	60	1	DF	--		Guying Uncertain

***Yellow highlighted poles were the two groups where several severely decayed poles were located sequentially.*

Figure 3. NESC Design Loading Summary for 26 Poles on East Marginal Way

6. Expected Storm Loading Analysis

The line of failed poles was studied further by creating a load case representing the upper limit 50 mph wind speed that was likely to have occurred during the storm. Those results were aligned with the poles that had an estimated remaining bending strength in Figure 4.

This analysis provides one perspective of pole strength compared to potential actual loading. The calculated remaining strength of pole 13 is 33% and the estimated actual load was 34%. With that small difference and variability in the estimates, it appears very likely that pole 13 was the first pole to fail due to a storm wind load that was greater than the remaining strength. Additional insights are provided by close study of the surveillance videos as explained in Section 7.

Projected Storm Loading & Estimated RSM of Original East Marginal Way Wood Poles

(Portions Excerpted from Appendix J)

Pole	SCL Pole No.	Length	Class	Species	Minimum Pole Class Circum (in)	EMTS** (in.)	75% EMTS** (in.)	Approx Remaining GL-RSM***	Loading From 50 mph Wind	Maximum Stress Point
1	1353076	60	1	WRC				No Decay	37%	Groundline
2	1353492	60	1	DF	Could not measure treated zone			--	43%	Groundline
3	1353082	65	1	DF				No Decay	35%	Groundline
4	1353090	65	1	DF				No Decay	42%	Groundline
5	1353061	65	1	DF	Could not measure treated zone			--	31%	Groundline
6	1353097	65	1	DF	No fracture section ID'd			Residue@10'	29%	Groundline
7	1354816	55	2	DF	Tap pole not modeled			No Decay	--	
8*	1354818	65	1	DF	49.5	2	1.5	57%	23%	Groundline
9*	1354825	65	1	DF	49.5	2	1.5	57%	30%	Groundline
10*	1354807	65	1	DF	Could not measure treated zone			--	34%	Groundline
11*	1358778	65	1	DF	49.5	1	0.75	33%	26%	Groundline
12*	1354824	65	1	DF	49.5	2	1.5	57%	48%	First Failures
13*	1354804	65	1	DF	49.5	1	0.75	33%	34%	
14	1354822	65	1	DF	49.5	1	0.75	33%	33%	Groundline
15	1354806	65	1	DF	No fracture section ID'd				38%	Groundline
16	1354812	65	1	DF	49.5	2	1.5	57%	45%	Groundline
17	1354902	85	1	DF	55.0	2	1.5	53%	48%	28 ft AGL
18	1328783	75	1	WRC	52.5	2	1.5	55%	38%	25 ft AGL
19	1354811	80	1	DF	54.0	2	1.5	54%	33%	Groundline
20	1354701	85	H1	DF	58.5	1	0.75	No Decay	36%	23 ft AGL
21	1328887	65	3	DF	43.5	2	1.5	62%	46%	Groundline
22*	2496259	60	2	DF	45.0	1	0.75	36%	36%	Groundline
23*	1328886	60	2	WRC	45.0	1	0.75	36%	39%	14 ft AGL
24*	1328893	65	2	WRC	46.5	1.5	1.125	48%	48%	18 ft AGL
25*	1328996	60	1	WRC	No fracture section ID'd				50%	20 ft AGL
26*	1328890	60	1	DF	48.0	0.75	0.56	26%	--	

**Yellow highlighted poles were the two groups where several severely decayed poles were located sequentially.*

***Estimated Minimum Treated Shell (EMTS) was an average estimate with variability of at least +25%. EMTS for RSM EMTS for RSM calculations was 75% of the average.*

**** **Residual Section Modulus (RSM)** calculates the remaining bending strength of a wood pole at ground line.*
*The formula for a sound pole is: SM_{solid} = pi*d^3/32; and for a hollow pole is: SM_{hollow} = (pi*(d^4-d$_i^4$)) /(32*d).*
*Therefore, the **RSM** is the ratio: [SM_{hollow} = (pi * (d4-d$_i$4)) / (32*d)] ÷ [SM_{solid} = pi * d^3 / 32].*
*These calculations for a hollow pole **RSM** are based on failing in bending. Poles with advanced internal decay have a thin outer shell which typically fails at a lower strength due to localized buckling*

Figure 4. Projected Actual Storm Loading & Estimated Bending Remaining Strength

7. Video Analysis

A. Poles 4 through 13

Footage from three of the videos gave a reasonable understanding of how the failures started and continued to propagate. The video from Boeing is viewing toward the south and is labeled "BOE_4_5_2019 3_47_36 PM", provides a good view of poles 4 through 13. The following frame is from 3:49:13 pm before any failures occurred.



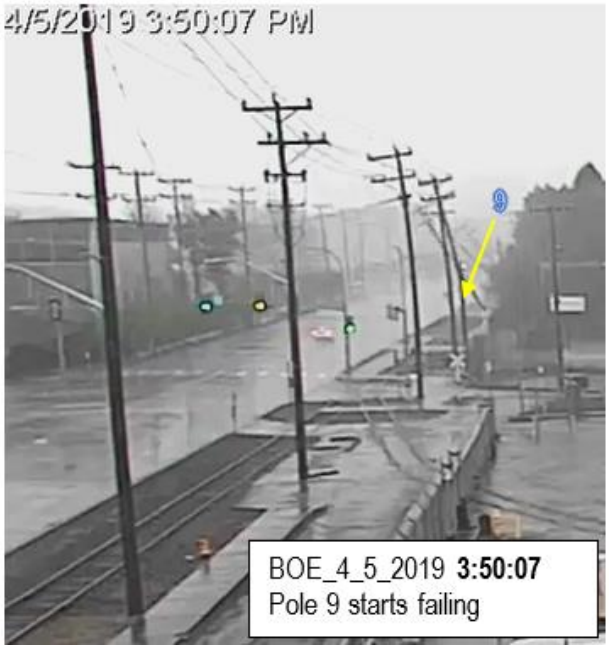
The next sequence of images shows that pole 12 and 13 appeared to fail first at very similar times. This seems to have started the propagation of failures in both the north and south directions. Failures south of pole 13 will be seen in frames from additional videos. This video clip stopped when pole 7 and 6 are beginning to fail but the failures continued up to pole 1.

The time between poles starting to fail was very short. From the time poles 12 and 13 are shown to be going down until pole 7 and 6 nearly failed was only about 6 seconds; 3:50:02 to 3:50:08. The following video frames were selected as being near the start of each pole failing.


4/5/2019 3:50:02 PM
12 & 13
BOE_4_5_2019 **3:50:02**
Poles 12 & 13 are falling


4/5/2019 3:50:04 PM
11
BOE_4_5_2019 **3:50:04**
Pole 11 starts failing


4/5/2019 3:50:05 PM
10
BOE_4_5_2019 **3:50:05**
Pole 10 starts failing


4/5/2019 3:50:07 PM
9
BOE_4_5_2019 **3:50:07**
Pole 9 starts failing


4/5/2019 3:50:07 PM
8
BOE_4_5_2019 **3:50:07**
Pole 8 starts failing


4/5/2019 3:50:08 PM
6
7
BOE_4_5_2019 **3:50:08**
Poles 7 & 6 start failing

Two additional aspects were reviewed about potential contributors to the pole failures. Firstly, there were electrical guy wires crisscrossing the street attached from pole 11 to 14. Both pole 11 and 14 had one guy attached while 12 and 13 had two guys attached. They were attached just above the telecom on the eventually failed poles and just below the electrical crossarms across the street. Since the guys were attached at lower levels on the poles along the west side of the street, they were likely in place to add support to the poles on the east side of the street.

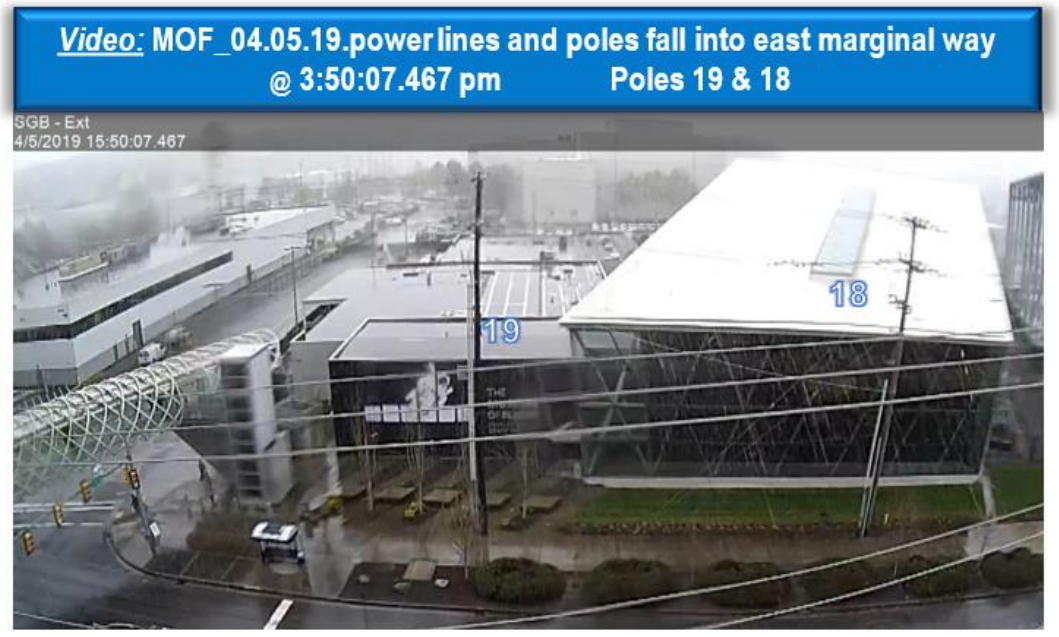
As poles 13, 12, and 11 failed, the deflection of the poles across the street did not significantly change so those poles were not likely imposing much load on the poles that did fail.

Pole 11 was also analyzed closely to see if two telecom attachments that came from across the street may have been a contributing factor to pole 11 failing and initiating the string of failures. Two guy wires had been attached to pole 11 in the telecom zone to offset the tension from the two telecom attachments. The guy wires extended westward to a stub pole which was then secured with a down guy. The stub pole failed during the storm so at some point there was no longer any support to pole 11 from the guy configuration.

Pole 11 was first modeled with the guy stub pole and the design was very adequate. Then the guy stub was removed to see how much tension the pole could support from the telecom attachments. Even without the guy, pole 11 could support over 5,000 pounds of tension from the attachments and still not be overloaded. The tension of the telecom attachments was likely less than half of that value. The video clearly shows poles south of pole 11 failing first, so there is no concern that the failure of the telecom guy system might have been the initial cause of the propagated failures.

B. Poles 18 and 19

The next video that showed poles failing was from the Museum of Flight and is labeled "MOF_04_05_19.power lines and poles fail into east marginal way.sgb". South is to the left within the images. Poles 18 and 19 are shown and are located directly in front of the Museum of Flight. Pole 18 is five poles away from pole 13 and time elapsed between their failures is around 9 seconds. This suggests that the ongoing string of failures very likely was traveling southward from pole 13.

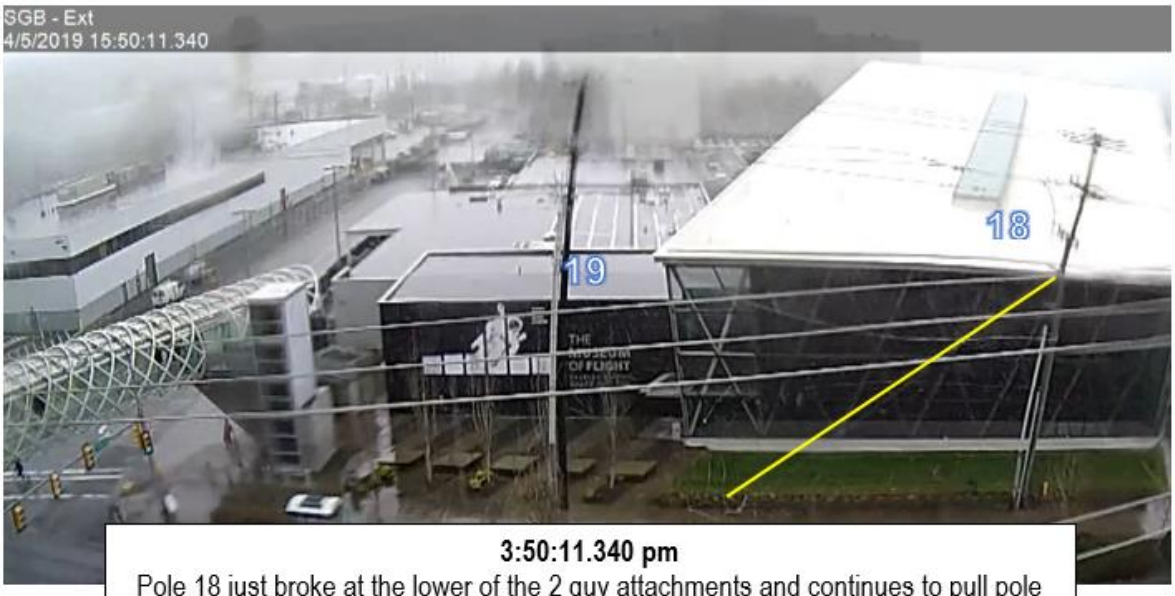


These images will demonstrate that pole 18 and 19 were experiencing extreme longitudinal loading as the poles to the north were failing. As shown in the second video frame, pole 18 had two longitudinal guys installed on the south side of the pole which resisted the wire tension loading from the northern poles.



3:50:10.216 pm
Pole 18 is deflecting longitudinally but has 2 inline guys (highlighted in yellow) on the south side of the pole resisting the wire tension load from the north spans.

The upper guy of pole 18 failed at some point, but the lower guy stayed in place and the pole broke at that connection. The top section is falling to the north.



3:50:11.340 pm
Pole 18 just broke at the lower of the 2 guy attachments and continues to pull pole 19 longitudinally to the north.

Subsequently the longitudinal bending of pole 19 becomes very pronounced.



3:50:12.339 pm
The top section of pole 18 continues pulling pole 19 longitudinally.
Pole 19 is bending but has not broken

Pole 19 appears to break at the groundline but largely from the longitudinal loading.



3:50:15.093 pm
Pole 19 appears to have broken at the groundline and the wires going north to pole 18 have become slack while the wires going south to pole 20 are very taught.



3:50:16.988 pm
As pole 18 falls, the wire tension from pole 18 pulls on pole 19 causing movement in the longitudinal and then transverse direction.

As pole 19 continues falling, the wire tension to the north reduces while the wire tension to the south to pole 20 increases and pole 19 is pulled toward the transverse direction. Pole 19 is the one that eventually landed on a moving car.

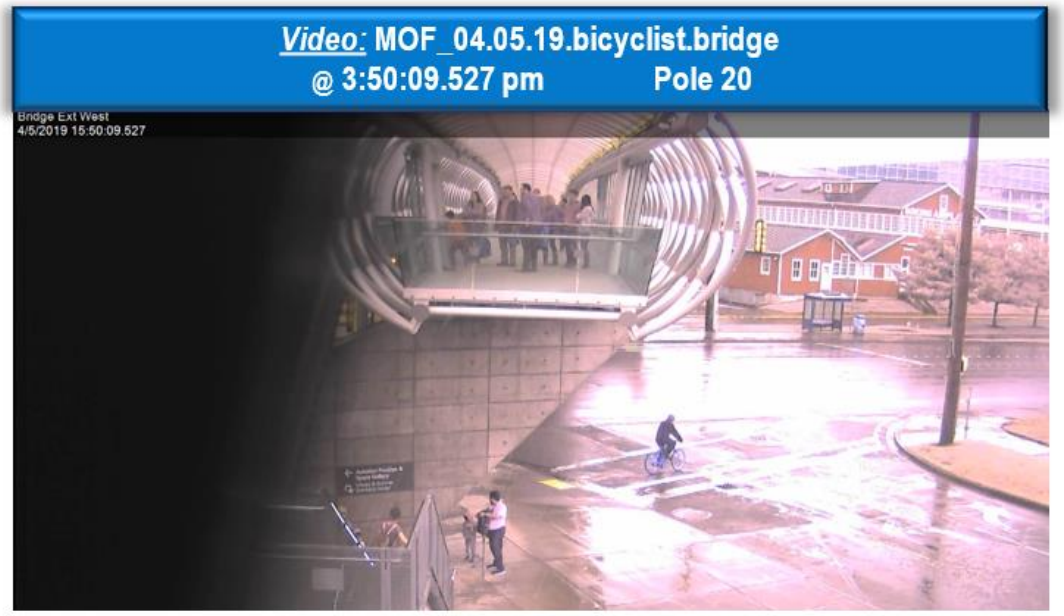


3:50:18.093 pm
As pole 19 falls, the wire tension on the south span increases the longitudinal pull on pole 20 on the other side of the bridge.

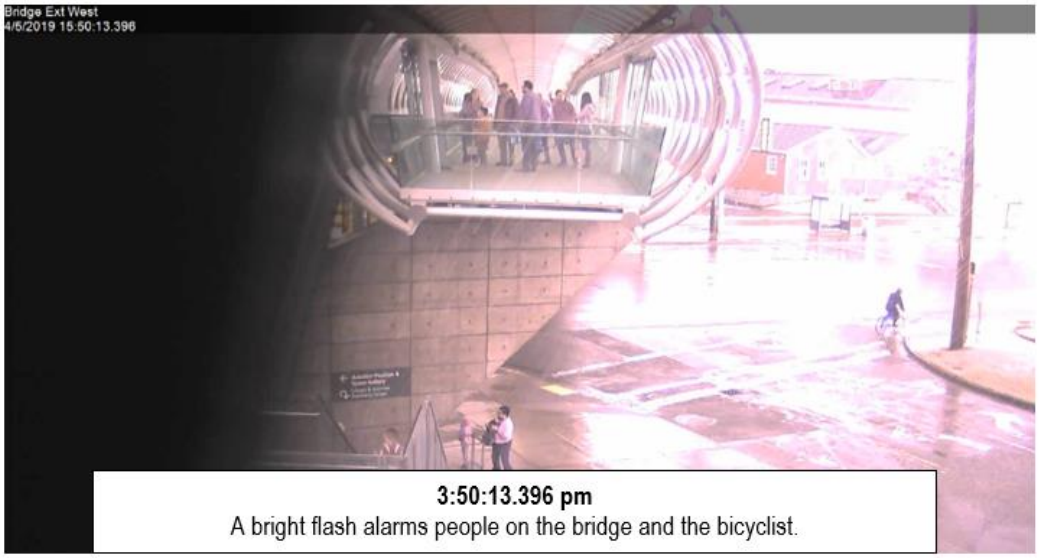
These poles clearly failed from longitudinal loading caused by neighboring poles falling. This suggests that once poles 12 and 13 failed, the longitudinal wire tension loads could have created enough force to fail even completely sound poles. This was the case for several poles on the north end of the line. The next video frames are of pole 20 which is the first pole on the south side of the walking bridge shown here.

C. Pole 20

These final video frames are also from a Museum of Flight camera and south is to the right in the images. The video is labeled "MOF_04.05.191550-1551.bicyclist.bridge ext west" and shows the failure of pole 20. People can be seen inside the walking bridge and a bicyclist is approaching the pole location.



This second frame shows that a sudden very bright flash startles the pedestrians and bicyclist.



As the people scramble, pole 20 is seen to waver back and forth from changes in the loading.

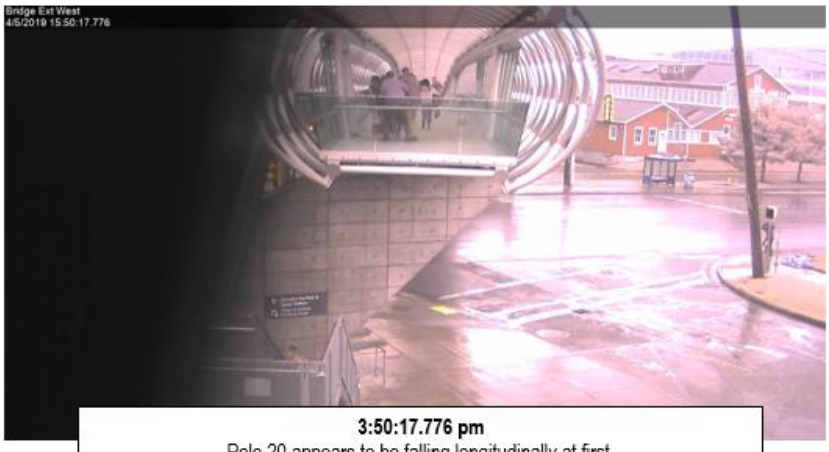


3:50:13.897 pm
Pole 20 deflecting longitudinally; waves back and forth for a few seconds..

At approximately 3:50 PM plus 17 seconds pole 20 appears to break at the groundline as it steadily falls in the following frames. Once again, this pole appears to begin falling in the longitudinal direction and then is pulled by the wire tension of the southern poles toward the transverse direction.



3:50:17.155 pm
Pole 20 appears to break as it steadily begins to fall..



3:50:17.776 pm
Pole 20 appears to be falling longitudinally at first.



This final frame is from a city of Tukwila camera which shows pole 20 from a different angle and demonstrates that the eventual failure was largely in the transverse direction. The video is labeled "TUK-94th South- 2019-04-08 09.07.11 AM". The timing shown on this video is not in sync with the BOE and MOF videos as it shows a time which occurred before the pole came down.



8. Map Showing the Timing of the Pole Failures

The times of failure gathered from the surveillance videos were added to the map of the 26 poles in Figure 5. The timing shows that the propagation of failures does move both northward and southward from poles 12 and 13. This validates that the propagated failures were likely initiated by the initial failure of poles 12 and 13. The wire tension loading from the falling poles was a significant contributor to the propagation of additional pole failures.



Figure 5. Map Showing Time When Failure Began for Poles in Surveillance Videos

9. Conclusions

The sequential failure of multiple poles in a line is often caused by the overload of a pole at some point closer to the middle of the downed poles. Once a pole begins to fall, neighboring poles experience significant longitudinal, transverse and vertical dynamic loading. These forces can be great enough to cause neighboring poles without decay to fail. Subsequent failures often occur in both directions from the original pole that failed.

When a line has only one set of 3-phase conductors that are small to medium diameter, one or more of the phase wires breaks along the way so the propagation of pole failures is limited. This line has two 3-phase circuits of 954 kcmil ACSR "Rail" conductors with individual ultimate tensile strengths of 25,900 lb. For all six wires, that equates to over 150,000 pounds of tensile capacity. Therefore, the phase wires on this line did not seem to break which is another reason why so many poles failed.

The video analysis in section 7B showed the significant longitudinal loading that pole 18 and 19 experienced as poles to the north were falling to the ground. Pole 18 had inline guy wires resisting the longitudinal load, but the pole broke at the lower guy attachment and the top section was clearly pulled northward. Pole 19 appeared to fail in the longitudinal direction as it was first pulled northward and while falling was subsequently pulled toward the transverse direction by the wire tension from the next pole down the line.

Poles 12 and 13 had advanced internal decay conditions at the groundline with a thin remaining outer shell. Western species poles with advanced internal decay have historically been evaluated differently for remaining strength compared to Southern Pine poles that have external decay below ground. Poles without decay and those with external decay typically fail in bending (Fig. 6). Poles with thin outer shell typically fail due to localized buckling of the thin shell; similar to how thin-walled steel poles fail (Fig. 7).



Figure 6. Wood Pole Bending Failure.



Figure 7. Steel Pole Localized Buckling Failure.

To demonstrate the localized buckling in wood poles, some dowels were drilled out to create a thin shell and the hollow section was placed at the simulated groundline. Figure 8 shows how the solid dowel failed in bending while Figure 9 shows a thin-walled dowel failing due to local buckling.



Figure 8. Solid Wood Dowel Failed in Bending

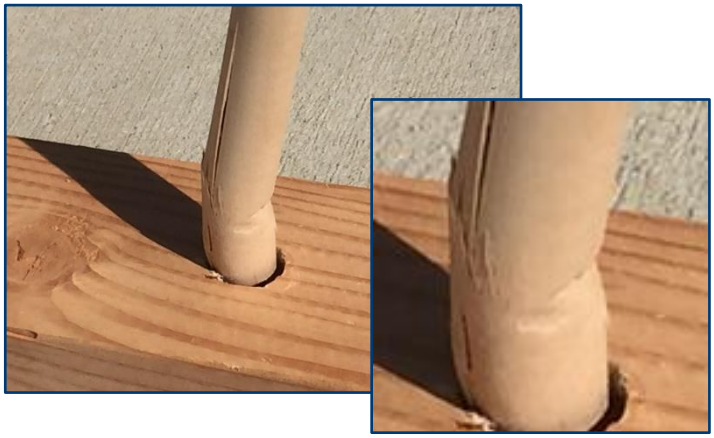


Figure 9. Hollow Dowel Failed Due to Local Buckling

The only form of remaining strength for a pole that can be calculated is by assuming a bending failure. It is known that when thin-walled poles fail due to local buckling at the groundline, they fail at a lower strength value than what is calculated for a bending failure. However, it is difficult to calculate the expected strength of a hollow pole because that value not only depends on multiple shell thickness measurements but is also affected by the height of the advanced decay within the pole. The higher that the internal decay extends above ground, the lower the expected strength.

Pole 12 failed at 4 to 5 feet above ground and the advanced internal decay extended from groundline to that level and above. The BOE (Boeing) video shows that pole 12 and 13 likely failed first and the extent and height of advanced internal decay would have contributed to the early failure.

The estimated strength values in Figure 4 are based on failing due to bending. The actual remaining strength for pole 12 was likely much lower than the estimated 57% remaining bending strength since the pole likely failed due to the local buckling effects of a thin outer shell. The remaining strength was likely less than the 48% load that the pole was estimated to experience during the storm.

The calculated bending strength for pole 13 was only 33% and again, localized buckling would have caused the pole to fail at a lower value. Since the estimated load on pole 13 was 34% of original pole capacity, and the pole remaining strength was likely below 33%, it is not surprising that pole 13 was one of the first poles to fail, if not the first.

Unlike many of the other poles, 12 and 13 were not shielded from the wind by nearby buildings and vegetation as shown in Figure 10. The wind speed exposure, due to a potential funneling effect and lack of obstruction, was very likely to have been greater than what neighboring poles experienced.



Figure 10. Photo showing the lack of wind shielding for poles 12 and 13.

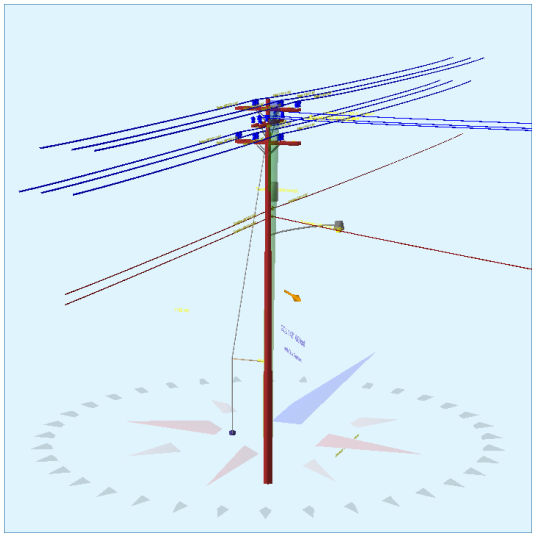
The MOF (Museum of Flight) videos showed significant dynamic loading on the poles located near poles that are falling. In addition to the existing storm wind loads in the transverse direction, the neighboring falling poles introduced significant longitudinal loading as seen in the pole 18 and 19 video. As neighboring poles get closer to the ground, they begin to induce additional vertical and transverse loads as well.

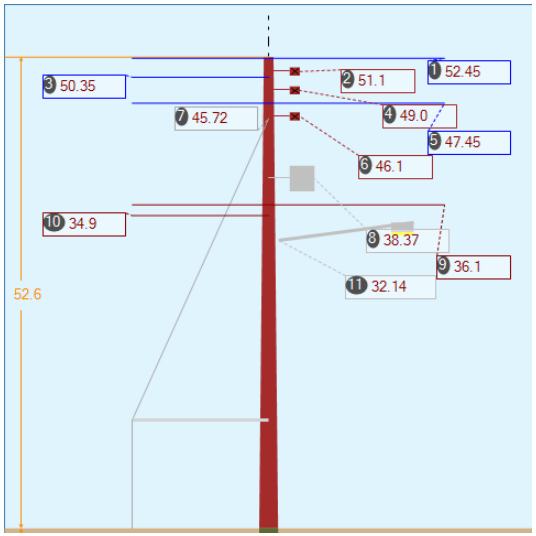
Once poles 12 and 13 failed, a propagation of failures occurred both northward and southward caused by the dynamic loads created by the storm combined with neighboring poles falling. The subsequent failure of poles propagating from 12 and 13 occurred in very short time frames.

APPENDIX H

NESC Rule 250B
Pole Loading Analysis Reports

Pole Num:	**Pole 1F**	Pole Length / Class:	**60 / 1**	Code:	**NESC**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**WESTERN RED CEDAR**	NESC Rule:	**Rule 250B**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**7.42**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**52.81**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**6,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.30**
Aux Data 5	**Unset**	Allowable Stress (psi):	**5,100**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:		**0° 0' 0" N**	Longitude:		**0° 0' 0" W**	Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**42.9**	0.0	142.0
Groundline	**42.9**	0.0	142.0
Vertical	**11.5**	42.17	90.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**81,049**	135.0	142.0
Groundline	**81,049**	135.0	142.0
GL Allowable	**198,226**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Single Helix Anchor	6.0	270.0		**50.3**	142.0	**63.3**	90.0
EHS 3/8 (Sidewalk)			45.7	**72.5**	142.0	**91.3**	90.0
Sidewalk Strut	6.0	270.0	12.1	**70.6**	142.0	**80.9**	90.0
			System Capacity Summary:	**Adequate**		**Near Capacity**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 135.0°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	2,407	74.7	**96,430**	119.0	**48.7**	**2,719**	1,759	8	**2,727**	**53.5**
GuyBraces	134	4.2	**-36,620**	-45.2	**-18.5**	**-1,247**	14,871	67	**-1,180**	**-23.1**
PowerEquipments	36	1.1	**497**	0.6	**0.3**	**14**	636	3	**17**	**0.3**
Pole	387	12.0	**8,834**	10.9	**4.5**	**249**	4,551	21	**270**	**5.3**
Crossarms	165	5.1	**7,316**	9.0	**3.7**	**206**	604	3	**209**	**4.1**
Streetlights	32	1.0	**1,721**	2.1	**0.9**	**49**	162	1	**49**	**1.0**
Insulators	63	1.9	**2,871**	3.5	**1.5**	**81**	452	2	**83**	**1.6**
Pole Load	3,223	100.0	**81,049**	100.0	**40.9**	**2,071**	23,035	104	**2,175**	**42.6**
Pole Reserve Capacity			**117,177**		**59.1**	**3,029**			**2,925**	**57.4**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 135.0°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	2,836	88.0	**72,215**	89.1	**36.4**	**1,822**	18,484	83	**1,905**	**37.4**
Pole	387	12.0	**8,834**	10.9	**4.5**	**249**	4,551	21	**270**	**5.3**
Totals:	3,223	100.0	**81,049**	100.0	**40.9**	**2,071**	23,035	104	**2,175**	**42.6**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		52.45	57.00	1.1650	1.33	1.075	114.0	1.0	114.0	3,000	-142,238	551	1,317	-140,370
Primary	ACSR 954 Rail		52.45	57.00	1.1650	0.70	1.075	67.0	180.0	67.0	3,000	144,787	324	744	145,855
Primary	ACSR 954 Rail		52.45	24.00	1.1650	1.33	1.075	114.0	1.0	114.0	3,000	-142,238	-232	1,317	-141,153
Primary	ACSR 954 Rail		52.45	24.00	1.1650	0.70	1.075	67.0	180.0	67.0	3,000	144,787	-136	744	145,395
Primary	ACSR 954 Rail		52.45	24.00	1.1650	1.33	1.075	114.0	1.0	114.0	3,000	-142,238	232	1,317	-140,689
Primary	ACSR 954 Rail		52.45	24.00	1.1650	0.70	1.075	67.0	180.0	67.0	3,000	144,787	136	744	145,668
Primary	AAC 3/0 AWG 7 STRAND PHLOX		50.35	24.00	0.4640	1.24	0.157	80.0	91.0	80.0	300	14,132	41	611	14,784
Primary	AAC 3/0 AWG 7 STRAND PHLOX		50.35	57.00	0.4640	1.24	0.157	80.0	91.0	80.0	300	14,132	97	611	14,840
Primary	AAC 3/0 AWG 7 STRAND PHLOX		50.35	57.00	0.4640	1.24	0.157	80.0	91.0	80.0	300	14,132	-97	611	14,646
Primary	ACSR 954 Rail		47.45	24.00	1.1650	1.33	1.075	114.0	1.0	114.0	3,000	-128,692	232	1,192	-127,268

Primary	ACSR 954 Rail	47.45	24.00	1.1650	0.70	1.075	67.0	180.0	67.0	3,000	130,998	136	674	131,808
Primary	ACSR 954 Rail	47.45	57.00	1.1650	1.33	1.075	114.0	1.0	114.0	3,000	-128,692	-551	1,192	-128,051
Primary	ACSR 954 Rail	47.45	57.00	1.1650	0.70	1.075	67.0	180.0	67.0	3,000	130,998	-324	674	131,348
Primary	ACSR 954 Rail	47.45	24.00	1.1650	1.33	1.075	114.0	1.0	114.0	3,000	-128,692	-232	1,192	-127,732
Primary	ACSR 954 Rail	47.45	24.00	1.1650	0.70	1.075	67.0	180.0	67.0	3,000	130,998	-136	674	131,536
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	36.10	8.59	0.2640	0.61	0.136	114.0	1.0	114.0	600	-19,560	16	416	-19,128
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	36.10	8.59	0.2640	0.22	0.136	67.0	180.0	67.0	600	19,911	10	235	20,155
Secondary	DUPLEX 4 AWG	34.90	7.93	0.6300	0.71	0.107	67.0	180.0	67.0	558	17,901	11	336	18,249
Secondary	DUPLEX 6 AWG	34.90	7.93	0.5370	1.28	0.071	114.0	120.0	114.0	357	15,645	16	116	15,778
										Totals:	**90,859**	**94**	**14,717**	**105,669**

PowerEquipment		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Transformer	1PH-15KVA		38.37	22.41	0.0	0.0	335.00	34.00	--	22.00	--	-840	1,385	544
											Totals:	**-840**	**1,385**	**544**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 8		51.10	6.66	0.0	0.0	53.00	5.50	4.50	120.00	0	3,007	3,007
Normal	CROSSARM 3-1/2 X 4-1/2 X 8		49.00	6.83	90.0	90.0	53.00	5.50	4.50	120.00	0	2,297	2,297
Normal	CROSSARM 3-1/2 X 4-1/2 X 8		46.10	7.05	0.0	0.0	53.00	5.50	4.50	120.00	0	2,713	2,713
										Totals:	**0**	**8,017**	**8,017**

Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		32.14	5.90	90.0	90.0	85.00	24.00	20.00	3.00	120.00	862	1,024	1,886
											Totals:	**862**	**1,024**	**1,886**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		51.33	57.00	83.3	0.0	13.00	5.25	13.50	166	353	519
Post	Post Insulator - 27 kV		51.33	-24.00	285.5	0.0	13.00	5.25	13.50	-70	353	284
Post	Post Insulator - 27 kV		51.33	24.00	105.5	90.5	13.00	5.25	13.50	70	353	423
Post	Post Insulator - 27 kV		49.23	24.00	164.1	0.0	13.00	5.25	13.50	70	339	409
Post	Post Insulator - 27 kV		49.23	57.00	173.2	0.0	13.00	5.25	13.50	166	339	505
Post	Post Insulator - 27 kV		49.23	-57.00	6.8	0.0	13.00	5.25	13.50	-166	339	173
Post	Post Insulator - 27 kV		46.33	24.00	73.6	0.0	13.00	5.25	13.50	70	319	389

Post	Post Insulator - 27 kV	46.33	-57.00	277.1	0.0	13.00	5.25	13.50	-166	319	153
Post	Post Insulator - 27 kV	46.33	-24.00	253.6	90.5	13.00	5.25	13.50	-70	319	249
Spool	Spool 4"	36.10	0.00	90.0	0.0	3.00	4.00	4.12	3	29	32
Spool	Spool 2.5"	34.90	0.00	90.0	0.0	1.00	2.50	2.12	1	9	10
								Totals:	**74**	**3,072**	**3,146**

Guy Wire and Brace		**Owner**	**Attach Height (ft)**	**End Height (ft)**	**Lead/Span Length (ft)**	**Wire Diameter (in)**	**Percent Solid (%)**	**Lead Angle (deg)**	**Incline Angle (deg)**	**Wire Weight (lbs/ft)**	**Rest Length (ft)**	**Stretch Length (in)**
EHS 3/8	Sidewalk		45.72	0.00	6.00	0.375	75.00	270.0	79.4	0.273	52.09	3.37

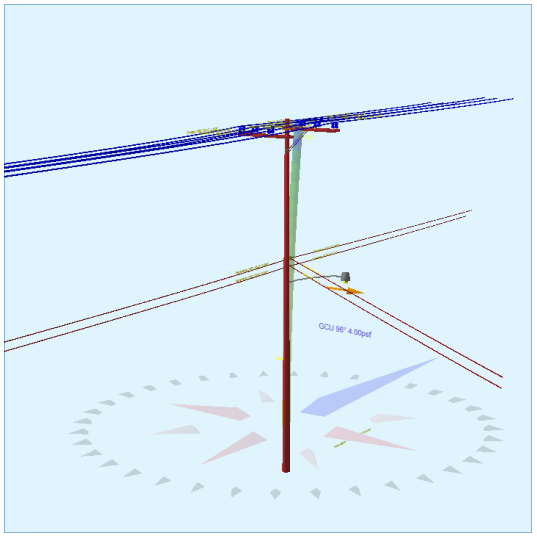
Guy Wire and Brace (Loads and Reactions)		**Elastic Modulus (psi)**	**Rated Tensile Strength (lbs)**	**Guy Strength Factor**	**Allowable Tension (lbs)**	**Initial Tension (lbs)**	**Loaded Tension*[2] (lbs)**	**Maximum Tension[2] (lbs)**	**Applied Tension[3] (lbs)**	**Vertical Load (lbs)**	**Shear Load In Guy Dir (lbs)**	**Shear Load At Report Angle (lbs)**	**Moment at GL[3] (ft-lb)**
EHS 3/8	Sidewalk	2.30e+7	15,400	0.90	13,860	700	12,656	11,506	10,050	9,878	1,850	-1,308	-40,128
									Totals:	**9,878**	**1,850**	**-1,308**	**-40,128**

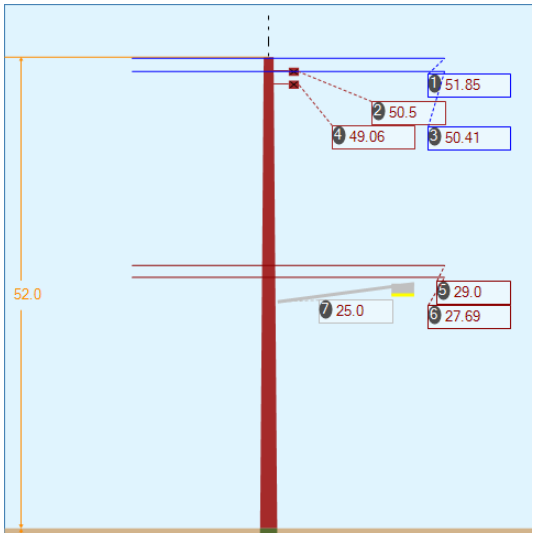
Anchor/Rod Load Summary	**Owner**	**Rod Length AGL (in)**	**Lead Length (ft)**	**Lead Angle (deg)**	**Strength of Assembly (lbs)**	**Anchor/Rod Strength Factor**	**Allowable Load (lbs)**	**Max Load[2] (lbs)**	**Load at Pole MCU[3] (lbs)**	**Max Required Capacity[2] (%)**
Single Helix Anchor		18.00	6.00	270.0	20,000	1.00	20,000	12,656	10,050	63.3

Pole Buckling

Buckling Constant	**Buckling Column Height* (ft)**	**Buckling Section Height (% Buckling Col. Hgt.)**	**Buckling Section Diameter (in)**	**Minimum Buckling Diameter at GL (in)**	**Diameter at Tip (in)**	**Diameter at GL (in)**	**Modulus of Elasticity (psi)**	**Pole Density (pcf)**	**Ice Density (pcf)**	**Pole Tip Height (ft)**	**Buckling Load Capacity at Height (lbs)**	**Buckling Load Applied at Height (lbs)**	**Buckling Load Factor of Safety**
0.71	42.16	35.88	14.45	9.79	8.60	16.82	1.43e+6	50.00	57.00	52.60	200,519	**2003.06**	**8.70**

Pole Num:	**Pole 2F**	Pole Length / Class:	**60 / 1**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**8.0**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**47.22**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**48.0**	0.0	95.6
Groundline	**48.0**	0.0	95.6
Vertical	**16.4**	35.0	95.6

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**89,433**	102.6	95.6
Groundline	**89,433**	102.6	95.6
GL Allowable	**188,937**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 102.6°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,917	81.3	**75,815**	84.8	**40.1**	**2,727**	2,083	12	**2,739**	**40.3**
Pole	356	15.1	**8,958**	10.0	**4.7**	**322**	4,623	26	**348**	**5.1**
Crossarms	12	0.5	**591**	0.7	**0.3**	**21**	513	3	**24**	**0.4**
Streetlights	32	1.4	**1,988**	2.2	**1.1**	**72**	162	1	**72**	**1.1**
Insulators	42	1.8	**2,081**	2.3	**1.1**	**75**	304	2	**77**	**1.1**
Pole Load	2,359	100.0	**89,433**	100.0	**47.3**	**3,217**	7,685	43	**3,261**	**48.0**
Pole Reserve Capacity			**99,504**		**52.7**	**3,583**			**3,539**	**52.0**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 102.6°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	2,003	84.9	**80,475**	90.0	**42.6**	**2,895**	3,062	17	**2,912**	**42.8**
Pole	356	15.1	**8,958**	10.0	**4.7**	**322**	4,623	26	**348**	**5.1**
Totals:	2,359	100.0	**89,433**	100.0	**47.3**	**3,217**	7,685	43	**3,261**	**48.0**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		51.85	108.83	1.1650	0.70	1.075	67.0	1.0	67.0	3,000	-31,323	853	1,649	-28,821
Primary	ACSR 954 Rail		51.85	108.83	1.1650	1.97	1.075	154.0	180.0	154.0	3,000	33,981	1,962	3,770	39,712
Primary	ACSR 954 Rail		51.85	68.90	1.1650	0.70	1.075	67.0	1.0	67.0	3,000	-31,323	540	1,649	-29,134
Primary	ACSR 954 Rail		51.85	68.90	1.1650	1.97	1.075	154.0	180.0	154.0	3,000	33,981	1,242	3,770	38,992
Primary	ACSR 954 Rail		51.85	36.10	1.1650	0.70	1.075	67.0	1.0	67.0	3,000	-31,323	283	1,649	-29,391
Primary	ACSR 954 Rail		51.85	36.10	1.1650	1.97	1.075	154.0	180.0	154.0	3,000	33,981	651	3,770	38,401
Primary	ACSR 954 Rail		50.41	106.60	1.1650	0.70	1.075	67.0	1.0	67.0	3,000	-30,454	-836	1,603	-29,687
Primary	ACSR 954 Rail		50.41	106.60	1.1650	1.97	1.075	154.0	180.0	154.0	3,000	33,038	-1,921	3,665	34,782
Primary	ACSR 954 Rail		50.41	75.00	1.1650	0.70	1.075	67.0	1.0	67.0	3,000	-30,454	-588	1,603	-29,439
Primary	ACSR 954 Rail		50.41	75.00	1.1650	1.97	1.075	154.0	180.0	154.0	3,000	33,038	-1,352	3,665	35,351
Primary	ACSR 954 Rail		50.41	37.59	1.1650	0.70	1.075	67.0	1.0	67.0	3,000	-30,454	-295	1,603	-29,146
Primary	ACSR 954 Rail		50.41	37.59	1.1650	1.97	1.075	154.0	180.0	154.0	3,000	33,038	-678	3,665	36,025
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		29.00	8.72	0.2640	0.22	0.136	67.0	1.0	67.0	600	-3,500	13	423	-3,064
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		29.00	8.72	0.2640	1.08	0.136	154.0	180.0	154.0	600	3,797	31	967	4,794
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		29.00	8.72	0.2640	0.31	0.136	80.0	130.0	80.0	600	15,449	16	134	15,599
Secondary	DUPLEX 6 AWG		27.69	8.05	0.5370	0.73	0.071	67.0	0.0	67.0	357	-2,157	13	545	-1,599
Secondary	DUPLEX 6 AWG		27.69	8.05	0.5370	1.79	0.071	154.0	180.0	154.0	357	2,157	30	1,253	3,440
Secondary	DUPLEX 6 AWG		27.69	8.05	0.5370	0.88	0.071	80.0	130.0	80.0	357	8,777	16	174	8,967
											Totals:	**40,244**	**-19**	**35,556**	**75,781**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		50.50	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	300	300

Normal	CROSSARM 3-1/2 X 4-1/2 X 8	49.06	6.73	0.0	0.0	53.00	5.50	4.50	120.00	0	291	291
									Totals:	**0**	**591**	**591**

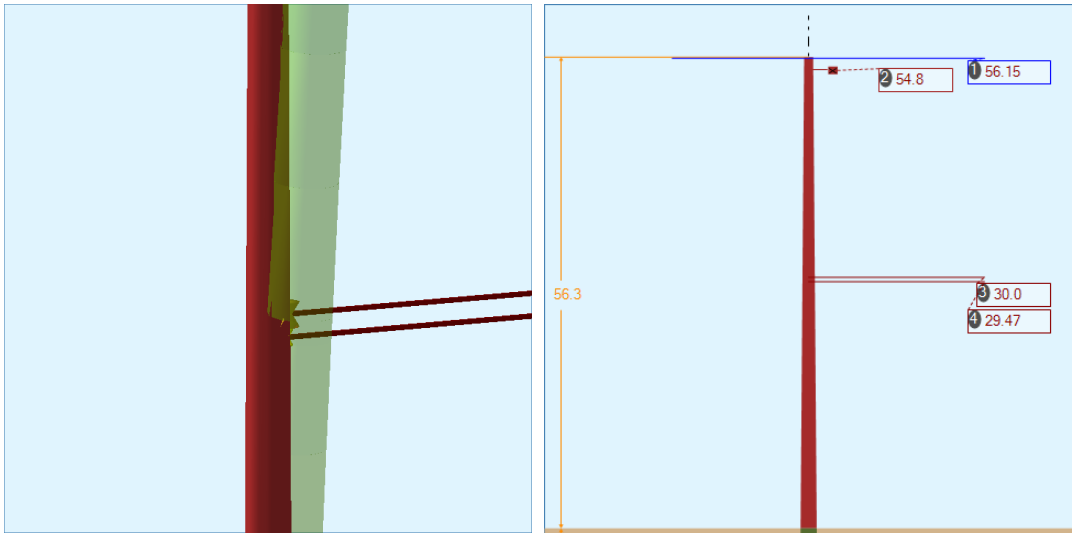
Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		25.00	5.97	90.0	90.0	85.00	24.00	20.00	3.00	120.00	1,191	796	1,987
											Totals:	**1,191**	**796**	**1,987**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		50.73	108.83	93.5	90.5	13.00	5.25	13.50	437	349	786
Post	Post Insulator - 27 kV		50.73	68.90	95.5	90.5	13.00	5.25	13.50	277	349	626
Post	Post Insulator - 27 kV		50.73	36.10	100.4	90.5	13.00	5.25	13.50	145	349	494
Post	Post Insulator - 27 kV		49.29	-106.60	266.4	90.5	13.00	5.25	13.50	-428	339	-89
Post	Post Insulator - 27 kV		49.29	-75.00	264.9	90.5	13.00	5.25	13.50	-301	339	38
Post	Post Insulator - 27 kV		49.29	-37.59	259.9	90.5	13.00	5.25	13.50	-151	339	188
Spool	Spool 4"		29.00	0.00	90.0	0.0	3.00	4.00	4.12	4	23	27
Spool	Spool 2.5"		27.69	0.00	90.0	0.0	1.00	2.50	2.12	1	7	8
									Totals:	**-16**	**2,096**	**2,080**

Pole Buckling

Buckling Constant	**Buckling Column Height* (ft)**	**Buckling Section Height (% Buckling Col. Hgt.)**	**Buckling Section Diameter (in)**	**Minimum Buckling Diameter at GL (in)**	**Diameter at Tip (in)**	**Diameter at GL (in)**	**Modulus of Elasticity (psi)**	**Pole Density (pcf)**	**Ice Density (pcf)**	**Pole Tip Height (ft)**	**Buckling Load Capacity at Height (lbs)**	**Buckling Load Applied at Height (lbs)**	**Buckling Load Factor of Safety**
2.00	34.96	34.32	13.55	9.57	8.60	15.04	2.38e+6	60.00	57.00	52.00	46,868	**468.60**	**6.10**

Pole Num:	**Pole 3**	Pole Length / Class:	**65 / 1**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**8.67**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.47**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**



Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**42.8**	0.0	82.7
Groundline	**42.8**	0.0	82.7
Vertical	**21.0**	38.92	82.7

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**86,064**	64.2	82.7
Groundline	**86,064**	64.2	82.7
GL Allowable	**204,318**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 64.2°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,594	79.0	**73,228**	85.1	**35.8**	**2,436**	2,745	15	**2,451**	**36.0**
Pole	374	18.5	**10,127**	11.8	**5.0**	**337**	5,187	28	**365**	**5.4**
Crossarms	9	0.5	**502**	0.6	**0.3**	**17**	312	2	**18**	**0.3**
Insulators	40	2.0	**2,207**	2.6	**1.1**	**73**	304	2	**75**	**1.1**
Pole Load	2,018	100.0	**86,064**	100.0	**42.1**	**2,863**	8,547	46	**2,909**	**42.8**
Pole Reserve Capacity			**118,254**		**57.9**	**3,937**			**3,891**	**57.2**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 64.2°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,643	81.5	**75,937**	88.2	**37.2**	**2,526**	3,360	18	**2,544**	**37.4**
Pole	374	18.5	**10,127**	11.8	**5.0**	**337**	5,187	28	**365**	**5.4**
Totals:	2,018	100.0	**86,064**	100.0	**42.1**	**2,863**	8,547	46	**2,909**	**42.8**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		56.15	33.00	1.1650	2.38	1.075	154.0	1.0	154.1	2,000	50,699	549	3,712	54,959
Primary	ACSR 954 Rail		56.15	33.00	1.1650	2.26	1.075	149.0	180.0	149.1	2,000	-48,940	531	3,631	-44,778
Primary	ACSR 954 Rail		56.15	58.00	1.1650	2.38	1.075	154.0	1.0	154.1	2,000	50,699	964	3,712	55,375
Primary	ACSR 954 Rail		56.15	58.00	1.1650	2.26	1.075	149.0	180.0	149.1	2,000	-48,940	933	3,631	-44,376
Primary	ACSR 954 Rail		56.15	12.00	1.1650	2.38	1.075	154.0	1.0	154.1	2,000	50,699	200	3,712	54,610
Primary	ACSR 954 Rail		56.15	12.00	1.1650	2.26	1.075	149.0	180.0	149.1	2,000	-48,940	193	3,631	-45,116
Primary	ACSR 954 Rail		56.15	58.00	1.1650	2.38	1.075	154.0	1.0	154.1	2,000	50,699	-964	3,712	53,446
Primary	ACSR 954 Rail		56.15	58.00	1.1650	2.26	1.075	149.0	180.0	149.1	2,000	-48,940	-933	3,631	-46,242
Primary	ACSR 954 Rail		56.15	33.00	1.1650	2.38	1.075	154.0	1.0	154.1	2,000	50,699	-549	3,712	53,862
Primary	ACSR 954 Rail		56.15	33.00	1.1650	2.26	1.075	149.0	180.0	149.1	2,000	-48,940	-531	3,631	-45,840
Primary	ACSR 954 Rail		56.15	12.00	1.1650	2.38	1.075	154.0	1.0	154.1	2,000	50,699	-200	3,712	54,211
Primary	ACSR 954 Rail		56.15	12.00	1.1650	2.26	1.075	149.0	180.0	149.1	2,000	-48,940	-193	3,631	-45,502
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		30.00	8.89	0.5220	2.33	0.198	154.0	1.0	154.0	600	8,119	43	1,216	9,378
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		29.47	8.18	0.5220	2.33	0.198	154.0	1.0	154.0	600	7,975	39	1,195	9,209
											Totals:	**26,645**	**82**	**46,467**	**73,194**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		54.80	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	501	501
										Totals:	**0**	**501**	**501**

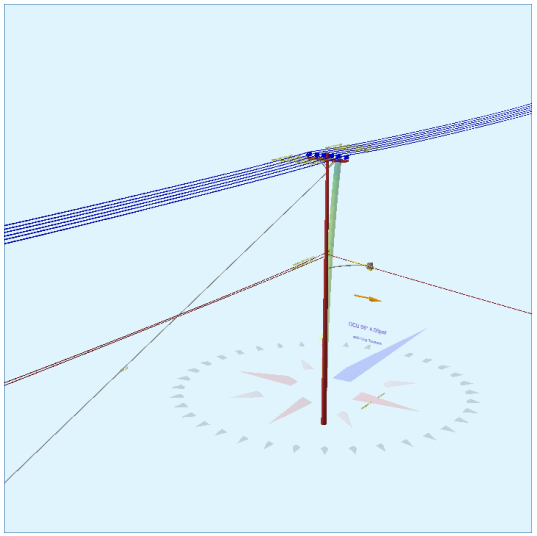
Insulator		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Post	Post Insulator - 27 kV		55.03	33.00	78.6	0.0	13.00	5.25	13.50	122	362	484
Post	Post Insulator - 27 kV		55.03	58.00	83.5	0.0	13.00	5.25	13.50	215	362	577

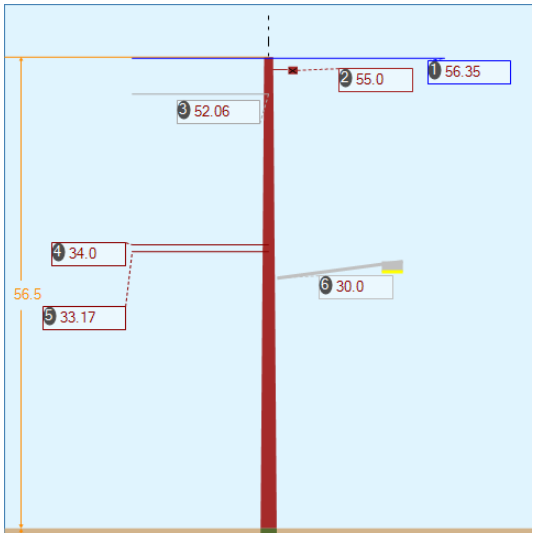
Post	Post Insulator - 27 kV	55.03	12.00	61.0	0.0	13.00	5.25	13.50	44	362	406
Post	Post Insulator - 27 kV	55.03	-58.00	263.5	90.0	13.00	5.25	13.50	-215	362	147
Post	Post Insulator - 27 kV	55.03	-33.00	258.6	90.0	13.00	5.25	13.50	-122	362	240
Post	Post Insulator - 27 kV	55.03	-12.00	241.0	90.0	13.00	5.25	13.50	-44	362	317
Spool	Spool 4"	30.00	0.00	90.0	0.0	3.00	4.00	4.12	4	23	27
Spool	Spool 2.5"	29.47	0.00	90.0	0.0	1.00	2.50	2.12	1	7	8
								Totals:	**5**	**2,201**	**2,206**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	38.94	34.60	13.79	10.45	8.60	15.44	2.38e+6	60.00	57.00	56.30	40,614	**407.00**	**4.76**

Pole Num:	**Pole 4**	Pole Length / Class:	**65 / 1**	Code:	**NESC**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**8.5**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.55**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.30**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**52.6**	0.0	98.6
Groundline	**52.6**	0.0	98.6
Vertical	**2.4**	38.08	0.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**106,602**	113.0	98.6
Groundline	**106,602**	113.0	98.6
GL Allowable	**205,284**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Anchor	120.0	180.0		**0.0**	98.6	**0.0**	0.0
EHS 3/8 (Span/Head)			52.1	**0.0**	98.6	**0.0**	0.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 113.0°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,963	79.8	**89,756**	84.2	**43.7**	**2,974**	2,383	13	**2,986**	**43.9**
GuyBraces	31	1.2	**1,592**	1.5	**0.8**	**53**	30	0	**53**	**0.8**
Pole	384	15.6	**10,414**	9.8	**5.1**	**345**	5,216	28	**373**	**5.5**
Crossarms	10	0.4	**523**	0.5	**0.3**	**17**	312	2	**19**	**0.3**
Streetlights	31	1.3	**2,054**	1.9	**1.0**	**68**	162	1	**69**	**1.0**
Insulators	41	1.7	**2,264**	2.1	**1.1**	**75**	304	2	**77**	**1.1**
Pole Load	2,459	100.0	**106,602**	100.0	**51.9**	**3,532**	8,407	45	**3,576**	**52.6**
Pole Reserve Capacity			**98,682**		**48.1**	**3,268**			**3,224**	**47.4**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 113.0°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	2,076	84.4	**96,188**	90.2	**46.9**	**3,187**	3,191	17	**3,204**	**47.1**
Pole	384	15.6	**10,414**	9.8	**5.1**	**345**	5,216	28	**373**	**5.5**
Totals:	2,459	100.0	**106,602**	100.0	**51.9**	**3,532**	8,407	45	**3,576**	**52.6**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		56.35	33.00	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-82,552	531	3,515	-78,506
Primary	ACSR 954 Rail		56.35	33.00	1.0610	1.39	1.075	120.0	180.0	120.0	3,000	86,098	428	2,804	89,329
Primary	ACSR 954 Rail		56.35	58.00	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-82,552	933	3,515	-78,104
Primary	ACSR 954 Rail		56.35	58.00	1.0610	1.39	1.075	120.0	180.0	120.0	3,000	86,098	752	2,804	89,653
Primary	ACSR 954 Rail		56.35	12.00	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-82,552	193	3,515	-78,844
Primary	ACSR 954 Rail		56.35	12.00	1.0610	1.39	1.075	120.0	180.0	120.0	3,000	86,098	156	2,804	89,057
Primary	ACSR 954 Rail		56.35	58.00	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-82,552	-933	3,515	-79,971
Primary	ACSR 954 Rail		56.35	58.00	1.0610	1.39	1.075	120.0	180.0	120.0	3,000	86,098	-752	2,804	88,150
Primary	ACSR 954 Rail		56.35	33.00	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-82,552	-531	3,515	-79,568
Primary	ACSR 954 Rail		56.35	33.00	1.0610	1.39	1.075	120.0	180.0	120.0	3,000	86,098	-428	2,804	88,474
Primary	ACSR 954 Rail		56.35	12.00	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-82,552	-193	3,515	-79,230
Primary	ACSR 954 Rail		56.35	12.00	1.0610	1.39	1.075	120.0	180.0	120.0	3,000	86,098	-156	2,804	88,746

Secondary	AAC 4/0 AWG 7 STRAND OXLIP	34.00	8.66	0.5220	2.01	0.198	120.0	180.0	120.0	400	6,921	33	1,107	8,060
Secondary	DUPLEX 6 AWG	33.17	7.96	0.5370	0.88	0.071	80.0	110.0	80.0	357	15,372	15	-8	15,379
Secondary	DUPLEX 6 AWG	33.17	7.96	0.5370	1.36	0.071	120.0	180.0	120.0	357	6,026	22	1,095	7,143
										Totals:	**49,592**	**70**	**40,106**	**89,768**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		55.00	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	523	523
										Totals:	**0**	**523**	**523**

Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		30.00	5.91	90.0	90.0	85.00	24.00	20.00	3.00	120.00	1,122	932	2,054
											Totals:	**1,122**	**932**	**2,054**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		55.23	33.00	78.6	0.0	13.00	5.25	13.50	125	371	496
Post	Post Insulator - 27 kV		55.23	58.00	83.5	0.0	13.00	5.25	13.50	220	371	590
Post	Post Insulator - 27 kV		55.23	12.00	61.0	0.0	13.00	5.25	13.50	45	371	416
Post	Post Insulator - 27 kV		55.23	-58.00	263.5	90.0	13.00	5.25	13.50	-220	371	151
Post	Post Insulator - 27 kV		55.23	-33.00	258.6	90.0	13.00	5.25	13.50	-125	371	246
Post	Post Insulator - 27 kV		55.23	-12.00	241.0	90.0	13.00	5.25	13.50	-45	371	325
Spool	Spool 4"		34.00	0.00	90.0	0.0	3.00	4.00	4.12	4	26	30
Spool	Spool 2.5"		33.17	0.00	90.0	0.0	1.00	2.50	2.12	1	8	9
									Totals:	**5**	**2,259**	**2,264**

Guy Wire and Brace		**Owner**	**Attach Height (ft)**	**End Height (ft)**	**Lead/Span Length (ft)**	**Wire Diameter (in)**	**Percent Solid (%)**	**Lead Angle (deg)**	**Incline Angle (deg)**	**Wire Weight (lbs/ft)**	**Rest Length (ft)**	**Stretch Length (in)**
EHS 3/8	Span/Head		52.06	10.06	120.00	0.375	75.00	180.0	19.3	0.273	127.34	0.00

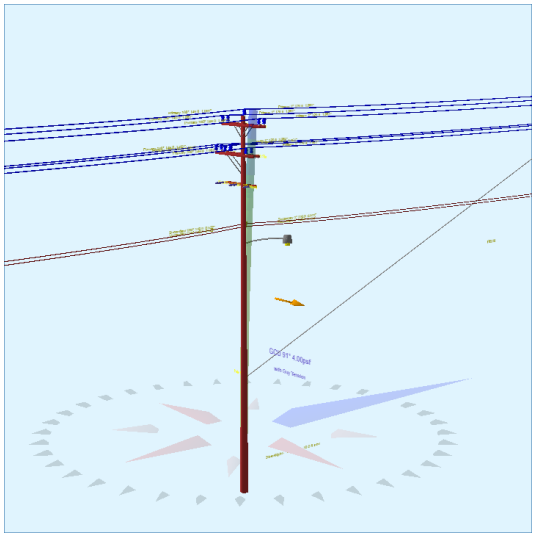
Guy Wire and Brace (Loads and Reactions)		**Elastic Modulus (psi)**	**Rated Tensile Strength (lbs)**	**Guy Strength Factor**	**Allowable Tension (lbs)**	**Initial Tension (lbs)**	**Loaded Tension*[2] (lbs)**	**Maximum Tension[2] (lbs)**	**Applied Tension[3] (lbs)**	**Vertical Load (lbs)**	**Shear Load In Guy Dir (lbs)**	**Shear Load At Report Angle (lbs)**	**Moment at GL[3] (ft-lb)**
EHS 3/8	Span/Head	2.30e+7	15,400	0.90	13,860	700	0	0	0	0	0	0	1,592
									Totals:	**0**	**0**	**0**	**1,592**

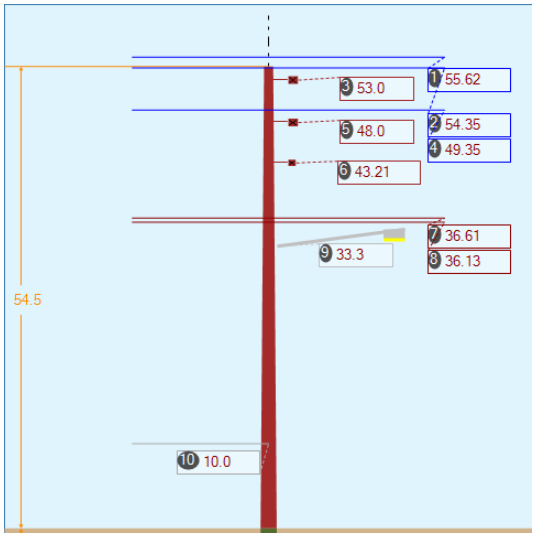
Anchor/Rod Load Summary	Owner	Rod Length AGL (in)	Lead Length (ft)	Lead Angle (deg)	Strength of Assembly (lbs)	Anchor/Rod Strength Factor	Allowable Load (lbs)	Max Load[2] (lbs)	Load at Pole MCU[3] (lbs)	Max Required Capacity[2] (%)
Anchor		30.00	120.00	180.0	20,000	1.00	20,000	0	0	0.0

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
0.71	38.11	34.49	13.86	6.10	8.60	15.46	2.38e+6	60.00	57.00	56.50	345,505	**3502.92**	**41.67**

Pole Num:	**Pole 5**	Pole Length / Class:	**65 / 1**	Code:	**NESC**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.5**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**47.78**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.30**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**40.9**	0.0	90.5
Groundline	**40.9**	0.0	90.5
Vertical	**2.5**	36.83	181.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**78,599**	90.7	90.5
Groundline	**78,599**	90.7	90.5
GL Allowable	**195,759**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Anchor	100.0	1.0		**0.0**	90.5	**2.1**	180.0
EHS 3/8 (Span/Head)			10.0	**0.0**	90.5	**3.1**	180.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 90.7°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,326	72.7	**63,468**	80.8	**32.4**	**2,190**	2,497	14	**2,204**	**32.4**
GuyBraces	27	1.5	**270**	0.3	**0.1**	**9**	25	0	**9**	**0.1**
Pole	378	20.7	**9,998**	12.7	**5.1**	**345**	4,924	27	**372**	**5.5**
Crossarms	9	0.5	**447**	0.6	**0.2**	**15**	718	4	**19**	**0.3**
Streetlights	32	1.8	**2,300**	2.9	**1.2**	**79**	162	1	**80**	**1.2**
Insulators	52	2.9	**2,116**	2.7	**1.1**	**73**	331	2	**75**	**1.1**
Pole Load	1,825	100.0	**78,599**	100.0	**40.2**	**2,712**	8,656	48	**2,760**	**40.6**
Pole Reserve Capacity			**117,160**		**59.8**	**4,088**			**4,040**	**59.4**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 90.7°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,446	79.3	**68,601**	87.3	**35.0**	**2,367**	3,732	21	**2,388**	**35.1**
Pole	378	20.7	**9,998**	12.7	**5.1**	**345**	4,924	27	**372**	**5.5**
Totals:	1,825	100.0	**78,599**	100.0	**40.2**	**2,712**	8,656	48	**2,760**	**40.6**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		55.63	4.30	1.0610	1.39	1.075	120.0	1.0	120.0	3,000	1,073	61	3,041	4,175
Primary	ACSR 954 Rail		55.63	4.30	1.0610	1.86	1.075	149.0	180.0	149.0	3,000	2,716	75	3,776	6,567
Primary	ACSR 954 Rail		54.35	57.00	1.0610	1.39	1.075	120.0	1.0	120.0	3,000	1,049	803	2,972	4,823
Primary	ACSR 954 Rail		54.35	57.00	1.0610	1.86	1.075	149.0	180.0	149.0	3,000	2,654	997	3,690	7,341
Primary	ACSR 954 Rail		54.35	57.00	1.0610	1.39	1.075	120.0	1.0	120.0	3,000	1,049	-803	2,972	3,218
Primary	ACSR 954 Rail		54.35	57.00	1.0610	1.86	1.075	149.0	180.0	149.0	3,000	2,654	-997	3,690	5,347
Primary	ACSR 954 Rail		49.35	78.89	1.0610	1.39	1.075	120.0	1.0	120.0	3,000	952	-1,111	2,699	2,540
Primary	ACSR 954 Rail		49.35	78.89	1.0610	1.86	1.075	149.0	180.0	149.0	3,000	2,410	-1,380	3,351	4,381
Primary	ACSR 954 Rail		49.35	48.87	1.0610	1.39	1.075	120.0	1.0	120.0	3,000	952	-688	2,699	2,963
Primary	ACSR 954 Rail		49.35	48.87	1.0610	1.86	1.075	149.0	180.0	149.0	3,000	2,410	-854	3,351	4,906
Primary	ACSR 954 Rail		49.35	18.06	1.0610	1.39	1.075	120.0	1.0	120.0	3,000	952	254	2,699	3,905
Primary	ACSR 954 Rail		49.35	18.06	1.0610	1.86	1.075	149.0	180.0	149.0	3,000	2,410	316	3,351	6,077

Secondary	AAC 4/0 AWG 7 STRAND OXLIP	36.61	8.38	0.5220	2.01	0.198	120.0	1.0	120.0	400	94	35	1,310	1,439
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	36.61	8.38	0.5220	2.66	0.198	149.0	180.0	149.0	400	238	43	1,626	1,908
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	36.13	7.66	0.5220	2.01	0.198	120.0	1.0	120.0	400	93	32	1,292	1,417
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	36.13	7.66	0.5220	2.66	0.198	149.0	179.5	149.0	400	399	40	1,604	2,043
									Totals:		**22,106**	**-3,178**	**44,121**	**63,050**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		53.00	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	205	205
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		48.00	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	185	185
Normal	8' x 3.5" x 4.5" SP - 3 Deadend		43.21	6.73	180.0	180.0	50.00	4.50	3.50	96.00	1	53	54
										Totals:	**1**	**443**	**444**

Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		33.30	5.58	90.0	90.0	85.00	24.00	20.00	3.00	120.00	1,216	1,068	2,285
											Totals:	**1,216**	**1,068**	**2,285**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		54.50	0.00	90.5	90.5	13.00	5.25	13.50	9	190	199
Post	Post Insulator - 27 kV		53.23	57.00	83.4	0.0	13.00	5.25	13.50	235	369	604
Post	Post Insulator - 27 kV		53.23	-57.00	276.6	0.0	13.00	5.25	13.50	-235	369	134
Post	Post Insulator - 27 kV		48.23	-78.89	265.0	90.5	13.00	5.25	13.50	-325	335	10
Post	Post Insulator - 27 kV		48.23	-48.87	261.9	90.5	13.00	5.25	13.50	-201	335	133
Post	Post Insulator - 27 kV		48.23	18.06	111.0	90.5	13.00	5.25	13.50	74	335	409
Deadend	Deadend Insulator		43.21	0.00	180.0	0.0	8.99	3.00	30.00	1	189	190
Deadend	Deadend Insulator		43.21	44.00	261.3	0.0	8.99	3.00	30.00	-62	189	127
Deadend	Deadend Insulator		43.21	-44.00	98.7	0.0	8.99	3.00	30.00	63	189	252
Spool	Spool 4"		36.61	0.00	90.5	0.5	3.00	4.00	4.12	4	29	33
Spool	Spool 2.5"		36.13	0.00	90.0	0.0	1.00	2.50	2.12	1	9	11
									Totals:	**-436**	**2,538**	**2,102**

Guy Wire and Brace		Owner	Attach Height (ft)	End Height (ft)	Lead/Span Length (ft)	Wire Diameter (in)	Percent Solid (%)	Lead Angle (deg)	Incline Angle (deg)	Wire Weight (lbs/ft)	Rest Length (ft)	Stretch Length (in)
EHS 3/8	Span/Head		10.00	55.00	100.00	0.375	75.00	1.0	-24.2	0.273	102.73	0.00

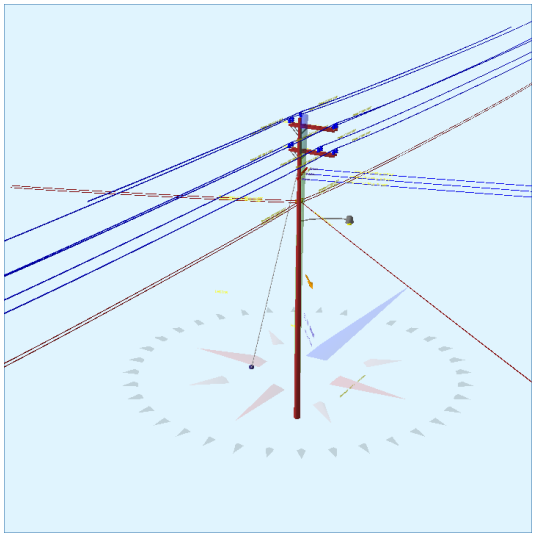
Guy Wire and Brace (Loads and Reactions)		Elastic Modulus (psi)	Rated Tensile Strength (lbs)	Guy Strength Factor	Allowable Tension (lbs)	Initial Tension (lbs)	Loaded Tension*[2] (lbs)	Maximum Tension[2] (lbs)	Applied Tension[3] (lbs)	Vertical Load (lbs)	Shear Load In Guy Dir (lbs)	Shear Load At Report Angle (lbs)	Moment at GL[3] (ft-lb)
EHS 3/8	Span/Head	2.30e+7	15,400	0.90	13,860	700	428	389	0	0	0	0	269
									Totals:	**0**	**0**	**0**	**269**

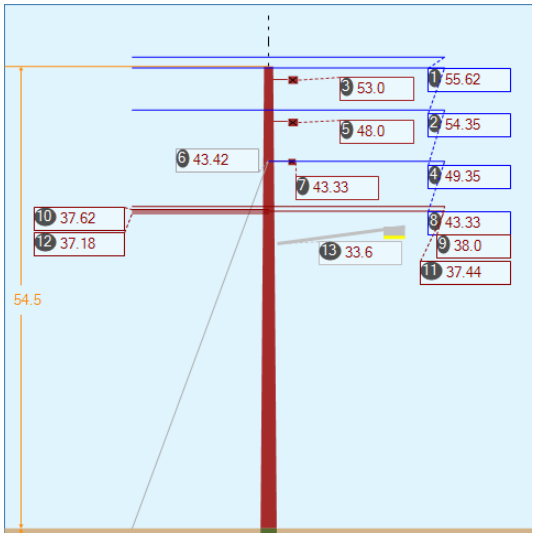
Anchor/Rod Load Summary	Owner	Rod Length AGL (in)	Lead Length (ft)	Lead Angle (deg)	Strength of Assembly (lbs)	Anchor/Rod Strength Factor	Allowable Load (lbs)	Max Load[2] (lbs)	Load at Pole MCU[3] (lbs)	Max Required Capacity[2] (%)
Anchor		30.00	100.00	1.0	20,000	1.00	20,000	428	0	2.1

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
0.71	36.78	34.40	13.67	6.02	8.60	15.22	2.38e+6	60.00	57.00	54.50	351,912	**3462.48**	**40.00**

Pole Num:	**Pole 6**	Pole Length / Class:	**65 / 1**	Code:	**NESC**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.5**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**47.78**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.30**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:		**0° 0' 0" N**	Longitude:		**0° 0' 0" W**	Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**35.5**	0.0	141.2
Groundline	**35.5**	0.0	142.0
Vertical	**10.2**	41.33	75.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**64,520**	137.4	141.2
Groundline	**64,520**	137.4	142.0
GL Allowable	**195,759**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Single Helix Anchor	10.0	255.0		**62.8**	141.2	**79.3**	80.0
EHS 7/16 (Down)			43.4	**67.1**	141.2	**84.7**	80.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 137.4°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	2,229	141.4	**93,753**	145.3	**47.9**	**3,627**	2,380	13	**3,640**	**53.5**
GuyBraces	-1,243	-78.9	**-48,474**	-75.1	**-24.8**	**-1,875**	18,428	101	**-1,774**	**-26.1**
Pole	378	24.0	**8,897**	13.8	**4.5**	**344**	4,924	27	**371**	**5.5**
Crossarms	128	8.1	**5,797**	9.0	**3.0**	**224**	608	3	**228**	**3.3**
Streetlights	32	2.0	**1,705**	2.6	**0.9**	**66**	162	1	**67**	**1.0**
Insulators	53	3.3	**2,842**	4.4	**1.5**	**110**	334	2	**112**	**1.6**
Pole Load	1,576	100.0	**64,520**	100.0	**33.0**	**2,496**	26,836	148	**2,644**	**38.9**
Pole Reserve Capacity			**131,239**		**67.0**	**4,304**			**4,156**	**61.1**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 137.4°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,199	76.0	**55,623**	86.2	**28.4**	**2,152**	21,912	121	**2,273**	**33.4**
Pole	378	24.0	**8,897**	13.8	**4.5**	**344**	4,924	27	**371**	**5.5**
Totals:	1,576	100.0	**64,520**	100.0	**33.0**	**2,496**	26,836	148	**2,644**	**38.9**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		55.63	4.30	1.1650	1.33	1.075	114.0	1.0	114.0	3,000	-157,236	-43	1,359	-155,920
Primary	ACSR 954 Rail		55.63	4.30	1.1650	0.70	1.075	67.0	180.0	67.0	3,000	159,825	-25	767	160,568
Primary	ACSR 954 Rail		54.35	93.00	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-153,635	1,101	1,627	-150,907
Primary	ACSR 954 Rail		54.35	93.00	1.0610	1.10	1.075	100.0	180.0	100.0	3,000	156,165	739	1,049	157,953
Primary	ACSR 954 Rail		54.35	23.00	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-153,635	-272	1,627	-152,280
Primary	ACSR 954 Rail		54.35	23.00	1.0610	1.10	1.075	100.0	180.0	100.0	3,000	156,165	-183	1,049	157,031
Primary	ACSR 954 Rail		49.35	93.83	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-139,514	1,111	1,478	-136,925
Primary	ACSR 954 Rail		49.35	93.83	1.0610	1.10	1.075	100.0	180.0	100.0	3,000	141,811	745	953	143,509
Primary	ACSR 954 Rail		49.35	54.40	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-139,514	644	1,478	-137,392
Primary	ACSR 954 Rail		49.35	54.40	1.0610	1.10	1.075	100.0	180.0	100.0	3,000	141,811	432	953	143,196
Primary	ACSR 954 Rail		49.35	23.32	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-139,514	-276	1,478	-138,312
Primary	ACSR 954 Rail		49.35	23.32	1.0610	1.10	1.075	100.0	180.0	100.0	3,000	141,811	-185	953	142,579

Primary	ACSR 1/0 AWG 6/1 RAVEN	43.33	36.73	0.3980	0.55	0.145	80.0	75.0	80.0	800	20,878	5	736	21,619
Primary	ACSR 1/0 AWG 6/1 RAVEN	43.33	57.31	0.3980	0.55	0.145	80.0	75.0	80.0	800	20,878	11	736	21,625
Primary	ACSR 1/0 AWG 6/1 RAVEN	43.33	57.31	0.3980	0.55	0.145	80.0	75.0	80.0	800	20,878	-4	736	21,610
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	38.00	8.30	0.5220	2.66	0.198	149.0	1.0	149.0	400	-14,310	29	744	-13,536
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	38.00	8.30	0.5220	1.60	0.198	100.0	180.0	100.0	400	14,545	19	480	15,045
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	37.62	7.57	0.5220	0.88	0.198	60.0	250.0	60.0	400	-7,518	-11	588	-6,940
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	37.44	7.58	0.5220	2.66	0.198	149.0	1.0	149.0	400	-14,099	27	733	-13,339
Secondary	DUPLEX 6 AWG	37.44	7.58	0.5370	1.11	0.071	100.0	130.0	100.0	357	17,231	13	28	17,272
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	37.44	7.58	0.5220	1.60	0.198	100.0	180.0	100.0	400	14,331	18	473	14,821
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	37.18	7.60	0.5220	0.88	0.198	60.0	250.0	60.0	400	-7,430	-11	581	-6,859
										Totals:	**79,926**	**3,883**	**20,609**	**104,419**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 8		53.00	6.64	0.0	0.0	53.00	5.50	4.50	120.00	0	3,210	3,210
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		48.00	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	2,907	2,907
Normal	8' x 3.5" x 4.5" SP - 3 Deadend		43.33	6.73	75.0	75.0	50.00	4.50	3.50	96.00	25	315	339
										Totals:	**25**	**6,432**	**6,457**

Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		33.60	5.57	90.0	90.0	85.00	24.00	20.00	3.00	120.00	823	1,076	1,899
											Totals:	**823**	**1,076**	**1,899**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		54.50	0.00	0.5	0.5	13.00	5.25	13.50	-6	189	183
Post	Post Insulator - 27 kV		53.23	93.00	94.1	90.5	13.00	5.25	13.50	259	368	627
Post	Post Insulator - 27 kV		53.23	-23.00	253.9	90.5	13.00	5.25	13.50	-64	368	304
Post	Post Insulator - 27 kV		48.23	93.83	94.2	90.5	13.00	5.25	13.50	261	334	595
Post	Post Insulator - 27 kV		48.23	54.40	97.3	90.5	13.00	5.25	13.50	152	334	485
Post	Post Insulator - 27 kV		48.23	-23.32	253.4	90.5	13.00	5.25	13.50	-65	334	269
Deadend	Deadend Insulator		43.33	0.00	75.0	0.0	8.99	3.00	30.00	24	189	213

Deadend	Deadend Insulator	43.33	44.00	156.3	0.0	8.99	3.00	30.00	80	189	269
Deadend	Deadend Insulator	43.33	-44.00	353.7	0.0	8.99	3.00	30.00	-31	189	158
Spool	Spool 4"	38.00	0.00	90.0	0.0	3.00	4.00	4.12	3	30	33
Spool	Spool 2.5"	37.62	0.00	270.0	0.0	1.00	2.50	2.12	-1	10	9
Spool	Spool 2.5"	37.44	0.00	90.0	0.0	1.00	2.50	2.12	1	10	10
Spool	Spool 2.5"	37.18	0.00	270.0	0.0	1.00	2.50	2.12	-1	10	9
								Totals:	**611**	**2,554**	**3,165**

Guy Wire and Brace		**Owner**	**Attach Height (ft)**	**End Height (ft)**	**Lead/Span Length (ft)**	**Wire Diameter (in)**	**Percent Solid (%)**	**Lead Angle (deg)**	**Incline Angle (deg)**	**Wire Weight (lbs/ft)**	**Rest Length (ft)**	**Stretch Length (in)**
EHS 7/16	Down		43.42	0.00	10.00	0.438	75.00	255.0	76.8	0.399	53.27	3.10

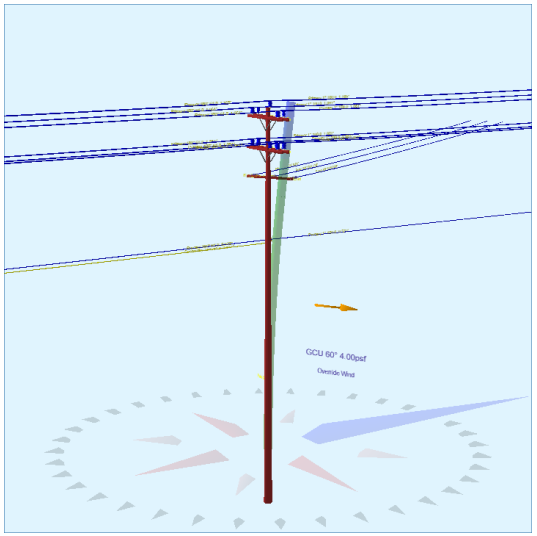
Guy Wire and Brace (Loads and Reactions)		**Elastic Modulus (psi)**	**Rated Tensile Strength (lbs)**	**Guy Strength Factor**	**Allowable Tension (lbs)**	**Initial Tension (lbs)**	**Loaded Tension*[2] (lbs)**	**Maximum Tension[2] (lbs)**	**Applied Tension[3] (lbs)**	**Vertical Load (lbs)**	**Shear Load In Guy Dir (lbs)**	**Shear Load At Report Angle (lbs)**	**Moment at GL[3] (ft-lb)**
EHS 7/16	Down	2.30e+7	20,800	0.90	18,720	700	15,863	14,421	12,566	12,232	2,879	-1,334	-53,989
									Totals:	**12,232**	**2,879**	**-1,334**	**-53,989**

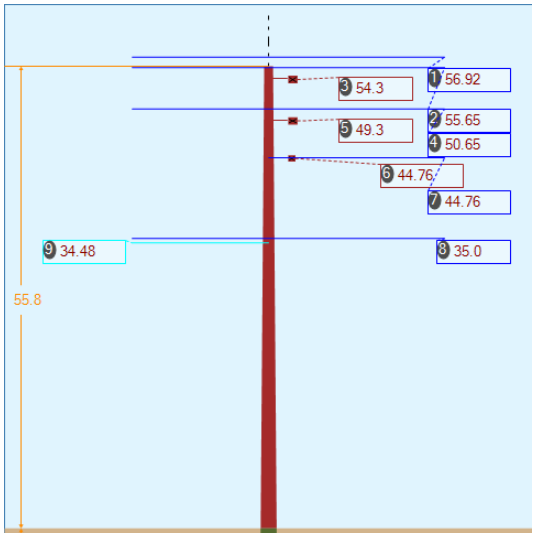
Anchor/Rod Load Summary	**Owner**	**Rod Length AGL (in)**	**Lead Length (ft)**	**Lead Angle (deg)**	**Strength of Assembly (lbs)**	**Anchor/Rod Strength Factor**	**Allowable Load (lbs)**	**Max Load[2] (lbs)**	**Load at Pole MCU[3] (lbs)**	**Max Required Capacity[2] (%)**
Single Helix Anchor		18.00	10.00	255.0	20,000	1.00	20,000	15,863	12,566	79.3

Pole Buckling

Buckling Constant	**Buckling Column Height* (ft)**	**Buckling Section Height (% Buckling Col. Hgt.)**	**Buckling Section Diameter (in)**	**Minimum Buckling Diameter at GL (in)**	**Diameter at Tip (in)**	**Diameter at GL (in)**	**Modulus of Elasticity (psi)**	**Pole Density (pcf)**	**Ice Density (pcf)**	**Pole Tip Height (ft)**	**Buckling Load Capacity at Height (lbs)**	**Buckling Load Applied at Height (lbs)**	**Buckling Load Factor of Safety**
0.71	41.25	34.94	13.46	8.60	8.60	15.22	2.38e+6	60.00	57.00	54.50	262,579	**2630.99**	**9.80**

Pole Num:	**Pole 8**	Pole Length / Class:	**65 / 1**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**9.17**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.28**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**	Elevation:	**0M**	





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**26.0**	0.0	60.0
Groundline	**26.0**	0.0	60.0
Vertical	**15.0**	35.17	60.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**50,792**	44.2	60.0
Groundline	**50,792**	44.2	60.0
GL Allowable	**201,916**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 44.2°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	605	54.5	**33,852**	66.7	**16.8**	**1,131**	1,529	8	**1,139**	**16.7**
Pole	375	33.8	**10,151**	20.0	**5.0**	**339**	5,113	28	**367**	**5.4**
Crossarms	80	7.2	**4,156**	8.2	**2.1**	**139**	718	4	**143**	**2.1**
Insulators	50	4.5	**2,633**	5.2	**1.3**	**88**	331	2	**90**	**1.3**
Pole Load	1,109	100.0	**50,792**	100.0	**25.2**	**1,696**	7,691	41	**1,738**	**25.6**
Pole Reserve Capacity			**151,124**		**74.8**	**5,104**			**5,062**	**74.4**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 44.2°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	734	66.2	**40,641**	80.0	**20.1**	**1,357**	2,578	14	**1,371**	**20.2**
Pole	375	33.8	**10,151**	20.0	**5.0**	**339**	5,113	28	**367**	**5.4**
Totals:	1,109	100.0	**50,792**	100.0	**25.2**	**1,696**	7,691	41	**1,738**	**25.6**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		56.93	4.30	1.1650	1.13	1.075	100.0	1.0	100.0	3,000	124,631	37	1,623	126,291
Primary	ACSR 954 Rail		56.93	4.30	1.1650	0.63	1.075	61.0	180.0	61.0	3,000	-122,571	23	1,019	-121,529
Primary	ACSR 954 Rail		55.65	44.00	1.0610	1.10	1.075	100.0	1.0	100.0	3,000	121,841	360	1,488	123,689
Primary	ACSR 954 Rail		55.65	44.00	1.0610	0.61	1.075	61.0	180.0	61.0	3,000	-119,827	220	934	-118,674
Primary	ACSR 954 Rail		55.65	44.00	1.0610	1.10	1.075	100.0	1.0	100.0	3,000	121,841	-360	1,488	122,969
Primary	ACSR 954 Rail		55.65	44.00	1.0610	0.61	1.075	61.0	180.0	61.0	3,000	-119,827	-220	934	-119,113
Primary	ACSR 954 Rail		50.65	18.00	1.0610	1.10	1.075	100.0	1.0	100.0	3,000	110,904	147	1,354	112,405
Primary	ACSR 954 Rail		50.65	18.00	1.0610	0.61	1.075	61.0	180.0	61.0	3,000	-109,070	90	850	-108,131
Primary	ACSR 954 Rail		50.65	44.00	1.0610	1.10	1.075	100.0	1.0	100.0	3,000	110,904	360	1,354	112,618
Primary	ACSR 954 Rail		50.65	44.00	1.0610	0.61	1.075	61.0	180.0	61.0	3,000	-109,070	220	850	-108,001
Primary	ACSR 954 Rail		50.65	44.00	1.0610	1.10	1.075	100.0	1.0	100.0	3,000	110,904	-360	1,354	111,898
Primary	ACSR 954 Rail		50.65	44.00	1.0610	0.61	1.075	61.0	180.0	61.0	3,000	-109,070	-220	850	-108,440
Primary	ACSR 2 AWG 6/1 SPARROW		44.76	36.72	0.3160	1.07	0.091	103.0	330.0	103.0	300	3,660	3	1,056	4,719
Primary	ACSR 2 AWG 6/1 SPARROW		44.76	57.31	0.3160	1.07	0.091	103.0	330.0	103.0	300	3,660	10	1,056	4,726
Primary	ACSR 2 AWG 6/1 SPARROW		44.76	57.31	0.3160	1.07	0.091	103.0	330.0	103.0	300	3,660	-6	1,056	4,710
Primary	AAC 4/0 AWG 7 STRAND OXLIP		35.00	8.56	0.5220	0.24	0.198	100.0	1.0	100.0	2,000	51,042	21	612	51,675
Primary	AAC 4/0 AWG 7 STRAND OXLIP		35.00	8.56	0.5220	0.09	0.198	61.0	180.0	61.0	2,000	-50,198	13	384	-49,802
Secondary	DUPLEX 6 AWG		34.48	7.84	0.5370	0.66	0.071	61.0	180.0	61.0	357	-8,827	8	384	-8,435
											Totals:	**14,586**	**345**	**18,643**	**33,573**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		54.30	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	2,125	2,125

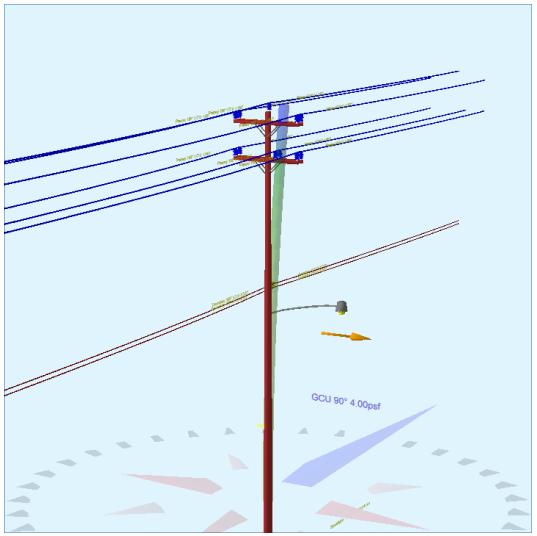
Normal	CROSSARM 3-1/2 X 4-1/2 X 10	49.30	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	1,929	1,929
Normal	8' x 3.5" x 4.5" SP - 3 Deadend	44.76	6.72	330.0	330.0	50.00	4.50	3.50	96.00	14	53	67
									Totals:	**14**	**4,107**	**4,122**

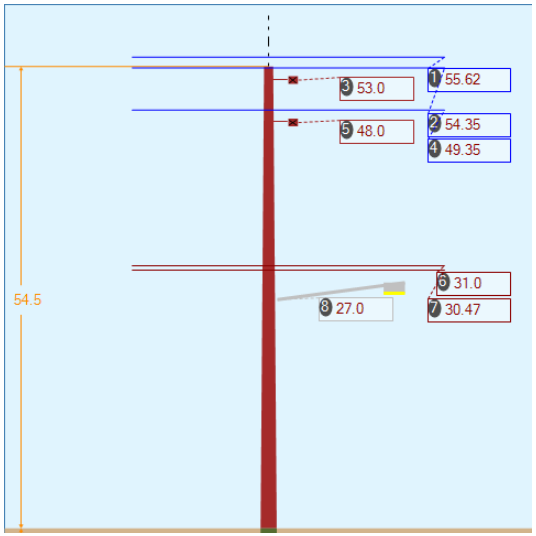
Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		55.80	0.00	0.0	0.0	13.00	5.25	13.50	6	187	193
Post	Post Insulator - 27 kV		54.53	44.00	81.4	0.0	13.00	5.25	13.50	126	364	490
Post	Post Insulator - 27 kV		54.53	-44.00	278.6	0.0	13.00	5.25	13.50	-126	364	237
Post	Post Insulator - 27 kV		49.53	18.00	68.9	0.0	13.00	5.25	13.50	52	331	382
Post	Post Insulator - 27 kV		49.53	44.00	81.0	0.0	13.00	5.25	13.50	126	331	457
Post	Post Insulator - 27 kV		49.53	-44.00	279.0	0.0	13.00	5.25	13.50	-126	331	204
Deadend	Deadend Insulator		44.76	0.00	330.0	0.0	8.99	3.00	30.00	14	188	203
Deadend	Deadend Insulator		44.76	44.00	51.3	0.0	8.99	3.00	30.00	75	188	263
Deadend	Deadend Insulator		44.76	-44.00	248.7	0.0	8.99	3.00	30.00	-46	188	142
Spool	Spool 4"		35.00	0.00	90.0	0.0	3.00	4.00	4.12	3	27	30
Spool	Spool 2.5"		34.48	0.00	90.0	0.0	1.00	2.50	2.12	1	9	9
									Totals:	**104**	**2,507**	**2,611**

Pole Buckling

Buckling Constant	**Buckling Column Height* (ft)**	**Buckling Section Height (% Buckling Col. Hgt.)**	**Buckling Section Diameter (in)**	**Minimum Buckling Diameter at GL (in)**	**Diameter at Tip (in)**	**Diameter at GL (in)**	**Modulus of Elasticity (psi)**	**Pole Density (pcf)**	**Ice Density (pcf)**	**Pole Tip Height (ft)**	**Buckling Load Capacity at Height (lbs)**	**Buckling Load Applied at Height (lbs)**	**Buckling Load Factor of Safety**
2.00	35.23	34.17	13.91	9.56	8.60	15.38	2.38e+6	60.00	57.00	55.80	51,282	**512.74**	**6.67**

Pole Num:	**Pole 9**	Pole Length / Class:	**65 / 1**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.5**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**47.78**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**37.1**	0.0	90.0
Groundline	**37.1**	0.0	90.0
Vertical	**17.5**	35.92	90.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**70,937**	90.0	90.0
Groundline	**70,937**	90.0	90.0
GL Allowable	**195,759**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 90.0°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,128	71.2	**56,406**	79.5	**28.8**	**1,949**	2,189	12	**1,961**	**28.8**
Pole	378	23.9	**9,987**	14.1	**5.1**	**345**	4,924	27	**372**	**5.5**
Crossarms	8	0.5	**391**	0.6	**0.2**	**14**	623	3	**17**	**0.2**
Streetlights	32	2.0	**2,098**	3.0	**1.1**	**73**	162	1	**73**	**1.1**
Insulators	39	2.5	**2,055**	2.9	**1.1**	**71**	279	2	**73**	**1.1**
Pole Load	1,586	100.0	**70,937**	100.0	**36.2**	**2,451**	8,177	45	**2,496**	**36.7**
Pole Reserve Capacity			**124,822**		**63.8**	**4,349**			**4,304**	**63.3**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 90.0°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,207	76.1	**60,950**	85.9	**31.1**	**2,106**	3,253	18	**2,123**	**31.2**
Pole	378	23.9	**9,987**	14.1	**5.1**	**345**	4,924	27	**372**	**5.5**
Totals:	1,586	100.0	**70,937**	100.0	**36.2**	**2,451**	8,177	45	**2,496**	**36.7**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		55.63	4.30	1.1650	0.63	1.075	61.0	1.0	61.0	3,000	2,782	0	1,649	4,431
Primary	ACSR 954 Rail		55.63	4.30	1.1650	2.39	1.075	177.0	180.0	177.0	3,000	133	0	4,785	4,918
Primary	ACSR 954 Rail		54.35	57.00	1.0610	0.61	1.075	61.0	1.0	61.0	3,000	2,719	408	1,510	4,637
Primary	ACSR 954 Rail		54.35	57.00	1.0610	2.36	1.075	177.0	180.0	177.0	3,000	130	1,184	4,384	5,698
Primary	ACSR 954 Rail		54.35	57.00	1.0610	0.61	1.075	61.0	1.0	61.0	3,000	2,719	-408	1,510	3,821
Primary	ACSR 954 Rail		54.35	57.00	1.0610	2.36	1.075	177.0	180.0	177.0	3,000	130	-1,184	4,384	3,329
Primary	ACSR 954 Rail		49.35	18.00	1.0610	0.61	1.075	61.0	1.0	61.0	3,000	2,469	129	1,372	3,969
Primary	ACSR 954 Rail		49.35	18.00	1.0610	2.36	1.075	177.0	180.0	177.0	3,000	118	374	3,981	4,472
Primary	ACSR 954 Rail		49.35	57.00	1.0610	0.61	1.075	61.0	1.0	61.0	3,000	2,469	408	1,372	4,248
Primary	ACSR 954 Rail		49.35	57.00	1.0610	2.36	1.075	177.0	180.0	177.0	3,000	118	1,184	3,981	5,283
Primary	ACSR 954 Rail		49.35	57.00	1.0610	0.61	1.075	61.0	1.0	61.0	3,000	2,469	-408	1,372	3,432
Primary	ACSR 954 Rail		49.35	57.00	1.0610	2.36	1.075	177.0	180.0	177.0	3,000	118	-1,184	3,981	2,914
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		31.00	8.72	0.5220	0.76	0.198	61.0	1.0	61.0	600	310	18	564	892
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		31.00	8.72	0.5220	2.79	0.198	177.0	180.0	177.0	600	15	54	1,636	1,704
Secondary	DUPLEX 6 AWG		30.47	8.01	0.5370	0.71	0.071	61.0	1.0	61.0	200	102	12	562	676
Secondary	DUPLEX 6 AWG		30.47	8.01	0.5370	2.48	0.071	177.0	180.0	177.0	200	5	35	1,631	1,671
											Totals:	**16,801**	**622**	**38,672**	**56,096**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		53.00	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	204	204
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		48.00	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	185	185
										Totals:	**0**	**389**	**389**

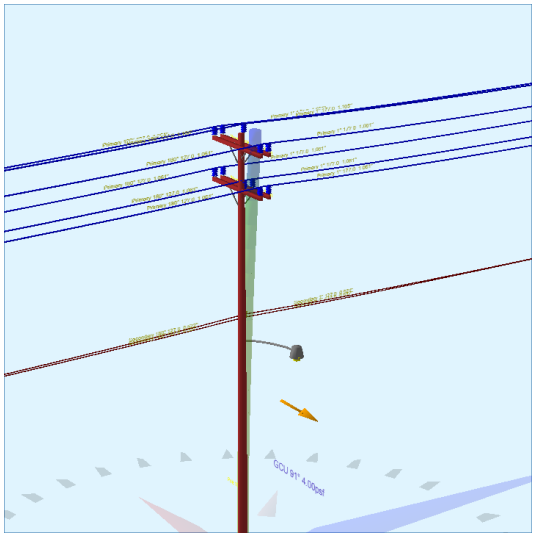
Streetlight		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
General	Streetlight - 10 ft. Arm		27.00	5.97	90.0	90.0	85.00	24.00	20.00	3.00	120.00	1,220	866	2,086
											Totals:	**1,220**	**866**	**2,086**

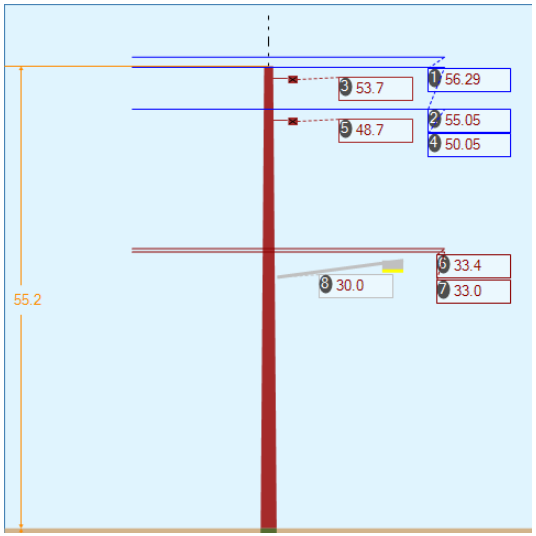
Insulator		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Post	Post Insulator - 27 kV		54.50	0.00	0.0	0.0	13.00	5.25	13.50	0	190	190
Post	Post Insulator - 27 kV		53.23	57.00	83.4	0.0	13.00	5.25	13.50	235	369	604
Post	Post Insulator - 27 kV		53.23	-57.00	276.6	0.0	13.00	5.25	13.50	-235	369	134
Post	Post Insulator - 27 kV		48.23	18.00	68.9	0.0	13.00	5.25	13.50	74	335	409
Post	Post Insulator - 27 kV		48.23	57.00	83.1	0.0	13.00	5.25	13.50	235	335	569
Post	Post Insulator - 27 kV		48.23	-57.00	276.9	0.0	13.00	5.25	13.50	-235	335	100
Spool	Spool 4"		31.00	0.00	90.0	0.0	3.00	4.00	4.12	4	25	29
Spool	Spool 2.5"		30.47	0.00	90.0	0.0	1.00	2.50	2.12	1	8	9
									Totals:	**80**	**1,964**	**2,044**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	35.91	34.30	13.72	9.84	8.60	15.22	2.38e+6	60.00	57.00	54.50	46,702	**467.27**	**5.71**

Pole Num:	**Pole 10**	Pole Length / Class:	**65 / 1**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**9.83**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.05**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**43.1**	0.0	90.7
Groundline	**43.1**	0.0	90.7
Vertical	**20.2**	37.33	90.7

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**83,600**	90.4	90.7
Groundline	**83,600**	90.4	90.7
GL Allowable	**199,059**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 90.4°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,352	74.5	**68,663**	82.1	**34.5**	**2,334**	2,796	15	**2,350**	**34.6**
Pole	385	21.2	**10,265**	12.3	**5.2**	**349**	5,025	27	**376**	**5.5**
Crossarms	8	0.4	**397**	0.5	**0.2**	**14**	513	3	**16**	**0.2**
Streetlights	32	1.8	**2,192**	2.6	**1.1**	**75**	162	1	**75**	**1.1**
Insulators	39	2.1	**2,083**	2.5	**1.1**	**71**	279	2	**72**	**1.1**
Pole Load	1,815	100.0	**83,600**	100.0	**42.0**	**2,842**	8,775	48	**2,890**	**42.5**
Pole Reserve Capacity			**115,459**		**58.0**	**3,958**			**3,910**	**57.5**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 90.4°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,431	78.8	**73,335**	87.7	**36.8**	**2,493**	3,750	20	**2,514**	**37.0**
Pole	385	21.2	**10,265**	12.3	**5.2**	**349**	5,025	27	**376**	**5.5**
Totals:	1,815	100.0	**83,600**	100.0	**42.0**	**2,842**	8,775	48	**2,890**	**42.5**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		56.30	4.30	1.1650	2.39	1.075	177.0	1.0	177.0	3,000	1,684	-1	4,843	6,526
Primary	ACSR 954 Rail		56.30	4.30	1.1650	1.53	1.075	127.0	180.0	127.0	3,000	1,266	0	3,475	4,740
Primary	ACSR 954 Rail		55.05	57.00	1.0610	2.36	1.075	177.0	1.0	177.0	3,000	1,647	1,184	4,440	7,271
Primary	ACSR 954 Rail		55.05	57.00	1.0610	1.50	1.075	127.0	180.0	127.0	3,000	1,238	850	3,186	5,273
Primary	ACSR 954 Rail		55.05	57.00	1.0610	2.36	1.075	177.0	1.0	177.0	3,000	1,647	-1,184	4,440	4,903
Primary	ACSR 954 Rail		55.05	57.00	1.0610	1.50	1.075	127.0	180.0	127.0	3,000	1,238	-850	3,186	3,574
Primary	ACSR 954 Rail		50.05	18.00	1.0610	2.36	1.075	177.0	1.0	177.0	3,000	1,498	374	4,037	5,908
Primary	ACSR 954 Rail		50.05	18.00	1.0610	1.50	1.075	127.0	180.0	127.0	3,000	1,126	268	2,896	4,290
Primary	ACSR 954 Rail		50.05	57.00	1.0610	2.36	1.075	177.0	1.0	177.0	3,000	1,498	1,184	4,037	6,719
Primary	ACSR 954 Rail		50.05	57.00	1.0610	1.50	1.075	127.0	180.0	127.0	3,000	1,126	850	2,896	4,872
Primary	ACSR 954 Rail		50.05	57.00	1.0610	2.36	1.075	177.0	1.0	177.0	3,000	1,498	-1,184	4,037	4,350
Primary	ACSR 954 Rail		50.05	57.00	1.0610	1.50	1.075	127.0	180.0	127.0	3,000	1,126	-850	2,896	3,172
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		33.40	8.62	0.5220	2.79	0.198	177.0	1.0	177.0	600	200	53	1,762	2,015
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		33.40	8.62	0.5220	1.82	0.198	127.0	180.0	127.0	600	150	38	1,264	1,452
Secondary	DUPLEX 6 AWG		33.00	7.89	0.5370	2.20	0.071	177.0	1.0	177.0	300	99	35	1,767	1,900
Secondary	DUPLEX 6 AWG		33.00	7.89	0.5370	1.50	0.071	127.0	180.0	127.0	300	74	25	1,267	1,367
											Totals:	**17,112**	**792**	**50,429**	**68,333**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 8		53.70	6.64	0.0	0.0	53.00	5.50	4.50	120.00	0	207	207
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		48.70	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	188	188
										Totals:	**0**	**395**	**395**

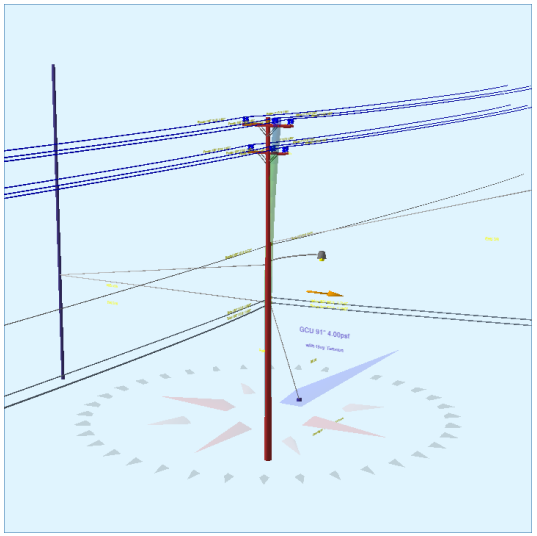
Streetlight		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
General	Streetlight - 10 ft. Arm		30.00	5.83	90.0	90.0	85.00	24.00	20.00	3.00	120.00	1,219	962	2,181
											Totals:	**1,219**	**962**	**2,181**

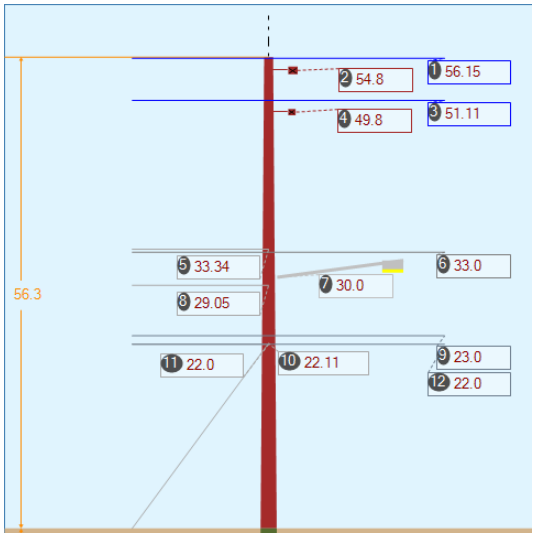
Insulator		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Post	Post Insulator - 27 kV		55.17	0.00	0.0	0.0	13.00	5.25	13.50	0	192	192
Post	Post Insulator - 27 kV		53.93	57.00	83.4	0.0	13.00	5.25	13.50	235	374	609
Post	Post Insulator - 27 kV		53.93	-57.00	276.6	0.0	13.00	5.25	13.50	-235	374	139
Post	Post Insulator - 27 kV		48.93	18.00	68.9	0.0	13.00	5.25	13.50	74	339	414
Post	Post Insulator - 27 kV		48.93	57.00	83.1	0.0	13.00	5.25	13.50	235	339	574
Post	Post Insulator - 27 kV		48.93	-57.00	276.9	0.0	13.00	5.25	13.50	-235	339	105
Spool	Spool 4"		33.40	0.00	90.5	0.5	3.00	4.00	4.12	4	27	31
Spool	Spool 2.5"		33.00	0.00	90.0	0.0	1.00	2.50	2.12	1	9	10
									Totals:	**79**	**1,993**	**2,073**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	37.31	34.44	13.74	10.25	8.60	15.30	2.38e+6	60.00	57.00	55.20	43,511	**434.42**	**4.95**

Pole Num:	**Pole 11**	Pole Length / Class:	**65 / 1**	Code:	**NESC**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**8.67**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.47**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.30**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**35.3**	29.33	90.5
Groundline	**12.6**	0.0	204.1
Vertical	**2.6**	31.83	179.3

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**31,965**	90.6	90.5
Groundline	**20,122**	166.1	204.1
GL Allowable	**204,318**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Anchor	60.0	80.0		**0.0**	90.5	**2.2**	260.0
EHS 3/8 (Span/Head)			33.3	**0.0**	90.5	**3.1**	260.0
Single Helix Anchor	50.0	270.0		**26.8**	90.5	**29.5**	90.9
EHS 5/16 (Span/Head)			29.1	**37.3**	90.5	**41.1**	90.5
EHS 5/16 (Span/Head)			22.0	**16.0**	90.5	**17.6**	91.2
Single Helix Anchor	12.0	0.0		**17.0**	90.5	**28.2**	180.0
EHS 3/8 (Down)			22.1	**24.5**	90.5	**40.6**	180.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 166.1°										
	Shear Load* (lbs)	**Applied Load (%)**	**Bending Moment (ft-lb)**	**Applied Moment (%)**	**Pole Capacity (%)**	**Bending Stress (+/- psi)**	**Vertical Load (lbs)**	**Vertical Stress (psi)**	**Total Stress (psi)**	**Pole Capacity (%)**
Powers	285	32.1	**12,168**	60.5	**6.0**	**503**	2,128	11	**514**	**7.6**
Comms	3,278	368.4	**59,495**	295.7	**29.1**	**2,457**	361	2	**2,459**	**36.2**
GuyBraces	-2,793	-314.0	**-54,714**	-271.9	**-26.8**	**-2,259**	5,346	29	**-2,231**	**-32.8**
Pole	98	11.0	**2,140**	10.6	**1.1**	**88**	5,187	28	**116**	**1.7**
Crossarms	3	0.3	**131**	0.7	**0.1**	**5**	513	3	**8**	**0.1**
Streetlights	8	0.9	**428**	2.1	**0.2**	**18**	162	1	**19**	**0.3**
Insulators	11	1.2	**473**	2.4	**0.2**	**20**	310	2	**21**	**0.3**
Pole Load	890	100.0	**20,122**	100.0	**9.9**	**831**	14,006	75	**906**	**13.3**
Pole Reserve Capacity			**184,196**		**90.2**	**5,969**			**5,894**	**86.7**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 166.1°										
	Shear Load* (lbs)	**Applied Load (%)**	**Bending Moment (ft-lb)**	**Applied Moment (%)**	**Pole Capacity (%)**	**Bending Stress (+/- psi)**	**Vertical Load (lbs)**	**Vertical Stress (psi)**	**Total Stress (psi)**	**Pole Capacity (%)**
<Undefined>	792	89.0	**17,982**	89.4	**8.8**	**743**	8,820	47	**790**	**11.6**
Pole	98	11.0	**2,140**	10.6	**1.1**	**88**	5,187	28	**116**	**1.7**
Totals:	890	100.0	**20,122**	100.0	**9.9**	**831**	14,006	75	**906**	**13.3**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		56.15	18.00	1.0610	1.50	1.075	127.0	1.0	127.0	3,000	-211,846	64	833	-210,949
Primary	ACSR 954 Rail		56.15	18.00	1.0610	1.29	1.075	113.0	180.0	113.0	3,000	212,795	57	692	213,544
Primary	ACSR 954 Rail		56.15	57.00	1.0610	1.50	1.075	127.0	1.0	127.0	3,000	-211,846	203	833	-210,809
Primary	ACSR 954 Rail		56.15	57.00	1.0610	1.29	1.075	113.0	180.0	113.0	3,000	212,795	181	692	213,668
Primary	ACSR 954 Rail		56.15	57.00	1.0610	1.50	1.075	127.0	1.0	127.0	3,000	-211,846	-203	833	-211,216
Primary	ACSR 954 Rail		56.15	57.00	1.0610	1.29	1.075	113.0	180.0	113.0	3,000	212,795	-181	692	213,306
Primary	ACSR 954 Rail		51.11	12.00	1.0610	1.50	1.075	127.0	1.0	127.0	3,000	-192,841	43	758	-192,040
Primary	ACSR 954 Rail		51.11	12.00	1.0610	1.29	1.075	113.0	180.0	113.0	3,000	193,704	38	630	194,373
Primary	ACSR 954 Rail		51.11	44.00	1.0610	1.50	1.075	127.0	1.0	127.0	3,000	-192,841	157	758	-191,925
Primary	ACSR 954 Rail		51.11	44.00	1.0610	1.29	1.075	113.0	180.0	113.0	3,000	193,704	140	630	194,474
Primary	ACSR 954 Rail		51.11	44.00	1.0610	1.50	1.075	127.0	1.0	127.0	3,000	-192,841	-157	758	-192,240
Primary	ACSR 954 Rail		51.11	44.00	1.0610	1.29	1.075	113.0	180.0	113.0	3,000	193,704	-140	630	194,195
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		33.00	8.71	0.5220	1.82	0.198	127.0	1.0	127.0	600	-24,879	9	320	-24,550
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		33.00	8.71	0.5220	1.58	0.198	113.0	180.0	113.0	600	24,991	8	266	25,265
											Totals:	**5,547**	**220**	**9,330**	**15,097**

Comm		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Telco	TELE 1.25		23.00	8.82	1.2500	0.87	0.600	60.0	80.0	60.0	1,200	2,414	11	129	2,553
Telco	TELE 1.0		23.00	8.82	1.0000	1.61	0.400	113.0	180.0	113.0	1,200	34,836	15	272	35,123
Telco	TELE 1.25		22.00	8.88	1.2500	0.87	0.600	60.0	80.0	60.0	1,200	2,309	11	123	2,443
Telco	TELE 1.5		22.00	8.88	1.5000	2.07	0.900	113.0	180.0	113.0	1,200	33,321	27	347	33,696
											Totals:	**72,879**	**64**	**871**	**73,815**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		54.80	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	103	103
Normal	CROSSARM 3-1/2 X 4-1/2 X 8		49.80	6.44	0.0	0.0	53.00	4.50	3.50	96.00	0	60	60
										Totals:	**0**	**163**	**163**

Streetlight	Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)

General	Streetlight - 10 ft. Arm	30.00	5.89	90.0	90.0	85.00	24.00	20.00	3.00	120.00	292	239	531
										Totals:	**292**	**239**	**531**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		55.03	18.00	69.8	0.0	13.00	5.25	13.50	18	95	113
Post	Post Insulator - 27 kV		55.03	57.00	83.4	0.0	13.00	5.25	13.50	56	95	151
Post	Post Insulator - 27 kV		55.03	-57.00	276.6	0.0	13.00	5.25	13.50	-56	95	39
Post	Post Insulator - 27 kV		49.99	12.00	61.8	0.0	13.00	5.25	13.50	12	86	98
Post	Post Insulator - 27 kV		49.99	44.00	81.7	0.0	13.00	5.25	13.50	43	86	130
Post	Post Insulator - 27 kV		49.99	-44.00	278.3	0.0	13.00	5.25	13.50	-43	86	43
Spool	Spool 4"		33.00	0.00	90.0	0.0	3.00	4.00	4.12	1	7	8
Spool	Spool 3"		23.00	0.00	90.0	0.0	2.00	3.00	3.19	1	3	3
Spool	Spool 3"		22.00	0.00	90.0	0.0	2.00	3.00	3.19	1	3	3
									Totals:	**32**	**555**	**587**

Guy Wire and Brace		**Owner**	**Attach Height (ft)**	**End Height (ft)**	**Lead/Span Length (ft)**	**Wire Diameter (in)**	**Percent Solid (%)**	**Lead Angle (deg)**	**Incline Angle (deg)**	**Wire Weight (lbs/ft)**	**Rest Length (ft)**	**Stretch Length (in)**
EHS 3/8	Span/Head		33.34	48.34	60.00	0.375	75.00	80.0	-14.0	0.273	57.36	0.00
EHS 5/16	Span/Head		29.05	22.05	50.00	0.312	75.00	270.0	8.0	0.205	50.43	1.72
EHS 5/16	Span/Head		22.00	22.00	50.00	0.312	75.00	270.0	0.0	0.205	48.73	0.71
EHS 3/8	Down		22.11	0.00	12.00	0.375	75.00	0.0	61.3	0.273	31.38	0.67

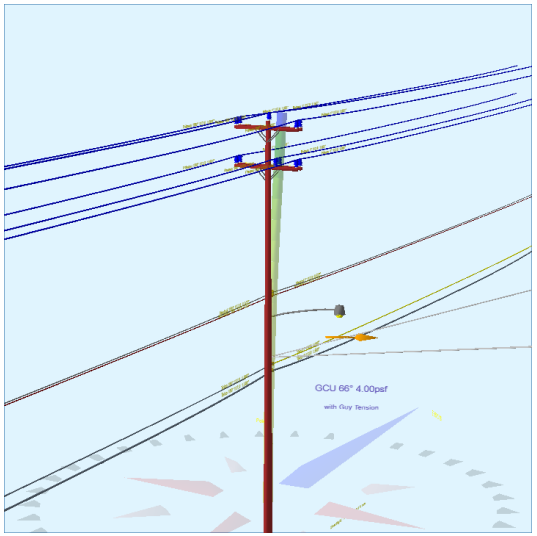
Guy Wire and Brace (Loads and Reactions)		**Elastic Modulus (psi)**	**Rated Tensile Strength (lbs)**	**Guy Strength Factor**	**Allowable Tension (lbs)**	**Initial Tension (lbs)**	**Loaded Tension*[2] (lbs)**	**Maximum Tension[2] (lbs)**	**Applied Tension[3] (lbs)**	**Vertical Load (lbs)**	**Shear Load In Guy Dir (lbs)**	**Shear Load At Report Angle (lbs)**	**Moment at GL[3] (ft-lb)**
EHS 3/8	Span/Head	2.30e+7	15,400	0.90	13,860	700	435	395	0	0	0	0	95
EHS 5/16	Span/Head	2.30e+7	11,200	0.90	10,080	700	4,140	3,763	3,763	520	3,727	-893	-25,935
EHS 5/16	Span/Head	2.30e+7	11,200	0.90	10,080	700	1,776	1,615	1,615	0	1,615	-387	-8,512
EHS 3/8	Down	2.30e+7	15,400	0.90	13,860	700	5,633	5,121	3,394	2,977	1,631	-1,583	-33,531
									Totals:	**3,497**	**6,973**	**-2,863**	**-67,883**

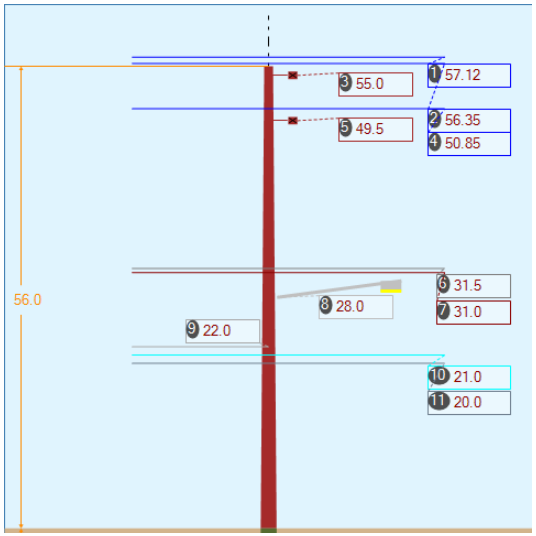
Anchor/Rod Load Summary	**Owner**	**Rod Length AGL (in)**	**Lead Length (ft)**	**Lead Angle (deg)**	**Strength of Assembly (lbs)**	**Anchor/Rod Strength Factor**	**Allowable Load (lbs)**	**Max Load[2] (lbs)**	**Load at Pole MCU[3] (lbs)**	**Max Required Capacity[2] (%)**
Anchor		30.00	60.00	80.0	20,000	1.00	20,000	435	0	2.2
Single Helix Anchor		18.00	50.00	270.0	20,000	1.00	20,000	5,902	5,365	29.5
Single Helix Anchor		18.00	12.00	0.0	20,000	1.00	20,000	5,633	3,394	28.2

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
0.71	31.84	33.76	14.12	6.21	8.60	15.44	2.38e+6	60.00	57.00	56.30	534,144	**5387.05**	**38.46**

Pole Num:	**Pole 12**	Pole Length / Class:	**65 / 1**	Code:	**NESC**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**9.0**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.36**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.30**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:		**0° 0' 0" N**	Longitude:		**0° 0' 0" W**	Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**57.9**	10.0	66.3
Groundline	**56.4**	0.0	66.3
Vertical	**2.2**	35.83	277.5

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**90,641**	43.2	66.3
Groundline	**114,463**	45.3	66.3
GL Allowable	**202,874**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Anchor	100.0	60.0		**0.0**	66.3	**0.0**	0.0
EHS 5/16 (Span/Head)			22.0	**0.0**	66.3	**0.0**	0.0
Anchor	100.0	135.0		**0.9**	66.3	**13.6**	290.0
EHS 5/16 (Span/Head)			22.0	**1.8**	66.3	**27.0**	290.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 45.3°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,708	70.8	**92,951**	81.2	**45.8**	**3,100**	2,090	11	**3,111**	**45.8**
Comms	186	7.7	**4,080**	3.6	**2.0**	**136**	477	3	**139**	**2.0**
GuyBraces	24	1.0	**524**	0.5	**0.3**	**18**	-26	0	**17**	**0.3**
Pole	366	15.2	**9,897**	8.7	**4.9**	**330**	5,142	28	**358**	**5.3**
Crossarms	63	2.6	**3,306**	2.9	**1.6**	**110**	623	3	**114**	**1.7**
Streetlights	30	1.2	**1,715**	1.5	**0.9**	**57**	162	1	**58**	**0.9**
Insulators	37	1.5	**1,989**	1.7	**1.0**	**66**	287	2	**68**	**1.0**
Pole Load	2,414	100.0	**114,463**	100.0	**56.4**	**3,817**	8,755	47	**3,864**	**56.8**
Pole Reserve Capacity			**88,411**		**43.6**	**2,983**			**2,936**	**43.2**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 45.3°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	2,048	84.8	**104,566**	91.4	**51.5**	**3,487**	3,612	19	**3,507**	**51.6**
Pole	366	15.2	**9,897**	8.7	**4.9**	**330**	5,142	28	**358**	**5.3**
Totals:	2,414	100.0	**114,463**	100.0	**56.4**	**3,817**	8,755	47	**3,864**	**56.8**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		57.13	4.30	1.1650	1.53	1.075	127.0	1.0	127.0	3,000	159,453	46	2,240	161,739
Primary	ACSR 954 Rail		57.13	4.30	1.1650	1.30	1.075	112.0	180.0	112.0	3,000	-156,709	41	2,026	-154,642
Primary	ACSR 954 Rail		56.35	57.00	1.0610	1.29	1.075	113.0	1.0	113.0	3,000	157,291	538	1,843	159,672
Primary	ACSR 954 Rail		56.35	57.00	1.0610	1.50	1.075	112.0	180.0	112.0	2,000	-103,056	533	1,874	-100,649
Primary	ACSR 954 Rail		56.35	57.00	1.0610	1.29	1.075	113.0	1.0	113.0	3,000	157,291	-538	1,843	158,597
Primary	ACSR 954 Rail		56.35	57.00	1.0610	1.27	1.075	112.0	180.0	112.0	3,000	-154,584	-533	1,874	-153,243
Primary	ACSR 954 Rail		50.85	18.00	1.0610	1.29	1.075	113.0	1.0	113.0	3,000	141,952	170	1,663	143,785
Primary	ACSR 954 Rail		50.85	18.00	1.0610	1.27	1.075	112.0	180.0	112.0	3,000	-139,509	168	1,691	-137,650
Primary	ACSR 954 Rail		50.85	57.00	1.0610	1.29	1.075	113.0	1.0	113.0	3,000	141,952	538	1,663	144,153
Primary	ACSR 954 Rail		50.85	57.00	1.0610	1.27	1.075	112.0	180.0	112.0	3,000	-139,509	533	1,691	-137,285
Primary	ACSR 954 Rail		50.85	57.00	1.0610	1.29	1.075	113.0	1.0	113.0	3,000	141,952	-538	1,663	143,078

Primary	ACSR 954 Rail	50.85	57.00	1.0610	1.27	1.075	112.0	180.0	112.0	3,000	-139,509	-533	1,691	-138,351
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	31.50	8.78	0.5220	1.58	0.198	113.0	1.0	113.0	600	17,570	25	674	18,269
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	31.50	8.78	0.5220	1.56	0.198	112.0	180.0	112.0	600	-17,268	24	685	-16,558
Secondary	DUPLEX 6 AWG	31.00	8.06	0.5370	1.27	0.071	113.0	1.0	113.0	357	10,288	16	673	10,978
Secondary	DUPLEX 6 AWG	31.00	8.06	0.5370	1.26	0.071	112.0	180.0	112.0	357	-10,111	16	684	-9,411
										Totals:	**67,496**	**506**	**24,479**	**92,481**

Comm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Cable Diameter (in)**	**Sag at Max Temp (ft)**	**Cable Weight (lbs/ft)**	**Lead/Span Length (ft)**	**Span Angle (deg)**	**Wire Length (ft)**	**Tension (lbs)**	**Tension Moment* (ft-lb)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Telco	TELE 1.0		21.00	8.92	1.0000	1.61	0.400	113.0	1.0	113.0	1,200	23,427	45	659	24,131
Telco	TELE 1.0		21.00	8.92	1.0000	1.60	0.400	112.0	180.0	112.0	1,200	-23,024	44	670	-22,309
Telco	TELE 1.5		20.00	8.98	1.5000	2.07	0.900	113.0	1.0	113.0	1,200	22,311	83	837	23,231
Telco	TELE 1.5		20.00	8.98	1.5000	2.04	0.900	112.0	180.0	112.0	1,200	-21,927	82	851	-20,994
											Totals:	**787**	**254**	**3,019**	**4,059**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		55.00	6.61	0.0	0.0	82.00	5.50	4.50	120.00	0	1,731	1,731
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		49.50	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	1,558	1,558
										Totals:	**0**	**3,289**	**3,289**

Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		28.00	6.00	90.0	90.0	85.00	24.00	20.00	3.00	120.00	868	839	1,707
											Totals:	**868**	**839**	**1,707**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		56.00	0.00	0.0	0.0	13.00	5.25	13.50	6	182	188
Post	Post Insulator - 27 kV		55.23	57.00	83.4	0.0	13.00	5.25	13.50	167	357	524
Post	Post Insulator - 27 kV		55.23	-57.00	276.6	0.0	13.00	5.25	13.50	-167	357	191
Post	Post Insulator - 27 kV		49.73	18.00	68.9	0.0	13.00	5.25	13.50	53	322	375
Post	Post Insulator - 27 kV		49.73	57.00	83.1	0.0	13.00	5.25	13.50	167	322	489
Post	Post Insulator - 27 kV		49.73	-57.00	276.9	0.0	13.00	5.25	13.50	-167	322	155
Spool	Spool 4"		31.50	0.00	90.0	0.0	3.00	4.00	4.12	3	24	27
Spool	Spool 2.5"		31.00	0.00	90.0	0.0	1.00	2.50	2.12	1	7	8
Spool	Spool 3"		21.00	0.00	90.0	0.0	2.00	3.00	3.19	2	9	11

Spool	Spool 3"		20.00	0.00	90.0	0.0	2.00	3.00	3.19	2	9	11
									Totals:	**67**	**1,912**	**1,979**

Guy Wire and Brace		**Owner**	**Attach Height (ft)**	**End Height (ft)**	**Lead/Span Length (ft)**	**Wire Diameter (in)**	**Percent Solid (%)**	**Lead Angle (deg)**	**Incline Angle (deg)**	**Wire Weight (lbs/ft)**	**Rest Length (ft)**	**Stretch Length (in)**
EHS 5/16	Span/Head		22.00	47.00	100.00	0.312	75.00	60.0	-14.0	0.205	100.75	0.00
EHS 5/16	Span/Head		22.00	47.00	100.00	0.312	75.00	135.0	-14.0	0.205	100.75	0.16

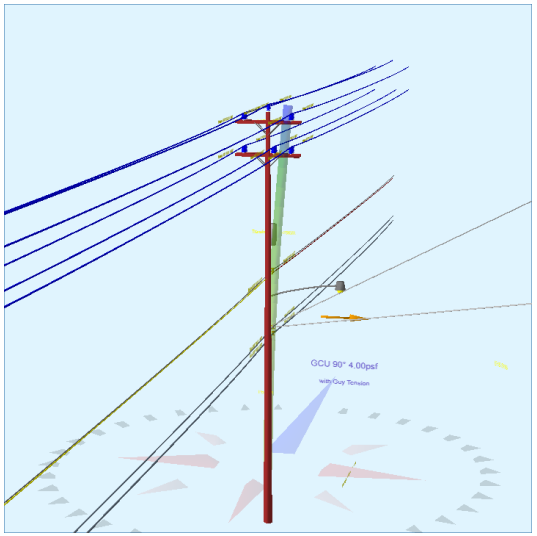
Guy Wire and Brace (Loads and Reactions)		**Elastic Modulus (psi)**	**Rated Tensile Strength (lbs)**	**Guy Strength Factor**	**Allowable Tension (lbs)**	**Initial Tension (lbs)**	**Loaded Tension*[2] (lbs)**	**Maximum Tension[2] (lbs)**	**Applied Tension[3] (lbs)**	**Vertical Load (lbs)**	**Shear Load In Guy Dir (lbs)**	**Shear Load At Report Angle (lbs)**	**Moment at GL[3] (ft-lb)**
EHS 5/16	Span/Head	2.30e+7	11,200	0.90	10,080	700	0	0	0	0	0	0	9
EHS 5/16	Span/Head	2.30e+7	11,200	0.90	10,080	700	2,724	2,477	177	-43	172	1	512
									Totals:	**-43**	**172**	**1**	**521**

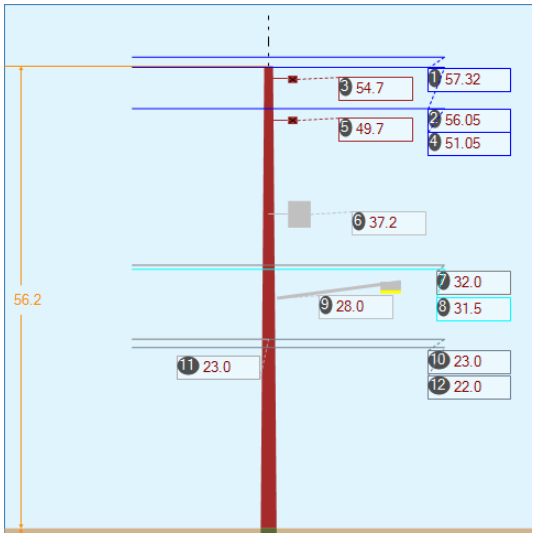
Anchor/Rod Load Summary	**Owner**	**Rod Length AGL (in)**	**Lead Length (ft)**	**Lead Angle (deg)**	**Strength of Assembly (lbs)**	**Anchor/Rod Strength Factor**	**Allowable Load (lbs)**	**Max Load[2] (lbs)**	**Load at Pole MCU[3] (lbs)**	**Max Required Capacity[2] (%)**
Anchor		0.00	100.00	60.0	20,000	1.00	20,000	0	0	0.0
Anchor		0.00	100.00	135.0	20,000	1.00	20,000	2,724	177	13.6

Pole Buckling

Buckling Constant	**Buckling Column Height* (ft)**	**Buckling Section Height (% Buckling Col. Hgt.)**	**Buckling Section Diameter (in)**	**Minimum Buckling Diameter at GL (in)**	**Diameter at Tip (in)**	**Diameter at GL (in)**	**Modulus of Elasticity (psi)**	**Pole Density (pcf)**	**Ice Density (pcf)**	**Pole Tip Height (ft)**	**Buckling Load Capacity at Height (lbs)**	**Buckling Load Applied at Height (lbs)**	**Buckling Load Factor of Safety**
0.71	35.81	34.24	13.90	5.93	8.60	15.40	2.38e+6	60.00	57.00	56.00	396,594	**3979.48**	**45.45**

Pole Num:	**Pole 13**	Pole Length / Class:	**65 / 1**	Code:	**NESC**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**8.83**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.43**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.30**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**45.0**	0.0	90.0
Groundline	**45.0**	0.0	90.0
Vertical	**2.5**	36.42	270.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**90,142**	89.4	90.0
Groundline	**90,142**	89.4	90.0
GL Allowable	**203,836**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Anchor	100.0	40.0		**0.0**	90.0	**4.7**	250.0
EHS 5/16 (Span/Head)			23.0	**0.0**	90.0	**9.2**	250.0
Anchor	100.0	140.0		**0.0**	90.0	**5.2**	290.0
EHS 5/16 (Span/Head)			23.0	**0.0**	90.0	**10.3**	290.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 89.4°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,270	60.3	**65,553**	72.7	**32.2**	**2,171**	2,299	12	**2,183**	**32.1**
Comms	291	13.8	**6,939**	7.7	**3.4**	**230**	441	2	**232**	**3.4**
GuyBraces	29	1.4	**682**	0.8	**0.3**	**23**	38	0	**23**	**0.3**
PowerEquipments	42	2.0	**1,577**	1.8	**0.8**	**52**	694	4	**56**	**0.8**
Pole	394	18.7	**10,706**	11.9	**5.3**	**355**	5,172	28	**382**	**5.6**
Crossarms	8	0.4	**405**	0.5	**0.2**	**13**	623	3	**17**	**0.2**
Streetlights	32	1.5	**2,134**	2.4	**1.1**	**71**	162	1	**72**	**1.1**
Insulators	41	1.9	**2,145**	2.4	**1.1**	**71**	291	2	**73**	**1.1**
Pole Load	2,107	100.0	**90,142**	100.0	**44.2**	**2,986**	9,719	52	**3,038**	**44.7**
Pole Reserve Capacity			**113,694**		**55.8**	**3,814**			**3,762**	**55.3**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 89.4°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,713	81.3	**79,436**	88.1	**39.0**	**2,631**	4,547	24	**2,655**	**39.0**
Pole	394	18.7	**10,706**	11.9	**5.3**	**355**	5,172	28	**382**	**5.6**
Totals:	2,107	100.0	**90,142**	100.0	**44.2**	**2,986**	9,719	52	**3,038**	**44.7**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		57.33	4.30	1.1650	1.30	1.075	112.0	1.0	112.0	3,000	6,375	1	3,119	9,494
Primary	ACSR 954 Rail		57.33	4.30	1.1650	1.70	1.075	138.0	180.0	138.0	3,000	-2,470	1	3,845	1,375
Primary	ACSR 954 Rail		56.05	44.00	1.0610	1.27	1.075	112.0	1.0	112.0	3,000	6,233	578	2,859	9,670
Primary	ACSR 954 Rail		56.05	44.00	1.0610	1.67	1.075	138.0	180.0	138.0	3,000	-2,415	713	3,524	1,822
Primary	ACSR 954 Rail		56.05	44.00	1.0610	1.27	1.075	112.0	1.0	112.0	3,000	6,233	-578	2,859	8,514
Primary	ACSR 954 Rail		56.05	44.00	1.0610	1.67	1.075	138.0	180.0	138.0	3,000	-2,415	-713	3,524	397
Primary	ACSR 954 Rail		51.05	12.00	1.0610	1.27	1.075	112.0	1.0	112.0	3,000	5,677	158	2,604	8,439
Primary	ACSR 954 Rail		51.05	12.00	1.0610	1.67	1.075	138.0	180.0	138.0	3,000	-2,200	194	3,210	1,205
Primary	ACSR 954 Rail		51.05	44.00	1.0610	1.27	1.075	112.0	1.0	112.0	3,000	5,677	578	2,604	8,860
Primary	ACSR 954 Rail		51.05	44.00	1.0610	1.67	1.075	138.0	180.0	138.0	3,000	-2,200	713	3,210	1,723

Primary	ACSR 954 Rail	51.05	44.00	1.0610	1.27	1.075	112.0	1.0	112.0	3,000	5,677	-578	2,604	7,703
Primary	ACSR 954 Rail	51.05	44.00	1.0610	1.67	1.075	138.0	180.0	138.0	3,000	-2,200	-713	3,210	298
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	32.00	8.77	0.5220	1.56	0.198	112.0	1.0	112.0	600	711	34	1,068	1,813
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	32.00	8.77	0.5220	2.02	0.198	138.0	180.0	138.0	600	-276	42	1,316	1,083
Secondary	DUPLEX 6 AWG	31.50	8.05	0.5370	1.26	0.071	112.0	1.0	112.0	357	416	23	1,066	1,505
Secondary	DUPLEX 6 AWG	31.50	8.05	0.5370	1.58	0.071	138.0	180.0	138.0	357	-161	28	1,315	1,181
										Totals:	**22,663**	**480**	**41,939**	**65,082**

Comm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Cable Diameter (in)**	**Sag at Max Temp (ft)**	**Cable Weight (lbs/ft)**	**Lead/Span Length (ft)**	**Span Angle (deg)**	**Wire Length (ft)**	**Tension (lbs)**	**Tension Moment* (ft-lb)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Telco	TELE 1.0		23.00	9.31	1.0000	1.60	0.400	112.0	1.0	112.0	1,200	1,022	65	1,126	2,214
Telco	TELE 1.0		23.00	9.31	1.0000	2.05	0.400	138.0	180.0	138.0	1,200	-396	80	1,389	1,073
Telco	TELE 1.25		22.00	9.37	1.2500	1.80	0.600	112.0	1.0	112.0	1,200	978	89	1,257	2,323
Telco	TELE 1.25		22.00	9.37	1.2500	2.34	0.600	138.0	180.0	138.0	1,200	-379	109	1,550	1,280
											Totals:	**1,225**	**343**	**5,321**	**6,890**

PowerEquipment		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Transformer	1PH-25KVA		37.20	22.45	0.0	0.0	365.00	39.00	--	22.00	--	14	1,551	1,566
											Totals:	**14**	**1,551**	**1,566**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		54.70	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	211	211
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		49.70	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	191	191
										Totals:	**0**	**402**	**402**

Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		28.00	6.01	90.0	90.0	85.00	24.00	20.00	3.00	120.00	1,220	898	2,119
											Totals:	**1,220**	**898**	**2,119**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		56.20	0.00	0.0	0.0	13.00	5.25	13.50	0	196	196
Post	Post Insulator - 27 kV		54.93	44.00	81.4	0.0	13.00	5.25	13.50	181	381	562
Post	Post Insulator - 27 kV		54.93	-44.00	278.6	0.0	13.00	5.25	13.50	-181	381	200

Post	Post Insulator - 27 kV	49.93	12.00	60.0	0.0	13.00	5.25	13.50	49	346	396
Post	Post Insulator - 27 kV	49.93	44.00	81.0	0.0	13.00	5.25	13.50	181	346	527
Post	Post Insulator - 27 kV	49.93	-44.00	279.0	0.0	13.00	5.25	13.50	-181	346	165
Spool	Spool 4"	32.00	0.00	90.0	0.0	3.00	4.00	4.12	4	26	30
Spool	Spool 2.5"	31.50	0.00	90.0	0.0	1.00	2.50	2.12	1	8	9
Spool	Spool 4"	23.00	0.00	90.0	0.0	3.00	4.00	4.12	4	18	23
Spool	Spool 4"	22.00	0.00	90.0	0.0	3.00	4.00	4.12	4	18	22
								Totals:	**64**	**2,066**	**2,130**

Guy Wire and Brace		Owner	Attach Height (ft)	End Height (ft)	Lead/Span Length (ft)	Wire Diameter (in)	Percent Solid (%)	Lead Angle (deg)	Incline Angle (deg)	Wire Weight (lbs/ft)	Rest Length (ft)	Stretch Length (in)
EHS 5/16	Span/Head		23.00	48.00	100.00	0.312	75.00	40.0	-14.0	0.205	100.78	0.00
EHS 5/16	Span/Head		23.00	48.00	100.00	0.312	75.00	140.0	-14.0	0.205	100.78	0.00

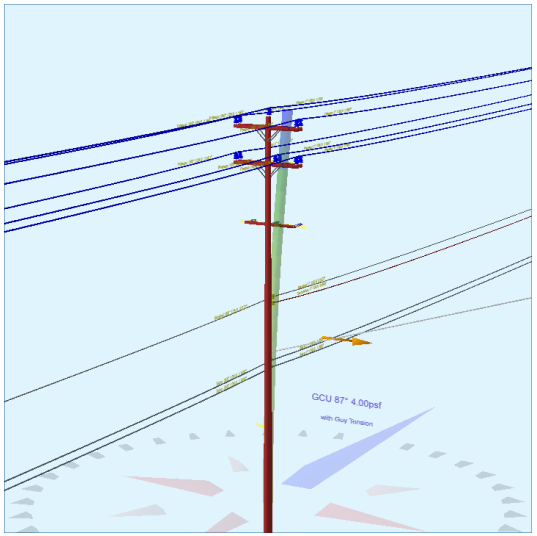
Guy Wire and Brace (Loads and Reactions)		Elastic Modulus (psi)	Rated Tensile Strength (lbs)	Guy Strength Factor	Allowable Tension (lbs)	Initial Tension (lbs)	Loaded Tension*[2] (lbs)	Maximum Tension[2] (lbs)	Applied Tension[3] (lbs)	Vertical Load (lbs)	Shear Load In Guy Dir (lbs)	Shear Load At Report Angle (lbs)	Moment at GL[3] (ft-lb)
EHS 5/16	Span/Head	2.30e+7	11,200	0.90	10,080	700	930	846	0	0	0	0	336
EHS 5/16	Span/Head	2.30e+7	11,200	0.90	10,080	700	1,039	945	0	0	0	0	341
									Totals:	**0**	**0**	**0**	**677**

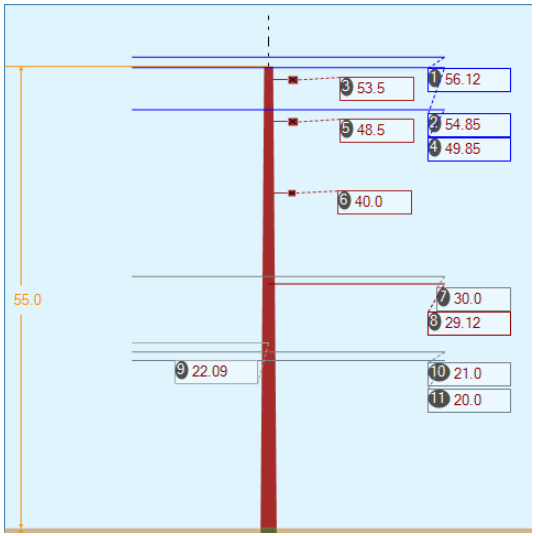
Anchor/Rod Load Summary	Owner	Rod Length AGL (in)	Lead Length (ft)	Lead Angle (deg)	Strength of Assembly (lbs)	Anchor/Rod Strength Factor	Allowable Load (lbs)	Max Load[2] (lbs)	Load at Pole MCU[3] (lbs)	Max Required Capacity[2] (%)
Anchor		0.00	100.00	40.0	20,000	1.00	20,000	930	0	4.7
Anchor		0.00	100.00	140.0	20,000	1.00	20,000	1,039	0	5.2

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
0.71	36.37	34.30	13.90	6.15	8.60	15.42	2.38e+6	60.00	57.00	56.20	384,444	**3887.65**	**40.00**

Pole Num:	**Pole 14**	Pole Length / Class:	**65 / 1**	Code:	**NESC**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.0**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**47.97**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.30**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**44.3**	0.0	87.0
Groundline	**44.3**	0.0	87.0
Vertical	**2.4**	36.33	250.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**86,253**	81.8	87.0
Groundline	**86,253**	81.8	87.0
GL Allowable	**198,112**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Anchor	100.0	70.0		**0.0**	87.0	**5.9**	260.0
EHS 3/8 (Span/Head)			22.1	**0.0**	87.0	**8.6**	260.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 81.8°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,333	64.6	**66,675**	77.3	**33.7**	**2,272**	2,435	13	**2,285**	**33.6**
Comms	284	13.8	**6,167**	7.2	**3.1**	**210**	400	2	**212**	**3.1**
GuyBraces	3	0.1	**58**	0.1	**0.0**	**2**	24	0	**2**	**0.0**
Pole	381	18.5	**10,166**	11.8	**5.1**	**346**	4,996	27	**374**	**5.5**
Crossarms	11	0.5	**536**	0.6	**0.3**	**18**	718	4	**22**	**0.3**
Insulators	52	2.5	**2,651**	3.1	**1.3**	**90**	353	2	**92**	**1.4**
Pole Load	2,064	100.0	**86,253**	100.0	**43.5**	**2,939**	8,927	49	**2,988**	**43.9**
Pole Reserve Capacity			**111,859**		**56.5**	**3,861**			**3,812**	**56.1**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 81.8°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,682	81.5	**76,087**	88.2	**38.4**	**2,592**	3,930	21	**2,614**	**38.4**
Pole	381	18.5	**10,166**	11.8	**5.1**	**346**	4,996	27	**374**	**5.5**
Totals:	2,064	100.0	**86,253**	100.0	**43.5**	**2,939**	8,927	49	**2,988**	**43.9**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		56.13	4.30	1.1650	1.70	1.075	138.0	1.0	138.0	3,000	35,139	10	3,707	38,856
Primary	ACSR 954 Rail		56.13	4.30	1.1650	1.56	1.075	129.0	180.0	129.0	3,000	-31,360	10	3,478	-27,872
Primary	ACSR 954 Rail		54.85	57.00	1.0610	1.67	1.075	138.0	1.0	138.0	3,000	34,342	914	3,396	38,652
Primary	ACSR 954 Rail		54.85	57.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	-30,648	854	3,187	-26,607
Primary	ACSR 954 Rail		54.85	57.00	1.0610	1.67	1.075	138.0	1.0	138.0	3,000	34,342	-914	3,396	36,824
Primary	ACSR 954 Rail		54.85	57.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	-30,648	-854	3,187	-28,315
Primary	ACSR 954 Rail		49.85	18.00	1.0610	1.67	1.075	138.0	1.0	138.0	3,000	31,214	289	3,087	34,590
Primary	ACSR 954 Rail		49.85	18.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	-27,857	270	2,897	-24,690
Primary	ACSR 954 Rail		49.85	57.00	1.0610	1.67	1.075	138.0	1.0	138.0	3,000	31,214	914	3,087	35,215
Primary	ACSR 954 Rail		49.85	57.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	-27,857	854	2,897	-24,106
Primary	ACSR 954 Rail		49.85	57.00	1.0610	1.67	1.075	138.0	1.0	138.0	3,000	31,214	-914	3,087	33,387
Primary	ACSR 954 Rail		49.85	57.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	-27,857	-854	2,897	-25,814

Neutral	AAC 4/0 AWG 7 STRAND OXLIP	30.00	8.81	0.5220	2.02	0.198	138.0	1.0	138.0	600	3,753	42	1,215	5,010
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	30.00	8.81	0.5220	1.86	0.198	129.0	180.0	129.0	600	-3,350	39	1,140	-2,170
Secondary	TRIPLEX 4 AWG	29.12	8.87	0.6800	2.07	0.164	138.0	1.0	138.0	300	1,822	43	1,362	3,227
										Totals:	**23,463**	**702**	**42,020**	**66,185**

Comm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Cable Diameter (in)**	**Sag at Max Temp (ft)**	**Cable Weight (lbs/ft)**	**Lead/Span Length (ft)**	**Span Angle (deg)**	**Wire Length (ft)**	**Tension (lbs)**	**Tension Moment* (ft-lb)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Telco	TELE 1.0		21.00	8.86	1.0000	2.05	0.400	138.0	1.0	138.0	1,200	5,255	76	1,248	6,579
Telco	TELE 1.0		21.00	8.86	1.0000	1.89	0.400	129.0	180.0	129.0	1,200	-4,689	71	1,171	-3,447
Telco	TELE 1.0		20.00	8.92	1.0000	2.05	0.400	138.0	1.0	138.0	1,200	5,004	76	1,189	6,269
Telco	TELE 1.0		20.00	8.92	1.0000	1.89	0.400	129.0	180.0	129.0	1,200	-4,466	71	1,116	-3,279
											Totals:	**1,103**	**293**	**4,725**	**6,121**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		53.50	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	244	244
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		48.50	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	221	221
Normal	8' x 3.5" x 4.5" SP - 3 Deadend		40.00	6.96	0.0	0.0	50.00	4.50	3.50	96.00	8	58	66
										Totals:	**8**	**524**	**532**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		55.00	0.00	0.0	0.0	13.00	5.25	13.50	1	191	192
Post	Post Insulator - 27 kV		53.73	57.00	83.4	0.0	13.00	5.25	13.50	232	371	603
Post	Post Insulator - 27 kV		53.73	-57.00	276.6	0.0	13.00	5.25	13.50	-232	371	139
Post	Post Insulator - 27 kV		48.73	18.00	68.9	0.0	13.00	5.25	13.50	73	337	410
Post	Post Insulator - 27 kV		48.73	57.00	83.1	0.0	13.00	5.25	13.50	232	337	569
Post	Post Insulator - 27 kV		48.73	-57.00	276.9	0.0	13.00	5.25	13.50	-232	337	104
Deadend	Deadend Insulator		40.00	0.00	0.0	0.0	8.99	3.00	30.00	8	174	182
Deadend	Deadend Insulator		40.00	44.00	81.0	0.0	8.99	3.00	30.00	70	174	244
Deadend	Deadend Insulator		40.00	-44.00	279.0	0.0	8.99	3.00	30.00	-54	174	120
Spool	Spool 4"		30.00	0.00	90.0	0.0	3.00	4.00	4.12	4	24	28
Spool	Spool 4"		29.12	0.00	90.0	0.0	3.00	4.00	4.12	4	23	27
Bolt	Single Bolt		21.00	0.00	90.0	0.0	5.00	3.00	0.00	7	0	7
Bolt	Single Bolt		20.00	0.00	90.0	0.0	5.00	3.00	0.00	7	0	7
									Totals:	**119**	**2,512**	**2,632**

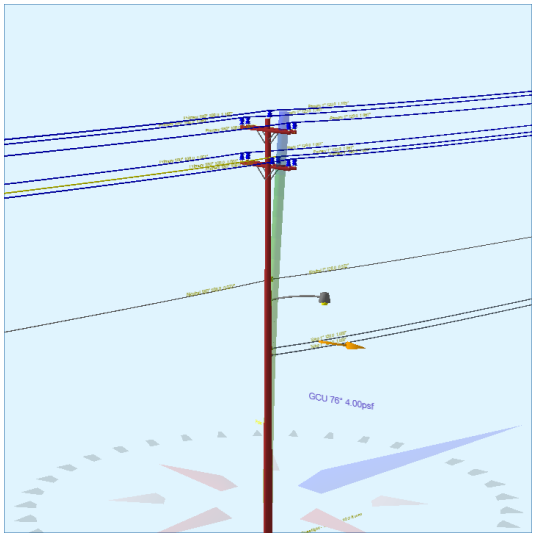
Guy Wire and Brace		Owner	Attach Height (ft)	End Height (ft)	Lead/Span Length (ft)	Wire Diameter (in)	Percent Solid (%)	Lead Angle (deg)	Incline Angle (deg)	Wire Weight (lbs/ft)	Rest Length (ft)	Stretch Length (in)
EHS 3/8	Span/Head		22.09	47.09	100.00	0.375	75.00	70.0	-14.0	0.273	99.10	0.00

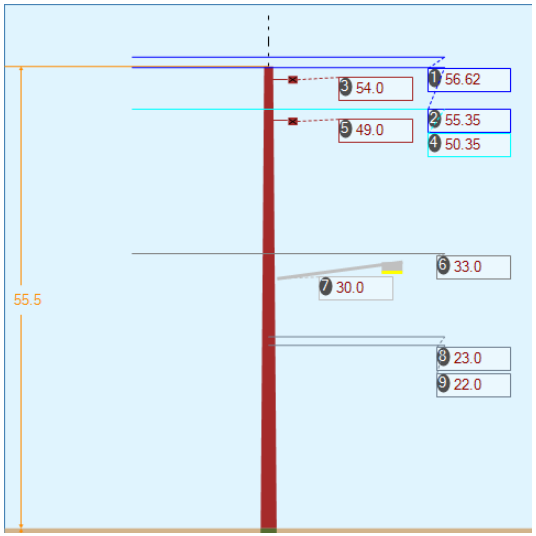
Guy Wire and Brace (Loads and Reactions)		Elastic Modulus (psi)	Rated Tensile Strength (lbs)	Guy Strength Factor	Allowable Tension (lbs)	Initial Tension (lbs)	Loaded Tension*[2] (lbs)	Maximum Tension[2] (lbs)	Applied Tension[3] (lbs)	Vertical Load (lbs)	Shear Load In Guy Dir (lbs)	Shear Load At Report Angle (lbs)	Moment at GL[3] (ft-lb)
EHS 3/8	Span/Head	2.30e+7	15,400	0.90	13,860	700	1,187	1,079	0	0	0	0	58
									Totals:	**0**	**0**	**0**	**58**

Anchor/Rod Load Summary	Owner	Rod Length AGL (in)	Lead Length (ft)	Lead Angle (deg)	Strength of Assembly (lbs)	Anchor/Rod Strength Factor	Allowable Load (lbs)	Max Load[2] (lbs)	Load at Pole MCU[3] (lbs)	Max Required Capacity[2] (%)
Anchor		18.00	100.00	70.0	20,000	1.00	20,000	1,187	0	5.9

Pole Buckling													
Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
0.71	36.28	34.33	13.76	6.02	8.60	15.28	2.38e+6	60.00	57.00	55.00	370,754	**3719.39**	**41.67**

Pole Num:	**Pole 15**	Pole Length / Class:	**65 / 1**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**9.5**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.17**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**42.1**	0.0	75.6
Groundline	**42.1**	0.0	75.6
Vertical	**17.8**	36.17	75.6

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**82,993**	59.8	75.6
Groundline	**82,993**	59.8	75.6
GL Allowable	**200,484**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 59.8°										
	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	882	38.7	**46,315**	55.8	**23.1**	**1,561**	2,109	11	**1,573**	**23.1**
Comms	922	40.5	**20,986**	25.3	**10.5**	**708**	193	1	**709**	**10.4**
Pole	373	16.4	**10,008**	12.1	**5.0**	**337**	5,069	27	**365**	**5.4**
Crossarms	32	1.4	**1,662**	2.0	**0.8**	**56**	623	3	**59**	**0.9**
Streetlights	31	1.4	**1,992**	2.4	**1.0**	**67**	162	1	**68**	**1.0**
Insulators	38	1.7	**2,030**	2.5	**1.0**	**68**	285	2	**70**	**1.0**
Pole Load	2,277	100.0	**82,993**	100.0	**41.4**	**2,798**	8,441	46	**2,844**	**41.8**
Pole Reserve Capacity			**117,491**		**58.6**	**4,002**			**3,956**	**58.2**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 59.8°										
	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,904	83.6	**72,985**	87.9	**36.4**	**2,461**	3,372	18	**2,479**	**36.5**
Pole	373	16.4	**10,008**	12.1	**5.0**	**337**	5,069	27	**365**	**5.4**
Totals:	2,277	100.0	**82,993**	100.0	**41.4**	**2,798**	8,441	46	**2,844**	**41.8**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		56.63	4.30	1.1650	1.56	1.075	129.0	1.0	129.0	3,000	88,040	33	2,929	91,002
Primary	ACSR 954 Rail		56.63	4.30	1.1650	1.24	1.075	108.0	180.0	108.0	3,000	-85,488	28	2,489	-82,971
Primary	ACSR 954 Rail		55.35	57.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	86,059	746	2,684	89,489
Primary	ACSR 954 Rail		55.35	57.00	1.0610	1.21	1.075	108.0	180.0	108.0	3,000	-83,565	625	2,281	-80,659
Primary	ACSR 954 Rail		55.35	57.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	86,059	-746	2,684	87,997
Primary	ACSR 954 Rail		55.35	57.00	1.0610	1.21	1.075	108.0	180.0	108.0	3,000	-83,565	-625	2,281	-81,908
Primary	ACSR 954 Rail		50.35	18.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	78,292	236	2,442	80,969
Primary	ACSR 954 Rail		50.35	18.00	1.0610	1.21	1.075	108.0	180.0	108.0	3,000	-76,022	197	2,075	-73,750
Primary	ACSR 954 Rail		50.35	57.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	78,292	746	2,442	81,479
Primary	ACSR 954 Rail		50.35	57.00	1.0610	1.21	1.075	108.0	180.0	108.0	3,000	-76,022	625	2,075	-73,323
Primary	ACSR 954 Rail		50.35	57.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	78,292	-746	2,442	79,987
Primary	ACSR 954 Rail		50.35	57.00	1.0610	1.21	1.075	108.0	180.0	108.0	3,000	-76,022	-625	2,075	-74,572

Neutral	AAC 4/0 AWG 7 STRAND OXLIP	33.00	8.66	0.5220	1.86	0.198	129.0	1.0	129.0	600	10,253	34	1,047	11,333
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	33.00	8.66	0.5220	1.49	0.198	108.0	180.0	108.0	600	-9,956	28	890	-9,038
										Totals:	**14,646**	**556**	**30,833**	**46,035**

Comm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Cable Diameter (in)**	**Sag at Max Temp (ft)**	**Cable Weight (lbs/ft)**	**Lead/Span Length (ft)**	**Span Angle (deg)**	**Wire Length (ft)**	**Tension (lbs)**	**Tension Moment* (ft-lb)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Telco	TELE 1.0		23.00	8.77	1.0000	2.14	0.400	129.0	1.0	129.0	800	9,528	61	1,071	10,660
Telco	TELE 1.0		22.00	8.83	1.0000	2.14	0.400	129.0	1.0	129.0	800	9,114	61	1,024	10,199
											Totals:	**18,641**	**123**	**2,095**	**20,859**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		54.00	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	866	866
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		49.00	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	786	786
										Totals:	**0**	**1,652**	**1,652**

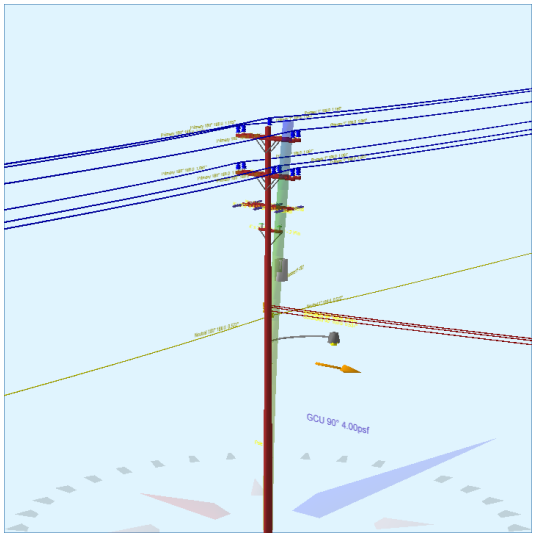
Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		30.00	5.84	90.0	90.0	85.00	24.00	20.00	3.00	120.00	1,054	926	1,980
											Totals:	**1,054**	**926**	**1,980**

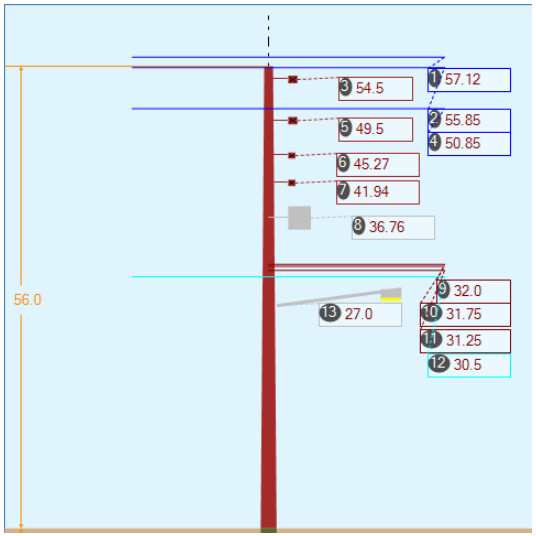
Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		55.50	0.00	0.0	0.0	13.00	5.25	13.50	4	186	190
Post	Post Insulator - 27 kV		54.23	57.00	83.4	0.0	13.00	5.25	13.50	203	362	565
Post	Post Insulator - 27 kV		54.23	-57.00	276.6	0.0	13.00	5.25	13.50	-203	362	159
Post	Post Insulator - 27 kV		49.23	18.00	68.9	0.0	13.00	5.25	13.50	64	329	393
Post	Post Insulator - 27 kV		49.23	57.00	83.1	0.0	13.00	5.25	13.50	203	329	531
Post	Post Insulator - 27 kV		49.23	-57.00	276.9	0.0	13.00	5.25	13.50	-203	329	126
Spool	Spool 4"		33.00	0.00	90.0	0.0	3.00	4.00	4.12	4	25	29
Spool	Spool 3"		23.00	0.00	90.0	0.0	2.00	3.00	3.19	2	10	13
Spool	Spool 3"		22.00	0.00	90.0	0.0	2.00	3.00	3.19	2	10	12
									Totals:	**77**	**1,941**	**2,018**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	36.18	34.30	13.83	9.95	8.60	15.34	2.38e+6	60.00	57.00	55.50	47,497	**474.21**	**5.62**

Pole Num:	**Pole 16**	Pole Length / Class:	**65 / 1**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**9.0**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.36**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**51.6**	0.0	90.0
Groundline	**51.6**	0.0	90.0
Vertical	**23.3**	37.92	90.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**102,912**	89.9	90.0
Groundline	**102,912**	89.9	90.0
GL Allowable	**202,874**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 89.9°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,830	77.1	**83,651**	81.3	**41.2**	**2,796**	2,703	15	**2,810**	**41.3**
PowerEquipments	36	1.5	**2,465**	2.4	**1.2**	**82**	636	3	**86**	**1.3**
Pole	392	16.5	**10,578**	10.3	**5.2**	**354**	5,142	28	**381**	**5.6**
Crossarms	11	0.5	**564**	0.6	**0.3**	**19**	908	5	**24**	**0.3**
Streetlights	32	1.4	**2,093**	2.0	**1.0**	**70**	162	1	**71**	**1.0**
Insulators	72	3.0	**3,561**	3.5	**1.8**	**119**	435	2	**121**	**1.8**
Pole Load	2,373	100.0	**102,912**	100.0	**50.7**	**3,439**	9,986	54	**3,493**	**51.4**
Pole Reserve Capacity			**99,962**		**49.3**	**3,361**			**3,307**	**48.6**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 89.9°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,981	83.5	**92,334**	89.7	**45.5**	**3,086**	4,844	26	**3,112**	**45.8**
Pole	392	16.5	**10,578**	10.3	**5.2**	**354**	5,142	28	**381**	**5.6**
Totals:	2,373	100.0	**102,912**	100.0	**50.7**	**3,439**	9,986	54	**3,493**	**51.4**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		57.13	4.30	1.1650	1.24	1.075	108.0	1.0	108.0	3,000	3,391	0	2,998	6,388
Primary	ACSR 954 Rail		57.13	4.30	1.1650	2.60	1.075	188.0	180.0	188.0	3,000	-397	0	5,220	4,823
Primary	ACSR 954 Rail		55.85	57.00	1.0610	1.21	1.075	108.0	1.0	108.0	3,000	3,315	723	2,748	6,785
Primary	ACSR 954 Rail		55.85	57.00	1.0610	2.57	1.075	188.0	180.0	188.0	3,000	-388	1,258	4,785	5,654
Primary	ACSR 954 Rail		55.85	57.00	1.0610	1.21	1.075	108.0	1.0	108.0	3,000	3,315	-723	2,748	5,340
Primary	ACSR 954 Rail		55.85	57.00	1.0610	2.57	1.075	188.0	180.0	188.0	3,000	-388	-1,258	4,785	3,138
Primary	ACSR 954 Rail		50.85	18.00	1.0610	1.21	1.075	108.0	1.0	108.0	3,000	3,019	228	2,502	5,749
Primary	ACSR 954 Rail		50.85	18.00	1.0610	2.57	1.075	188.0	180.0	188.0	3,000	-354	397	4,357	4,400
Primary	ACSR 954 Rail		50.85	57.00	1.0610	1.21	1.075	108.0	1.0	108.0	3,000	3,019	723	2,502	6,243
Primary	ACSR 954 Rail		50.85	57.00	1.0610	2.57	1.075	188.0	180.0	188.0	3,000	-354	1,258	4,357	5,261
Primary	ACSR 954 Rail		50.85	57.00	1.0610	1.21	1.075	108.0	1.0	108.0	3,000	3,019	-723	2,502	4,798
Primary	ACSR 954 Rail		50.85	57.00	1.0610	2.57	1.075	188.0	180.0	188.0	3,000	-354	-1,258	4,357	2,745

Secondary	DUPLEX 6 AWG	32.00	8.75	0.5370	0.51	0.071	100.0	90.0	100.0	200	6,392	0	0	6,392
Secondary	DUPLEX 6 AWG	31.75	8.77	0.5370	0.51	0.071	100.0	90.0	100.0	200	6,342	0	0	6,342
Secondary	DUPLEX 6 AWG	31.25	8.80	0.5370	0.51	0.071	100.0	90.0	100.0	200	6,242	0	0	6,242
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	30.50	8.84	0.5220	1.49	0.198	108.0	1.0	108.0	600	362	33	982	1,376
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	30.50	8.84	0.5220	3.03	0.198	188.0	180.0	188.0	600	-42	58	1,709	1,725
										Totals:	**36,137**	**716**	**46,548**	**83,401**

PowerEquipment		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Transformer	1PH-15KVA		36.76	22.46	70.0	70.0	335.00	34.00	--	22.00	--	1,121	1,337	2,457
											Totals:	**1,121**	**1,337**	**2,457**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		54.50	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	210	210
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		49.50	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	191	191
Normal	8' x 3.5" x 4.5" SP - 3 Deadend		45.27	6.70	180.0	180.0	50.00	4.50	3.50	96.00	0	55	55
Normal	8' x 3.5" x 4.5" SP - 3 Deadend		45.27	6.70	0.0	0.0	50.00	4.50	3.50	96.00	0	55	56
Normal	4' x 3.5" x 4.5" SP - 2 Pin		41.94	6.90	0.0	0.0	50.00	4.50	3.50	48.00	0	51	52
										Totals:	**0**	**563**	**563**

Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		27.00	6.06	90.0	90.0	85.00	24.00	20.00	3.00	120.00	1,221	866	2,087
											Totals:	**1,221**	**866**	**2,087**

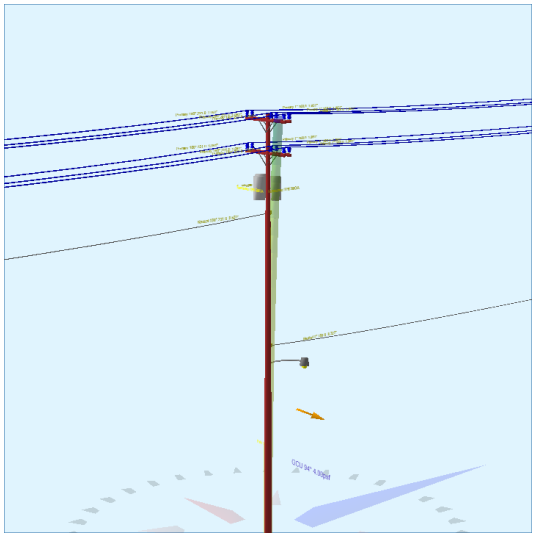
Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		56.00	0.00	0.0	0.0	13.00	5.25	13.50	0	195	195
Post	Post Insulator - 27 kV		54.73	57.00	83.4	0.0	13.00	5.25	13.50	235	379	614
Post	Post Insulator - 27 kV		54.73	-57.00	276.6	0.0	13.00	5.25	13.50	-235	379	145
Post	Post Insulator - 27 kV		49.73	18.00	68.9	0.0	13.00	5.25	13.50	74	345	419
Post	Post Insulator - 27 kV		49.73	57.00	83.1	0.0	13.00	5.25	13.50	235	345	580
Post	Post Insulator - 27 kV		49.73	-57.00	276.9	0.0	13.00	5.25	13.50	-235	345	110
Deadend	Deadend Insulator		45.27	0.00	180.0	0.0	8.99	3.00	30.00	0	198	198
Deadend	Deadend Insulator		45.27	44.00	261.3	0.0	8.99	3.00	30.00	-63	198	135

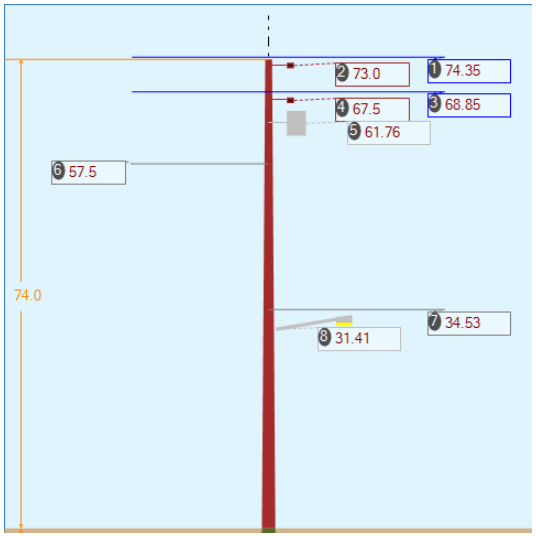
Deadend	Deadend Insulator	45.27	-44.00	98.7	0.0	8.99	3.00	30.00	63	198	261
Deadend	Deadend Insulator	45.27	0.00	0.0	0.0	8.99	3.00	30.00	0	198	198
Deadend	Deadend Insulator	45.27	44.00	81.3	0.0	8.99	3.00	30.00	63	198	261
Deadend	Deadend Insulator	45.27	-44.00	278.7	0.0	8.99	3.00	30.00	-63	198	136
Pin	15 kV Pin Insulator 6" Dia x 8"	42.13	18.00	69.0	0.0	10.00	6.00	8.00	29	99	127
Pin	15 kV Pin Insulator 6" Dia x 8"	42.13	-20.00	289.0	0.0	10.00	6.00	8.00	-32	99	67
Spool	Spool 4"	32.00	0.00	180.0	90.0	3.00	4.00	4.12	0	26	26
Spool	Spool 4"	31.75	0.00	180.0	90.0	3.00	4.00	4.12	0	25	25
Spool	Spool 4"	31.25	0.00	180.0	90.0	3.00	4.00	4.12	0	25	25
Spool	Spool 4"	30.50	0.00	90.0	0.0	3.00	4.00	4.12	4	24	29
								Totals:	**75**	**3,475**	**3,550**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	37.95	34.49	13.80	10.69	8.60	15.40	2.38e+6	60.00	57.00	56.00	42,899	**428.60**	**4.29**

Pole Num:	**Pole 17**	Pole Length / Class:	**85 / 1**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**11.0**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**53.23**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**59.9**	27.67	94.1
Groundline	**54.9**	0.0	93.4
Vertical	**52.7**	52.0	94.1

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**86,260**	102.2	94.1
Groundline	**148,496**	97.9	93.4
GL Allowable	**270,579**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 97.9°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,578	66.5	**113,448**	76.4	**41.9**	**2,851**	3,715	16	**2,867**	**42.2**
PowerEquipments	164	6.9	**10,458**	7.0	**3.9**	**263**	3,648	16	**279**	**4.1**
Pole	550	23.2	**18,985**	12.8	**7.0**	**477**	7,769	34	**512**	**7.5**
Crossarms	10	0.4	**675**	0.5	**0.3**	**17**	623	3	**20**	**0.3**
Streetlights	29	1.2	**1,780**	1.2	**0.7**	**45**	142	1	**45**	**0.7**
Insulators	43	1.8	**3,150**	2.1	**1.2**	**79**	308	1	**81**	**1.2**
Pole Load	2,373	100.0	**148,496**	100.0	**54.9**	**3,731**	16,206	72	**3,803**	**55.9**
Pole Reserve Capacity			**122,083**		**45.1**	**3,069**			**2,997**	**44.1**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 97.9°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,823	76.8	**129,511**	87.2	**47.9**	**3,254**	8,437	37	**3,292**	**48.4**
Pole	550	23.2	**18,985**	12.8	**7.0**	**477**	7,769	34	**512**	**7.5**
Totals:	2,373	100.0	**148,496**	100.0	**54.9**	**3,731**	16,206	72	**3,803**	**55.9**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		74.35	18.00	1.0610	2.57	1.075	188.0	1.0	188.0	3,000	-26,716	393	6,313	-20,010
Primary	ACSR 954 Rail		74.35	18.00	1.0610	3.49	1.075	231.0	180.0	231.1	3,000	30,580	483	7,731	38,794
Primary	ACSR 954 Rail		74.35	57.00	1.0610	2.57	1.075	188.0	1.0	188.0	3,000	-26,716	1,246	6,313	-19,157
Primary	ACSR 954 Rail		74.35	57.00	1.0610	3.49	1.075	231.0	180.0	231.1	3,000	30,580	1,531	7,731	39,842
Primary	ACSR 954 Rail		74.35	57.00	1.0610	2.57	1.075	188.0	1.0	188.0	3,000	-26,716	-1,246	6,313	-21,649
Primary	ACSR 954 Rail		74.35	57.00	1.0610	3.49	1.075	231.0	180.0	231.1	3,000	30,580	-1,531	7,731	36,780
Primary	ACSR 954 Rail		68.85	18.00	1.0610	2.57	1.075	188.0	1.0	188.0	3,000	-24,741	393	5,847	-18,501
Primary	ACSR 954 Rail		68.85	18.00	1.0610	3.49	1.075	231.0	180.0	231.1	3,000	28,319	483	7,160	35,962
Primary	ACSR 954 Rail		68.85	57.00	1.0610	2.57	1.075	188.0	1.0	188.0	3,000	-24,741	1,246	5,847	-17,649
Primary	ACSR 954 Rail		68.85	57.00	1.0610	3.49	1.075	231.0	180.0	231.1	3,000	28,319	1,531	7,160	37,010
Primary	ACSR 954 Rail		68.85	57.00	1.0610	2.57	1.075	188.0	1.0	188.0	3,000	-24,741	-1,246	5,847	-20,141
Primary	ACSR 954 Rail		68.85	57.00	1.0610	3.49	1.075	231.0	180.0	231.1	3,000	28,319	-1,531	7,160	33,948

Neutral	AAC 4/0 AWG 7 STRAND OXLIP	57.50	8.23	0.5220	4.01	0.198	231.0	180.0	231.1	600	4,727	65	3,912	8,704
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	34.53	9.52	0.5220	3.03	0.198	188.0	1.0	188.0	600	-2,480	62	1,919	-500
										Totals:	**24,569**	**1,881**	**86,984**	**113,434**

PowerEquipment		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Transformer	1PH-50KVA		61.76	22.99	90.0	90.0	640.00	47.00	--	24.00	--	2,307	3,379	5,686
Transformer	1PH-50KVA		61.76	22.99	180.0	180.0	640.00	47.00	--	24.00	--	319	3,379	3,698
Transformer	1PH-50KVA		61.76	22.99	270.0	270.0	640.00	47.00	--	24.00	--	-2,307	3,379	1,072
											Totals:	**319**	**10,137**	**10,456**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		73.00	6.60	0.0	0.0	82.00	5.50	4.50	120.00	0	350	350
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		67.50	6.91	0.0	0.0	82.00	5.50	4.50	120.00	0	324	324
										Totals:	**0**	**674**	**674**

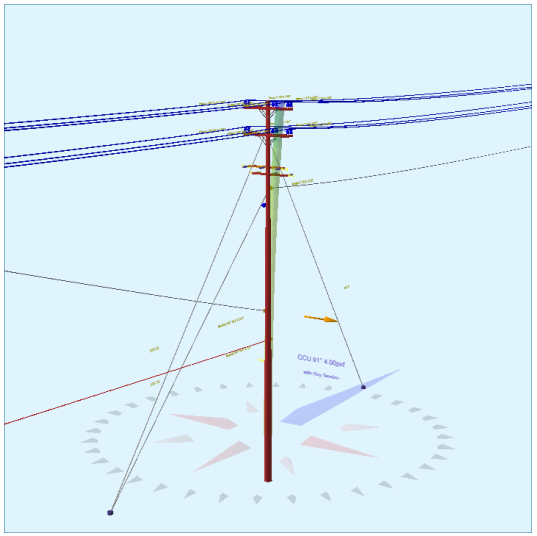
Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 8 ft. Arm		31.41	6.70	90.0	90.0	75.00	24.00	20.00	3.00	96.00	884	896	1,780
											Totals:	**884**	**896**	**1,780**

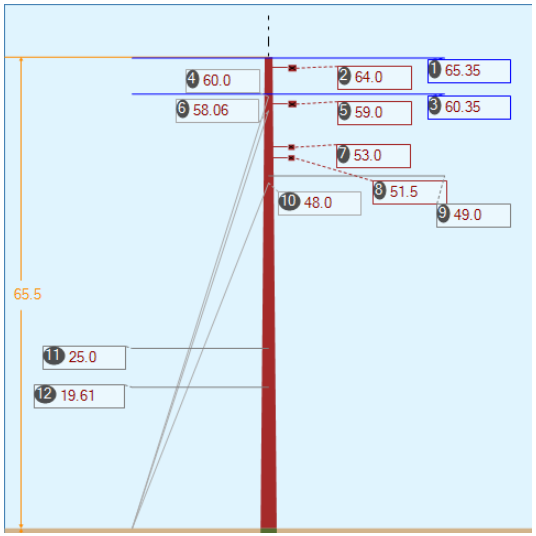
Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		73.23	18.00	69.9	0.0	13.00	5.25	13.50	73	506	579
Post	Post Insulator - 27 kV		73.23	57.00	83.4	0.0	13.00	5.25	13.50	232	506	738
Post	Post Insulator - 27 kV		73.23	-57.00	276.6	0.0	13.00	5.25	13.50	-232	506	273
Post	Post Insulator - 27 kV		67.73	18.00	69.0	0.0	13.00	5.25	13.50	73	468	541
Post	Post Insulator - 27 kV		67.73	57.00	83.1	0.0	13.00	5.25	13.50	232	468	700
Post	Post Insulator - 27 kV		67.73	-57.00	276.9	0.0	13.00	5.25	13.50	-232	468	236
Spool	Spool 4"		57.50	0.00	90.0	0.0	3.00	4.00	4.12	4	46	50
Spool	Spool 4"		34.53	0.00	90.0	0.0	3.00	4.00	4.12	4	28	32
									Totals:	**155**	**2,995**	**3,150**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	52.04	35.20	14.88	14.43	8.60	16.95	2.38e+6	60.00	57.00	74.00	30,766	**307.51**	**1.90**

Pole Num:	**Pole 18**	Pole Length / Class:	**75 / 1**	Code:	**NESC**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**WESTERN RED CEDAR**	NESC Rule:	**Rule 250B**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**9.5**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**56.43**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**6,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.30**
Aux Data 5	**Unset**	Allowable Stress (psi):	**5,100**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**51.1**	25.0	90.5
Groundline	**46.1**	0.0	90.5
Vertical	**4.2**	44.33	270.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**62,357**	83.0	90.5
Groundline	**111,448**	98.2	90.5
GL Allowable	**241,776**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Single Helix Anchor	48.0	180.0		**2.5**	90.5	**7.7**	0.0
EHS 3/8 (Down)			60.0	**2.3**	90.5	**6.5**	0.0
EHS 3/8 (Down)			48.0	**1.3**	90.5	**4.6**	0.0
Single Helix Anchor	39.0	0.0		**0.0**	90.5	**1.8**	180.0
EHS 3/8 (Down)			58.1	**0.0**	90.5	**2.6**	180.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 98.2°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,493	68.3	**85,240**	76.5	**35.3**	**1,796**	2,643	10	**1,807**	**35.4**
GuyBraces	107	4.9	**5,907**	5.3	**2.4**	**125**	641	3	**127**	**2.5**
Pole	503	23.0	**15,333**	13.8	**6.3**	**323**	6,232	25	**348**	**6.8**
Crossarms	10	0.5	**618**	0.6	**0.3**	**13**	813	3	**16**	**0.3**
Insulators	74	3.4	**4,351**	3.9	**1.8**	**92**	458	2	**93**	**1.8**
Pole Load	2,186	100.0	**111,448**	100.0	**46.1**	**2,349**	10,787	43	**2,391**	**46.9**
Pole Reserve Capacity			**130,328**		**53.9**	**2,751**			**2,709**	**53.1**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 98.2°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,683	77.0	**96,115**	86.2	**39.8**	**2,026**	4,556	18	**2,044**	**40.1**
Pole	503	23.0	**15,333**	13.8	**6.3**	**323**	6,232	25	**348**	**6.8**
Totals:	2,186	100.0	**111,448**	100.0	**46.1**	**2,349**	10,787	43	**2,391**	**46.9**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		65.35	18.00	1.0610	3.49	1.075	231.0	1.0	231.1	3,000	-32,019	483	6,823	-24,712
Primary	ACSR 954 Rail		65.35	18.00	1.0610	0.90	1.075	85.0	180.0	85.0	3,000	36,430	178	2,505	39,112
Primary	ACSR 954 Rail		65.35	57.00	1.0610	3.49	1.075	231.0	1.0	231.1	3,000	-32,019	1,530	6,823	-23,666
Primary	ACSR 954 Rail		65.35	57.00	1.0610	0.90	1.075	85.0	180.0	85.0	3,000	36,430	563	2,505	39,497
Primary	ACSR 954 Rail		65.35	57.00	1.0610	3.49	1.075	231.0	1.0	231.1	3,000	-32,019	-1,530	6,823	-26,725
Primary	ACSR 954 Rail		65.35	57.00	1.0610	0.90	1.075	85.0	180.0	85.0	3,000	36,430	-563	2,505	38,372
Primary	ACSR 954 Rail		60.35	18.00	1.0610	3.49	1.075	231.0	1.0	231.1	3,000	-29,571	483	6,302	-22,786
Primary	ACSR 954 Rail		60.35	18.00	1.0610	0.90	1.075	85.0	180.0	85.0	3,000	33,645	178	2,313	36,136
Primary	ACSR 954 Rail		60.35	57.00	1.0610	3.49	1.075	231.0	1.0	231.1	3,000	-29,571	1,530	6,302	-21,739
Primary	ACSR 954 Rail		60.35	57.00	1.0610	0.90	1.075	85.0	180.0	85.0	3,000	33,645	563	2,313	36,521
Primary	ACSR 954 Rail		60.35	57.00	1.0610	3.49	1.075	231.0	1.0	231.1	3,000	-29,571	-1,530	6,302	-24,798
Primary	ACSR 954 Rail		60.35	57.00	1.0610	0.90	1.075	85.0	180.0	85.0	3,000	33,645	-563	2,313	35,395

Neutral	AAC 4/0 AWG 7 STRAND OXLIP	49.00	8.48	0.5220	4.01	0.198	231.0	1.0	231.1	600	-4,798	67	3,347	-1,384
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	25.00	10.19	0.5220	0.33	0.198	85.0	180.0	85.0	600	2,680	99	627	3,407
Neutral	AAC 4 AWG 7 STRAND ROSE	19.61	10.08	0.2320	0.07	0.039	85.0	180.0	85.0	600	2,183	-4	352	2,531
										Totals:	**25,521**	**1,484**	**58,157**	**85,161**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		64.00	6.65	0.0	0.0	82.00	5.50	4.50	120.00	0	253	253
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		59.00	7.01	0.0	0.0	82.00	5.50	4.50	120.00	0	233	233
Normal	8' x 3.5" x 4.5" SP - 3 Deadend		53.00	6.94	180.0	180.0	50.00	4.50	3.50	96.00	8	67	75
Normal	8' x 3.5" x 4.5" SP - 3 Deadend		51.50	7.05	0.0	0.0	50.00	4.50	3.50	96.00	-8	65	57
										Totals:	**0**	**617**	**617**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		64.23	18.00	69.7	0.0	13.00	5.25	13.50	73	441	514
Post	Post Insulator - 27 kV		64.23	57.00	83.3	0.0	13.00	5.25	13.50	232	441	673
Post	Post Insulator - 27 kV		64.23	-57.00	276.7	0.0	13.00	5.25	13.50	-232	441	209
Post	Post Insulator - 27 kV		59.23	18.00	68.7	0.0	13.00	5.25	13.50	73	407	480
Post	Post Insulator - 27 kV		59.23	57.00	83.0	0.0	13.00	5.25	13.50	232	407	639
Post	Post Insulator - 27 kV		59.23	-57.00	277.0	0.0	13.00	5.25	13.50	-232	407	175
Deadend	Deadend Insulator		53.00	0.00	180.0	0.0	8.99	3.00	30.00	8	230	237
Deadend	Deadend Insulator		53.00	44.00	261.0	0.0	8.99	3.00	30.00	-54	230	175
Deadend	Deadend Insulator		53.00	-44.00	99.0	0.0	8.99	3.00	30.00	69	230	299
Deadend	Deadend Insulator		51.50	0.00	0.0	0.0	8.99	3.00	30.00	-8	223	216
Deadend	Deadend Insulator		51.50	44.00	80.9	0.0	8.99	3.00	30.00	54	223	278
Deadend	Deadend Insulator		51.50	-44.00	279.1	0.0	8.99	3.00	30.00	-70	223	154
Spool	Spool 4"		49.00	0.00	90.0	0.0	3.00	4.00	4.12	4	39	43
Post	Post Insulator - 35 kV		45.83	0.00	180.0	180.0	23.00	5.75	16.75	12	216	228
Spool	Spool 4"		25.00	0.00	270.0	180.0	3.00	4.00	4.12	-5	20	15
Spool	Spool 3"		19.61	0.00	90.0	0.0	2.00	3.00	3.19	3	9	12
									Totals:	**161**	**4,186**	**4,347**

Guy Wire and Brace		Owner	Attach Height (ft)	End Height (ft)	Lead/Span Length (ft)	Wire Diameter (in)	Percent Solid (%)	Lead Angle (deg)	Incline Angle (deg)	Wire Weight (lbs/ft)	Rest Length (ft)	Stretch Length (in)
EHS 3/8	Down		60.00	0.00	48.00	0.375	75.00	180.0	51.1	0.273	82.74	0.17
EHS 3/8	Down		48.00	0.00	48.00	0.375	75.00	180.0	44.8	0.273	73.11	0.08
EHS 3/8	Down		58.06	0.00	39.00	0.375	75.00	0.0	55.9	0.273	76.31	0.00

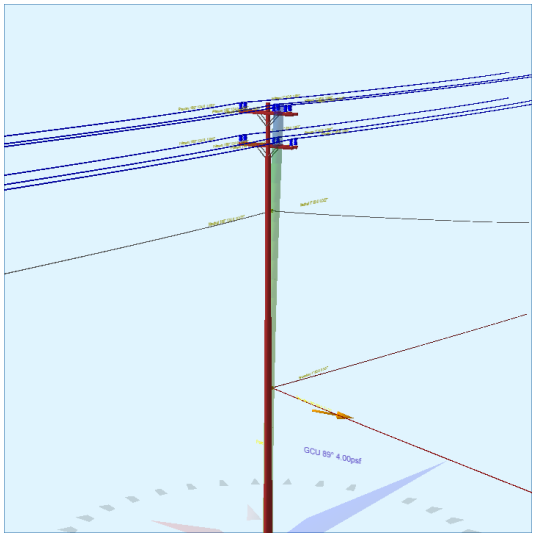
Guy Wire and Brace (Loads and Reactions)		Elastic Modulus (psi)	Rated Tensile Strength (lbs)	Guy Strength Factor	Allowable Tension (lbs)	Initial Tension (lbs)	Loaded Tension*[2] (lbs)	Maximum Tension[2] (lbs)	Applied Tension[3] (lbs)	Vertical Load (lbs)	Shear Load In Guy Dir (lbs)	Shear Load At Report Angle (lbs)	Moment at GL[3] (ft-lb)
EHS 3/8	Down	2.30e+7	15,400	0.90	13,860	700	906	824	317	247	199	28	2,974
EHS 3/8	Down	2.30e+7	15,400	0.90	13,860	700	637	579	183	129	130	19	1,796
EHS 3/8	Down	2.30e+7	15,400	0.90	13,860	700	363	330	0	0	0	0	1,132
									Totals:	**376**	**329**	**47**	**5,902**

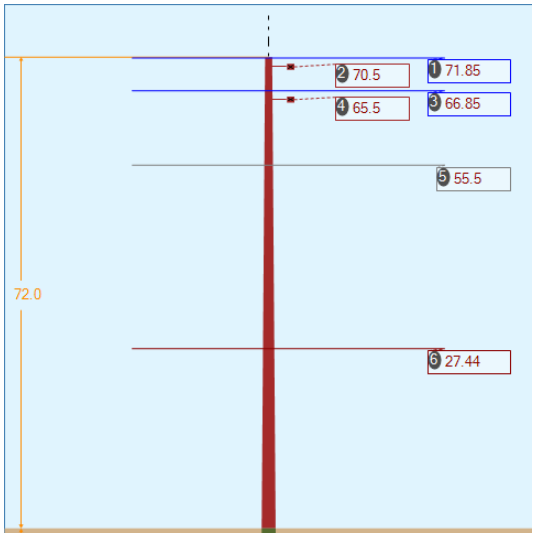
Anchor/Rod Load Summary	Owner	Rod Length AGL (in)	Lead Length (ft)	Lead Angle (deg)	Strength of Assembly (lbs)	Anchor/Rod Strength Factor	Allowable Load (lbs)	Max Load[2] (lbs)	Load at Pole MCU[3] (lbs)	Max Required Capacity[2] (%)
Single Helix Anchor		18.00	48.00	180.0	20,000	1.00	20,000	1,541	499	7.7
Single Helix Anchor		18.00	39.00	0.0	20,000	1.00	20,000	363	0	1.8

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
0.71	44.31	35.29	15.73	8.15	8.60	17.97	1.43e+6	50.00	57.00	65.50	254,721	**2568.38**	**23.81**

Pole Num:	**Pole 19**	Pole Length / Class:	**80 / 1**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**8.0**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**53.27**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**37.8**	0.0	88.6
Groundline	**37.8**	0.0	87.9
Vertical	**21.8**	43.42	88.6

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**100,349**	86.2	88.6
Groundline	**100,349**	86.2	87.9
GL Allowable	**271,227**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 86.2°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,371	70.0	**78,778**	78.5	**29.1**	**1,972**	2,096	9	**1,981**	**29.1**
Pole	536	27.4	**18,030**	18.0	**6.7**	**451**	7,567	34	**485**	**7.1**
Crossarms	8	0.4	**546**	0.5	**0.2**	**14**	623	3	**16**	**0.2**
Insulators	43	2.2	**2,995**	3.0	**1.1**	**75**	306	1	**76**	**1.1**
Pole Load	1,958	100.0	**100,349**	100.0	**37.0**	**2,512**	10,593	47	**2,559**	**37.6**
Pole Reserve Capacity			**170,878**		**63.0**	**4,288**			**4,241**	**62.4**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 86.2°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,422	72.6	**82,319**	82.0	**30.4**	**2,061**	3,025	13	**2,074**	**30.5**
Pole	536	27.4	**18,030**	18.0	**6.7**	**451**	7,567	34	**485**	**7.1**
Totals:	1,958	100.0	**100,349**	100.0	**37.0**	**2,512**	10,593	47	**2,559**	**37.6**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		71.85	18.00	1.0610	0.90	1.075	85.0	1.0	85.0	3,000	18,115	179	2,770	21,064
Primary	ACSR 954 Rail		71.85	18.00	1.0610	1.61	1.075	134.0	180.0	134.0	3,000	-14,361	282	4,375	-9,703
Primary	ACSR 954 Rail		71.85	44.00	1.0610	0.90	1.075	85.0	1.0	85.0	3,000	18,115	438	2,770	21,323
Primary	ACSR 954 Rail		71.85	44.00	1.0610	1.61	1.075	134.0	180.0	134.0	3,000	-14,361	690	4,375	-9,295
Primary	ACSR 954 Rail		71.85	57.00	1.0610	0.90	1.075	85.0	1.0	85.0	3,000	18,115	-567	2,770	20,317
Primary	ACSR 954 Rail		71.85	57.00	1.0610	1.61	1.075	134.0	180.0	134.0	3,000	-14,361	-894	4,375	-10,880
Primary	ACSR 954 Rail		66.85	18.00	1.0610	0.90	1.075	85.0	1.0	85.0	3,000	16,855	179	2,578	19,612
Primary	ACSR 954 Rail		66.85	18.00	1.0610	1.61	1.075	134.0	180.0	134.0	3,000	-13,362	282	4,071	-9,008
Primary	ACSR 954 Rail		66.85	57.00	1.0610	0.90	1.075	85.0	1.0	85.0	3,000	16,855	567	2,578	20,000
Primary	ACSR 954 Rail		66.85	57.00	1.0610	1.61	1.075	134.0	180.0	134.0	3,000	-13,362	894	4,071	-8,396
Primary	ACSR 954 Rail		66.85	57.00	1.0610	0.90	1.075	85.0	1.0	85.0	3,000	16,855	-567	2,578	18,865
Primary	ACSR 954 Rail		66.85	57.00	1.0610	1.61	1.075	134.0	180.0	134.0	3,000	-13,362	-894	4,071	-10,185
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		55.50	8.26	0.5220	0.32	0.198	85.0	1.0	85.0	600	2,764	83	1,400	4,247
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		55.50	8.26	0.5220	1.95	0.198	134.0	180.0	134.0	600	-2,217	38	2,211	32
Secondary	DUPLEX 6 AWG		27.44	9.38	0.5370	0.22	0.071	85.0	1.0	85.0	357	822	31	702	1,555
Secondary	DUPLEX 6 AWG		27.44	9.38	0.5370	1.11	0.071	100.0	110.0	100.0	357	8,962	23	122	9,108
											Totals:	**32,071**	**765**	**45,819**	**78,655**

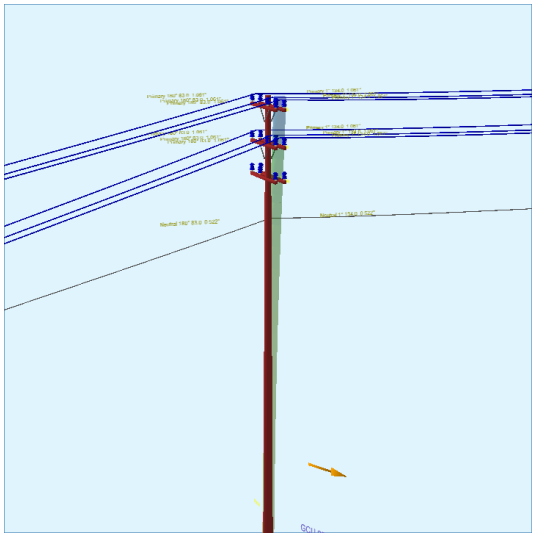
Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		70.50	6.63	0.0	0.0	82.00	5.50	4.50	120.00	0	283	283
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		65.50	6.92	0.0	0.0	82.00	5.50	4.50	120.00	0	263	263
										Totals:	**0**	**545**	**545**

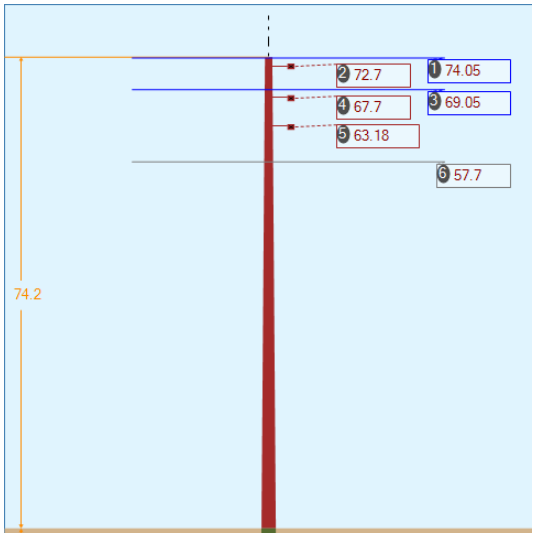
Insulator		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Post	Post Insulator - 27 kV		70.73	18.00	69.8	0.0	13.00	5.25	13.50	74	489	563
Post	Post Insulator - 27 kV		70.73	44.00	81.4	0.0	13.00	5.25	13.50	181	489	670
Post	Post Insulator - 27 kV		70.73	-57.00	276.6	0.0	13.00	5.25	13.50	-234	489	255
Post	Post Insulator - 27 kV		65.73	18.00	69.0	0.0	13.00	5.25	13.50	74	455	529
Post	Post Insulator - 27 kV		65.73	57.00	83.1	0.0	13.00	5.25	13.50	234	455	689
Post	Post Insulator - 27 kV		65.73	-57.00	276.9	0.0	13.00	5.25	13.50	-234	455	221
Spool	Spool 4"		55.50	0.00	90.0	0.0	3.00	4.00	4.12	4	44	48
Spool	Spool 3"		27.44	0.00	90.0	0.0	2.00	3.00	3.19	3	13	16
									Totals:	**101**	**2,889**	**2,991**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	43.38	34.46	15.22	11.59	8.60	16.97	2.38e+6	60.00	57.00	72.00	48,532	**485.90**	**4.59**

Pole Num:	**Pole 20**	Pole Length / Class:	**85 / H1**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.83**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**56.71**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**37.1**	25.33	68.4
Groundline	**34.3**	0.0	66.3
Vertical	**44.3**	53.0	68.4

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**68,146**	56.0	68.4
Groundline	**112,167**	56.1	66.3
GL Allowable	**327,191**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 56.1°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,137	61.5	**83,011**	74.0	**25.4**	**1,724**	6,609	26	**1,750**	**25.7**
Pole	577	31.2	**20,008**	17.8	**6.1**	**416**	8,884	35	**450**	**6.6**
Crossarms	72	3.9	**4,889**	4.4	**1.5**	**102**	935	4	**105**	**1.5**
Insulators	61	3.3	**4,259**	3.8	**1.3**	**89**	450	2	**90**	**1.3**
Pole Load	1,847	100.0	**112,167**	100.0	**34.3**	**2,329**	16,877	66	**2,395**	**35.2**
Pole Reserve Capacity			**215,024**		**65.7**	**4,471**			**4,405**	**64.8**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 56.1°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,270	68.8	**92,159**	82.2	**28.2**	**1,914**	7,994	31	**1,945**	**28.6**
Pole	577	31.2	**20,008**	17.8	**6.1**	**416**	8,884	35	**450**	**6.6**
Totals:	1,847	100.0	**112,167**	100.0	**34.3**	**2,329**	16,877	66	**2,395**	**35.2**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		74.05	18.00	1.0610	1.61	1.075	134.0	1.0	134.0	3,000	127,044	235	3,426	130,705
Primary	ACSR 954 Rail		74.05	18.00	1.0610	0.33	1.075	83.0	180.0	83.0	3,000	-120,719	947	2,163	-117,609
Primary	ACSR 954 Rail		74.05	57.00	1.0610	1.61	1.075	134.0	1.0	134.0	3,000	127,044	744	3,426	131,214
Primary	ACSR 954 Rail		74.05	57.00	1.0610	0.33	1.075	83.0	180.0	83.0	3,000	-120,719	2,999	2,163	-115,557
Primary	ACSR 954 Rail		74.05	57.00	1.0610	1.61	1.075	134.0	1.0	134.0	3,000	127,044	-744	3,426	129,725
Primary	ACSR 954 Rail		74.05	57.00	1.0610	0.33	1.075	83.0	180.0	83.0	3,000	-120,719	-2,999	2,163	-121,555
Primary	ACSR 954 Rail		69.05	18.00	1.0610	1.61	1.075	134.0	1.0	134.0	3,000	118,471	235	3,195	121,901
Primary	ACSR 954 Rail		69.05	18.00	1.0610	0.34	1.075	83.0	180.0	83.0	3,000	-110,204	1,219	2,017	-106,968
Primary	ACSR 954 Rail		69.05	57.00	1.0610	1.61	1.075	134.0	1.0	134.0	3,000	118,471	744	3,195	122,410
Primary	ACSR 954 Rail		69.05	57.00	1.0610	0.34	1.075	83.0	180.0	83.0	3,000	-110,204	3,861	2,017	-104,327
Primary	ACSR 954 Rail		69.05	57.00	1.0610	1.61	1.075	134.0	1.0	134.0	3,000	118,471	-744	3,195	120,922
Primary	ACSR 954 Rail		69.05	57.00	1.0610	0.34	1.075	83.0	180.0	83.0	3,000	-110,204	-3,861	2,017	-112,048
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		57.70	8.60	0.5220	1.95	0.198	134.0	1.0	134.0	600	19,786	33	1,746	21,565
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		57.70	8.60	0.5220	0.31	0.198	83.0	180.0	83.0	600	-18,643	107	1,103	-17,434
											Totals:	**44,921**	**2,776**	**35,248**	**82,945**

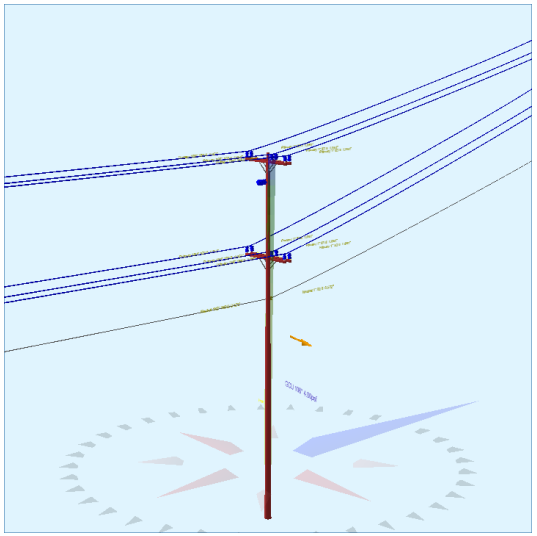
Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		72.70	6.95	0.0	0.0	82.00	5.50	4.50	120.00	0	1,744	1,744
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		67.70	7.25	0.0	0.0	82.00	5.50	4.50	120.00	0	1,624	1,624
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		63.18	7.52	0.0	0.0	82.00	5.50	4.50	120.00	0	1,516	1,516
										Totals:	**0**	**4,885**	**4,885**

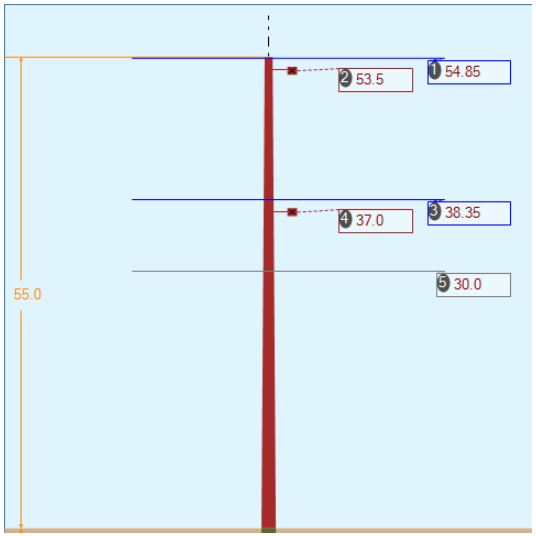
Insulator		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Post	Post Insulator - 27 kV		72.93	18.00	68.9	0.0	13.00	5.25	13.50	62	493	555
Post	Post Insulator - 27 kV		72.93	57.00	83.0	0.0	13.00	5.25	13.50	195	493	688
Post	Post Insulator - 27 kV		72.93	-57.00	277.0	0.0	13.00	5.25	13.50	-195	493	298
Post	Post Insulator - 27 kV		67.93	18.00	68.1	0.0	13.00	5.25	13.50	62	460	521
Post	Post Insulator - 27 kV		67.93	57.00	82.7	0.0	13.00	5.25	13.50	195	460	654
Post	Post Insulator - 27 kV		67.93	-57.00	277.3	0.0	13.00	5.25	13.50	-195	460	265
Post	Post Insulator - 27 kV		63.41	-18.00	292.7	0.0	13.00	5.25	13.50	-62	429	368
Post	Post Insulator - 27 kV		63.41	57.00	82.5	0.0	13.00	5.25	13.50	195	429	624
Post	Post Insulator - 27 kV		63.41	-57.00	277.5	0.0	13.00	5.25	13.50	-195	429	234
Spool	Spool 4"		57.70	0.00	90.0	0.0	3.00	4.00	4.12	3	45	49
									Totals:	**65**	**4,191**	**4,256**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	52.97	35.23	15.83	14.72	9.24	18.06	2.38e+6	60.00	57.00	74.20	38,112	**380.98**	**2.26**

Pole Num:	**Pole 21**	Pole Length / Class:	**65 / 3**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.0**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**42.11**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**50.6**	0.0	105.6
Groundline	**50.6**	0.0	105.6
Vertical	**0.0**	0.08	105.6

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**67,404**	121.4	105.6
Groundline	**67,404**	121.4	105.6
GL Allowable	**133,980**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 121.4°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,243	75.5	**54,832**	81.4	**40.9**	**2,781**	-2,442	-17	**2,764**	**40.6**
Pole	320	19.4	**8,433**	12.5	**6.3**	**428**	3,778	27	**455**	**6.7**
Crossarms	35	2.1	**1,592**	2.4	**1.2**	**81**	623	4	**85**	**1.3**
Insulators	49	3.0	**2,547**	3.8	**1.9**	**129**	405	3	**132**	**1.9**
Pole Load	1,647	100.0	**67,404**	100.0	**50.3**	**3,419**	2,363	17	**3,436**	**50.5**
Pole Reserve Capacity			**66,576**		**49.7**	**3,381**			**3,364**	**49.5**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 121.4°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,327	80.6	**58,971**	87.5	**44.0**	**2,991**	-1,415	-10	**2,981**	**43.8**
Pole	320	19.4	**8,433**	12.5	**6.3**	**428**	3,778	27	**455**	**6.7**
Totals:	1,647	100.0	**67,404**	100.0	**50.3**	**3,419**	2,363	17	**3,436**	**50.5**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		54.85	18.00	1.0610	0.33	1.075	83.0	1.0	83.0	3,000	-81,313	-674	1,731	-80,256
Primary	ACSR 954 Rail		54.85	18.00	1.0610	2.21	1.075	169.0	180.0	169.0	3,000	85,882	305	3,471	89,658
Primary	ACSR 954 Rail		54.85	57.00	1.0610	0.33	1.075	83.0	1.0	83.0	3,000	-81,313	-2,134	1,731	-81,716
Primary	ACSR 954 Rail		54.85	57.00	1.0610	2.21	1.075	169.0	180.0	169.0	3,000	85,882	965	3,471	90,318
Primary	ACSR 954 Rail		54.85	57.00	1.0610	0.33	1.075	83.0	1.0	83.0	3,000	-81,313	2,134	1,731	-77,449
Primary	ACSR 954 Rail		54.85	57.00	1.0610	2.21	1.075	169.0	180.0	169.0	3,000	85,882	-965	3,471	88,389
Primary	ACSR 954 Rail		38.35	18.00	1.0610	0.34	1.075	83.0	1.0	83.0	3,000	-55,677	-953	1,211	-55,420
Primary	ACSR 954 Rail		38.35	18.00	1.0610	2.21	1.075	169.0	180.0	169.0	3,000	60,070	305	2,428	62,802
Primary	ACSR 954 Rail		38.35	57.00	1.0610	0.34	1.075	83.0	1.0	83.0	3,000	-55,677	-3,019	1,211	-57,486
Primary	ACSR 954 Rail		38.35	57.00	1.0610	2.21	1.075	169.0	180.0	169.0	3,000	60,070	965	2,428	63,463
Primary	ACSR 954 Rail		38.35	57.00	1.0610	0.34	1.075	83.0	1.0	83.0	3,000	-55,677	3,019	1,211	-51,448
Primary	ACSR 954 Rail		38.35	57.00	1.0610	2.21	1.075	169.0	180.0	169.0	3,000	60,070	-965	2,428	61,533
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		30.00	8.04	0.5220	0.31	0.198	83.0	1.0	83.0	600	-8,813	-63	619	-8,256
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		30.00	8.04	0.5220	2.63	0.198	169.0	180.0	169.0	600	9,386	40	1,242	10,668
											Totals:	**27,458**	**-1,041**	**28,382**	**54,800**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		53.50	5.99	0.0	0.0	82.00	5.50	4.50	120.00	0	941	941
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		37.00	6.91	0.0	0.0	82.00	5.50	4.50	120.00	0	651	651
										Totals:	**0**	**1,591**	**1,591**

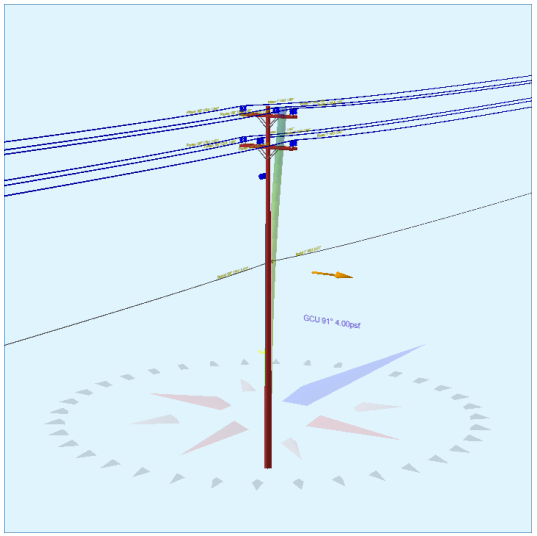
Insulator	Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)

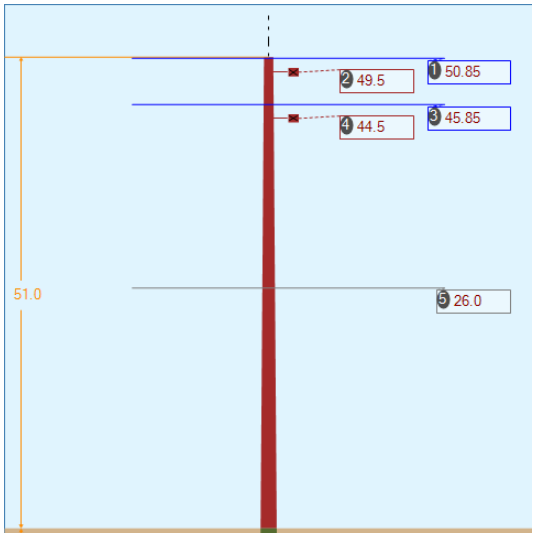
Post	Post Insulator - 27 kV	53.73	18.00	71.6	0.0	13.00	5.25	13.50	63	358	422
Post	Post Insulator - 27 kV	53.73	57.00	84.0	0.0	13.00	5.25	13.50	200	358	559
Post	Post Insulator - 27 kV	53.73	-57.00	276.0	0.0	13.00	5.25	13.50	-200	358	158
Post	Post Insulator - 69 kV	50.04	0.00	180.0	180.0	54.00	7.25	25.38	131	440	570
Post	Post Insulator - 27 kV	37.23	18.00	69.0	0.0	13.00	5.25	13.50	63	249	312
Post	Post Insulator - 27 kV	37.23	57.00	83.1	0.0	13.00	5.25	13.50	200	249	449
Post	Post Insulator - 27 kV	37.23	-57.00	276.9	0.0	13.00	5.25	13.50	-200	249	49
Spool	Spool 4"	30.00	0.00	90.0	0.0	3.00	4.00	4.12	3	23	26
								Totals:	**260**	**2,285**	**2,546**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	0.08	30.01	13.40	0.31	7.32	13.41	2.38e+6	60.00	57.00	55.00	7.90e+9	**8**	**8**

Pole Num:	**Pole 22**	Pole Length / Class:	**60 / 2**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250B**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**9.0**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**43.89**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,800**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**45.8**	0.0	90.5
Groundline	**45.8**	0.0	90.5
Vertical	**23.9**	36.17	90.5

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**68,045**	90.9	90.5
Groundline	**68,045**	90.9	90.5
GL Allowable	**151,685**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 90.9°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,227	76.2	**57,312**	84.2	**37.8**	**2,567**	2,642	17	**2,585**	**38.0**
Pole	326	20.2	**8,055**	11.8	**5.3**	**361**	3,907	25	**386**	**5.7**
Crossarms	8	0.5	**364**	0.5	**0.2**	**16**	623	4	**20**	**0.3**
Insulators	50	3.1	**2,314**	3.4	**1.5**	**104**	378	2	**106**	**1.6**
Pole Load	1,611	100.0	**68,045**	100.0	**44.9**	**3,048**	7,551	49	**3,097**	**45.6**
Pole Reserve Capacity			**83,640**		**55.1**	**3,752**			**3,703**	**54.4**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 90.9°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,285	79.8	**59,990**	88.2	**39.6**	**2,687**	3,644	24	**2,711**	**39.9**
Pole	326	20.2	**8,055**	11.8	**5.3**	**361**	3,907	25	**386**	**5.7**
Totals:	1,611	100.0	**68,045**	100.0	**44.9**	**3,048**	7,551	49	**3,097**	**45.6**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		50.85	18.00	1.0610	2.21	1.075	169.0	1.0	169.0	3,000	226	357	3,916	4,499
Primary	ACSR 954 Rail		50.85	18.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	2,439	272	2,989	5,700
Primary	ACSR 954 Rail		50.85	57.00	1.0610	2.21	1.075	169.0	1.0	169.0	3,000	226	1,130	3,916	5,273
Primary	ACSR 954 Rail		50.85	57.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	2,439	863	2,989	6,291
Primary	ACSR 954 Rail		50.85	57.00	1.0610	2.21	1.075	169.0	1.0	169.0	3,000	226	-1,130	3,916	3,012
Primary	ACSR 954 Rail		50.85	57.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	2,439	-863	2,989	4,565
Primary	ACSR 954 Rail		45.85	18.00	1.0610	2.21	1.075	169.0	1.0	169.0	3,000	204	-357	3,532	3,378
Primary	ACSR 954 Rail		45.85	18.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	2,199	-272	2,695	4,622
Primary	ACSR 954 Rail		45.85	57.00	1.0610	2.21	1.075	169.0	1.0	169.0	3,000	204	1,130	3,532	4,866
Primary	ACSR 954 Rail		45.85	57.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	2,199	863	2,695	5,757
Primary	ACSR 954 Rail		45.85	57.00	1.0610	2.21	1.075	169.0	1.0	169.0	3,000	204	-1,130	3,532	2,605
Primary	ACSR 954 Rail		45.85	57.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	2,199	-863	2,695	4,032
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		26.00	8.45	0.5220	2.63	0.198	169.0	1.0	169.0	600	23	50	1,310	1,382
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		26.00	8.45	0.5220	1.86	0.198	129.0	180.0	129.0	600	249	38	1,000	1,287
											Totals:	**15,476**	**87**	**41,705**	**57,269**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		49.50	6.32	0.0	0.0	82.00	5.50	4.50	120.00	0	191	191
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		44.50	6.61	0.0	0.0	82.00	5.50	4.50	120.00	0	172	172
										Totals:	**0**	**363**	**363**

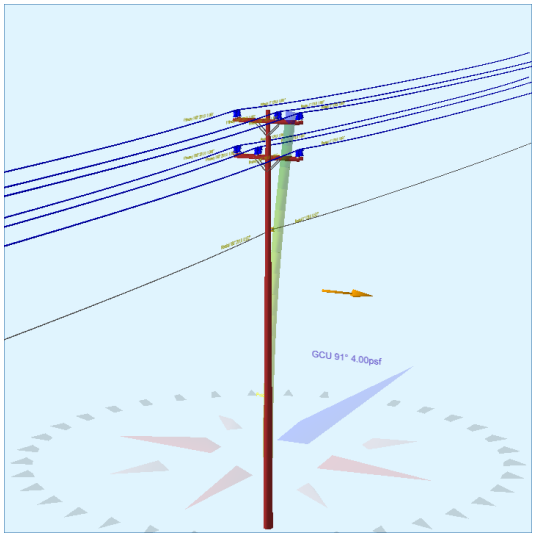
Insulator	Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)

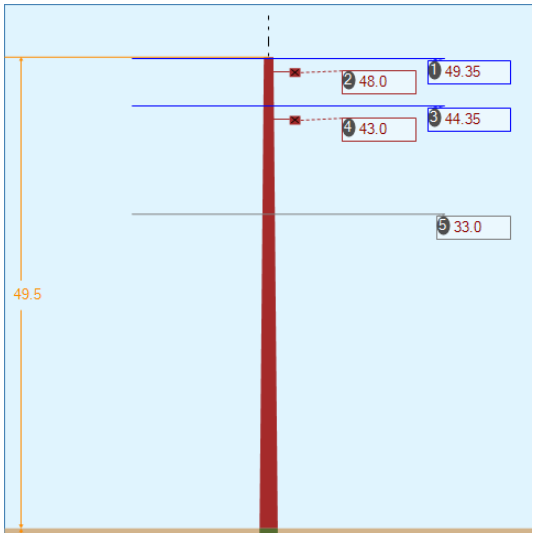
Post	Post Insulator - 27 kV	49.73	18.00	70.7	0.0	13.00	5.25	13.50	74	345	419
Post	Post Insulator - 27 kV	49.73	57.00	83.7	0.0	13.00	5.25	13.50	235	345	580
Post	Post Insulator - 27 kV	49.73	-57.00	276.3	0.0	13.00	5.25	13.50	-235	345	110
Post	Post Insulator - 27 kV	44.73	-18.00	290.2	0.0	13.00	5.25	13.50	-74	311	236
Post	Post Insulator - 27 kV	44.73	57.00	83.4	0.0	13.00	5.25	13.50	235	311	545
Post	Post Insulator - 27 kV	44.73	-57.00	276.6	0.0	13.00	5.25	13.50	-235	311	76
Post	Post Insulator - 55 kV	39.96	0.00	180.0	180.0	40.00	7.00	22.88	3	318	321
Spool	Spool 4"	26.00	0.00	90.0	0.0	3.00	4.00	4.12	4	21	25
								Totals:	**7**	**2,306**	**2,312**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	36.20	34.58	12.49	9.76	7.96	13.98	2.38e+6	60.00	57.00	51.00	31,633	**315.95**	**4.18**

Pole Num:	**Pole 23**	Pole Length / Class:	**60 / 2**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**WESTERN RED CEDAR**	NESC Rule:	**Rule 250B**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.5**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**47.92**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**6,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**5,100**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**50.7**	13.67	90.7
Groundline	**47.9**	0.0	90.7
Vertical	**29.3**	36.0	90.7

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**48,241**	90.5	90.7
Groundline	**70,970**	90.5	90.7
GL Allowable	**148,047**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 90.5°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,324	77.5	**60,731**	85.6	**41.0**	**2,091**	2,926	16	**2,107**	**41.3**
Pole	335	19.6	**7,952**	11.2	**5.4**	**274**	3,568	20	**293**	**5.8**
Crossarms	8	0.5	**352**	0.5	**0.2**	**12**	623	3	**16**	**0.3**
Insulators	42	2.5	**1,936**	2.7	**1.3**	**67**	302	2	**68**	**1.3**
Pole Load	1,709	100.0	**70,970**	100.0	**47.9**	**2,443**	7,419	41	**2,484**	**48.7**
Pole Reserve Capacity			**77,077**		**52.1**	**2,657**			**2,616**	**51.3**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 90.5°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,374	80.4	**63,018**	88.8	**42.6**	**2,170**	3,851	21	**2,191**	**43.0**
Pole	335	19.6	**7,952**	11.2	**5.4**	**274**	3,568	20	**293**	**5.8**
Totals:	1,709	100.0	**70,970**	100.0	**47.9**	**2,443**	7,419	41	**2,484**	**48.7**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		49.35	18.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	1,171	273	2,901	4,345
Primary	ACSR 954 Rail		49.35	18.00	1.0610	2.84	1.075	201.0	180.0	201.1	3,000	1,415	425	4,520	6,360
Primary	ACSR 954 Rail		49.35	57.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	1,171	863	2,901	4,936
Primary	ACSR 954 Rail		49.35	57.00	1.0610	2.84	1.075	201.0	180.0	201.1	3,000	1,415	1,345	4,520	7,280
Primary	ACSR 954 Rail		49.35	57.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	1,171	-863	2,901	3,210
Primary	ACSR 954 Rail		49.35	57.00	1.0610	2.84	1.075	201.0	180.0	201.1	3,000	1,415	-1,345	4,520	4,590
Primary	ACSR 954 Rail		44.35	18.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	1,053	-273	2,608	3,388
Primary	ACSR 954 Rail		44.35	18.00	1.0610	2.84	1.075	201.0	180.0	201.1	3,000	1,272	-425	4,063	4,910
Primary	ACSR 954 Rail		44.35	57.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	1,053	863	2,608	4,523
Primary	ACSR 954 Rail		44.35	57.00	1.0610	2.84	1.075	201.0	180.0	201.1	3,000	1,272	1,345	4,063	6,679
Primary	ACSR 954 Rail		44.35	57.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	1,053	-863	2,608	2,797
Primary	ACSR 954 Rail		44.35	57.00	1.0610	2.84	1.075	201.0	180.0	201.1	3,000	1,272	-1,345	4,063	3,990
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		33.00	8.19	0.5220	1.86	0.198	129.0	1.0	129.0	600	157	37	1,269	1,462
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		33.00	8.19	0.5220	3.31	0.198	201.0	180.0	201.1	600	189	57	1,977	2,223
											Totals:	**15,079**	**94**	**45,520**	**60,693**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		48.00	6.34	0.0	0.0	82.00	5.50	4.50	120.00	0	185	185
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		43.00	6.71	0.0	0.0	82.00	5.50	4.50	120.00	0	166	166
										Totals:	**0**	**351**	**351**

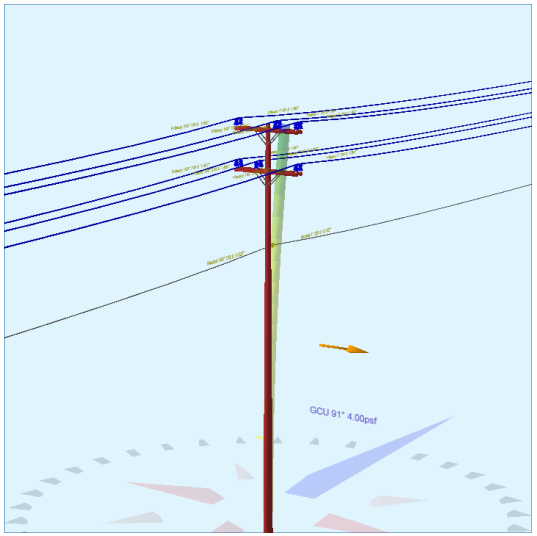
Insulator	Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)

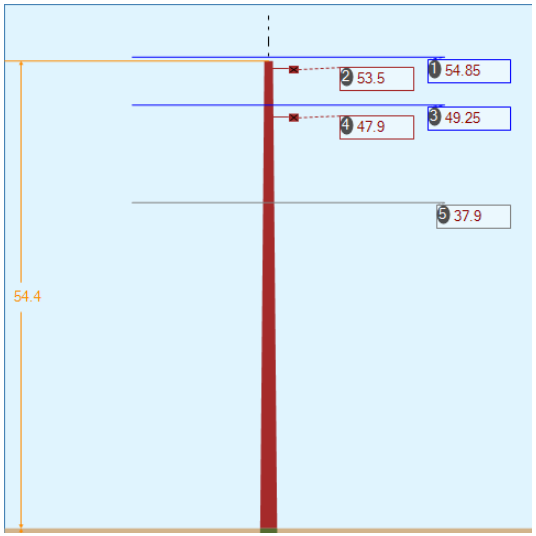
Post	Post Insulator - 27 kV	48.23	18.00	70.6	0.0	13.00	5.25	13.50	74	335	409
Post	Post Insulator - 27 kV	48.23	57.00	83.7	0.0	13.00	5.25	13.50	235	335	569
Post	Post Insulator - 27 kV	48.23	-57.00	276.3	0.0	13.00	5.25	13.50	-235	335	100
Post	Post Insulator - 27 kV	43.23	-18.00	290.4	0.0	13.00	5.25	13.50	-74	300	226
Post	Post Insulator - 27 kV	43.23	57.00	83.3	0.0	13.00	5.25	13.50	235	300	535
Post	Post Insulator - 27 kV	43.23	-57.00	276.7	0.0	13.00	5.25	13.50	-235	300	66
Spool	Spool 4"	33.00	0.00	90.0	0.0	3.00	4.00	4.12	4	26	30
								Totals:	**4**	**1,931**	**1,935**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	36.01	35.22	13.38	11.22	7.96	15.26	1.43e+6	50.00	57.00	49.50	25,295	**253.22**	**3.41**

Pole Num:	**Pole 24**	Pole Length / Class:	**65 / 2**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**WESTERN RED CEDAR**	NESC Rule:	**Rule 250B**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.58**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**49.43**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**6,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**5,100**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**64.5**	19.0	90.7
Groundline	**59.4**	0.0	90.7
Vertical	**40.9**	40.5	90.7

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**58,413**	90.6	90.7
Groundline	**96,611**	90.6	90.7
GL Allowable	**162,560**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 90.6°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,655	79.5	**84,379**	87.3	**51.9**	**2,645**	3,893	20	**2,665**	**52.3**
Pole	376	18.1	**9,685**	10.0	**6.0**	**304**	4,098	21	**325**	**6.4**
Crossarms	8	0.4	**392**	0.4	**0.2**	**12**	623	3	**15**	**0.3**
Insulators	42	2.0	**2,155**	2.2	**1.3**	**68**	302	2	**69**	**1.4**
Pole Load	2,080	100.0	**96,611**	100.0	**59.4**	**3,029**	8,916	46	**3,075**	**60.3**
Pole Reserve Capacity			**65,949**		**40.6**	**2,071**			**2,025**	**39.7**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 90.6°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,705	81.9	**86,926**	90.0	**53.5**	**2,725**	4,818	25	**2,750**	**53.9**
Pole	376	18.1	**9,685**	10.0	**6.0**	**304**	4,098	21	**325**	**6.4**
Totals:	2,080	100.0	**96,611**	100.0	**59.4**	**3,029**	8,916	46	**3,075**	**60.3**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		54.85	18.00	1.0610	2.84	1.075	201.0	1.0	201.1	3,000	1,242	425	5,024	6,690
Primary	ACSR 954 Rail		54.85	18.00	1.0610	3.65	1.075	238.0	180.0	238.1	3,000	1,632	503	5,948	8,083
Primary	ACSR 954 Rail		54.85	57.00	1.0610	2.84	1.075	201.0	1.0	201.1	3,000	1,242	1,345	5,024	7,610
Primary	ACSR 954 Rail		54.85	57.00	1.0610	3.65	1.075	238.0	180.0	238.1	3,000	1,632	1,592	5,948	9,173
Primary	ACSR 954 Rail		54.85	57.00	1.0610	2.84	1.075	201.0	1.0	201.1	3,000	1,242	-1,345	5,024	4,921
Primary	ACSR 954 Rail		54.85	57.00	1.0610	3.65	1.075	238.0	180.0	238.1	3,000	1,632	-1,592	5,948	5,988
Primary	ACSR 954 Rail		49.25	18.00	1.0610	2.84	1.075	201.0	1.0	201.1	3,000	1,115	-425	4,511	5,202
Primary	ACSR 954 Rail		49.25	18.00	1.0610	3.65	1.075	238.0	180.0	238.1	3,000	1,466	-503	5,341	6,304
Primary	ACSR 954 Rail		49.25	57.00	1.0610	2.84	1.075	201.0	1.0	201.1	3,000	1,115	1,345	4,511	6,971
Primary	ACSR 954 Rail		49.25	57.00	1.0610	3.65	1.075	238.0	180.0	238.1	3,000	1,466	1,592	5,341	8,399
Primary	ACSR 954 Rail		49.25	57.00	1.0610	2.84	1.075	201.0	1.0	201.1	3,000	1,115	-1,345	4,511	4,282
Primary	ACSR 954 Rail		49.25	57.00	1.0610	3.65	1.075	238.0	180.0	238.1	3,000	1,466	-1,592	5,341	5,215
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		37.90	8.16	0.5220	3.31	0.198	201.0	1.0	201.1	600	171	57	2,271	2,499
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		37.90	8.16	0.5220	4.18	0.198	238.0	180.0	238.1	600	225	67	2,688	2,981
											Totals:	**16,764**	**124**	**67,432**	**84,320**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		53.50	6.29	0.0	0.0	82.00	5.50	4.50	120.00	0	207	207
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		47.90	6.69	0.0	0.0	82.00	5.50	4.50	120.00	0	185	185
										Totals:	**0**	**392**	**392**

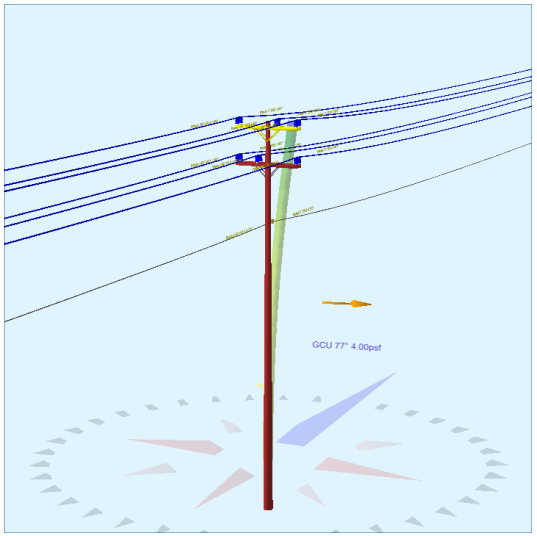
Insulator	Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)

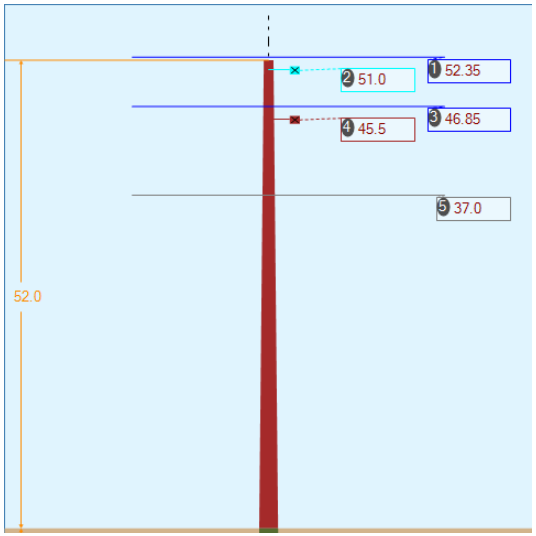
Post	Post Insulator - 27 kV	53.73	18.00	70.7	0.0	13.00	5.25	13.50	74	373	447
Post	Post Insulator - 27 kV	53.73	57.00	83.7	0.0	13.00	5.25	13.50	235	373	607
Post	Post Insulator - 27 kV	53.73	-57.00	276.3	0.0	13.00	5.25	13.50	-235	373	138
Post	Post Insulator - 27 kV	48.13	-18.00	290.4	0.0	13.00	5.25	13.50	-74	334	260
Post	Post Insulator - 27 kV	48.13	57.00	83.3	0.0	13.00	5.25	13.50	235	334	569
Post	Post Insulator - 27 kV	48.13	-57.00	276.7	0.0	13.00	5.25	13.50	-235	334	99
Spool	Spool 4"	37.90	0.00	90.0	0.0	3.00	4.00	4.12	4	30	34
								Totals:	**4**	**2,150**	**2,154**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	40.53	35.52	13.68	12.59	7.96	15.74	1.43e+6	50.00	57.00	54.40	21,782	**217.99**	**2.44**

Pole Num:	**Pole 25**	Pole Length / Class:	**60 / 1**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**WESTERN RED CEDAR**	NESC Rule:	**Rule 250B**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**8.0**	Construction Grade:	**C**	Pole Strength Factor:	**0.85**
Aux Data 3	**Unset**	G/L Circumference (in):	**52.52**	Loading District:	**Medium**	Transverse Wind LF:	**1.75**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**6,000**	Ice Thickness (in):	**0.25**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**5,100**	Wind Speed (mph):	**39.53**	Vertical LF:	**1.90**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**4.00**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**53.4**	19.33	77.0
Groundline	**48.9**	0.0	76.3
Vertical	**24.1**	36.92	77.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**56,417**	51.7	77.0
Groundline	**95,401**	53.7	76.3
GL Allowable	**194,929**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 53.7°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,663	79.7	**83,179**	87.2	**42.7**	**2,176**	3,059	14	**2,190**	**42.9**
Pole	353	16.9	**8,730**	9.2	**4.5**	**228**	4,464	20	**249**	**4.9**
Crossarms	33	1.6	**1,607**	1.7	**0.8**	**42**	623	3	**45**	**0.9**
Insulators	39	1.9	**1,884**	2.0	**1.0**	**49**	302	1	**51**	**1.0**
Pole Load	2,088	100.0	**95,401**	100.0	**48.9**	**2,496**	8,448	38	**2,534**	**49.7**
Pole Reserve Capacity			**99,528**		**51.1**	**2,604**			**2,566**	**50.3**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 53.7°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,735	83.1	**86,671**	90.9	**44.5**	**2,267**	3,984	18	**2,285**	**44.8**
Pole	353	16.9	**8,730**	9.2	**4.5**	**228**	4,464	20	**249**	**4.9**
Totals:	2,088	100.0	**95,401**	100.0	**48.9**	**2,496**	8,448	38	**2,534**	**49.7**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		52.35	18.00	1.0610	3.65	1.075	238.0	1.0	238.1	3,000	95,194	405	4,385	99,985
Primary	ACSR 954 Rail		52.35	18.00	1.0610	1.41	1.075	107.0	180.0	107.0	2,000	-61,998	182	2,006	-59,810
Primary	ACSR 954 Rail		52.35	57.00	1.0610	3.65	1.075	238.0	1.0	238.1	3,000	95,194	1,284	4,385	100,863
Primary	ACSR 954 Rail		52.35	57.00	1.0610	1.20	1.075	107.0	180.0	107.0	3,000	-92,997	577	2,006	-90,414
Primary	ACSR 954 Rail		52.35	57.00	1.0610	3.65	1.075	238.0	1.0	238.1	3,000	95,194	-1,284	4,385	98,295
Primary	ACSR 954 Rail		52.35	57.00	1.0610	1.20	1.075	107.0	180.0	107.0	3,000	-92,997	-577	2,006	-91,568
Primary	ACSR 954 Rail		46.85	18.00	1.0610	3.65	1.075	238.0	1.0	238.1	3,000	85,202	-405	3,924	88,721
Primary	ACSR 954 Rail		46.85	18.00	1.0610	1.20	1.075	107.0	180.0	107.0	3,000	-83,235	-182	1,795	-81,623
Primary	ACSR 954 Rail		46.85	57.00	1.0610	3.65	1.075	238.0	1.0	238.1	3,000	85,202	1,284	3,924	90,411
Primary	ACSR 954 Rail		46.85	57.00	1.0610	1.20	1.075	107.0	180.0	107.0	3,000	-83,235	577	1,795	-80,863
Primary	ACSR 954 Rail		46.85	57.00	1.0610	3.65	1.075	238.0	1.0	238.1	3,000	85,202	-1,284	3,924	87,843
Primary	ACSR 954 Rail		46.85	57.00	1.0610	1.20	1.075	107.0	180.0	107.0	3,000	-83,235	-577	1,795	-82,017
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		37.00	8.47	0.5220	4.18	0.198	238.0	1.0	238.1	600	13,444	56	2,027	15,527
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		37.00	8.47	0.5220	1.48	0.198	107.0	180.0	107.0	600	-13,134	25	927	-12,181
											Totals:	**43,803**	**82**	**39,284**	**83,169**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		51.00	6.63	0.0	0.0	82.00	5.50	4.50	120.00	0	849	849
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		45.50	7.05	0.0	0.0	82.00	5.50	4.50	120.00	0	758	758
										Totals:	**0**	**1,607**	**1,607**

Insulator	Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)

Post	Post Insulator - 27 kV	51.23	18.00	69.8	0.0	13.00	5.25	13.50	60	326	386
Post	Post Insulator - 27 kV	51.23	57.00	83.4	0.0	13.00	5.25	13.50	189	326	515
Post	Post Insulator - 27 kV	51.23	-57.00	276.6	0.0	13.00	5.25	13.50	-189	326	137
Post	Post Insulator - 27 kV	45.73	-18.00	291.4	0.0	13.00	5.25	13.50	-60	292	232
Post	Post Insulator - 27 kV	45.73	57.00	82.9	0.0	13.00	5.25	13.50	189	292	481
Post	Post Insulator - 27 kV	45.73	-57.00	277.1	0.0	13.00	5.25	13.50	-189	292	102
Spool	Spool 4"	37.00	0.00	90.0	0.0	3.00	4.00	4.12	3	27	30
								Totals:	**3**	**1,881**	**1,884**

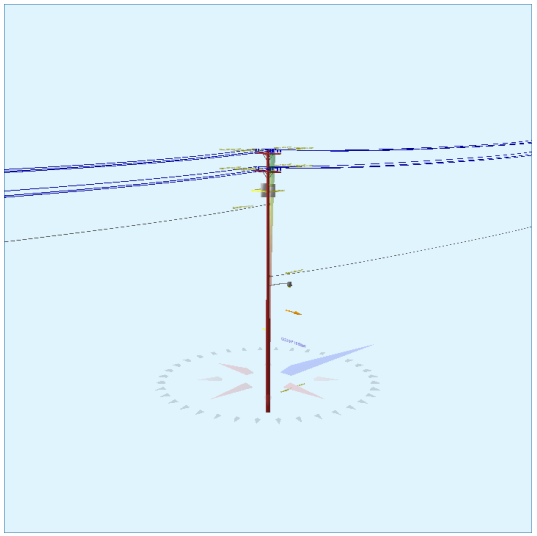
Pole Buckling

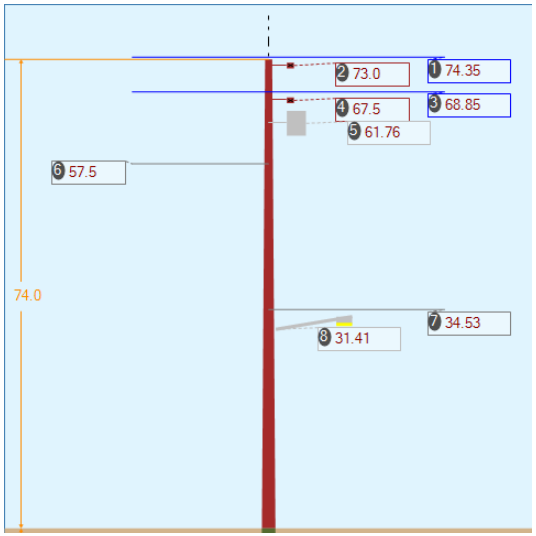
Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	36.86	35.17	14.69	11.71	8.60	16.73	1.43e+6	50.00	57.00	52.00	35,075	**350.54**	**4.15**

APPENDIX I

NESC Rule 250C Extreme Wind Pole Loading Analysis Reports

Pole Num:	**Pole 17**	Pole Length / Class:	**85 / 1**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250C**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**11.0**	Construction Grade:	**C**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**53.29**	Loading District:	**Special**	Transverse Wind LF:	**0.87**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**85.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**18.50**	Max 250C Wind (mph)	**87.84**
Latitude:		**0° 0' 0" N**	Longitude:		**0° 0' 0" W**	Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**96.3**	14.33	94.1
Groundline	**94.3**	0.0	93.4
Vertical	**26.6**	50.42	94.1

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**171,756**	97.2	94.1
Groundline	**225,874**	96.1	93.4
GL Allowable	**239,599**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 96.1°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	2,072	53.1	**148,288**	65.7	**61.9**	**3,684**	1,393	6	**3,690**	**61.5**
PowerEquipments	387	9.9	**24,214**	10.7	**10.1**	**602**	1,920	8	**610**	**10.2**
Pole	1,254	32.1	**41,916**	18.6	**17.5**	**1,041**	4,184	19	**1,060**	**17.7**
Crossarms	22	0.6	**1,580**	0.7	**0.7**	**39**	328	1	**41**	**0.7**
Streetlights	63	1.6	**2,457**	1.1	**1.0**	**61**	75	0	**61**	**1.0**
Insulators	104	2.7	**7,419**	3.3	**3.1**	**184**	162	1	**185**	**3.1**
Pole Load	3,901	100.0	**225,874**	100.0	**94.3**	**5,612**	8,062	36	**5,648**	**94.1**
Pole Reserve Capacity			**13,725**		**5.7**	**388**			**352**	**5.9**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 96.1°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	2,647	67.9	**183,958**	81.4	**76.8**	**4,570**	3,878	17	**4,588**	**76.5**
Pole	1,254	32.1	**41,916**	18.6	**17.5**	**1,041**	4,184	19	**1,060**	**17.7**
Totals:	3,901	100.0	**225,874**	100.0	**94.3**	**5,612**	8,062	36	**5,648**	**94.1**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		74.35	18.00	1.0610	2.83	1.075	188.0	1.0	188.1	2,500	-16,594	151	9,417	-7,027
Primary	ACSR 954 Rail		74.35	18.00	1.0610	3.89	1.075	231.0	180.0	231.1	2,500	19,825	185	11,342	31,352
Primary	ACSR 954 Rail		74.35	57.00	1.0610	2.83	1.075	188.0	1.0	188.1	2,500	-16,594	477	9,417	-6,700
Primary	ACSR 954 Rail		74.35	57.00	1.0610	3.89	1.075	231.0	180.0	231.1	2,500	19,825	586	11,342	31,753
Primary	ACSR 954 Rail		74.35	57.00	1.0610	2.83	1.075	188.0	1.0	188.1	2,500	-16,594	-477	9,417	-7,655
Primary	ACSR 954 Rail		74.35	57.00	1.0610	3.89	1.075	231.0	180.0	231.1	2,500	19,825	-586	11,342	30,581
Primary	ACSR 954 Rail		68.85	18.00	1.0610	2.83	1.075	188.0	1.0	188.1	2,500	-15,368	151	8,616	-6,601
Primary	ACSR 954 Rail		68.85	18.00	1.0610	3.89	1.075	231.0	180.0	231.1	2,500	18,359	185	10,376	28,921
Primary	ACSR 954 Rail		68.85	57.00	1.0610	2.83	1.075	188.0	1.0	188.1	2,500	-15,368	477	8,616	-6,275
Primary	ACSR 954 Rail		68.85	57.00	1.0610	3.89	1.075	231.0	180.0	231.1	2,500	18,359	586	10,376	29,322
Primary	ACSR 954 Rail		68.85	57.00	1.0610	2.57	1.075	188.0	1.0	188.0	3,000	-18,441	-477	8,616	-10,303
Primary	ACSR 954 Rail		68.85	57.00	1.0610	3.49	1.075	231.0	180.0	231.1	3,000	22,031	-586	10,376	31,821

Neutral	AAC 4/0 AWG 7 STRAND OXLIP	57.50	8.23	0.5220	4.04	0.198	231.0	180.0	231.1	600	3,677	16	4,156	7,848
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	34.53	9.52	0.5220	3.05	0.198	188.0	1.0	188.0	600	-1,849	15	1,918	84
										Totals:	**21,094**	**702**	**125,326**	**147,122**

PowerEquipment		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Transformer	1PH-50KVA		61.76	22.99	90.0	90.0	640.00	47.00	--	24.00	--	1,226	7,964	9,190
Transformer	1PH-50KVA		61.76	22.99	180.0	180.0	640.00	47.00	--	24.00	--	131	7,964	8,095
Transformer	1PH-50KVA		61.76	22.99	270.0	270.0	640.00	47.00	--	24.00	--	-1,226	7,964	6,738
											Totals:	**131**	**23,892**	**24,023**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		73.00	6.76	0.0	0.0	82.00	5.50	4.50	120.00	0	818	818
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		67.50	7.06	0.0	0.0	82.00	5.50	4.50	120.00	0	750	750
										Totals:	**0**	**1,568**	**1,568**

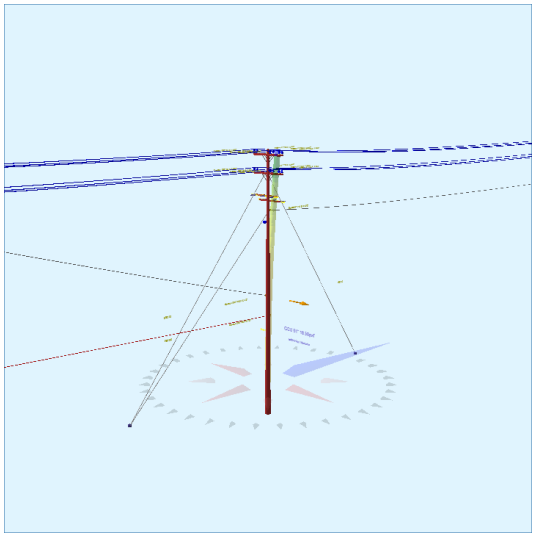
Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 8 ft. Arm		31.41	6.70	90.0	90.0	75.00	24.00	20.00	3.00	96.00	467	1,971	2,438
											Totals:	**467**	**1,971**	**2,438**

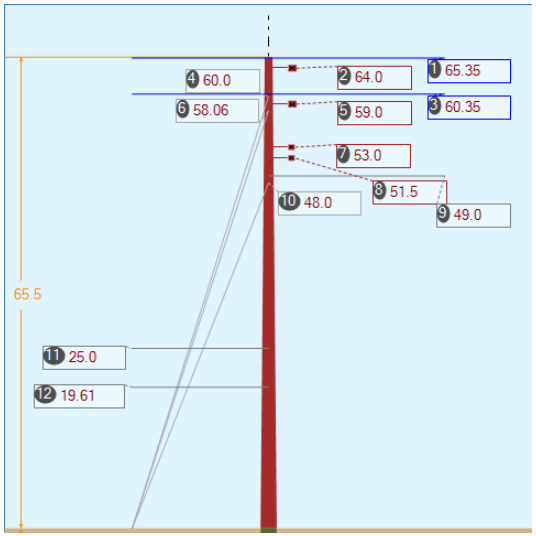
Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		73.23	18.00	69.4	0.0	13.00	5.25	13.50	39	1,236	1,275
Post	Post Insulator - 27 kV		73.23	57.00	83.2	0.0	13.00	5.25	13.50	123	1,236	1,359
Post	Post Insulator - 27 kV		73.23	-57.00	276.8	0.0	13.00	5.25	13.50	-123	1,236	1,113
Post	Post Insulator - 27 kV		67.73	18.00	68.6	0.0	13.00	5.25	13.50	39	1,133	1,172
Post	Post Insulator - 27 kV		67.73	57.00	82.9	0.0	13.00	5.25	13.50	123	1,133	1,256
Post	Post Insulator - 27 kV		67.73	-57.00	277.1	0.0	13.00	5.25	13.50	-123	1,133	1,010
Spool	Spool 4"		57.50	0.00	90.0	0.0	3.00	4.00	4.12	2	109	111
Spool	Spool 4"		34.53	0.00	90.0	0.0	3.00	4.00	4.12	2	61	64
									Totals:	**82**	**7,279**	**7,360**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	50.45	34.85	15.05	12.19	8.92	16.97	2.38e+6	60.00	57.00	74.00	30,268	**303.09**	**3.76**

Pole Num:	**Pole 18**	Pole Length / Class:	**75 / 1**	Code:	**NESC**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**WESTERN RED CEDAR**	NESC Rule:	**Rule 250C**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**9.5**	Construction Grade:	**C**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**56.43**	Loading District:	**Special**	Transverse Wind LF:	**0.87**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**6,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**4,500**	Wind Speed (mph):	**85.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**18.50**	Max 250C Wind (mph)	**103.8**
Latitude:		**0° 0' 0" N**	Longitude:		**0° 0' 0" W**	Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**74.1**	22.33	90.5
Groundline	**70.4**	0.0	90.5
Vertical	**2.1**	42.83	270.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**87,354**	86.6	90.5
Groundline	**150,194**	94.7	90.5
GL Allowable	**213,331**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Single Helix Anchor	48.0	180.0		**1.8**	90.5	**12.2**	0.0
EHS 3/8 (Down)			60.0	**1.6**	90.5	**10.1**	0.0
EHS 3/8 (Down)			48.0	**1.0**	90.5	**7.4**	0.0
Single Helix Anchor	39.0	0.0		**0.0**	90.5	**8.1**	180.0
EHS 3/8 (Down)			58.1	**0.0**	90.5	**11.7**	180.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 94.7°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,675	54.5	**101,312**	67.5	**47.5**	**2,114**	870	3	**2,117**	**47.0**
GuyBraces	80	2.6	**4,507**	3.0	**2.1**	**94**	317	1	**95**	**2.1**
Pole	1,120	36.4	**32,732**	21.8	**15.3**	**683**	3,280	13	**696**	**15.5**
Crossarms	25	0.8	**1,473**	1.0	**0.7**	**31**	428	2	**32**	**0.7**
Insulators	175	5.7	**10,169**	6.8	**4.8**	**212**	241	1	**213**	**4.7**
Pole Load	3,075	100.0	**150,194**	100.0	**70.4**	**3,133**	5,136	20	**3,154**	**70.1**
Pole Reserve Capacity			**63,137**		**29.6**	**1,367**			**1,346**	**29.9**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 94.7°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,955	63.6	**117,462**	78.2	**55.1**	**2,451**	1,856	7	**2,458**	**54.6**
Pole	1,120	36.4	**32,732**	21.8	**15.3**	**683**	3,280	13	**696**	**15.5**
Totals:	3,075	100.0	**150,194**	100.0	**70.4**	**3,133**	5,136	20	**3,154**	**70.1**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		65.35	18.00	1.0610	3.89	1.075	231.0	1.0	231.1	2,500	-10,554	186	9,828	-541
Primary	ACSR 954 Rail		65.35	18.00	1.0610	0.97	1.075	85.0	180.0	85.0	2,500	13,400	68	3,870	17,338
Primary	ACSR 954 Rail		65.35	57.00	1.0610	3.89	1.075	231.0	1.0	231.1	2,500	-10,554	588	9,828	-139
Primary	ACSR 954 Rail		65.35	57.00	1.0610	0.97	1.075	85.0	180.0	85.0	2,500	13,400	216	3,870	17,486
Primary	ACSR 954 Rail		65.35	57.00	1.0610	3.89	1.075	231.0	1.0	231.1	2,500	-10,554	-588	9,828	-1,314
Primary	ACSR 954 Rail		65.35	57.00	1.0610	0.97	1.075	85.0	180.0	85.0	2,500	13,400	-216	3,870	17,053
Primary	ACSR 954 Rail		60.35	18.00	1.0610	3.89	1.075	231.0	1.0	231.1	2,500	-9,747	186	8,962	-599
Primary	ACSR 954 Rail		60.35	18.00	1.0610	0.97	1.075	85.0	180.0	85.0	2,500	12,375	68	3,531	15,974
Primary	ACSR 954 Rail		60.35	57.00	1.0610	3.89	1.075	231.0	1.0	231.1	2,500	-9,747	588	8,962	-197
Primary	ACSR 954 Rail		60.35	57.00	1.0610	0.97	1.075	85.0	180.0	85.0	2,500	12,375	216	3,531	16,122
Primary	ACSR 954 Rail		60.35	57.00	1.0610	3.89	1.075	231.0	1.0	231.1	2,500	-9,747	-588	8,962	-1,373
Primary	ACSR 954 Rail		60.35	57.00	1.0610	0.97	1.075	85.0	180.0	85.0	2,500	12,375	-216	3,531	15,690

Neutral	AAC 4/0 AWG 7 STRAND OXLIP	49.00	8.48	0.5220	4.04	0.198	231.0	1.0	231.1	600	-1,898	16	3,476	1,594
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	25.00	10.19	0.5220	0.33	0.198	85.0	180.0	85.0	600	1,183	129	634	1,946
Neutral	AAC 4 AWG 7 STRAND ROSE	19.61	10.08	0.2320	0.08	0.039	85.0	180.0	85.0	600	964	-16	213	1,161
										Totals:	**16,671**	**637**	**82,893**	**100,201**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		64.00	6.65	0.0	0.0	82.00	5.50	4.50	120.00	0	602	602
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		59.00	7.01	0.0	0.0	82.00	5.50	4.50	120.00	0	550	550
Normal	8' x 3.5" x 4.5" SP - 3 Deadend		53.00	6.94	180.0	180.0	50.00	4.50	3.50	96.00	2	155	157
Normal	8' x 3.5" x 4.5" SP - 3 Deadend		51.50	7.05	0.0	0.0	50.00	4.50	3.50	96.00	-2	150	148
										Totals:	**0**	**1,457**	**1,457**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		64.23	18.00	69.7	0.0	13.00	5.25	13.50	39	1,066	1,105
Post	Post Insulator - 27 kV		64.23	57.00	83.3	0.0	13.00	5.25	13.50	123	1,066	1,189
Post	Post Insulator - 27 kV		64.23	-57.00	276.7	0.0	13.00	5.25	13.50	-123	1,066	943
Post	Post Insulator - 27 kV		59.23	18.00	68.7	0.0	13.00	5.25	13.50	39	973	1,012
Post	Post Insulator - 27 kV		59.23	57.00	83.0	0.0	13.00	5.25	13.50	123	973	1,097
Post	Post Insulator - 27 kV		59.23	-57.00	277.0	0.0	13.00	5.25	13.50	-123	973	850
Deadend	Deadend Insulator		53.00	0.00	180.0	0.0	8.99	3.00	30.00	2	543	545
Deadend	Deadend Insulator		53.00	44.00	261.0	0.0	8.99	3.00	30.00	-31	543	512
Deadend	Deadend Insulator		53.00	-44.00	99.0	0.0	8.99	3.00	30.00	35	543	578
Deadend	Deadend Insulator		51.50	0.00	0.0	0.0	8.99	3.00	30.00	-2	525	523
Deadend	Deadend Insulator		51.50	44.00	80.9	0.0	8.99	3.00	30.00	31	525	556
Deadend	Deadend Insulator		51.50	-44.00	279.1	0.0	8.99	3.00	30.00	-35	525	490
Spool	Spool 4"		49.00	0.00	90.0	0.0	3.00	4.00	4.12	2	91	93
Post	Post Insulator - 35 kV		45.83	0.00	180.0	180.0	23.00	5.75	16.75	4	501	504
Spool	Spool 4"		25.00	0.00	270.0	180.0	3.00	4.00	4.12	-3	43	40
Spool	Spool 3"		19.61	0.00	90.0	0.0	2.00	3.00	3.19	2	19	20
									Totals:	**82**	**9,975**	**10,058**

Guy Wire and Brace		Owner	Attach Height (ft)	End Height (ft)	Lead/Span Length (ft)	Wire Diameter (in)	Percent Solid (%)	Lead Angle (deg)	Incline Angle (deg)	Wire Weight (lbs/ft)	Rest Length (ft)	Stretch Length (in)
EHS 3/8	Down		60.00	0.00	48.00	0.375	75.00	180.0	51.1	0.273	82.74	0.12
EHS 3/8	Down		48.00	0.00	48.00	0.375	75.00	180.0	44.8	0.273	73.11	0.06
EHS 3/8	Down		58.06	0.00	39.00	0.375	75.00	0.0	55.9	0.273	76.31	0.00

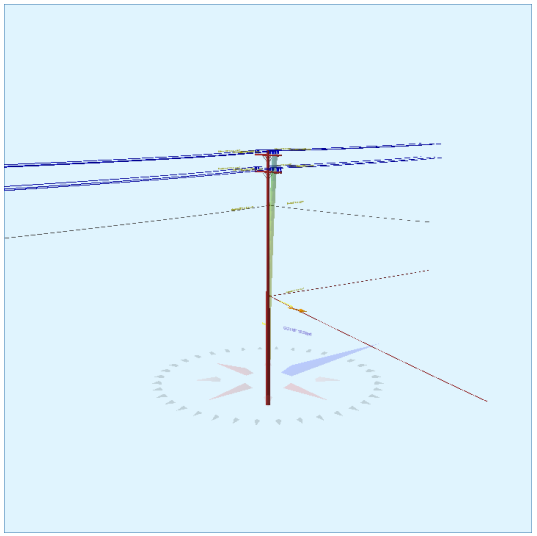
Guy Wire and Brace (Loads and Reactions)		Elastic Modulus (psi)	Rated Tensile Strength (lbs)	Guy Strength Factor	Allowable Tension (lbs)	Initial Tension (lbs)	Loaded Tension*[2] (lbs)	Maximum Tension[2] (lbs)	Applied Tension[3] (lbs)	Vertical Load (lbs)	Shear Load In Guy Dir (lbs)	Shear Load At Report Angle (lbs)	Moment at GL[3] (ft-lb)
EHS 3/8	Down	2.30e+7	15,400	0.90	13,860	700	1,404	1,404	228	177	143	12	2,014
EHS 3/8	Down	2.30e+7	15,400	0.90	13,860	700	1,031	1,031	134	94	95	8	1,279
EHS 3/8	Down	2.30e+7	15,400	0.90	13,860	700	1,627	1,627	0	0	0	0	1,164
									Totals:	**272**	**238**	**19**	**4,457**

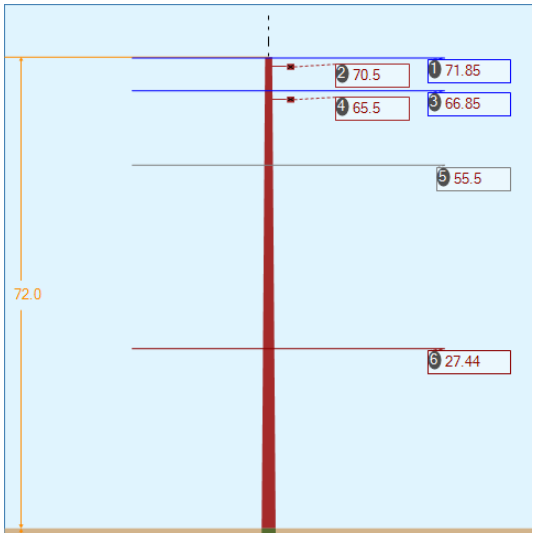
Anchor/Rod Load Summary	Owner	Rod Length AGL (in)	Lead Length (ft)	Lead Angle (deg)	Strength of Assembly (lbs)	Anchor/Rod Strength Factor	Allowable Load (lbs)	Max Load[2] (lbs)	Load at Pole MCU[3] (lbs)	Max Required Capacity[2] (%)
Single Helix Anchor		18.00	48.00	180.0	20,000	1.00	20,000	2,430	361	12.2
Single Helix Anchor		18.00	39.00	0.0	20,000	1.00	20,000	1,627	0	8.1

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
0.71	42.83	35.11	15.81	6.83	8.60	17.97	1.43e+6	50.00	57.00	65.50	245,883	**2445.58**	**47.62**

Pole Num:	**Pole 19**	Pole Length / Class:	**80 / 1**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250C**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**8.0**	Construction Grade:	**C**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**53.27**	Loading District:	**Special**	Transverse Wind LF:	**0.87**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**85.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**18.50**	Max 250C Wind (mph)	**114.87**
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**61.2**	0.0	87.7
Groundline	**61.2**	0.0	87.7
Vertical	**11.2**	41.67	87.7

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**145,452**	86.5	87.7
Groundline	**145,452**	86.5	87.7
GL Allowable	**239,318**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 86.5°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,638	55.3	**97,914**	67.3	**40.9**	**2,423**	838	4	**2,427**	**40.4**
Pole	1,201	40.6	**39,038**	26.8	**16.3**	**966**	3,983	18	**984**	**16.4**
Crossarms	20	0.7	**1,363**	0.9	**0.6**	**34**	328	1	**35**	**0.6**
Insulators	103	3.5	**7,136**	4.9	**3.0**	**177**	161	1	**177**	**3.0**
Pole Load	2,962	100.0	**145,452**	100.0	**60.8**	**3,599**	5,310	24	**3,623**	**60.4**
Pole Reserve Capacity			**93,866**		**39.2**	**2,401**			**2,377**	**39.6**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 86.5°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,761	59.4	**106,414**	73.2	**44.5**	**2,633**	1,327	6	**2,639**	**44.0**
Pole	1,201	40.6	**39,038**	26.8	**16.3**	**966**	3,983	18	**984**	**16.4**
Totals:	2,962	100.0	**145,452**	100.0	**60.8**	**3,599**	5,310	24	**3,623**	**60.4**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		71.85	18.00	1.0610	0.97	1.075	85.0	1.0	85.0	2,500	14,159	68	4,311	18,539
Primary	ACSR 954 Rail		71.85	18.00	1.0610	1.74	1.075	134.0	180.0	134.0	2,500	-11,030	108	6,632	-4,290
Primary	ACSR 954 Rail		71.85	44.00	1.0610	0.97	1.075	85.0	1.0	85.0	2,500	14,159	167	4,311	18,637
Primary	ACSR 954 Rail		71.85	44.00	1.0610	1.74	1.075	134.0	180.0	134.0	2,500	-11,030	264	6,632	-4,135
Primary	ACSR 954 Rail		71.85	57.00	1.0610	0.97	1.075	85.0	1.0	85.0	2,500	14,159	-217	4,311	18,254
Primary	ACSR 954 Rail		71.85	57.00	1.0610	1.74	1.075	134.0	180.0	134.0	2,500	-11,030	-341	6,632	-4,740
Primary	ACSR 954 Rail		66.85	18.00	1.0610	0.97	1.075	85.0	1.0	85.0	2,500	13,175	68	3,967	17,210
Primary	ACSR 954 Rail		66.85	18.00	1.0610	1.74	1.075	134.0	180.0	134.0	2,500	-10,263	108	6,102	-4,053
Primary	ACSR 954 Rail		66.85	57.00	1.0610	0.97	1.075	85.0	1.0	85.0	2,500	13,175	217	3,967	17,358
Primary	ACSR 954 Rail		66.85	57.00	1.0610	1.74	1.075	134.0	180.0	134.0	2,500	-10,263	341	6,102	-3,820
Primary	ACSR 954 Rail		66.85	57.00	1.0610	0.97	1.075	85.0	1.0	85.0	2,500	13,175	-217	3,967	16,925
Primary	ACSR 954 Rail		66.85	57.00	1.0610	1.74	1.075	134.0	180.0	134.0	2,500	-10,263	-341	6,102	-4,503
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		55.50	8.26	0.5220	0.32	0.198	85.0	1.0	85.0	600	2,593	67	1,580	4,240
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		55.50	8.26	0.5220	1.96	0.198	134.0	180.0	134.0	600	-2,043	9	2,429	394
Secondary	DUPLEX 6 AWG		27.44	9.38	0.5370	0.22	0.071	85.0	1.0	85.0	357	771	14	724	1,509
Secondary	DUPLEX 6 AWG		27.44	9.38	0.5370	1.11	0.071	100.0	110.0	100.0	357	8,982	3	128	9,113
											Totals:	**28,427**	**318**	**67,895**	**96,639**

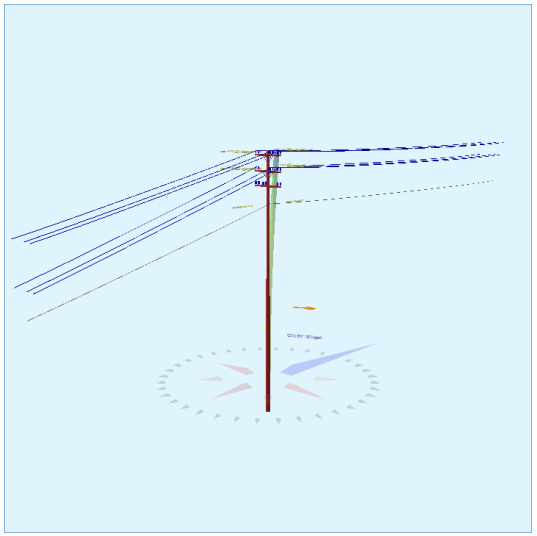
Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		70.50	6.63	0.0	0.0	82.00	5.50	4.50	120.00	0	701	701
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		65.50	6.92	0.0	0.0	82.00	5.50	4.50	120.00	0	645	645
										Totals:	**0**	**1,346**	**1,346**

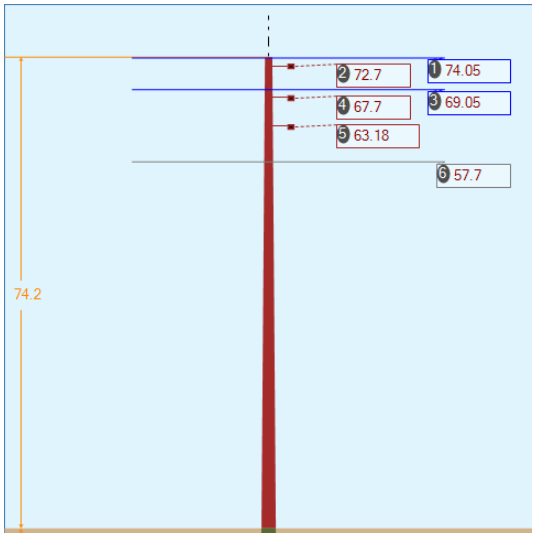
Insulator		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Post	Post Insulator - 27 kV		70.73	18.00	69.8	0.0	13.00	5.25	13.50	39	1,190	1,229
Post	Post Insulator - 27 kV		70.73	44.00	81.4	0.0	13.00	5.25	13.50	95	1,190	1,285
Post	Post Insulator - 27 kV		70.73	-57.00	276.6	0.0	13.00	5.25	13.50	-123	1,190	1,066
Post	Post Insulator - 27 kV		65.73	18.00	69.0	0.0	13.00	5.25	13.50	39	1,096	1,135
Post	Post Insulator - 27 kV		65.73	57.00	83.1	0.0	13.00	5.25	13.50	123	1,096	1,219
Post	Post Insulator - 27 kV		65.73	-57.00	276.9	0.0	13.00	5.25	13.50	-123	1,096	973
Spool	Spool 4"		55.50	0.00	90.0	0.0	3.00	4.00	4.12	2	105	107
Spool	Spool 3"		27.44	0.00	90.0	0.0	2.00	3.00	3.19	2	28	29
									Totals:	**53**	**6,990**	**7,044**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	41.72	34.29	15.30	9.82	8.60	16.97	2.38e+6	60.00	57.00	72.00	47,203	**474.12**	**8.93**

Pole Num:	**Pole 20**	Pole Length / Class:	**85 / H1**	Code:	**NESC**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**Rule 250C**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.83**	Construction Grade:	**C**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**56.71**	Loading District:	**Special**	Transverse Wind LF:	**0.87**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**85.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**18.50**	Max 250C Wind (mph)	**122.87**
Latitude:		**0° 0' 0" N**	Longitude:		**0° 0' 0" W**	Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**56.8**	0.0	60.7
Groundline	**56.8**	0.0	60.0
Vertical	**34.3**	55.5	60.7

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**160,469**	55.7	60.7
Groundline	**160,469**	55.7	60.0
GL Allowable	**288,698**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 55.7°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,231	42.0	**90,118**	56.2	**31.2**	**1,848**	4,768	19	**1,867**	**31.1**
Pole	1,322	45.1	**44,341**	27.6	**15.4**	**910**	4,676	18	**928**	**15.5**
Crossarms	225	7.7	**15,502**	9.7	**5.4**	**318**	492	2	**320**	**5.3**
Insulators	151	5.2	**10,509**	6.6	**3.6**	**216**	237	1	**216**	**3.6**
Pole Load	2,930	100.0	**160,469**	100.0	**55.6**	**3,291**	10,172	40	**3,331**	**55.5**
Pole Reserve Capacity			**128,229**		**44.4**	**2,709**			**2,669**	**44.5**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 55.7°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,608	54.9	**116,128**	72.4	**40.2**	**2,382**	5,497	21	**2,403**	**40.1**
Pole	1,322	45.1	**44,341**	27.6	**15.4**	**910**	4,676	18	**928**	**15.5**
Totals:	2,930	100.0	**160,469**	100.0	**55.6**	**3,291**	10,172	40	**3,331**	**55.5**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		74.05	18.00	1.0610	1.74	1.075	134.0	1.0	134.0	2,500	106,953	89	4,854	111,897
Primary	ACSR 954 Rail		74.05	18.00	1.0610	0.39	1.075	83.0	180.0	83.0	2,500	-101,668	735	3,160	-97,773
Primary	ACSR 954 Rail		74.05	57.00	1.0610	1.74	1.075	134.0	1.0	134.0	2,500	106,953	283	4,854	112,090
Primary	ACSR 954 Rail		74.05	57.00	1.0610	0.39	1.075	83.0	180.0	83.0	2,500	-101,668	2,326	3,160	-96,182
Primary	ACSR 954 Rail		74.05	57.00	1.0610	1.74	1.075	134.0	1.0	134.0	2,500	106,953	-283	4,854	111,525
Primary	ACSR 954 Rail		74.05	57.00	1.0610	0.39	1.075	83.0	180.0	83.0	2,500	-101,668	-2,326	3,160	-100,834
Primary	ACSR 954 Rail		69.05	18.00	1.0610	1.74	1.075	134.0	1.0	134.0	2,500	99,736	89	4,477	104,303
Primary	ACSR 954 Rail		69.05	18.00	1.0610	0.41	1.075	83.0	180.0	83.0	2,500	-92,812	965	2,915	-88,932
Primary	ACSR 954 Rail		69.05	57.00	1.0610	1.74	1.075	134.0	1.0	134.0	2,500	99,736	283	4,477	104,497
Primary	ACSR 954 Rail		69.05	57.00	1.0610	0.41	1.075	83.0	180.0	83.0	2,500	-92,812	3,056	2,915	-86,841
Primary	ACSR 954 Rail		69.05	57.00	1.0610	1.74	1.075	134.0	1.0	134.0	2,500	99,736	-283	4,477	103,931
Primary	ACSR 954 Rail		69.05	57.00	1.0610	0.41	1.075	83.0	180.0	83.0	2,500	-92,812	-3,056	2,915	-92,954
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		57.70	8.60	0.5220	1.96	0.198	134.0	1.0	134.0	600	19,988	8	1,795	21,791
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		57.70	8.60	0.5220	0.31	0.198	83.0	180.0	83.0	600	-18,841	95	1,169	-17,577
											Totals:	**37,776**	**1,981**	**49,183**	**88,940**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		72.70	6.95	0.0	0.0	82.00	5.50	4.50	120.00	0	5,508	5,508
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		67.70	7.25	0.0	0.0	82.00	5.50	4.50	120.00	0	5,085	5,085
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		63.18	7.52	0.0	0.0	82.00	5.50	4.50	120.00	0	4,706	4,706
										Totals:	**0**	**15,299**	**15,299**

Insulator		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Post	Post Insulator - 27 kV		72.93	18.00	68.9	0.0	13.00	5.25	13.50	32	1,227	1,259
Post	Post Insulator - 27 kV		72.93	57.00	83.0	0.0	13.00	5.25	13.50	102	1,227	1,329
Post	Post Insulator - 27 kV		72.93	-57.00	277.0	0.0	13.00	5.25	13.50	-102	1,227	1,125
Post	Post Insulator - 27 kV		67.93	18.00	68.1	0.0	13.00	5.25	13.50	32	1,133	1,165
Post	Post Insulator - 27 kV		67.93	57.00	82.7	0.0	13.00	5.25	13.50	102	1,133	1,235
Post	Post Insulator - 27 kV		67.93	-57.00	277.3	0.0	13.00	5.25	13.50	-102	1,133	1,031
Post	Post Insulator - 27 kV		63.41	-18.00	292.7	0.0	13.00	5.25	13.50	-32	1,049	1,017
Post	Post Insulator - 27 kV		63.41	57.00	82.5	0.0	13.00	5.25	13.50	102	1,049	1,151
Post	Post Insulator - 27 kV		63.41	-57.00	277.5	0.0	13.00	5.25	13.50	-102	1,049	947
Spool	Spool 4"		57.70	0.00	90.0	0.0	3.00	4.00	4.12	2	109	111
									Totals:	**34**	**10,337**	**10,371**

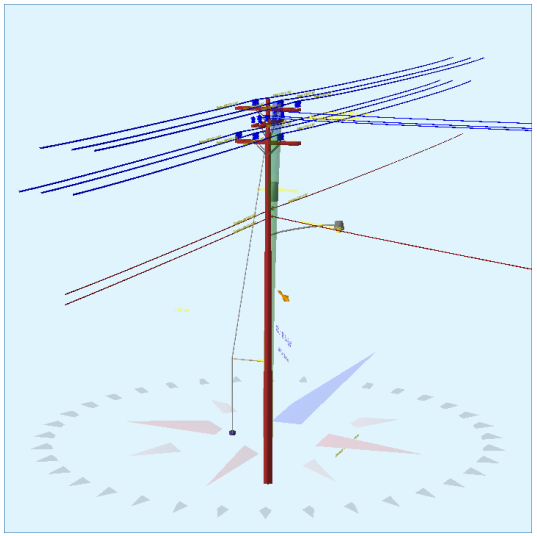
Pole Buckling

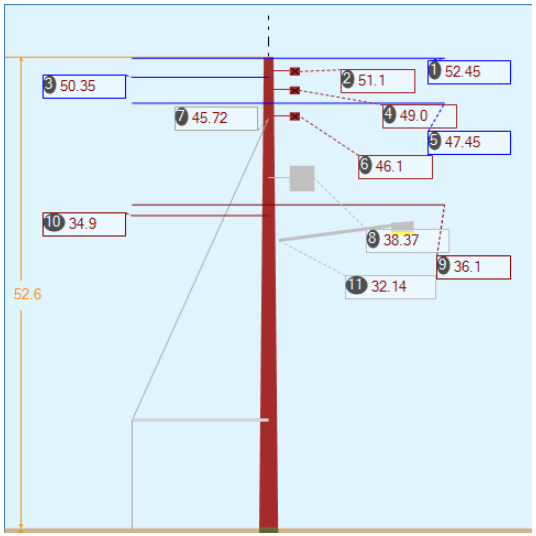
Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	55.53	35.48	15.71	13.81	9.24	18.06	2.38e+6	60.00	57.00	74.20	29,648	**296.56**	**2.92**

APPENDIX J

Expected Storm
Pole Loading Analysis Reports

Pole Num:	**Pole 1F**	Pole Length / Class:	**60 / 1**	Code:	**N/A**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**WESTERN RED CEDAR**	NESC Rule:	**-**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**7.42**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**52.81**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**6,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**4,500**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:		**0° 0' 0" N**	Longitude:		**0° 0' 0" W**	Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**37.1**	0.0	148.6
Groundline	**37.1**	0.0	148.6
Vertical	**6.2**	41.67	90.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**62,904**	138.6	148.6
Groundline	**62,904**	138.6	148.6
GL Allowable	**174,905**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Single Helix Anchor	6.0	270.0		**36.4**	148.6	**42.7**	90.0
EHS 3/8 (Sidewalk)			45.7	**52.5**	148.6	**61.6**	90.0
Sidewalk Strut	6.0	270.0	12.1	**51.1**	148.6	**60.0**	90.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 138.6°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,721	73.8	**70,410**	111.9	**40.3**	**1,920**	623	3	**1,923**	**42.7**
GuyBraces	5	0.2	**-26,706**	-42.5	**-15.3**	**-860**	7,189	32	**-828**	**-18.4**
PowerEquipments	31	1.3	**689**	1.1	**0.4**	**19**	335	2	**20**	**0.5**
Pole	329	14.1	**7,283**	11.6	**4.2**	**199**	2,395	11	**209**	**4.7**
Crossarms	159	6.8	**7,295**	11.6	**4.2**	**199**	318	1	**200**	**4.5**
Streetlights	28	1.2	**1,240**	2.0	**0.7**	**34**	85	0	**34**	**0.8**
Insulators	57	2.5	**2,694**	4.3	**1.5**	**74**	238	1	**75**	**1.7**
Pole Load	2,330	100.0	**62,904**	100.0	**36.0**	**1,583**	11,183	50	**1,633**	**36.3**
Pole Reserve Capacity			**112,001**		**64.0**	**2,917**			**2,867**	**63.7**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 138.6°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	2,001	85.9	**55,621**	88.4	**31.8**	**1,385**	8,787	40	**1,424**	**31.6**
Pole	329	14.1	**7,283**	11.6	**4.2**	**199**	2,395	11	**209**	**4.7**
Totals:	2,330	100.0	**62,904**	100.0	**36.0**	**1,583**	11,183	50	**1,633**	**36.3**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		52.45	57.00	1.1650	1.33	1.075	114.0	1.0	114.0	3,000	-116,231	193	628	-115,410
Primary	ACSR 954 Rail		52.45	57.00	1.1650	0.70	1.075	67.0	180.0	67.0	3,000	118,068	113	362	118,543
Primary	ACSR 954 Rail		52.45	24.00	1.1650	1.33	1.075	114.0	1.0	114.0	3,000	-116,231	-81	628	-115,684
Primary	ACSR 954 Rail		52.45	24.00	1.1650	0.70	1.075	67.0	180.0	67.0	3,000	118,068	-48	362	118,382
Primary	ACSR 954 Rail		52.45	24.00	1.1650	1.33	1.075	114.0	1.0	114.0	3,000	-116,231	81	628	-115,522
Primary	ACSR 954 Rail		52.45	24.00	1.1650	0.70	1.075	67.0	180.0	67.0	3,000	118,068	48	362	118,478
Primary	AAC 3/0 AWG 7 STRAND PHLOX		50.35	24.00	0.4640	1.24	0.157	80.0	91.0	80.0	300	10,199	9	294	10,502
Primary	AAC 3/0 AWG 7 STRAND PHLOX		50.35	57.00	0.4640	1.24	0.157	80.0	91.0	80.0	300	10,199	22	294	10,515
Primary	AAC 3/0 AWG 7 STRAND PHLOX		50.35	57.00	0.4640	1.24	0.157	80.0	91.0	80.0	300	10,199	-22	294	10,470
Primary	ACSR 954 Rail		47.45	24.00	1.1650	1.33	1.075	114.0	1.0	114.0	3,000	-105,162	81	560	-104,521

Primary	ACSR 954 Rail	47.45	24.00	1.1650	0.70	1.075	67.0	180.0	67.0	3,000	106,824	48	323	107,194
Primary	ACSR 954 Rail	47.45	57.00	1.1650	1.33	1.075	114.0	1.0	114.0	3,000	-105,162	-193	560	-104,795
Primary	ACSR 954 Rail	47.45	57.00	1.1650	0.70	1.075	67.0	180.0	67.0	3,000	106,824	-113	323	107,034
Primary	ACSR 954 Rail	47.45	24.00	1.1650	1.33	1.075	114.0	1.0	114.0	3,000	-105,162	-81	560	-104,683
Primary	ACSR 954 Rail	47.45	24.00	1.1650	0.70	1.075	67.0	180.0	67.0	3,000	106,824	-48	323	107,099
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	36.10	8.59	0.2640	0.61	0.136	114.0	1.0	114.0	600	-15,984	4	93	-15,887
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	36.10	8.59	0.2640	0.22	0.136	67.0	180.0	67.0	600	16,236	2	54	16,292
Secondary	DUPLEX 4 AWG	34.90	7.93	0.6300	0.71	0.107	67.0	180.0	67.0	558	14,598	2	123	14,722
Secondary	DUPLEX 6 AWG	34.90	7.93	0.5370	1.28	0.071	114.0	120.0	114.0	357	11,812	2	77	11,890
										Totals:	**67,758**	**19**	**6,844**	**74,621**

PowerEquipment		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Transformer	1PH-15KVA		38.37	22.41	0.0	0.0	335.00	34.00	--	22.00	--	-469	1,199	730
											Totals:	**-469**	**1,199**	**730**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 8		51.10	6.66	0.0	0.0	53.00	5.50	4.50	120.00	0	3,182	3,182
Normal	CROSSARM 3-1/2 X 4-1/2 X 8		49.00	6.83	90.0	90.0	53.00	5.50	4.50	120.00	0	1,715	1,715
Normal	CROSSARM 3-1/2 X 4-1/2 X 8		46.10	7.05	0.0	0.0	53.00	5.50	4.50	120.00	0	2,834	2,834
										Totals:	**0**	**7,731**	**7,731**

Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		32.14	5.90	90.0	90.0	85.00	24.00	20.00	3.00	120.00	425	890	1,315
											Totals:	**425**	**890**	**1,315**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		51.33	57.00	83.3	0.0	13.00	5.25	13.50	82	326	407
Post	Post Insulator - 27 kV		51.33	-24.00	285.5	0.0	13.00	5.25	13.50	-34	326	291
Post	Post Insulator - 27 kV		51.33	24.00	105.5	90.5	13.00	5.25	13.50	34	326	360
Post	Post Insulator - 27 kV		49.23	24.00	164.1	0.0	13.00	5.25	13.50	39	311	350
Post	Post Insulator - 27 kV		49.23	57.00	173.2	0.0	13.00	5.25	13.50	93	311	403
Post	Post Insulator - 27 kV		49.23	-57.00	6.8	0.0	13.00	5.25	13.50	-93	311	218
Post	Post Insulator - 27 kV		46.33	24.00	73.6	0.0	13.00	5.25	13.50	34	290	325

Post	Post Insulator - 27 kV	46.33	-57.00	277.1	0.0	13.00	5.25	13.50	-82	290	209
Post	Post Insulator - 27 kV	46.33	-24.00	253.6	90.5	13.00	5.25	13.50	-34	290	256
Spool	Spool 4"	36.10	0.00	90.0	0.0	3.00	4.00	4.12	1	25	27
Spool	Spool 2.5"	34.90	0.00	90.0	0.0	1.00	2.50	2.12	0	8	8
								Totals:	**41**	**2,814**	**2,855**

Guy Wire and Brace		**Owner**	**Attach Height (ft)**	**End Height (ft)**	**Lead/Span Length (ft)**	**Wire Diameter (in)**	**Percent Solid (%)**	**Lead Angle (deg)**	**Incline Angle (deg)**	**Wire Weight (lbs/ft)**	**Rest Length (ft)**	**Stretch Length (in)**
EHS 3/8	Sidewalk		45.72	0.00	6.00	0.375	75.00	270.0	79.4	0.273	52.09	2.44

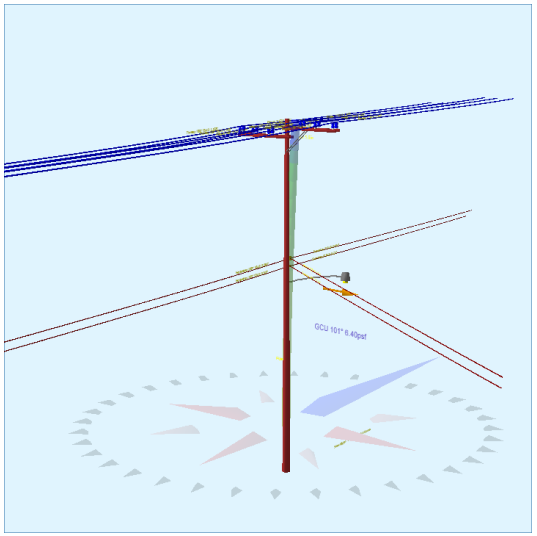
Guy Wire and Brace (Loads and Reactions)		**Elastic Modulus (psi)**	**Rated Tensile Strength (lbs)**	**Guy Strength Factor**	**Allowable Tension (lbs)**	**Initial Tension (lbs)**	**Loaded Tension*[2] (lbs)**	**Maximum Tension[2] (lbs)**	**Applied Tension[3] (lbs)**	**Vertical Load (lbs)**	**Shear Load In Guy Dir (lbs)**	**Shear Load At Report Angle (lbs)**	**Moment at GL[3] (ft-lb)**
EHS 3/8	Sidewalk	2.30e+7	15,400	0.90	13,860	700	8,540	8,540	7,279	7,154	1,340	-887	-28,304
									Totals:	**7,154**	**1,340**	**-887**	**-28,304**

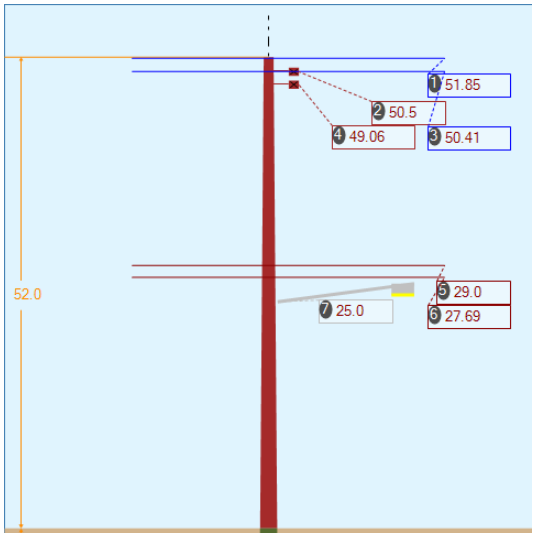
Anchor/Rod Load Summary	**Owner**	**Rod Length AGL (in)**	**Lead Length (ft)**	**Lead Angle (deg)**	**Strength of Assembly (lbs)**	**Anchor/Rod Strength Factor**	**Allowable Load (lbs)**	**Max Load[2] (lbs)**	**Load at Pole MCU[3] (lbs)**	**Max Required Capacity[2] (%)**
Single Helix Anchor		18.00	6.00	270.0	20,000	1.00	20,000	8,540	7,279	42.7

Pole Buckling

Buckling Constant	**Buckling Column Height* (ft)**	**Buckling Section Height (% Buckling Col. Hgt.)**	**Buckling Section Diameter (in)**	**Minimum Buckling Diameter at GL (in)**	**Diameter at Tip (in)**	**Diameter at GL (in)**	**Modulus of Elasticity (psi)**	**Pole Density (pcf)**	**Ice Density (pcf)**	**Pole Tip Height (ft)**	**Buckling Load Capacity at Height (lbs)**	**Buckling Load Applied at Height (lbs)**	**Buckling Load Factor of Safety**
0.71	41.75	35.82	14.48	8.37	8.60	16.82	1.43e+6	50.00	57.00	52.60	181,786	**1803.67**	**16.13**

Pole Num:	**Pole 2F**	Pole Length / Class:	**60 / 1**	Code:	**N/A**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**8.0**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**47.22**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**43.5**	0.0	101.3
Groundline	**43.5**	0.0	101.3
Vertical	**8.0**	33.5	101.3

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**72,019**	107.4	101.3
Groundline	**72,019**	107.4	101.3
GL Allowable	**166,709**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 107.4°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,592	80.4	**60,635**	84.2	**36.4**	**2,169**	744	4	**2,173**	**36.2**
Pole	305	15.4	**7,252**	10.1	**4.4**	**259**	2,433	14	**273**	**4.6**
Crossarms	18	0.9	**889**	1.2	**0.5**	**32**	270	2	**33**	**0.6**
Streetlights	27	1.4	**1,297**	1.8	**0.8**	**46**	85	0	**47**	**0.8**
Insulators	39	2.0	**1,946**	2.7	**1.2**	**70**	160	1	**71**	**1.2**
Pole Load	1,981	100.0	**72,019**	100.0	**43.2**	**2,577**	3,692	21	**2,597**	**43.3**
Pole Reserve Capacity			**94,690**		**56.8**	**3,423**			**3,403**	**56.7**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 107.4°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,676	84.6	**64,767**	89.9	**38.9**	**2,317**	1,259	7	**2,324**	**38.7**
Pole	305	15.4	**7,252**	10.1	**4.4**	**259**	2,433	14	**273**	**4.6**
Totals:	1,981	100.0	**72,019**	100.0	**43.2**	**2,577**	3,692	21	**2,597**	**43.3**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		51.85	108.83	1.1650	0.70	1.075	67.0	1.0	67.0	3,000	-43,873	312	978	-42,583
Primary	ACSR 954 Rail		51.85	108.83	1.1650	1.97	1.075	154.0	180.0	154.0	3,000	46,473	717	2,123	49,313
Primary	ACSR 954 Rail		51.85	68.90	1.1650	0.70	1.075	67.0	1.0	67.0	3,000	-43,873	197	978	-42,698
Primary	ACSR 954 Rail		51.85	68.90	1.1650	1.97	1.075	154.0	180.0	154.0	3,000	46,473	454	2,123	49,050
Primary	ACSR 954 Rail		51.85	36.10	1.1650	0.70	1.075	67.0	1.0	67.0	3,000	-43,873	103	978	-42,792
Primary	ACSR 954 Rail		51.85	36.10	1.1650	1.97	1.075	154.0	180.0	154.0	3,000	46,473	238	2,123	48,834
Primary	ACSR 954 Rail		50.41	106.60	1.1650	0.70	1.075	67.0	1.0	67.0	3,000	-42,655	-305	947	-42,014
Primary	ACSR 954 Rail		50.41	106.60	1.1650	1.97	1.075	154.0	180.0	154.0	3,000	45,184	-702	2,055	46,537
Primary	ACSR 954 Rail		50.41	75.00	1.1650	0.70	1.075	67.0	1.0	67.0	3,000	-42,655	-215	947	-41,924
Primary	ACSR 954 Rail		50.41	75.00	1.1650	1.97	1.075	154.0	180.0	154.0	3,000	45,184	-494	2,055	46,745
Primary	ACSR 954 Rail		50.41	37.59	1.1650	0.70	1.075	67.0	1.0	67.0	3,000	-42,655	-108	947	-41,817
Primary	ACSR 954 Rail		50.41	37.59	1.1650	1.97	1.075	154.0	180.0	154.0	3,000	45,184	-247	2,055	46,991
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		29.00	8.72	0.2640	0.22	0.136	67.0	1.0	67.0	600	-4,903	3	114	-4,785
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		29.00	8.72	0.2640	1.09	0.136	154.0	180.0	154.0	600	5,193	7	247	5,448
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		29.00	8.72	0.2640	0.31	0.136	80.0	130.0	80.0	600	16,060	4	26	16,090
Secondary	DUPLEX 6 AWG		27.69	8.05	0.5370	0.73	0.071	67.0	0.0	67.0	357	-2,950	2	218	-2,731
Secondary	DUPLEX 6 AWG		27.69	8.05	0.5370	1.80	0.071	154.0	180.0	154.0	357	2,950	4	477	3,431
Secondary	DUPLEX 6 AWG		27.69	8.05	0.5370	0.87	0.071	80.0	130.0	80.0	357	9,124	2	51	9,177
											Totals:	**40,862**	**-30**	**19,441**	**60,273**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		50.50	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	449	449

Normal	CROSSARM 3-1/2 X 4-1/2 X 8	49.06	6.73	0.0	0.0	53.00	5.50	4.50	120.00	0	435	435
									Totals:	**0**	**884**	**884**

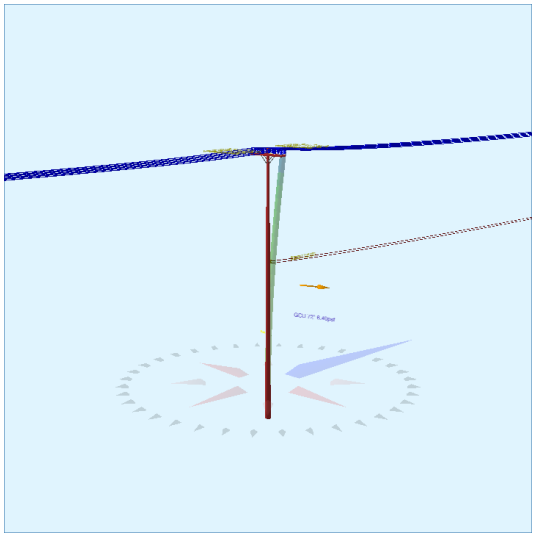
Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		25.00	5.97	90.0	90.0	85.00	24.00	20.00	3.00	120.00	613	677	1,290
											Totals:	**613**	**677**	**1,290**

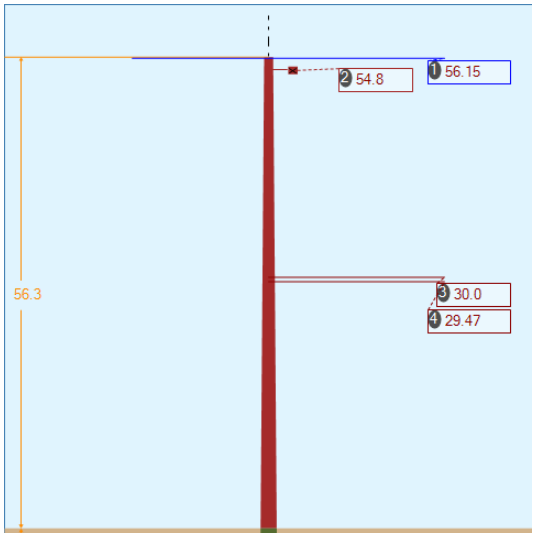
Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		50.73	108.83	93.5	90.5	13.00	5.25	13.50	225	325	550
Post	Post Insulator - 27 kV		50.73	68.90	95.5	90.5	13.00	5.25	13.50	142	325	467
Post	Post Insulator - 27 kV		50.73	36.10	100.4	90.5	13.00	5.25	13.50	75	325	399
Post	Post Insulator - 27 kV		49.29	-106.60	266.4	90.5	13.00	5.25	13.50	-220	314	94
Post	Post Insulator - 27 kV		49.29	-75.00	264.9	90.5	13.00	5.25	13.50	-155	314	159
Post	Post Insulator - 27 kV		49.29	-37.59	259.9	90.5	13.00	5.25	13.50	-78	314	237
Spool	Spool 4"		29.00	0.00	90.0	0.0	3.00	4.00	4.12	2	20	22
Spool	Spool 2.5"		27.69	0.00	90.0	0.0	1.00	2.50	2.12	1	6	7
									Totals:	**-8**	**1,943**	**1,934**

Pole Buckling

Buckling Constant	**Buckling Column Height* (ft)**	**Buckling Section Height (% Buckling Col. Hgt.)**	**Buckling Section Diameter (in)**	**Minimum Buckling Diameter at GL (in)**	**Diameter at Tip (in)**	**Diameter at GL (in)**	**Modulus of Elasticity (psi)**	**Pole Density (pcf)**	**Ice Density (pcf)**	**Pole Tip Height (ft)**	**Buckling Load Capacity at Height (lbs)**	**Buckling Load Applied at Height (lbs)**	**Buckling Load Factor of Safety**
2.00	33.45	34.13	13.62	7.99	8.60	15.04	2.38e+6	60.00	57.00	52.00	46,143	**461.53**	**12.50**

Pole Num:	**Pole 3**	Pole Length / Class:	**65 / 1**	Code:	**N/A**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**8.67**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.47**	Loading District:	**N/A**	Transverse Wind LF:	**0.87**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**	Elevation:	**0M**	





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**34.6**	0.0	72.0
Groundline	**34.6**	0.0	72.0
Vertical	**9.9**	36.92	72.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**61,706**	49.8	72.0
Groundline	**61,706**	49.8	72.0
GL Allowable	**180,280**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 49.8°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,299	79.9	**51,842**	84.0	**28.8**	**1,713**	1,008	5	**1,719**	**28.6**
Pole	275	16.9	**7,049**	11.4	**3.9**	**233**	2,730	15	**248**	**4.1**
Crossarms	19	1.2	**1,050**	1.7	**0.6**	**35**	164	1	**36**	**0.6**
Insulators	32	2.0	**1,765**	2.9	**1.0**	**58**	160	1	**59**	**1.0**
Pole Load	1,624	100.0	**61,706**	100.0	**34.2**	**2,039**	4,062	22	**2,061**	**34.4**
Pole Reserve Capacity			**118,574**		**65.8**	**3,961**			**3,939**	**65.6**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 49.8°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,350	83.1	**54,657**	88.6	**30.3**	**1,806**	1,332	7	**1,814**	**30.2**
Pole	275	16.9	**7,049**	11.4	**3.9**	**233**	2,730	15	**248**	**4.1**
Totals:	1,624	100.0	**61,706**	100.0	**34.2**	**2,039**	4,062	22	**2,061**	**34.4**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		56.15	33.00	1.1650	2.38	1.075	154.0	1.0	154.1	2,000	74,057	174	1,538	75,769
Primary	ACSR 954 Rail		56.15	33.00	1.1650	2.26	1.075	149.0	180.0	149.1	2,000	-72,570	168	1,523	-70,879
Primary	ACSR 954 Rail		56.15	58.00	1.1650	2.38	1.075	154.0	1.0	154.1	2,000	74,057	306	1,538	75,901
Primary	ACSR 954 Rail		56.15	58.00	1.1650	2.26	1.075	149.0	180.0	149.1	2,000	-72,570	296	1,523	-70,751
Primary	ACSR 954 Rail		56.15	12.00	1.1650	2.38	1.075	154.0	1.0	154.1	2,000	74,057	63	1,538	75,659
Primary	ACSR 954 Rail		56.15	12.00	1.1650	2.26	1.075	149.0	180.0	149.1	2,000	-72,570	61	1,523	-70,986
Primary	ACSR 954 Rail		56.15	58.00	1.1650	2.38	1.075	154.0	1.0	154.1	2,000	74,057	-306	1,538	75,290
Primary	ACSR 954 Rail		56.15	58.00	1.1650	2.26	1.075	149.0	180.0	149.1	2,000	-72,570	-296	1,523	-71,342
Primary	ACSR 954 Rail		56.15	33.00	1.1650	2.38	1.075	154.0	1.0	154.1	2,000	74,057	-174	1,538	75,422
Primary	ACSR 954 Rail		56.15	33.00	1.1650	2.26	1.075	149.0	180.0	149.1	2,000	-72,570	-168	1,523	-71,215
Primary	ACSR 954 Rail		56.15	12.00	1.1650	2.38	1.075	154.0	1.0	154.1	2,000	74,057	-63	1,538	75,532
Primary	ACSR 954 Rail		56.15	12.00	1.1650	2.26	1.075	149.0	180.0	149.1	2,000	-72,570	-61	1,523	-71,108
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		30.00	8.89	0.5220	2.33	0.198	154.0	1.0	154.0	600	11,859	9	336	12,204
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		29.47	8.18	0.5220	2.33	0.198	154.0	1.0	154.0	600	11,650	8	329	11,987
											Totals:	**32,431**	**17**	**19,034**	**51,482**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		54.80	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	1,042	1,042
										Totals:	**0**	**1,042**	**1,042**

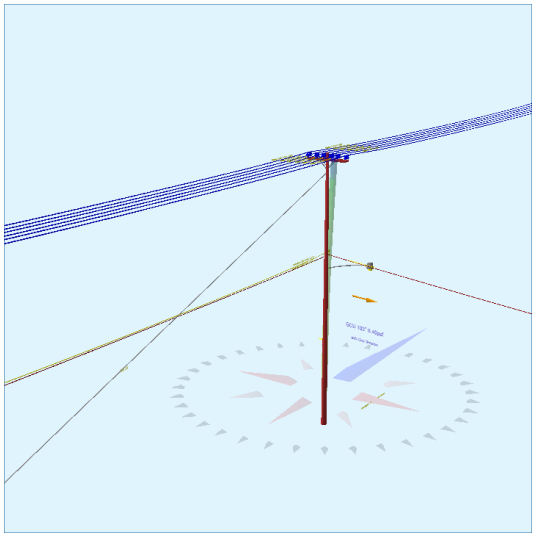
Insulator		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Post	Post Insulator - 27 kV		55.03	33.00	78.6	0.0	13.00	5.25	13.50	55	288	343
Post	Post Insulator - 27 kV		55.03	58.00	83.5	0.0	13.00	5.25	13.50	96	288	384

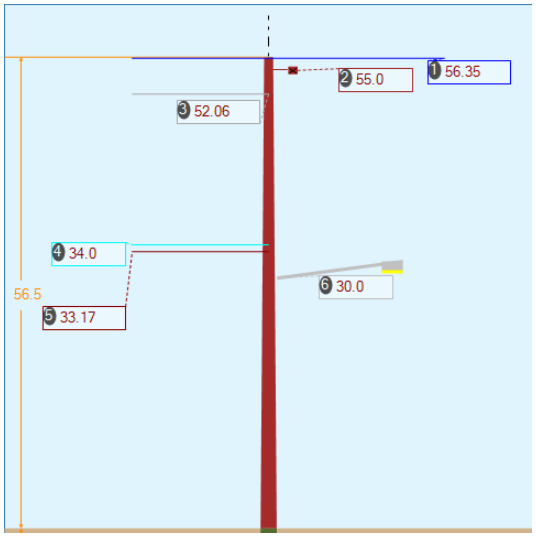
Post	Post Insulator - 27 kV	55.03	12.00	61.0	0.0	13.00	5.25	13.50	20	288	308
Post	Post Insulator - 27 kV	55.03	-58.00	263.5	90.0	13.00	5.25	13.50	-96	288	192
Post	Post Insulator - 27 kV	55.03	-33.00	258.6	90.0	13.00	5.25	13.50	-55	288	233
Post	Post Insulator - 27 kV	55.03	-12.00	241.0	90.0	13.00	5.25	13.50	-20	288	268
Spool	Spool 4"	30.00	0.00	90.0	0.0	3.00	4.00	4.12	2	17	19
Spool	Spool 2.5"	29.47	0.00	90.0	0.0	1.00	2.50	2.12	1	5	6
								Totals:	**2**	**1,751**	**1,753**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	36.89	34.35	13.89	8.65	8.60	15.44	2.38e+6	60.00	57.00	56.30	41,081	**410.26**	**10.10**

Pole Num:	**Pole 4**	Pole Length / Class:	**65 / 1**	Code:	**N/A**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**8.5**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.55**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**41.7**	0.0	103.4
Groundline	**41.7**	0.0	103.4
Vertical	**1.2**	36.33	0.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**74,862**	116.9	103.4
Groundline	**74,862**	116.9	103.4
GL Allowable	**181,133**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Anchor	120.0	180.0		**0.0**	103.4	**0.0**	0.0
EHS 3/8 (Span/Head)			52.1	**0.0**	103.4	**0.0**	0.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 116.9°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,377	76.5	**61,403**	82.0	**33.9**	**2,021**	887	5	**2,026**	**33.8**
GuyBraces	12	0.7	**625**	0.8	**0.3**	**21**	18	0	**21**	**0.3**
Pole	333	18.5	**8,570**	11.5	**4.7**	**282**	2,745	15	**297**	**4.9**
Crossarms	13	0.7	**731**	1.0	**0.4**	**24**	164	1	**25**	**0.4**
Streetlights	27	1.5	**1,394**	1.9	**0.8**	**46**	85	0	**46**	**0.8**
Insulators	39	2.1	**2,141**	2.9	**1.2**	**71**	160	1	**71**	**1.2**
Pole Load	1,800	100.0	**74,862**	100.0	**41.3**	**2,464**	4,059	22	**2,486**	**41.4**
Pole Reserve Capacity			**106,271**		**58.7**	**3,536**			**3,514**	**58.6**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 116.9°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,467	81.5	**66,292**	88.6	**36.6**	**2,182**	1,313	7	**2,189**	**36.5**
Pole	333	18.5	**8,570**	11.5	**4.7**	**282**	2,745	15	**297**	**4.9**
Totals:	1,800	100.0	**74,862**	100.0	**41.3**	**2,464**	4,059	22	**2,486**	**41.4**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		56.35	33.00	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-73,976	196	1,937	-71,843
Primary	ACSR 954 Rail		56.35	33.00	1.0610	1.39	1.075	120.0	180.0	120.0	3,000	76,620	158	1,563	78,342
Primary	ACSR 954 Rail		56.35	58.00	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-73,976	345	1,937	-71,694
Primary	ACSR 954 Rail		56.35	58.00	1.0610	1.39	1.075	120.0	180.0	120.0	3,000	76,620	278	1,563	78,462
Primary	ACSR 954 Rail		56.35	12.00	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-73,976	71	1,937	-71,968
Primary	ACSR 954 Rail		56.35	12.00	1.0610	1.39	1.075	120.0	180.0	120.0	3,000	76,620	58	1,563	78,241
Primary	ACSR 954 Rail		56.35	58.00	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-73,976	-345	1,937	-72,384
Primary	ACSR 954 Rail		56.35	58.00	1.0610	1.39	1.075	120.0	180.0	120.0	3,000	76,620	-278	1,563	77,906
Primary	ACSR 954 Rail		56.35	33.00	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-73,976	-196	1,937	-72,235
Primary	ACSR 954 Rail		56.35	33.00	1.0610	1.39	1.075	120.0	180.0	120.0	3,000	76,620	-158	1,563	78,026
Primary	ACSR 954 Rail		56.35	12.00	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-73,976	-71	1,937	-72,110
Primary	ACSR 954 Rail		56.35	12.00	1.0610	1.39	1.075	120.0	180.0	120.0	3,000	76,620	-58	1,563	78,126

Secondary	AAC 4/0 AWG 7 STRAND OXLIP	34.00	8.66	0.5220	2.00	0.198	120.0	180.0	120.0	400	6,159	8	432	6,598
Secondary	DUPLEX 6 AWG	33.17	7.96	0.5370	0.88	0.071	80.0	110.0	80.0	357	11,755	2	-5	11,752
Secondary	DUPLEX 6 AWG	33.17	7.96	0.5370	1.36	0.071	120.0	180.0	120.0	357	5,363	3	432	5,797
										Totals:	**39,143**	**12**	**21,861**	**61,016**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		55.00	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	726	726
										Totals:	**0**	**726**	**726**

Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		30.00	5.91	90.0	90.0	85.00	24.00	20.00	3.00	120.00	572	813	1,385
											Totals:	**572**	**813**	**1,385**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		55.23	33.00	78.6	0.0	13.00	5.25	13.50	64	349	413
Post	Post Insulator - 27 kV		55.23	58.00	83.5	0.0	13.00	5.25	13.50	112	349	461
Post	Post Insulator - 27 kV		55.23	12.00	61.0	0.0	13.00	5.25	13.50	23	349	372
Post	Post Insulator - 27 kV		55.23	-58.00	263.5	90.0	13.00	5.25	13.50	-112	349	237
Post	Post Insulator - 27 kV		55.23	-33.00	258.6	90.0	13.00	5.25	13.50	-64	349	285
Post	Post Insulator - 27 kV		55.23	-12.00	241.0	90.0	13.00	5.25	13.50	-23	349	326
Spool	Spool 4"		34.00	0.00	90.0	0.0	3.00	4.00	4.12	2	23	25
Spool	Spool 2.5"		33.17	0.00	90.0	0.0	1.00	2.50	2.12	1	7	8
									Totals:	**3**	**2,125**	**2,127**

Guy Wire and Brace		**Owner**	**Attach Height (ft)**	**End Height (ft)**	**Lead/Span Length (ft)**	**Wire Diameter (in)**	**Percent Solid (%)**	**Lead Angle (deg)**	**Incline Angle (deg)**	**Wire Weight (lbs/ft)**	**Rest Length (ft)**	**Stretch Length (in)**
EHS 3/8	Span/Head		52.06	10.06	120.00	0.375	75.00	180.0	19.3	0.273	127.34	0.00

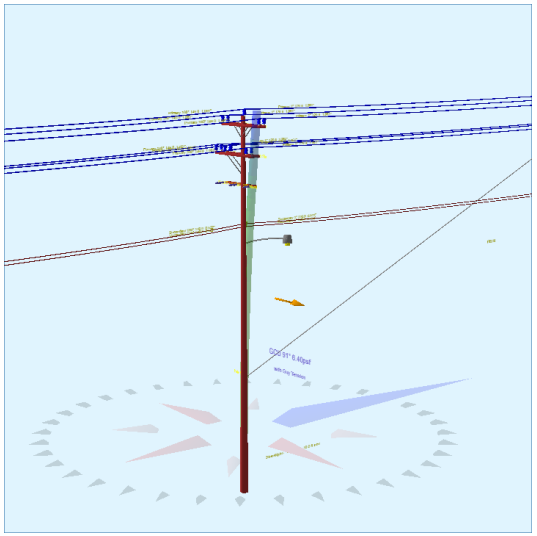
Guy Wire and Brace (Loads and Reactions)		**Elastic Modulus (psi)**	**Rated Tensile Strength (lbs)**	**Guy Strength Factor**	**Allowable Tension (lbs)**	**Initial Tension (lbs)**	**Loaded Tension*[2] (lbs)**	**Maximum Tension[2] (lbs)**	**Applied Tension[3] (lbs)**	**Vertical Load (lbs)**	**Shear Load In Guy Dir (lbs)**	**Shear Load At Report Angle (lbs)**	**Moment at GL[3] (ft-lb)**
EHS 3/8	Span/Head	2.30e+7	15,400	0.90	13,860	700	0	0	0	0	0	0	621
									Totals:	**0**	**0**	**0**	**621**

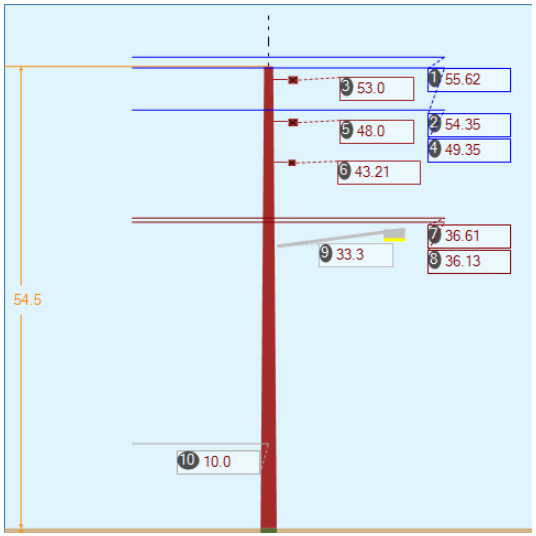
Anchor/Rod Load Summary	Owner	Rod Length AGL (in)	Lead Length (ft)	Lead Angle (deg)	Strength of Assembly (lbs)	Anchor/Rod Strength Factor	Allowable Load (lbs)	Max Load[2] (lbs)	Load at Pole MCU[3] (lbs)	Max Required Capacity[2] (%)
Anchor		30.00	120.00	180.0	20,000	1.00	20,000	0	0	0.0

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
0.71	36.28	34.28	13.94	5.09	8.60	15.46	2.38e+6	60.00	57.00	56.50	344,881	**3382.27**	**83.33**

Pole Num:	**Pole 5**	Pole Length / Class:	**65 / 1**	Code:	**N/A**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.5**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**47.78**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**31.2**	0.0	90.5
Groundline	**31.2**	0.0	90.5
Vertical	**1.2**	35.33	181.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**53,156**	90.7	90.5
Groundline	**53,156**	90.7	90.5
GL Allowable	**172,729**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Anchor	100.0	1.0		**0.0**	90.5	**1.7**	180.0
EHS 3/8 (Span/Head)			10.0	**0.0**	90.5	**2.5**	180.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 90.7°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	818	66.1	**40,717**	76.6	**23.6**	**1,393**	921	5	**1,398**	**23.3**
GuyBraces	10	0.8	**96**	0.2	**0.1**	**3**	14	0	**3**	**0.1**
Pole	326	26.3	**8,176**	15.4	**4.7**	**280**	2,592	14	**294**	**4.9**
Crossarms	8	0.7	**417**	0.8	**0.2**	**14**	378	2	**16**	**0.3**
Streetlights	28	2.3	**1,605**	3.0	**0.9**	**55**	85	0	**55**	**0.9**
Insulators	48	3.9	**2,145**	4.0	**1.2**	**73**	174	1	**74**	**1.2**
Pole Load	1,238	100.0	**53,156**	100.0	**30.8**	**1,819**	4,164	23	**1,842**	**30.7**
Pole Reserve Capacity			**119,573**		**69.2**	**4,181**			**4,158**	**69.3**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 90.7°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	912	73.7	**44,980**	84.6	**26.0**	**1,539**	1,572	9	**1,548**	**25.8**
Pole	326	26.3	**8,176**	15.4	**4.7**	**280**	2,592	14	**294**	**4.9**
Totals:	1,238	100.0	**53,156**	100.0	**30.8**	**1,819**	4,164	23	**1,842**	**30.7**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		55.63	4.30	1.0610	1.39	1.075	120.0	1.0	120.0	3,000	825	23	1,776	2,625
Primary	ACSR 954 Rail		55.63	4.30	1.0610	1.86	1.075	149.0	180.0	149.0	3,000	2,090	29	2,173	4,291
Primary	ACSR 954 Rail		54.35	57.00	1.0610	1.39	1.075	120.0	1.0	120.0	3,000	806	306	1,729	2,841
Primary	ACSR 954 Rail		54.35	57.00	1.0610	1.86	1.075	149.0	180.0	149.0	3,000	2,042	380	2,115	4,537
Primary	ACSR 954 Rail		54.35	57.00	1.0610	1.39	1.075	120.0	1.0	120.0	3,000	806	-306	1,729	2,229
Primary	ACSR 954 Rail		54.35	57.00	1.0610	1.86	1.075	149.0	180.0	149.0	3,000	2,042	-380	2,115	3,776
Primary	ACSR 954 Rail		49.35	78.89	1.0610	1.39	1.075	120.0	1.0	120.0	3,000	732	-424	1,546	1,855
Primary	ACSR 954 Rail		49.35	78.89	1.0610	1.86	1.075	149.0	180.0	149.0	3,000	1,854	-526	1,892	3,219
Primary	ACSR 954 Rail		49.35	48.87	1.0610	1.39	1.075	120.0	1.0	120.0	3,000	732	-263	1,546	2,016
Primary	ACSR 954 Rail		49.35	48.87	1.0610	1.86	1.075	149.0	180.0	149.0	3,000	1,854	-326	1,892	3,420
Primary	ACSR 954 Rail		49.35	18.06	1.0610	1.39	1.075	120.0	1.0	120.0	3,000	732	97	1,546	2,376
Primary	ACSR 954 Rail		49.35	18.06	1.0610	1.86	1.075	149.0	180.0	149.0	3,000	1,854	121	1,892	3,866

Secondary	AAC 4/0 AWG 7 STRAND OXLIP	36.61	8.38	0.5220	2.01	0.198	120.0	1.0	120.0	400	72	8	542	622
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	36.61	8.38	0.5220	2.66	0.198	149.0	180.0	149.0	400	183	10	662	856
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	36.13	7.66	0.5220	2.01	0.198	120.0	1.0	120.0	400	71	8	533	612
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	36.13	7.66	0.5220	2.66	0.198	149.0	179.5	149.0	400	307	9	652	968
										Totals:	**17,005**	**-1,234**	**24,340**	**40,110**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		53.00	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	191	191
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		48.00	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	171	171
Normal	8' x 3.5" x 4.5" SP - 3 Deadend		43.21	6.73	180.0	180.0	50.00	4.50	3.50	96.00	0	48	49
										Totals:	**0**	**410**	**411**

Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		33.30	5.58	90.0	90.0	85.00	24.00	20.00	3.00	120.00	640	941	1,581
											Totals:	**640**	**941**	**1,581**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		54.50	0.00	90.5	90.5	13.00	5.25	13.50	5	178	182
Post	Post Insulator - 27 kV		53.23	57.00	83.4	0.0	13.00	5.25	13.50	123	344	468
Post	Post Insulator - 27 kV		53.23	-57.00	276.6	0.0	13.00	5.25	13.50	-123	344	221
Post	Post Insulator - 27 kV		48.23	-78.89	265.0	90.5	13.00	5.25	13.50	-171	308	138
Post	Post Insulator - 27 kV		48.23	-48.87	261.9	90.5	13.00	5.25	13.50	-106	308	203
Post	Post Insulator - 27 kV		48.23	18.06	111.0	90.5	13.00	5.25	13.50	39	308	348
Deadend	Deadend Insulator		43.21	0.00	180.0	0.0	8.99	3.00	30.00	0	172	172
Deadend	Deadend Insulator		43.21	44.00	261.3	0.0	8.99	3.00	30.00	-33	172	139
Deadend	Deadend Insulator		43.21	-44.00	98.7	0.0	8.99	3.00	30.00	33	172	205
Spool	Spool 4"		36.61	0.00	90.5	0.5	3.00	4.00	4.12	2	26	28
Spool	Spool 2.5"		36.13	0.00	90.0	0.0	1.00	2.50	2.12	1	8	9
									Totals:	**-229**	**2,343**	**2,113**

Guy Wire and Brace		Owner	Attach Height (ft)	End Height (ft)	Lead/Span Length (ft)	Wire Diameter (in)	Percent Solid (%)	Lead Angle (deg)	Incline Angle (deg)	Wire Weight (lbs/ft)	Rest Length (ft)	Stretch Length (in)
EHS 3/8	Span/Head		10.00	55.00	100.00	0.375	75.00	1.0	-24.2	0.273	102.73	0.00

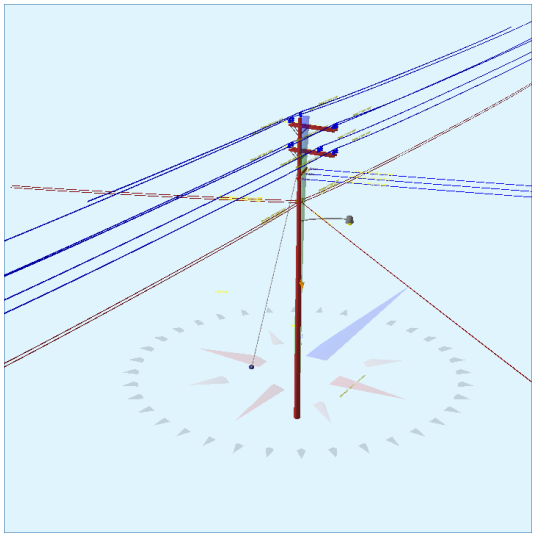
Guy Wire and Brace (Loads and Reactions)		Elastic Modulus (psi)	Rated Tensile Strength (lbs)	Guy Strength Factor	Allowable Tension (lbs)	Initial Tension (lbs)	Loaded Tension*[2] (lbs)	Maximum Tension[2] (lbs)	Applied Tension[3] (lbs)	Vertical Load (lbs)	Shear Load In Guy Dir (lbs)	Shear Load At Report Angle (lbs)	Moment at GL[3] (ft-lb)
EHS 3/8	Span/Head	2.30e+7	15,400	0.90	13,860	700	348	348	0	0	0	0	95
									Totals:	**0**	**0**	**0**	**95**

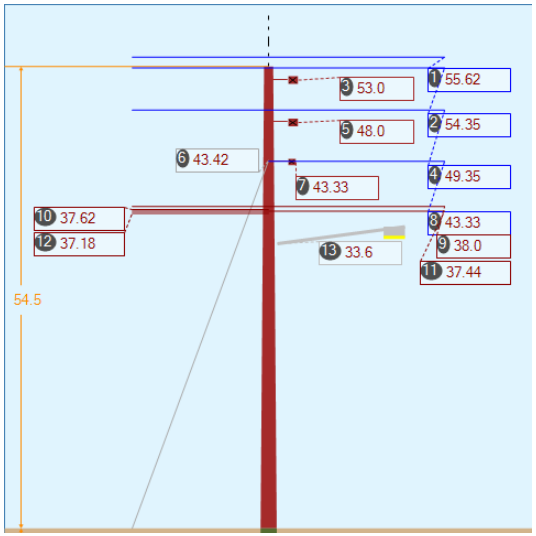
Anchor/Rod Load Summary	Owner	Rod Length AGL (in)	Lead Length (ft)	Lead Angle (deg)	Strength of Assembly (lbs)	Anchor/Rod Strength Factor	Allowable Load (lbs)	Max Load[2] (lbs)	Load at Pole MCU[3] (lbs)	Max Required Capacity[2] (%)
Anchor		30.00	100.00	1.0	20,000	1.00	20,000	348	0	1.7

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
0.71	35.27	34.22	13.74	5.04	8.60	15.22	2.38e+6	60.00	57.00	54.50	344,531	**3469.88**	**83.33**

Pole Num:	**Pole 6**	Pole Length / Class:	**65 / 1**	Code:	**N/A**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.5**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**47.78**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**29.4**	0.0	148.6
Groundline	**29.4**	0.0	148.6
Vertical	**5.2**	40.83	75.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**48,880**	137.9	148.6
Groundline	**48,880**	137.9	148.6
GL Allowable	**172,729**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Single Helix Anchor	10.0	255.0		**43.2**	148.6	**51.1**	80.0
EHS 7/16 (Down)			43.4	**46.1**	148.6	**54.6**	80.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 137.9°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,561	125.7	**65,571**	134.2	**38.0**	**2,486**	849	5	**2,491**	**41.5**
GuyBraces	-843	-67.8	**-33,511**	-68.6	**-19.4**	**-1,271**	8,442	46	**-1,224**	**-20.4**
Pole	320	25.8	**7,250**	14.8	**4.2**	**275**	2,592	14	**289**	**4.8**
Crossarms	128	10.3	**5,903**	12.1	**3.4**	**224**	320	2	**226**	**3.8**
Streetlights	28	2.2	**1,248**	2.6	**0.7**	**47**	85	0	**48**	**0.8**
Insulators	48	3.8	**2,419**	5.0	**1.4**	**92**	176	1	**93**	**1.5**
Pole Load	1,242	100.0	**48,880**	100.0	**28.3**	**1,854**	12,463	69	**1,922**	**32.0**
Pole Reserve Capacity			**123,849**		**71.7**	**4,147**			**4,078**	**68.0**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 137.9°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	922	74.2	**41,630**	85.2	**24.1**	**1,579**	9,872	54	**1,633**	**27.2**
Pole	320	25.8	**7,250**	14.8	**4.2**	**275**	2,592	14	**289**	**4.8**
Totals:	1,242	100.0	**48,880**	100.0	**28.3**	**1,854**	12,463	69	**1,922**	**32.0**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		55.63	4.30	1.1650	1.33	1.075	114.0	1.0	114.0	3,000	-121,958	-16	681	-121,293
Primary	ACSR 954 Rail		55.63	4.30	1.1650	0.70	1.075	67.0	180.0	67.0	3,000	123,931	-9	392	124,314
Primary	ACSR 954 Rail		54.35	93.00	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-119,165	416	774	-117,974
Primary	ACSR 954 Rail		54.35	93.00	1.0610	1.10	1.075	100.0	180.0	100.0	3,000	121,092	279	509	121,880
Primary	ACSR 954 Rail		54.35	23.00	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-119,165	-103	774	-118,493
Primary	ACSR 954 Rail		54.35	23.00	1.0610	1.10	1.075	100.0	180.0	100.0	3,000	121,092	-69	509	121,532
Primary	ACSR 954 Rail		49.35	93.83	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-108,212	420	693	-107,099
Primary	ACSR 954 Rail		49.35	93.83	1.0610	1.10	1.075	100.0	180.0	100.0	3,000	109,962	282	455	110,699
Primary	ACSR 954 Rail		49.35	54.40	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-108,212	243	693	-107,275
Primary	ACSR 954 Rail		49.35	54.40	1.0610	1.10	1.075	100.0	180.0	100.0	3,000	109,962	163	455	110,581
Primary	ACSR 954 Rail		49.35	23.32	1.0610	1.86	1.075	149.0	1.0	149.0	3,000	-108,212	-104	693	-107,623
Primary	ACSR 954 Rail		49.35	23.32	1.0610	1.10	1.075	100.0	180.0	100.0	3,000	109,962	-70	455	110,347

Primary	ACSR 1/0 AWG 6/1 RAVEN	43.33	36.73	0.3980	0.55	0.145	80.0	75.0	80.0	800	15,789	1	292	16,083
Primary	ACSR 1/0 AWG 6/1 RAVEN	43.33	57.31	0.3980	0.55	0.145	80.0	75.0	80.0	800	15,789	2	292	16,084
Primary	ACSR 1/0 AWG 6/1 RAVEN	43.33	57.31	0.3980	0.55	0.145	80.0	75.0	80.0	800	15,789	-1	292	16,081
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	38.00	8.30	0.5220	2.66	0.198	149.0	1.0	149.0	400	-11,099	7	253	-10,839
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	38.00	8.30	0.5220	1.60	0.198	100.0	180.0	100.0	400	11,279	5	166	11,450
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	37.62	7.57	0.5220	0.88	0.198	60.0	250.0	60.0	400	-5,661	-3	263	-5,400
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	37.44	7.58	0.5220	2.66	0.198	149.0	1.0	149.0	400	-10,935	6	249	-10,680
Secondary	DUPLEX 6 AWG	37.44	7.58	0.5370	1.11	0.071	100.0	130.0	100.0	357	13,239	2	21	13,262
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	37.44	7.58	0.5220	1.60	0.198	100.0	180.0	100.0	400	11,112	4	164	11,280
Secondary	AAC 4/0 AWG 7 STRAND OXLIP	37.18	7.60	0.5220	0.88	0.198	60.0	250.0	60.0	400	-5,595	-3	260	-5,337
										Totals:	**60,789**	**1,453**	**9,336**	**71,577**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 8		53.00	6.64	0.0	0.0	53.00	5.50	4.50	120.00	0	3,283	3,283
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		48.00	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	2,937	2,937
Normal	8' x 3.5" x 4.5" SP - 3 Deadend		43.33	6.73	75.0	75.0	50.00	4.50	3.50	96.00	13	212	225
										Totals:	**13**	**6,431**	**6,444**

Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		33.60	5.57	90.0	90.0	85.00	24.00	20.00	3.00	120.00	429	934	1,363
											Totals:	**429**	**934**	**1,363**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		54.50	0.00	0.5	0.5	13.00	5.25	13.50	-3	175	171
Post	Post Insulator - 27 kV		53.23	93.00	94.1	90.5	13.00	5.25	13.50	135	339	474
Post	Post Insulator - 27 kV		53.23	-23.00	253.9	90.5	13.00	5.25	13.50	-33	339	305
Post	Post Insulator - 27 kV		48.23	93.83	94.2	90.5	13.00	5.25	13.50	136	303	439
Post	Post Insulator - 27 kV		48.23	54.40	97.3	90.5	13.00	5.25	13.50	79	303	382
Post	Post Insulator - 27 kV		48.23	-23.32	253.4	90.5	13.00	5.25	13.50	-34	303	269
Deadend	Deadend Insulator		43.33	0.00	75.0	0.0	8.99	3.00	30.00	13	170	182

Deadend	Deadend Insulator	43.33	44.00	156.3	0.0	8.99	3.00	30.00	42	170	211
Deadend	Deadend Insulator	43.33	-44.00	353.7	0.0	8.99	3.00	30.00	-17	170	153
Spool	Spool 4"	38.00	0.00	90.0	0.0	3.00	4.00	4.12	1	27	28
Spool	Spool 2.5"	37.62	0.00	270.0	0.0	1.00	2.50	2.12	0	9	8
Spool	Spool 2.5"	37.44	0.00	90.0	0.0	1.00	2.50	2.12	0	8	9
Spool	Spool 2.5"	37.18	0.00	270.0	0.0	1.00	2.50	2.12	0	8	8
								Totals:	**318**	**2,322**	**2,640**

Guy Wire and Brace		Owner	Attach Height (ft)	End Height (ft)	Lead/Span Length (ft)	Wire Diameter (in)	Percent Solid (%)	Lead Angle (deg)	Incline Angle (deg)	Wire Weight (lbs/ft)	Rest Length (ft)	Stretch Length (in)
EHS 7/16	Down		43.42	0.00	10.00	0.438	75.00	255.0	76.8	0.399	53.27	2.13

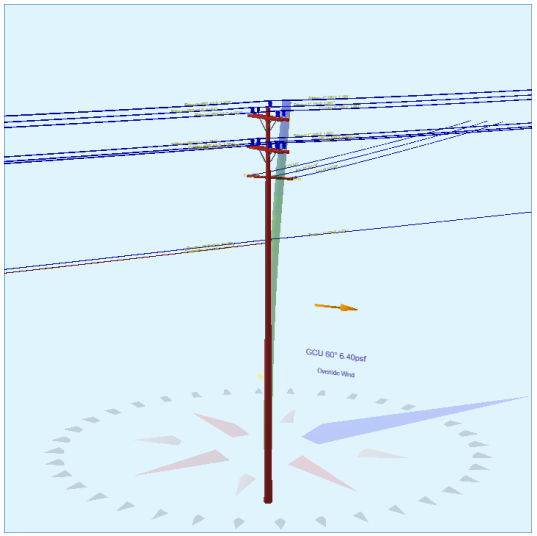
Guy Wire and Brace (Loads and Reactions)		Elastic Modulus (psi)	Rated Tensile Strength (lbs)	Guy Strength Factor	Allowable Tension (lbs)	Initial Tension (lbs)	Loaded Tension*[2] (lbs)	Maximum Tension[2] (lbs)	Applied Tension[3] (lbs)	Vertical Load (lbs)	Shear Load In Guy Dir (lbs)	Shear Load At Report Angle (lbs)	Moment at GL[3] (ft-lb)
EHS 7/16	Down	2.30e+7	20,800	0.90	18,720	700	10,215	10,215	8,630	8,401	1,977	-901	-36,581
									Totals:	**8,401**	**1,977**	**-901**	**-36,581**

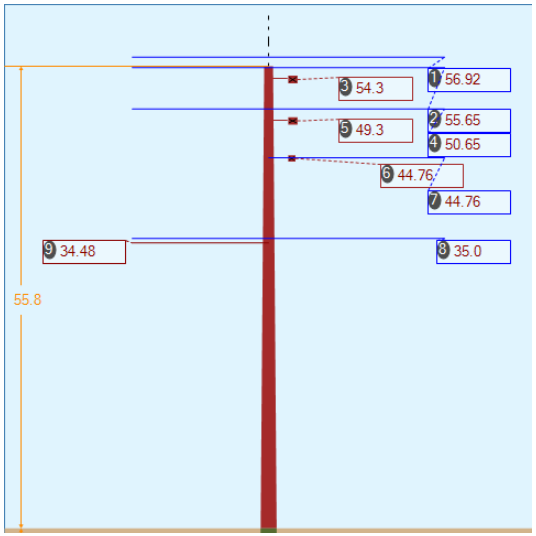
Anchor/Rod Load Summary	Owner	Rod Length AGL (in)	Lead Length (ft)	Lead Angle (deg)	Strength of Assembly (lbs)	Anchor/Rod Strength Factor	Allowable Load (lbs)	Max Load[2] (lbs)	Load at Pole MCU[3] (lbs)	Max Required Capacity[2] (%)
Single Helix Anchor		18.00	10.00	255.0	20,000	1.00	20,000	10,215	8,630	51.1

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
0.71	40.76	34.88	13.48	7.27	8.60	15.22	2.38e+6	60.00	57.00	54.50	239,042	**2396.79**	**19.23**

Pole Num:	**Pole 8**	Pole Length / Class:	**65 / 1**	Code:	**N/A**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**9.17**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.28**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:	**0° 0' 0" W**	Elevation:	**0M**		





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**23.3**	0.0	60.0
Groundline	**23.3**	0.0	60.0
Vertical	**7.6**	33.92	60.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**40,586**	33.5	60.0
Groundline	**40,586**	33.5	60.0
GL Allowable	**178,161**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 33.5°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	452	51.3	**26,125**	64.4	**14.7**	**864**	551	3	**867**	**14.4**
Pole	301	34.2	**7,754**	19.1	**4.4**	**256**	2,691	15	**271**	**4.5**
Crossarms	84	9.5	**4,443**	11.0	**2.5**	**147**	378	2	**149**	**2.5**
Insulators	43	4.9	**2,264**	5.6	**1.3**	**75**	174	1	**76**	**1.3**
Pole Load	881	100.0	**40,586**	100.0	**22.8**	**1,342**	3,794	20	**1,363**	**22.7**
Pole Reserve Capacity			**137,575**		**77.2**	**4,658**			**4,637**	**77.3**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 33.5°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	580	65.8	**32,832**	80.9	**18.4**	**1,086**	1,103	6	**1,092**	**18.2**
Pole	301	34.2	**7,754**	19.1	**4.4**	**256**	2,691	15	**271**	**4.5**
Totals:	881	100.0	**40,586**	100.0	**22.8**	**1,342**	3,794	20	**1,363**	**22.7**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		56.93	4.30	1.1650	1.13	1.075	100.0	1.0	100.0	3,000	144,161	16	777	144,955
Primary	ACSR 954 Rail		56.93	4.30	1.1650	0.63	1.075	61.0	180.0	61.0	3,000	-142,537	10	504	-142,023
Primary	ACSR 954 Rail		55.65	44.00	1.0610	1.10	1.075	100.0	1.0	100.0	3,000	140,935	109	689	141,733
Primary	ACSR 954 Rail		55.65	44.00	1.0610	0.61	1.075	61.0	180.0	61.0	3,000	-139,347	66	447	-138,833
Primary	ACSR 954 Rail		55.65	44.00	1.0610	1.10	1.075	100.0	1.0	100.0	3,000	140,935	-109	689	141,515
Primary	ACSR 954 Rail		55.65	44.00	1.0610	0.61	1.075	61.0	180.0	61.0	3,000	-139,347	-66	447	-138,966
Primary	ACSR 954 Rail		50.65	18.00	1.0610	1.10	1.075	100.0	1.0	100.0	3,000	128,283	44	618	128,946
Primary	ACSR 954 Rail		50.65	18.00	1.0610	0.61	1.075	61.0	180.0	61.0	3,000	-126,838	27	401	-126,409
Primary	ACSR 954 Rail		50.65	44.00	1.0610	1.10	1.075	100.0	1.0	100.0	3,000	128,283	109	618	129,010
Primary	ACSR 954 Rail		50.65	44.00	1.0610	0.61	1.075	61.0	180.0	61.0	3,000	-126,838	66	401	-126,370
Primary	ACSR 954 Rail		50.65	44.00	1.0610	1.10	1.075	100.0	1.0	100.0	3,000	128,283	-109	618	128,793
Primary	ACSR 954 Rail		50.65	44.00	1.0610	0.61	1.075	61.0	180.0	61.0	3,000	-126,838	-66	401	-126,503
Primary	ACSR 2 AWG 6/1 SPARROW		44.76	36.72	0.3160	1.07	0.091	103.0	330.0	103.0	300	5,993	1	320	6,314
Primary	ACSR 2 AWG 6/1 SPARROW		44.76	57.31	0.3160	1.07	0.091	103.0	330.0	103.0	300	5,993	2	320	6,315
Primary	ACSR 2 AWG 6/1 SPARROW		44.76	57.31	0.3160	1.07	0.091	103.0	330.0	103.0	300	5,993	-1	320	6,312
Primary	AAC 4/0 AWG 7 STRAND OXLIP		35.00	8.56	0.5220	0.24	0.198	100.0	1.0	100.0	2,000	59,041	4	200	59,244
Primary	AAC 4/0 AWG 7 STRAND OXLIP		35.00	8.56	0.5220	0.09	0.198	61.0	180.0	61.0	2,000	-58,376	2	130	-58,244
Secondary	DUPLEX 6 AWG		34.48	7.84	0.5370	0.66	0.071	61.0	180.0	61.0	357	-10,265	1	131	-10,133
											Totals:	**17,515**	**107**	**8,032**	**25,654**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		54.30	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	2,270	2,270

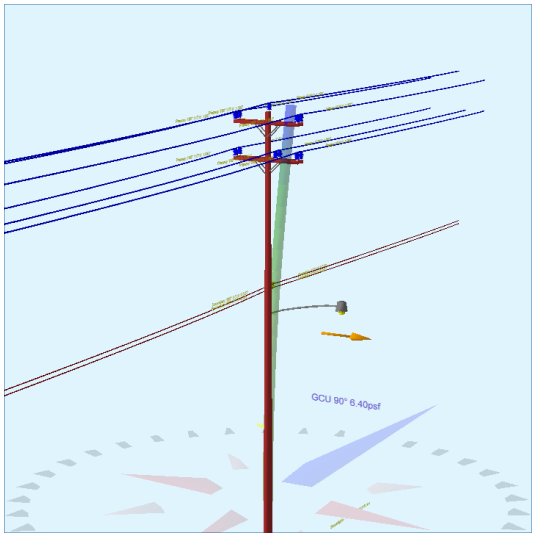
Normal	CROSSARM 3-1/2 X 4-1/2 X 10	49.30	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	2,036	2,036
Normal	8' x 3.5" x 4.5" SP - 3 Deadend	44.76	6.72	330.0	330.0	50.00	4.50	3.50	96.00	12	45	57
									Totals:	**12**	**4,351**	**4,363**

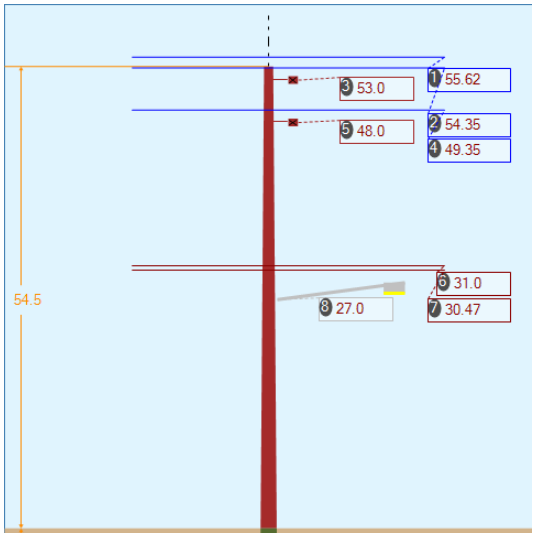
Insulator		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Post	Post Insulator - 27 kV		55.80	0.00	0.0	0.0	13.00	5.25	13.50	4	163	167
Post	Post Insulator - 27 kV		54.53	44.00	81.4	0.0	13.00	5.25	13.50	53	317	369
Post	Post Insulator - 27 kV		54.53	-44.00	278.6	0.0	13.00	5.25	13.50	-53	317	264
Post	Post Insulator - 27 kV		49.53	18.00	68.9	0.0	13.00	5.25	13.50	22	284	306
Post	Post Insulator - 27 kV		49.53	44.00	81.0	0.0	13.00	5.25	13.50	53	284	337
Post	Post Insulator - 27 kV		49.53	-44.00	279.0	0.0	13.00	5.25	13.50	-53	284	232
Deadend	Deadend Insulator		44.76	0.00	330.0	0.0	8.99	3.00	30.00	12	160	172
Deadend	Deadend Insulator		44.76	44.00	51.3	0.0	8.99	3.00	30.00	42	160	202
Deadend	Deadend Insulator		44.76	-44.00	248.7	0.0	8.99	3.00	30.00	-17	160	143
Spool	Spool 4"		35.00	0.00	90.0	0.0	3.00	4.00	4.12	1	22	23
Spool	Spool 2.5"		34.48	0.00	90.0	0.0	1.00	2.50	2.12	0	7	7
									Totals:	**64**	**2,160**	**2,223**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	33.92	34.02	13.97	8.08	8.60	15.38	2.38e+6	60.00	57.00	55.80	49,675	**499.27**	**13.16**

Pole Num:	**Pole 9**	Pole Length / Class:	**65 / 1**	Code:	**N/A**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.5**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**47.78**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**	Elevation:	**0M**	





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**29.9**	0.0	90.0
Groundline	**29.9**	0.0	90.0
Vertical	**8.7**	34.5	90.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**50,897**	90.2	90.0
Groundline	**50,897**	90.2	90.0
GL Allowable	**172,729**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 90.2°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	763	65.8	**39,059**	76.7	**22.6**	**1,337**	800	4	**1,341**	**22.3**
Pole	326	28.1	**8,176**	16.1	**4.7**	**280**	2,592	14	**294**	**4.9**
Crossarms	7	0.6	**366**	0.7	**0.2**	**13**	328	2	**14**	**0.2**
Streetlights	28	2.4	**1,405**	2.8	**0.8**	**48**	85	0	**49**	**0.8**
Insulators	36	3.1	**1,891**	3.7	**1.1**	**65**	147	1	**66**	**1.1**
Pole Load	1,159	100.0	**50,897**	100.0	**29.5**	**1,742**	3,951	22	**1,763**	**29.4**
Pole Reserve Capacity			**121,832**		**70.5**	**4,258**			**4,237**	**70.6**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 90.2°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	834	71.9	**42,721**	83.9	**24.7**	**1,462**	1,360	7	**1,469**	**24.5**
Pole	326	28.1	**8,176**	16.1	**4.7**	**280**	2,592	14	**294**	**4.9**
Totals:	1,159	100.0	**50,897**	100.0	**29.5**	**1,742**	3,951	22	**1,763**	**29.4**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		55.63	4.30	1.1650	0.63	1.075	61.0	1.0	61.0	3,000	2,436	0	1,026	3,462
Primary	ACSR 954 Rail		55.63	4.30	1.1650	2.39	1.075	177.0	180.0	177.0	3,000	479	0	2,798	3,278
Primary	ACSR 954 Rail		54.35	57.00	1.0610	0.61	1.075	61.0	1.0	61.0	3,000	2,380	156	910	3,445
Primary	ACSR 954 Rail		54.35	57.00	1.0610	2.36	1.075	177.0	180.0	177.0	3,000	468	452	2,480	3,400
Primary	ACSR 954 Rail		54.35	57.00	1.0610	0.61	1.075	61.0	1.0	61.0	3,000	2,380	-156	910	3,134
Primary	ACSR 954 Rail		54.35	57.00	1.0610	2.36	1.075	177.0	180.0	177.0	3,000	468	-452	2,480	2,496
Primary	ACSR 954 Rail		49.35	18.00	1.0610	0.61	1.075	61.0	1.0	61.0	3,000	2,161	49	814	3,024
Primary	ACSR 954 Rail		49.35	18.00	1.0610	2.36	1.075	177.0	180.0	177.0	3,000	425	143	2,218	2,786
Primary	ACSR 954 Rail		49.35	57.00	1.0610	0.61	1.075	61.0	1.0	61.0	3,000	2,161	156	814	3,131
Primary	ACSR 954 Rail		49.35	57.00	1.0610	2.36	1.075	177.0	180.0	177.0	3,000	425	452	2,218	3,095
Primary	ACSR 954 Rail		49.35	57.00	1.0610	0.61	1.075	61.0	1.0	61.0	3,000	2,161	-156	814	2,820
Primary	ACSR 954 Rail		49.35	57.00	1.0610	2.36	1.075	177.0	180.0	177.0	3,000	425	-452	2,218	2,191
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		31.00	8.72	0.5220	0.76	0.198	61.0	1.0	61.0	600	271	4	236	511
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		31.00	8.72	0.5220	2.79	0.198	177.0	180.0	177.0	600	53	13	641	707
Secondary	DUPLEX 6 AWG		30.47	8.01	0.5370	0.71	0.071	61.0	1.0	61.0	200	89	1	238	328
Secondary	DUPLEX 6 AWG		30.47	8.01	0.5370	2.49	0.071	177.0	180.0	177.0	200	17	4	646	668
											Totals:	**16,802**	**215**	**21,461**	**38,477**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		53.00	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	190	190
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		48.00	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	170	170
										Totals:	**0**	**361**	**361**

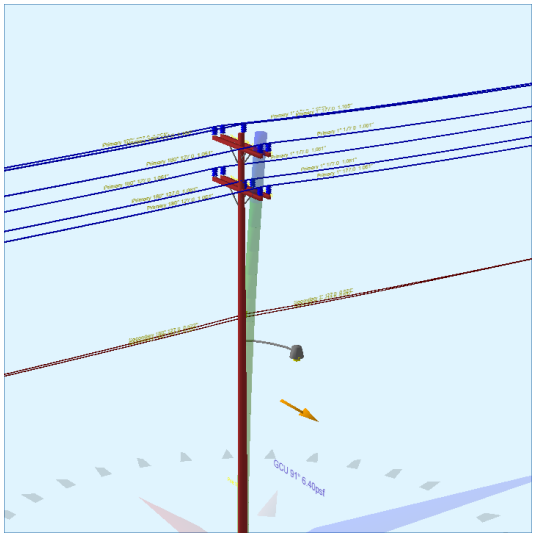
Streetlight		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
General	Streetlight - 10 ft. Arm		27.00	5.97	90.0	90.0	85.00	24.00	20.00	3.00	120.00	642	742	1,384
											Totals:	**642**	**742**	**1,384**

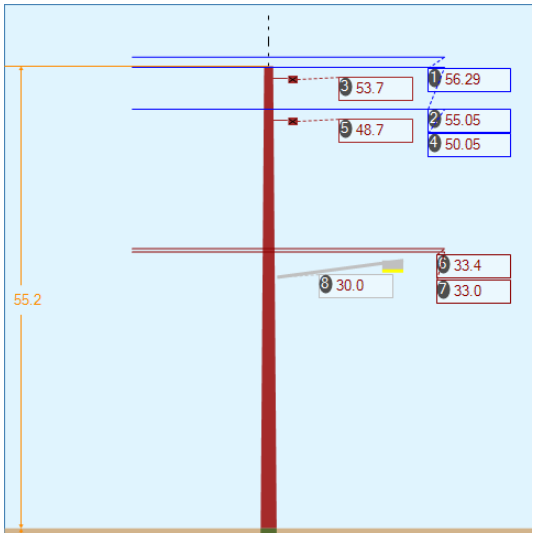
Insulator		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Post	Post Insulator - 27 kV		54.50	0.00	0.0	0.0	13.00	5.25	13.50	0	178	178
Post	Post Insulator - 27 kV		53.23	57.00	83.4	0.0	13.00	5.25	13.50	123	344	468
Post	Post Insulator - 27 kV		53.23	-57.00	276.6	0.0	13.00	5.25	13.50	-123	344	221
Post	Post Insulator - 27 kV		48.23	18.00	68.9	0.0	13.00	5.25	13.50	39	308	347
Post	Post Insulator - 27 kV		48.23	57.00	83.1	0.0	13.00	5.25	13.50	123	308	432
Post	Post Insulator - 27 kV		48.23	-57.00	276.9	0.0	13.00	5.25	13.50	-123	308	185
Spool	Spool 4"		31.00	0.00	90.0	0.0	3.00	4.00	4.12	2	22	24
Spool	Spool 2.5"		30.47	0.00	90.0	0.0	1.00	2.50	2.12	1	7	8
									Totals:	**42**	**1,821**	**1,862**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	34.45	34.12	13.78	8.25	8.60	15.22	2.38e+6	60.00	57.00	54.50	45,653	**454.16**	**11.49**

Pole Num:	**Pole 10**	Pole Length / Class:	**65 / 1**	Code:	**N/A**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**9.83**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.05**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**33.6**	0.0	90.5
Groundline	**33.6**	0.0	90.5
Vertical	**9.7**	35.58	90.5

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**58,017**	90.5	90.5
Groundline	**58,017**	90.5	90.5
GL Allowable	**175,640**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 90.5°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	884	68.7	**45,821**	79.0	**26.1**	**1,545**	1,021	6	**1,550**	**25.8**
Pole	332	25.8	**8,408**	14.5	**4.8**	**283**	2,645	14	**298**	**5.0**
Crossarms	7	0.6	**372**	0.6	**0.2**	**13**	270	1	**14**	**0.2**
Streetlights	28	2.2	**1,497**	2.6	**0.9**	**51**	85	0	**51**	**0.8**
Insulators	36	2.8	**1,918**	3.3	**1.1**	**65**	147	1	**65**	**1.1**
Pole Load	1,286	100.0	**58,017**	100.0	**33.0**	**1,956**	4,168	23	**1,978**	**33.0**
Pole Reserve Capacity			**117,623**		**67.0**	**4,044**			**4,022**	**67.0**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 90.5°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	955	74.2	**49,609**	85.5	**28.2**	**1,672**	1,523	8	**1,681**	**28.0**
Pole	332	25.8	**8,408**	14.5	**4.8**	**283**	2,645	14	**298**	**5.0**
Totals:	1,286	100.0	**58,017**	100.0	**33.0**	**1,956**	4,168	23	**1,978**	**33.0**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		56.30	4.30	1.1650	2.39	1.075	177.0	1.0	177.0	3,000	1,469	0	2,837	4,306
Primary	ACSR 954 Rail		56.30	4.30	1.1650	1.53	1.075	127.0	180.0	127.0	3,000	1,481	0	2,085	3,566
Primary	ACSR 954 Rail		55.05	57.00	1.0610	2.36	1.075	177.0	1.0	177.0	3,000	1,436	452	2,516	4,405
Primary	ACSR 954 Rail		55.05	57.00	1.0610	1.50	1.075	127.0	180.0	127.0	3,000	1,449	324	1,850	3,622
Primary	ACSR 954 Rail		55.05	57.00	1.0610	2.36	1.075	177.0	1.0	177.0	3,000	1,436	-452	2,516	3,501
Primary	ACSR 954 Rail		55.05	57.00	1.0610	1.50	1.075	127.0	180.0	127.0	3,000	1,449	-324	1,850	2,974
Primary	ACSR 954 Rail		50.05	18.00	1.0610	2.36	1.075	177.0	1.0	177.0	3,000	1,306	143	2,254	3,703
Primary	ACSR 954 Rail		50.05	18.00	1.0610	1.50	1.075	127.0	180.0	127.0	3,000	1,317	102	1,657	3,077
Primary	ACSR 954 Rail		50.05	57.00	1.0610	2.36	1.075	177.0	1.0	177.0	3,000	1,306	452	2,254	4,012
Primary	ACSR 954 Rail		50.05	57.00	1.0610	1.50	1.075	127.0	180.0	127.0	3,000	1,317	324	1,657	3,299
Primary	ACSR 954 Rail		50.05	57.00	1.0610	2.36	1.075	177.0	1.0	177.0	3,000	1,306	-452	2,254	3,108
Primary	ACSR 954 Rail		50.05	57.00	1.0610	1.50	1.075	127.0	180.0	127.0	3,000	1,317	-324	1,657	2,650
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		33.40	8.62	0.5220	2.79	0.198	177.0	1.0	177.0	600	174	13	698	885
Secondary	AAC 4/0 AWG 7 STRAND OXLIP		33.40	8.62	0.5220	1.82	0.198	127.0	180.0	127.0	600	176	9	514	698
Secondary	DUPLEX 6 AWG		33.00	7.89	0.5370	2.21	0.071	177.0	1.0	177.0	300	86	4	709	799
Secondary	DUPLEX 6 AWG		33.00	7.89	0.5370	1.50	0.071	127.0	180.0	127.0	300	87	3	521	611
											Totals:	**17,112**	**273**	**27,831**	**45,216**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 8		53.70	6.64	0.0	0.0	53.00	5.50	4.50	120.00	0	194	194
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		48.70	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	174	174
										Totals:	**0**	**367**	**367**

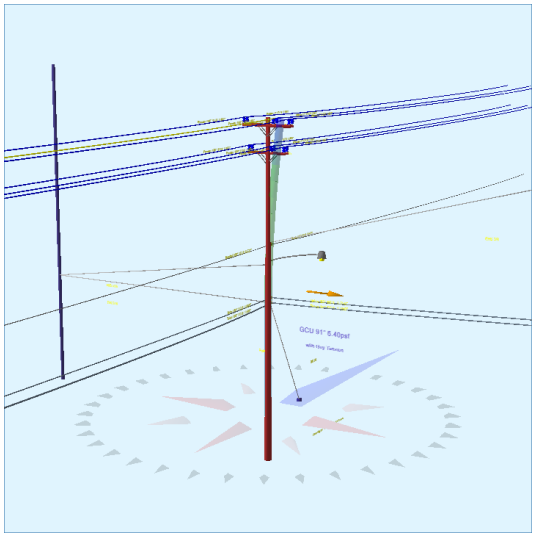
Streetlight		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
General	Streetlight - 10 ft. Arm		30.00	5.83	90.0	90.0	85.00	24.00	20.00	3.00	120.00	641	836	1,478
											Totals:	**641**	**836**	**1,478**

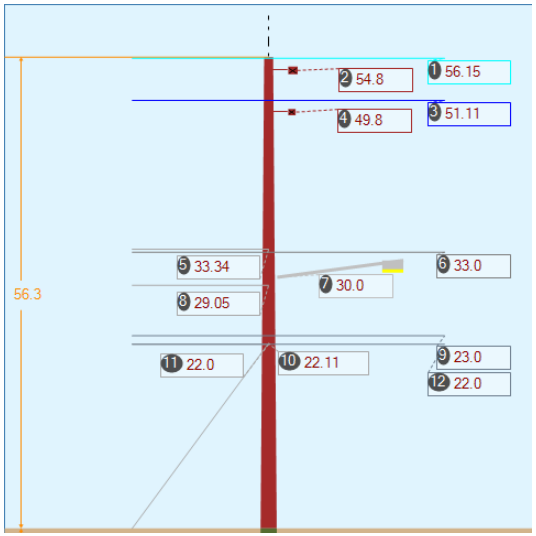
Insulator		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Post	Post Insulator - 27 kV		55.17	0.00	0.0	0.0	13.00	5.25	13.50	0	180	180
Post	Post Insulator - 27 kV		53.93	57.00	83.4	0.0	13.00	5.25	13.50	123	350	473
Post	Post Insulator - 27 kV		53.93	-57.00	276.6	0.0	13.00	5.25	13.50	-123	350	226
Post	Post Insulator - 27 kV		48.93	18.00	68.9	0.0	13.00	5.25	13.50	39	314	353
Post	Post Insulator - 27 kV		48.93	57.00	83.1	0.0	13.00	5.25	13.50	123	314	437
Post	Post Insulator - 27 kV		48.93	-57.00	276.9	0.0	13.00	5.25	13.50	-123	314	190
Spool	Spool 4"		33.40	0.00	90.5	0.5	3.00	4.00	4.12	2	24	26
Spool	Spool 2.5"		33.00	0.00	90.0	0.0	1.00	2.50	2.12	1	7	8
									Totals:	**42**	**1,851**	**1,893**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	35.63	34.24	13.81	8.53	8.60	15.30	2.38e+6	60.00	57.00	55.20	43,059	**429.72**	**10.31**

Pole Num:	**Pole 11**	Pole Length / Class:	**65 / 1**	Code:	**N/A**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**8.67**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.47**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**26.3**	29.33	90.5
Groundline	**11.1**	0.0	197.0
Vertical	**1.3**	30.83	179.3

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**21,164**	90.6	90.5
Groundline	**15,768**	161.9	197.0
GL Allowable	**180,280**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Anchor	60.0	80.0		**0.0**	90.5	**0.9**	260.0
EHS 3/8 (Span/Head)			33.3	**0.0**	90.5	**1.2**	260.0
Single Helix Anchor	50.0	270.0		**19.1**	90.5	**19.1**	90.5
EHS 5/16 (Span/Head)			29.1	**26.1**	90.5	**26.1**	90.5
EHS 5/16 (Span/Head)			22.0	**11.8**	90.5	**11.8**	90.5
Single Helix Anchor	12.0	0.0		**13.0**	90.5	**20.6**	180.0
EHS 3/8 (Down)			22.1	**18.8**	90.5	**29.7**	180.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 161.9°										
	Shear Load* (lbs)	**Applied Load (%)**	**Bending Moment (ft-lb)**	**Applied Moment (%)**	**Pole Capacity (%)**	**Bending Stress (+/- psi)**	**Vertical Load (lbs)**	**Vertical Stress (psi)**	**Total Stress (psi)**	**Pole Capacity (%)**
Powers	234	33.7	**10,170**	64.5	**5.6**	**414**	798	4	**418**	**7.0**
Comms	2,645	380.0	**48,715**	309.0	**27.0**	**1,982**	109	1	**1,982**	**33.0**
GuyBraces	-2,318	-333.0	**-46,475**	-294.7	**-25.8**	**-1,890**	2,700	14	**-1,876**	**-31.3**
Pole	109	15.7	**2,273**	14.4	**1.3**	**93**	2,730	15	**107**	**1.8**
Crossarms	3	0.5	**141**	0.9	**0.1**	**6**	270	1	**7**	**0.1**
Streetlights	9	1.3	**382**	2.4	**0.2**	**16**	85	0	**16**	**0.3**
Insulators	13	1.8	**562**	3.6	**0.3**	**23**	163	1	**24**	**0.4**
Pole Load	696	100.0	**15,768**	100.0	**8.8**	**641**	6,855	37	**678**	**11.3**
Pole Reserve Capacity			**164,512**		**91.3**	**5,359**			**5,322**	**88.7**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 161.9°										
	Shear Load* (lbs)	**Applied Load (%)**	**Bending Moment (ft-lb)**	**Applied Moment (%)**	**Pole Capacity (%)**	**Bending Stress (+/- psi)**	**Vertical Load (lbs)**	**Vertical Stress (psi)**	**Total Stress (psi)**	**Pole Capacity (%)**
<Undefined>	587	84.3	**13,495**	85.6	**7.5**	**549**	4,125	22	**571**	**9.5**
Pole	109	15.7	**2,273**	14.4	**1.3**	**93**	2,730	15	**107**	**1.8**
Totals:	696	100.0	**15,768**	100.0	**8.8**	**641**	6,855	37	**678**	**11.3**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		56.15	18.00	1.0610	1.50	1.075	127.0	1.0	127.0	3,000	-159,308	32	619	-158,657
Primary	ACSR 954 Rail		56.15	18.00	1.0610	1.29	1.075	113.0	180.0	113.0	3,000	160,247	28	527	160,803
Primary	ACSR 954 Rail		56.15	57.00	1.0610	1.50	1.075	127.0	1.0	127.0	3,000	-159,308	101	619	-158,588
Primary	ACSR 954 Rail		56.15	57.00	1.0610	1.29	1.075	113.0	180.0	113.0	3,000	160,247	90	527	160,864
Primary	ACSR 954 Rail		56.15	57.00	1.0610	1.50	1.075	127.0	1.0	127.0	3,000	-159,308	-101	619	-158,790
Primary	ACSR 954 Rail		56.15	57.00	1.0610	1.29	1.075	113.0	180.0	113.0	3,000	160,247	-90	527	160,685
Primary	ACSR 954 Rail		51.11	12.00	1.0610	1.50	1.075	127.0	1.0	127.0	3,000	-145,016	21	556	-144,439
Primary	ACSR 954 Rail		51.11	12.00	1.0610	1.29	1.075	113.0	180.0	113.0	3,000	145,871	19	473	146,363
Primary	ACSR 954 Rail		51.11	44.00	1.0610	1.50	1.075	127.0	1.0	127.0	3,000	-145,016	78	556	-144,383
Primary	ACSR 954 Rail		51.11	44.00	1.0610	1.29	1.075	113.0	180.0	113.0	3,000	145,871	69	473	146,413
Primary	ACSR 954 Rail		51.11	44.00	1.0610	1.50	1.075	127.0	1.0	127.0	3,000	-145,016	-78	556	-144,538
Primary	ACSR 954 Rail		51.11	44.00	1.0610	1.29	1.075	113.0	180.0	113.0	3,000	145,871	-69	473	146,275
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		33.00	8.71	0.5220	1.82	0.198	127.0	1.0	127.0	600	-18,709	3	166	-18,541
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		33.00	8.71	0.5220	1.58	0.198	113.0	180.0	113.0	600	18,820	3	141	18,963
											Totals:	**5,490**	**106**	**6,834**	**12,430**

Comm		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Telco	TELE 1.25		23.00	8.82	1.2500	0.87	0.600	60.0	80.0	60.0	1,200	3,892	4	72	3,967
Telco	TELE 1.0		23.00	8.82	1.0000	1.62	0.400	113.0	180.0	113.0	1,200	26,233	5	179	26,417
Telco	TELE 1.25		22.00	8.88	1.2500	0.87	0.600	60.0	80.0	60.0	1,200	3,722	4	68	3,795
Telco	TELE 1.5		22.00	8.88	1.5000	2.07	0.900	113.0	180.0	113.0	1,200	25,093	12	255	25,359
											Totals:	**58,940**	**25**	**573**	**59,539**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		54.80	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	109	109
Normal	CROSSARM 3-1/2 X 4-1/2 X 8		49.80	6.44	0.0	0.0	53.00	4.50	3.50	96.00	0	63	63
										Totals:	**0**	**173**	**173**

Streetlight	Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)

General	Streetlight - 10 ft. Arm	30.00	5.89	90.0	90.0	85.00	24.00	20.00	3.00	120.00	199	267	467
										Totals:	**199**	**267**	**467**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		55.03	18.00	69.8	0.0	13.00	5.25	13.50	12	114	126
Post	Post Insulator - 27 kV		55.03	57.00	83.4	0.0	13.00	5.25	13.50	38	114	153
Post	Post Insulator - 27 kV		55.03	-57.00	276.6	0.0	13.00	5.25	13.50	-38	114	76
Post	Post Insulator - 27 kV		49.99	12.00	61.8	0.0	13.00	5.25	13.50	8	103	111
Post	Post Insulator - 27 kV		49.99	44.00	81.7	0.0	13.00	5.25	13.50	30	103	132
Post	Post Insulator - 27 kV		49.99	-44.00	278.3	0.0	13.00	5.25	13.50	-30	103	73
Spool	Spool 4"		33.00	0.00	90.0	0.0	3.00	4.00	4.12	1	7	8
Spool	Spool 3"		23.00	0.00	90.0	0.0	2.00	3.00	3.19	0	3	3
Spool	Spool 3"		22.00	0.00	90.0	0.0	2.00	3.00	3.19	0	3	3
									Totals:	**22**	**664**	**686**

Guy Wire and Brace		**Owner**	**Attach Height (ft)**	**End Height (ft)**	**Lead/Span Length (ft)**	**Wire Diameter (in)**	**Percent Solid (%)**	**Lead Angle (deg)**	**Incline Angle (deg)**	**Wire Weight (lbs/ft)**	**Rest Length (ft)**	**Stretch Length (in)**
EHS 3/8	Span/Head		33.34	48.34	60.00	0.375	75.00	80.0	-14.0	0.273	57.36	0.00
EHS 5/16	Span/Head		29.05	22.05	50.00	0.312	75.00	270.0	8.0	0.205	50.43	1.20
EHS 5/16	Span/Head		22.00	22.00	50.00	0.312	75.00	270.0	0.0	0.205	48.73	0.53
EHS 3/8	Down		22.11	0.00	12.00	0.375	75.00	0.0	61.3	0.273	31.38	0.51

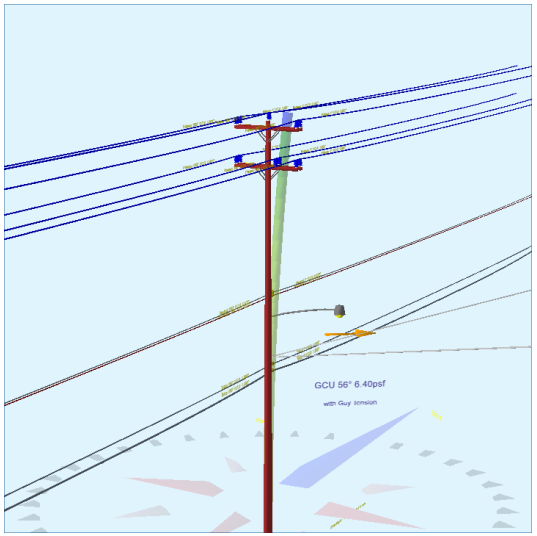
Guy Wire and Brace (Loads and Reactions)		**Elastic Modulus (psi)**	**Rated Tensile Strength (lbs)**	**Guy Strength Factor**	**Allowable Tension (lbs)**	**Initial Tension (lbs)**	**Loaded Tension*[2] (lbs)**	**Maximum Tension[2] (lbs)**	**Applied Tension[3] (lbs)**	**Vertical Load (lbs)**	**Shear Load In Guy Dir (lbs)**	**Shear Load At Report Angle (lbs)**	**Moment at GL[3] (ft-lb)**
EHS 3/8	Span/Head	2.30e+7	15,400	0.90	13,860	700	171	171	0	0	0	0	40
EHS 5/16	Span/Head	2.30e+7	11,200	0.90	10,080	700	2,627	2,627	2,627	363	2,602	-809	-23,500
EHS 5/16	Span/Head	2.30e+7	11,200	0.90	10,080	700	1,191	1,191	1,191	0	1,191	-370	-8,150
EHS 3/8	Down	2.30e+7	15,400	0.90	13,860	700	4,110	4,110	2,603	2,283	1,251	-1,189	-25,191
									Totals:	**2,646**	**5,044**	**-2,368**	**-56,801**

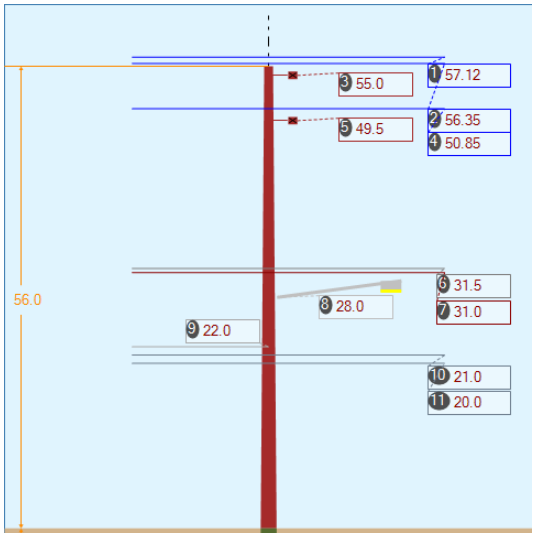
Anchor/Rod Load Summary	**Owner**	**Rod Length AGL (in)**	**Lead Length (ft)**	**Lead Angle (deg)**	**Strength of Assembly (lbs)**	**Anchor/Rod Strength Factor**	**Allowable Load (lbs)**	**Max Load[2] (lbs)**	**Load at Pole MCU[3] (lbs)**	**Max Required Capacity[2] (%)**
Anchor		30.00	60.00	80.0	20,000	1.00	20,000	171	0	0.9
Single Helix Anchor		18.00	50.00	270.0	20,000	1.00	20,000	3,810	3,810	19.0
Single Helix Anchor		18.00	12.00	0.0	20,000	1.00	20,000	4,110	2,603	20.6

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
0.71	30.76	33.63	14.17	5.25	8.60	15.44	2.38e+6	60.00	57.00	56.30	512,383	**5272.98**	**76.92**

Pole Num:	**Pole 12**	Pole Length / Class:	**65 / 1**	Code:	**N/A**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**9.0**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.36**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**47.9**	12.67	55.6
Groundline	**46.7**	0.0	57.9
Vertical	**1.1**	34.83	277.5

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**62,022**	37.9	55.6
Groundline	**83,589**	42.8	57.9
GL Allowable	**179,007**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Anchor	100.0	60.0		**0.0**	55.6	**0.0**	0.0
EHS 5/16 (Span/Head)			22.0	**0.0**	55.6	**0.0**	0.0
Anchor	100.0	135.0		**2.5**	55.6	**9.1**	300.0
EHS 5/16 (Span/Head)			22.0	**4.9**	55.6	**18.0**	300.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 42.8°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,190	67.9	**65,801**	78.7	**36.8**	**2,185**	763	4	**2,189**	**36.5**
Comms	96	5.5	**2,051**	2.5	**1.2**	**68**	146	1	**69**	**1.1**
GuyBraces	-10	-0.5	**-213**	-0.3	**-0.1**	**-7**	-98	-1	**-8**	**-0.1**
Pole	330	18.8	**8,447**	10.1	**4.7**	**280**	2,707	15	**295**	**4.9**
Crossarms	83	4.8	**4,394**	5.3	**2.5**	**146**	328	2	**148**	**2.5**
Streetlights	27	1.5	**1,202**	1.4	**0.7**	**40**	85	0	**40**	**0.7**
Insulators	36	2.1	**1,908**	2.3	**1.1**	**63**	151	1	**64**	**1.1**
Pole Load	1,752	100.0	**83,589**	100.0	**46.7**	**2,775**	4,082	22	**2,797**	**46.6**
Pole Reserve Capacity			**95,418**		**53.3**	**3,225**			**3,203**	**53.4**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 42.8°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,423	81.2	**75,142**	89.9	**42.0**	**2,495**	1,376	7	**2,502**	**41.7**
Pole	330	18.8	**8,447**	10.1	**4.7**	**280**	2,707	15	**295**	**4.9**
Totals:	1,752	100.0	**83,589**	100.0	**46.7**	**2,775**	4,082	22	**2,797**	**46.6**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		57.13	4.30	1.1650	1.53	1.075	127.0	1.0	127.0	3,000	127,860	18	1,153	129,031
Primary	ACSR 954 Rail		57.13	4.30	1.1650	1.30	1.075	112.0	180.0	112.0	3,000	-125,845	16	1,057	-124,772
Primary	ACSR 954 Rail		56.35	57.00	1.0610	1.29	1.075	113.0	1.0	113.0	3,000	126,126	196	926	127,248
Primary	ACSR 954 Rail		56.35	57.00	1.0610	1.50	1.075	112.0	180.0	112.0	2,000	-82,759	194	947	-81,618
Primary	ACSR 954 Rail		56.35	57.00	1.0610	1.29	1.075	113.0	1.0	113.0	3,000	126,126	-196	926	126,856
Primary	ACSR 954 Rail		56.35	57.00	1.0610	1.27	1.075	112.0	180.0	112.0	3,000	-124,139	-194	947	-123,386
Primary	ACSR 954 Rail		50.85	18.00	1.0610	1.29	1.075	113.0	1.0	113.0	3,000	113,826	62	822	114,711
Primary	ACSR 954 Rail		50.85	18.00	1.0610	1.27	1.075	112.0	180.0	112.0	3,000	-112,033	61	842	-111,130
Primary	ACSR 954 Rail		50.85	57.00	1.0610	1.29	1.075	113.0	1.0	113.0	3,000	113,826	196	822	114,845
Primary	ACSR 954 Rail		50.85	57.00	1.0610	1.27	1.075	112.0	180.0	112.0	3,000	-112,033	194	842	-110,997
Primary	ACSR 954 Rail		50.85	57.00	1.0610	1.29	1.075	113.0	1.0	113.0	3,000	113,826	-196	822	114,453

Primary	ACSR 954 Rail	50.85	57.00	1.0610	1.27	1.075	112.0	180.0	112.0	3,000	-112,033	-194	842	-111,386
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	31.50	8.78	0.5220	1.58	0.198	113.0	1.0	113.0	600	14,089	6	234	14,329
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	31.50	8.78	0.5220	1.56	0.198	112.0	180.0	112.0	600	-13,867	6	240	-13,622
Secondary	DUPLEX 6 AWG	31.00	8.06	0.5370	1.27	0.071	113.0	1.0	113.0	357	8,250	2	237	8,488
Secondary	DUPLEX 6 AWG	31.00	8.06	0.5370	1.26	0.071	112.0	180.0	112.0	357	-8,120	2	242	-7,876
										Totals:	**53,102**	**172**	**11,901**	**65,175**

Comm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Cable Diameter (in)**	**Sag at Max Temp (ft)**	**Cable Weight (lbs/ft)**	**Lead/Span Length (ft)**	**Span Angle (deg)**	**Wire Length (ft)**	**Tension (lbs)**	**Tension Moment* (ft-lb)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Telco	TELE 1.0		21.00	8.92	1.0000	1.62	0.400	113.0	1.0	113.0	1,200	18,785	11	282	19,079
Telco	TELE 1.0		21.00	8.92	1.0000	1.60	0.400	112.0	180.0	112.0	1,200	-18,489	11	288	-18,190
Telco	TELE 1.5		20.00	8.98	1.5000	2.07	0.900	113.0	1.0	113.0	1,200	17,891	26	400	18,316
Telco	TELE 1.5		20.00	8.98	1.5000	2.04	0.900	112.0	180.0	112.0	1,200	-17,609	26	409	-17,174
											Totals:	**578**	**74**	**1,379**	**2,031**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		55.00	6.61	0.0	0.0	82.00	5.50	4.50	120.00	0	2,305	2,305
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		49.50	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	2,047	2,047
										Totals:	**0**	**4,352**	**4,352**

Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		28.00	6.00	90.0	90.0	85.00	24.00	20.00	3.00	120.00	436	754	1,191
											Totals:	**436**	**754**	**1,191**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		56.00	0.00	0.0	0.0	13.00	5.25	13.50	3	179	182
Post	Post Insulator - 27 kV		55.23	57.00	83.4	0.0	13.00	5.25	13.50	84	350	434
Post	Post Insulator - 27 kV		55.23	-57.00	276.6	0.0	13.00	5.25	13.50	-84	350	266
Post	Post Insulator - 27 kV		49.73	18.00	68.9	0.0	13.00	5.25	13.50	26	311	338
Post	Post Insulator - 27 kV		49.73	57.00	83.1	0.0	13.00	5.25	13.50	84	311	395
Post	Post Insulator - 27 kV		49.73	-57.00	276.9	0.0	13.00	5.25	13.50	-84	311	227
Spool	Spool 4"		31.50	0.00	90.0	0.0	3.00	4.00	4.12	1	22	23
Spool	Spool 2.5"		31.00	0.00	90.0	0.0	1.00	2.50	2.12	0	7	7
Spool	Spool 3"		21.00	0.00	90.0	0.0	2.00	3.00	3.19	1	8	9

Spool	Spool 3"	20.00	0.00	90.0	0.0	2.00	3.00	3.19	1	7	8
								Totals:	**34**	**1,856**	**1,890**

Guy Wire and Brace		**Owner**	**Attach Height (ft)**	**End Height (ft)**	**Lead/Span Length (ft)**	**Wire Diameter (in)**	**Percent Solid (%)**	**Lead Angle (deg)**	**Incline Angle (deg)**	**Wire Weight (lbs/ft)**	**Rest Length (ft)**	**Stretch Length (in)**
EHS 5/16	Span/Head		22.00	47.00	100.00	0.312	75.00	60.0	-14.0	0.205	100.75	0.00
EHS 5/16	Span/Head		22.00	47.00	100.00	0.312	75.00	135.0	-14.0	0.205	100.75	0.45

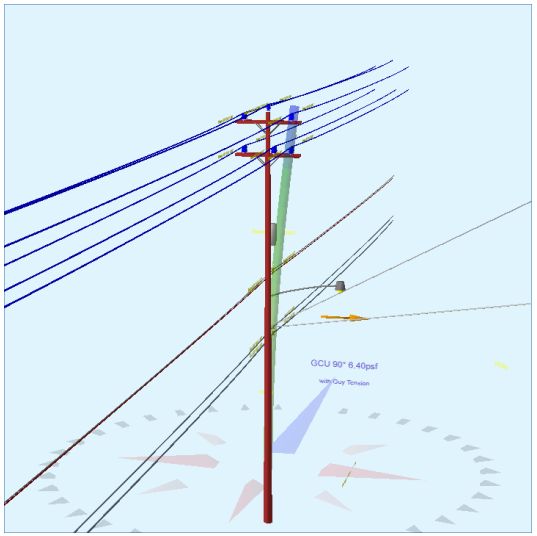
Guy Wire and Brace (Loads and Reactions)		**Elastic Modulus (psi)**	**Rated Tensile Strength (lbs)**	**Guy Strength Factor**	**Allowable Tension (lbs)**	**Initial Tension (lbs)**	**Loaded Tension*[2] (lbs)**	**Maximum Tension[2] (lbs)**	**Applied Tension[3] (lbs)**	**Vertical Load (lbs)**	**Shear Load In Guy Dir (lbs)**	**Shear Load At Report Angle (lbs)**	**Moment at GL[3] (ft-lb)**
EHS 5/16	Span/Head	2.30e+7	11,200	0.90	10,080	700	0	0	0	0	0	0	25
EHS 5/16	Span/Head	2.30e+7	11,200	0.90	10,080	700	1,812	1,812	490	-119	475	-18	-236
									Totals:	**-119**	**475**	**-18**	**-211**

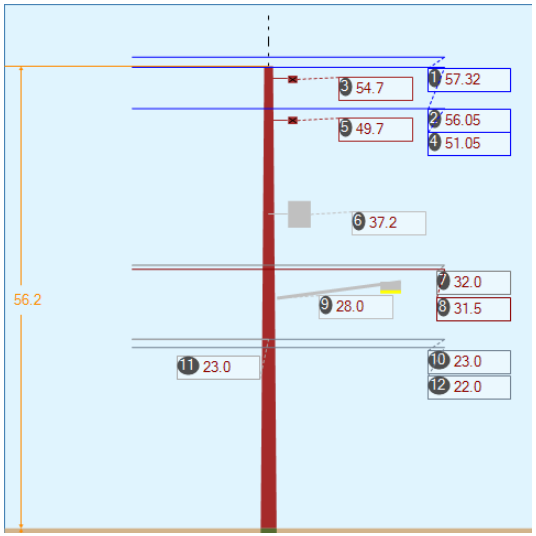
Anchor/Rod Load Summary	**Owner**	**Rod Length AGL (in)**	**Lead Length (ft)**	**Lead Angle (deg)**	**Strength of Assembly (lbs)**	**Anchor/Rod Strength Factor**	**Allowable Load (lbs)**	**Max Load[2] (lbs)**	**Load at Pole MCU[3] (lbs)**	**Max Required Capacity[2] (%)**
Anchor		0.00	100.00	60.0	20,000	1.00	20,000	0	0	0.0
Anchor		0.00	100.00	135.0	20,000	1.00	20,000	1,812	490	9.1

Pole Buckling

Buckling Constant	**Buckling Column Height* (ft)**	**Buckling Section Height (% Buckling Col. Hgt.)**	**Buckling Section Diameter (in)**	**Minimum Buckling Diameter at GL (in)**	**Diameter at Tip (in)**	**Diameter at GL (in)**	**Modulus of Elasticity (psi)**	**Pole Density (pcf)**	**Ice Density (pcf)**	**Pole Tip Height (ft)**	**Buckling Load Capacity at Height (lbs)**	**Buckling Load Applied at Height (lbs)**	**Buckling Load Factor of Safety**
0.71	34.83	34.12	13.95	4.97	8.60	15.40	2.38e+6	60.00	57.00	56.00	374,859	**3711.02**	**90.91**

Pole Num:	**Pole 13**	Pole Length / Class:	**65 / 1**	Code:	**N/A**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**8.83**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.43**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**33.6**	0.0	90.0
Groundline	**33.6**	0.0	90.0
Vertical	**1.3**	35.17	270.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**59,771**	89.6	90.0
Groundline	**59,771**	89.6	90.0
GL Allowable	**179,855**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Anchor	100.0	40.0		**0.0**	90.0	**2.7**	240.0
EHS 5/16 (Span/Head)			23.0	**0.0**	90.0	**5.4**	240.0
Anchor	100.0	140.0		**0.0**	90.0	**3.0**	300.0
EHS 5/16 (Span/Head)			23.0	**0.0**	90.0	**5.9**	300.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 89.6°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	794	56.0	**41,746**	69.8	**23.2**	**1,374**	840	4	**1,378**	**23.0**
Comms	165	11.6	**3,857**	6.5	**2.1**	**127**	125	1	**128**	**2.1**
GuyBraces	10	0.7	**241**	0.4	**0.1**	**8**	21	0	**8**	**0.1**
PowerEquipments	36	2.5	**1,361**	2.3	**0.8**	**45**	365	2	**47**	**0.8**
Pole	340	24.0	**8,771**	14.7	**4.9**	**289**	2,722	15	**303**	**5.1**
Crossarms	7	0.5	**380**	0.6	**0.2**	**13**	328	2	**14**	**0.2**
Streetlights	28	1.9	**1,435**	2.4	**0.8**	**47**	85	0	**48**	**0.8**
Insulators	38	2.7	**1,980**	3.3	**1.1**	**65**	153	1	**66**	**1.1**
Pole Load	1,417	100.0	**59,771**	100.0	**33.2**	**1,967**	4,639	25	**1,992**	**33.2**
Pole Reserve Capacity			**120,084**		**66.8**	**4,033**			**4,008**	**66.8**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 89.6°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,077	76.0	**51,000**	85.3	**28.4**	**1,678**	1,917	10	**1,688**	**28.1**
Pole	340	24.0	**8,771**	14.7	**4.9**	**289**	2,722	15	**303**	**5.1**
Totals:	1,417	100.0	**59,771**	100.0	**33.2**	**1,967**	4,639	25	**1,992**	**33.2**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		57.33	4.30	1.1650	1.30	1.075	112.0	1.0	112.0	3,000	4,215	0	1,892	6,108
Primary	ACSR 954 Rail		57.33	4.30	1.1650	1.70	1.075	138.0	180.0	138.0	3,000	-1,211	0	2,301	1,090
Primary	ACSR 954 Rail		56.05	44.00	1.0610	1.27	1.075	112.0	1.0	112.0	3,000	4,121	221	1,678	6,020
Primary	ACSR 954 Rail		56.05	44.00	1.0610	1.67	1.075	138.0	180.0	138.0	3,000	-1,185	272	2,041	1,128
Primary	ACSR 954 Rail		56.05	44.00	1.0610	1.27	1.075	112.0	1.0	112.0	3,000	4,121	-221	1,678	5,579
Primary	ACSR 954 Rail		56.05	44.00	1.0610	1.67	1.075	138.0	180.0	138.0	3,000	-1,185	-272	2,041	584
Primary	ACSR 954 Rail		51.05	12.00	1.0610	1.27	1.075	112.0	1.0	112.0	3,000	3,754	60	1,507	5,321
Primary	ACSR 954 Rail		51.05	12.00	1.0610	1.67	1.075	138.0	180.0	138.0	3,000	-1,079	74	1,832	827
Primary	ACSR 954 Rail		51.05	44.00	1.0610	1.27	1.075	112.0	1.0	112.0	3,000	3,754	221	1,507	5,482
Primary	ACSR 954 Rail		51.05	44.00	1.0610	1.67	1.075	138.0	180.0	138.0	3,000	-1,079	272	1,832	1,025

Primary	ACSR 954 Rail	51.05	44.00	1.0610	1.27	1.075	112.0	1.0	112.0	3,000	3,754	-221	1,507	5,040
Primary	ACSR 954 Rail	51.05	44.00	1.0610	1.67	1.075	138.0	180.0	138.0	3,000	-1,079	-272	1,832	481
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	32.00	8.77	0.5220	1.56	0.198	112.0	1.0	112.0	600	470	8	435	913
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	32.00	8.77	0.5220	2.02	0.198	138.0	180.0	138.0	600	-135	10	528	403
Secondary	DUPLEX 6 AWG	31.50	8.05	0.5370	1.26	0.071	112.0	1.0	112.0	357	275	3	439	717
Secondary	DUPLEX 6 AWG	31.50	8.05	0.5370	1.59	0.071	138.0	180.0	138.0	357	-79	3	534	458
										Totals:	**17,434**	**159**	**23,584**	**41,177**

Comm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Cable Diameter (in)**	**Sag at Max Temp (ft)**	**Cable Weight (lbs/ft)**	**Lead/Span Length (ft)**	**Span Angle (deg)**	**Wire Length (ft)**	**Tension (lbs)**	**Tension Moment* (ft-lb)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Telco	TELE 1.0		23.00	9.31	1.0000	1.60	0.400	112.0	1.0	112.0	1,200	676	17	570	1,264
Telco	TELE 1.0		23.00	9.31	1.0000	2.05	0.400	138.0	180.0	138.0	1,200	-194	21	693	520
Telco	TELE 1.25		22.00	9.37	1.2500	1.80	0.600	112.0	1.0	112.0	1,200	647	26	678	1,350
Telco	TELE 1.25		22.00	9.37	1.2500	2.34	0.600	138.0	180.0	138.0	1,200	-186	32	823	670
											Totals:	**942**	**97**	**2,764**	**3,804**

PowerEquipment		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Transformer	1PH-25KVA		37.20	22.45	0.0	0.0	365.00	39.00	--	22.00	--	5	1,337	1,342
											Totals:	**5**	**1,337**	**1,342**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		54.70	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	197	197
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		49.70	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	177	177
										Totals:	**0**	**374**	**374**

Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		28.00	6.01	90.0	90.0	85.00	24.00	20.00	3.00	120.00	642	774	1,416
											Totals:	**642**	**774**	**1,416**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		56.20	0.00	0.0	0.0	13.00	5.25	13.50	0	184	184
Post	Post Insulator - 27 kV		54.93	44.00	81.4	0.0	13.00	5.25	13.50	95	357	452
Post	Post Insulator - 27 kV		54.93	-44.00	278.6	0.0	13.00	5.25	13.50	-95	357	261

Post	Post Insulator - 27 kV	49.93	12.00	60.0	0.0	13.00	5.25	13.50	26	321	347
Post	Post Insulator - 27 kV	49.93	44.00	81.0	0.0	13.00	5.25	13.50	95	321	416
Post	Post Insulator - 27 kV	49.93	-44.00	279.0	0.0	13.00	5.25	13.50	-95	321	225
Spool	Spool 4"	32.00	0.00	90.0	0.0	3.00	4.00	4.12	2	22	25
Spool	Spool 2.5"	31.50	0.00	90.0	0.0	1.00	2.50	2.12	1	7	8
Spool	Spool 4"	23.00	0.00	90.0	0.0	3.00	4.00	4.12	2	15	18
Spool	Spool 4"	22.00	0.00	90.0	0.0	3.00	4.00	4.12	2	15	17
								Totals:	**34**	**1,919**	**1,953**

Guy Wire and Brace		Owner	Attach Height (ft)	End Height (ft)	Lead/Span Length (ft)	Wire Diameter (in)	Percent Solid (%)	Lead Angle (deg)	Incline Angle (deg)	Wire Weight (lbs/ft)	Rest Length (ft)	Stretch Length (in)
EHS 5/16	Span/Head		23.00	48.00	100.00	0.312	75.00	40.0	-14.0	0.205	100.78	0.00
EHS 5/16	Span/Head		23.00	48.00	100.00	0.312	75.00	140.0	-14.0	0.205	100.78	0.00

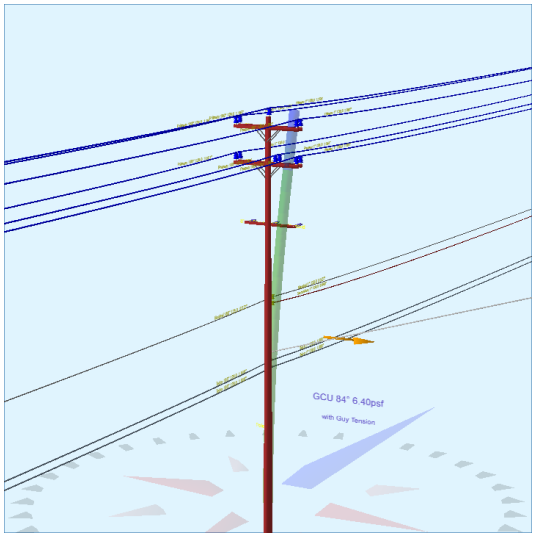
Guy Wire and Brace (Loads and Reactions)		Elastic Modulus (psi)	Rated Tensile Strength (lbs)	Guy Strength Factor	Allowable Tension (lbs)	Initial Tension (lbs)	Loaded Tension*² (lbs)	Maximum Tension² (lbs)	Applied Tension³ (lbs)	Vertical Load (lbs)	Shear Load In Guy Dir (lbs)	Shear Load At Report Angle (lbs)	Moment at GL³ (ft-lb)
EHS 5/16	Span/Head	2.30e+7	11,200	0.90	10,080	700	547	547	0	0	0	0	118
EHS 5/16	Span/Head	2.30e+7	11,200	0.90	10,080	700	596	596	0	0	0	0	119
									Totals:	**0**	**0**	**0**	**238**

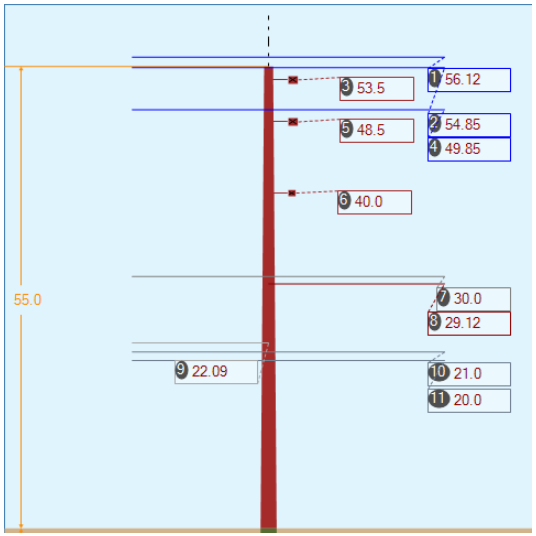
Anchor/Rod Load Summary	Owner	Rod Length AGL (in)	Lead Length (ft)	Lead Angle (deg)	Strength of Assembly (lbs)	Anchor/Rod Strength Factor	Allowable Load (lbs)	Max Load² (lbs)	Load at Pole MCU³ (lbs)	Max Required Capacity² (%)
Anchor		0.00	100.00	40.0	20,000	1.00	20,000	547	0	2.7
Anchor		0.00	100.00	140.0	20,000	1.00	20,000	596	0	3.0

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
0.71	35.21	34.16	13.96	5.17	8.60	15.42	2.38e+6	60.00	57.00	56.20	367,593	**3568.20**	**76.92**

Pole Num:	**Pole 14**	Pole Length / Class:	**65 / 1**	Code:	**N/A**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.0**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**47.97**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**33.1**	0.0	84.1
Groundline	**33.1**	0.0	84.1
Vertical	**1.2**	35.0	250.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**57,180**	79.1	84.1
Groundline	**57,180**	79.1	84.1
GL Allowable	**174,805**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Anchor	100.0	70.0		**0.0**	84.1	**2.9**	260.0
EHS 3/8 (Span/Head)			22.1	**0.0**	84.1	**4.1**	260.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 79.1°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	846	60.9	**42,534**	74.4	**24.3**	**1,440**	899	5	**1,445**	**24.1**
Comms	153	11.0	**3,259**	5.7	**1.9**	**110**	107	1	**111**	**1.8**
GuyBraces	1	0.1	**30**	0.1	**0.0**	**1**	14	0	**1**	**0.0**
Pole	329	23.6	**8,312**	14.5	**4.8**	**281**	2,630	14	**296**	**4.9**
Crossarms	12	0.9	**628**	1.1	**0.4**	**21**	378	2	**23**	**0.4**
Insulators	48	3.5	**2,417**	4.2	**1.4**	**82**	186	1	**83**	**1.4**
Pole Load	1,390	100.0	**57,180**	100.0	**32.7**	**1,935**	4,213	23	**1,958**	**32.6**
Pole Reserve Capacity			**117,625**		**67.3**	**4,065**			**4,042**	**67.4**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 79.1°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,061	76.4	**48,868**	85.5	**28.0**	**1,654**	1,583	9	**1,663**	**27.7**
Pole	329	23.6	**8,312**	14.5	**4.8**	**281**	2,630	14	**296**	**4.9**
Totals:	1,390	100.0	**57,180**	100.0	**32.7**	**1,935**	4,213	23	**1,958**	**32.6**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		56.13	4.30	1.1650	1.70	1.075	138.0	1.0	138.0	3,000	34,759	5	2,181	36,945
Primary	ACSR 954 Rail		56.13	4.30	1.1650	1.56	1.075	129.0	180.0	129.0	3,000	-31,876	5	2,060	-29,811
Primary	ACSR 954 Rail		54.85	57.00	1.0610	1.67	1.075	138.0	1.0	138.0	3,000	33,970	346	1,933	36,249
Primary	ACSR 954 Rail		54.85	57.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	-31,152	323	1,826	-29,003
Primary	ACSR 954 Rail		54.85	57.00	1.0610	1.67	1.075	138.0	1.0	138.0	3,000	33,970	-346	1,933	35,557
Primary	ACSR 954 Rail		54.85	57.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	-31,152	-323	1,826	-29,650
Primary	ACSR 954 Rail		49.85	18.00	1.0610	1.67	1.075	138.0	1.0	138.0	3,000	30,876	109	1,731	32,717
Primary	ACSR 954 Rail		49.85	18.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	-28,315	102	1,635	-26,578
Primary	ACSR 954 Rail		49.85	57.00	1.0610	1.67	1.075	138.0	1.0	138.0	3,000	30,876	346	1,731	32,953
Primary	ACSR 954 Rail		49.85	57.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	-28,315	323	1,635	-26,357
Primary	ACSR 954 Rail		49.85	57.00	1.0610	1.67	1.075	138.0	1.0	138.0	3,000	30,876	-346	1,731	32,261
Primary	ACSR 954 Rail		49.85	57.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	-28,315	-323	1,635	-27,003

Neutral	AAC 4/0 AWG 7 STRAND OXLIP	30.00	8.81	0.5220	2.02	0.198	138.0	1.0	138.0	600	3,713	10	477	4,199
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	30.00	8.81	0.5220	1.86	0.198	129.0	180.0	129.0	600	-3,405	9	450	-2,945
Secondary	TRIPLEX 4 AWG	29.12	8.87	0.6800	2.08	0.164	138.0	1.0	138.0	300	1,802	8	600	2,410
										Totals:	**18,312**	**248**	**23,385**	**41,944**

Comm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Cable Diameter (in)**	**Sag at Max Temp (ft)**	**Cable Weight (lbs/ft)**	**Lead/Span Length (ft)**	**Span Angle (deg)**	**Wire Length (ft)**	**Tension (lbs)**	**Tension Moment* (ft-lb)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Telco	TELE 1.0		21.00	8.86	1.0000	2.05	0.400	138.0	1.0	138.0	1,200	5,198	20	606	5,824
Telco	TELE 1.0		21.00	8.86	1.0000	1.89	0.400	129.0	180.0	129.0	1,200	-4,767	19	573	-4,175
Telco	TELE 1.0		20.00	8.92	1.0000	2.05	0.400	138.0	1.0	138.0	1,200	4,950	20	573	5,544
Telco	TELE 1.0		20.00	8.92	1.0000	1.89	0.400	129.0	180.0	129.0	1,200	-4,540	19	542	-3,979
											Totals:	**842**	**78**	**2,295**	**3,214**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		53.50	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	288	288
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		48.50	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	258	258
Normal	8' x 3.5" x 4.5" SP - 3 Deadend		40.00	6.96	0.0	0.0	50.00	4.50	3.50	96.00	5	67	72
										Totals:	**5**	**614**	**619**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		55.00	0.00	0.0	0.0	13.00	5.25	13.50	1	179	180
Post	Post Insulator - 27 kV		53.73	57.00	83.4	0.0	13.00	5.25	13.50	121	347	468
Post	Post Insulator - 27 kV		53.73	-57.00	276.6	0.0	13.00	5.25	13.50	-121	347	226
Post	Post Insulator - 27 kV		48.73	18.00	68.9	0.0	13.00	5.25	13.50	38	311	349
Post	Post Insulator - 27 kV		48.73	57.00	83.1	0.0	13.00	5.25	13.50	121	311	432
Post	Post Insulator - 27 kV		48.73	-57.00	276.9	0.0	13.00	5.25	13.50	-121	311	190
Deadend	Deadend Insulator		40.00	0.00	0.0	0.0	8.99	3.00	30.00	5	157	162
Deadend	Deadend Insulator		40.00	44.00	81.0	0.0	8.99	3.00	30.00	38	157	195
Deadend	Deadend Insulator		40.00	-44.00	279.0	0.0	8.99	3.00	30.00	-27	157	130
Spool	Spool 4"		30.00	0.00	90.0	0.0	3.00	4.00	4.12	2	21	23
Spool	Spool 4"		29.12	0.00	90.0	0.0	3.00	4.00	4.12	2	20	22
Bolt	Single Bolt		21.00	0.00	90.0	0.0	5.00	3.00	0.00	4	0	4
Bolt	Single Bolt		20.00	0.00	90.0	0.0	5.00	3.00	0.00	4	0	4
									Totals:	**67**	**2,317**	**2,384**

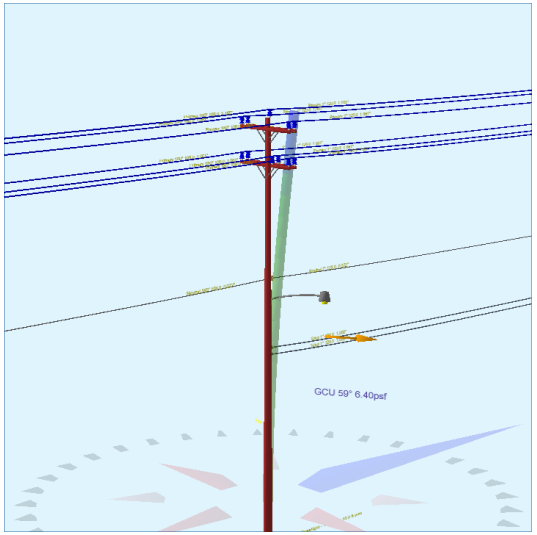
Guy Wire and Brace		Owner	Attach Height (ft)	End Height (ft)	Lead/Span Length (ft)	Wire Diameter (in)	Percent Solid (%)	Lead Angle (deg)	Incline Angle (deg)	Wire Weight (lbs/ft)	Rest Length (ft)	Stretch Length (in)
EHS 3/8	Span/Head		22.09	47.09	100.00	0.375	75.00	70.0	-14.0	0.273	99.10	0.00

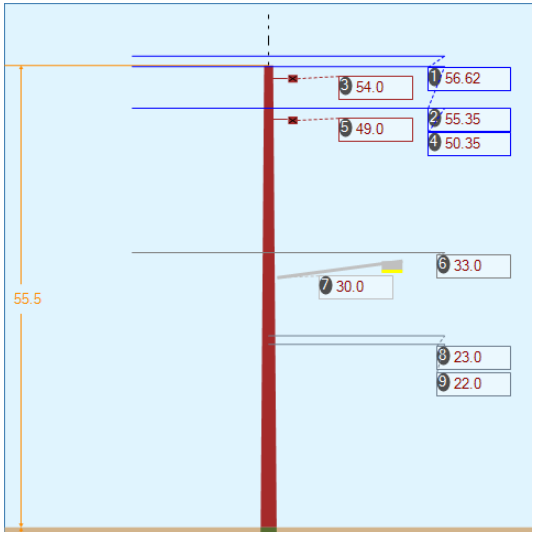
Guy Wire and Brace (Loads and Reactions)		Elastic Modulus (psi)	Rated Tensile Strength (lbs)	Guy Strength Factor	Allowable Tension (lbs)	Initial Tension (lbs)	Loaded Tension*[2] (lbs)	Maximum Tension[2] (lbs)	Applied Tension[3] (lbs)	Vertical Load (lbs)	Shear Load In Guy Dir (lbs)	Shear Load At Report Angle (lbs)	Moment at GL[3] (ft-lb)
EHS 3/8	Span/Head	2.30e+7	15,400	0.90	13,860	700	573	573	0	0	0	0	30
									Totals:	**0**	**0**	**0**	**30**

Anchor/Rod Load Summary	Owner	Rod Length AGL (in)	Lead Length (ft)	Lead Angle (deg)	Strength of Assembly (lbs)	Anchor/Rod Strength Factor	Allowable Load (lbs)	Max Load[2] (lbs)	Load at Pole MCU[3] (lbs)	Max Required Capacity[2] (%)
Anchor		18.00	100.00	70.0	20,000	1.00	20,000	573	0	2.9

Pole Buckling													
Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
0.71	35.04	34.18	13.82	5.04	8.60	15.28	2.38e+6	60.00	57.00	55.00	356,431	**3510.84**	**83.33**

Pole Num:	**Pole 15**	Pole Length / Class:	**65 / 1**	Code:	**N/A**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**9.5**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.17**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**38.4**	0.0	58.6
Groundline	**38.4**	0.0	58.6
Vertical	**8.8**	34.83	58.6

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**67,354**	45.7	58.6
Groundline	**67,354**	45.7	58.6
GL Allowable	**176,898**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 45.7°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	477	22.6	**25,331**	37.6	**14.3**	**849**	788	4	**853**	**14.2**
Comms	1,172	55.5	**26,708**	39.7	**15.1**	**895**	52	0	**895**	**14.9**
Pole	326	15.4	**8,289**	12.3	**4.7**	**278**	2,668	14	**292**	**4.9**
Crossarms	74	3.5	**3,854**	5.7	**2.2**	**129**	328	2	**131**	**2.2**
Streetlights	27	1.3	**1,289**	1.9	**0.7**	**43**	85	0	**44**	**0.7**
Insulators	36	1.7	**1,882**	2.8	**1.1**	**63**	150	1	**64**	**1.1**
Pole Load	2,111	100.0	**67,354**	100.0	**38.1**	**2,257**	4,070	22	**2,279**	**38.0**
Pole Reserve Capacity			**109,544**		**61.9**	**3,743**			**3,721**	**62.0**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 45.7°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,785	84.6	**59,065**	87.7	**33.4**	**1,979**	1,402	8	**1,987**	**33.1**
Pole	326	15.4	**8,289**	12.3	**4.7**	**278**	2,668	14	**292**	**4.9**
Totals:	2,111	100.0	**67,354**	100.0	**38.1**	**2,257**	4,070	22	**2,279**	**38.0**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		56.63	4.30	1.1650	1.56	1.075	129.0	1.0	129.0	3,000	120,937	17	1,264	122,218
Primary	ACSR 954 Rail		56.63	4.30	1.1650	1.24	1.075	108.0	180.0	108.0	3,000	-118,833	15	1,101	-117,717
Primary	ACSR 954 Rail		55.35	57.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	118,216	236	1,121	119,572
Primary	ACSR 954 Rail		55.35	57.00	1.0610	1.21	1.075	108.0	180.0	108.0	3,000	-116,159	197	976	-114,986
Primary	ACSR 954 Rail		55.35	57.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	118,216	-236	1,121	119,101
Primary	ACSR 954 Rail		55.35	57.00	1.0610	1.21	1.075	108.0	180.0	108.0	3,000	-116,159	-197	976	-115,380
Primary	ACSR 954 Rail		50.35	18.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	107,546	74	1,005	108,625
Primary	ACSR 954 Rail		50.35	18.00	1.0610	1.21	1.075	108.0	180.0	108.0	3,000	-105,675	62	875	-104,738
Primary	ACSR 954 Rail		50.35	57.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	107,546	236	1,005	108,787
Primary	ACSR 954 Rail		50.35	57.00	1.0610	1.21	1.075	108.0	180.0	108.0	3,000	-105,675	197	875	-104,603
Primary	ACSR 954 Rail		50.35	57.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	107,546	-236	1,005	108,315
Primary	ACSR 954 Rail		50.35	57.00	1.0610	1.21	1.075	108.0	180.0	108.0	3,000	-105,675	-197	875	-104,997

Neutral	AAC 4/0 AWG 7 STRAND OXLIP	33.00	8.66	0.5220	1.86	0.198	129.0	1.0	129.0	600	14,084	7	305	14,396
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	33.00	8.66	0.5220	1.49	0.198	108.0	180.0	108.0	600	-13,839	6	266	-13,567
										Totals:	**12,076**	**181**	**12,771**	**25,027**

Comm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Cable Diameter (in)**	**Sag at Max Temp (ft)**	**Cable Weight (lbs/ft)**	**Lead/Span Length (ft)**	**Span Angle (deg)**	**Wire Length (ft)**	**Tension (lbs)**	**Tension Moment* (ft-lb)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Telco	TELE 1.0		23.00	8.77	1.0000	2.14	0.400	129.0	1.0	129.0	800	13,088	13	386	13,488
Telco	TELE 1.0		22.00	8.83	1.0000	2.14	0.400	129.0	1.0	129.0	800	12,519	14	367	12,900
											Totals:	**25,607**	**27**	**753**	**26,388**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		54.00	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	2,008	2,008
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		49.00	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	1,800	1,800
										Totals:	**0**	**3,808**	**3,808**

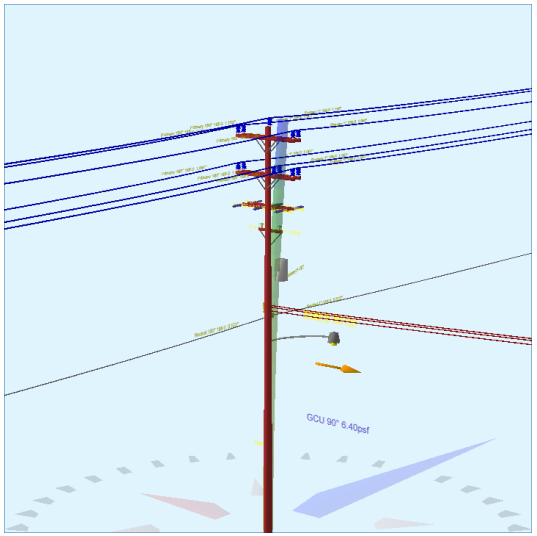
Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		30.00	5.84	90.0	90.0	85.00	24.00	20.00	3.00	120.00	459	815	1,274
											Totals:	**459**	**815**	**1,274**

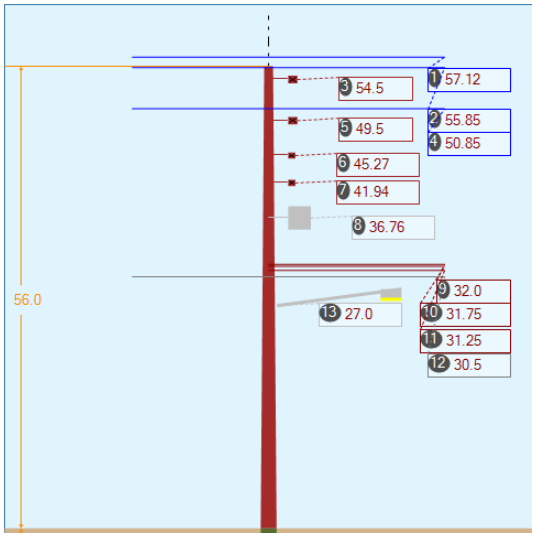
Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		55.50	0.00	0.0	0.0	13.00	5.25	13.50	3	177	180
Post	Post Insulator - 27 kV		54.23	57.00	83.4	0.0	13.00	5.25	13.50	88	343	431
Post	Post Insulator - 27 kV		54.23	-57.00	276.6	0.0	13.00	5.25	13.50	-88	343	254
Post	Post Insulator - 27 kV		49.23	18.00	68.9	0.0	13.00	5.25	13.50	28	308	336
Post	Post Insulator - 27 kV		49.23	57.00	83.1	0.0	13.00	5.25	13.50	88	308	396
Post	Post Insulator - 27 kV		49.23	-57.00	276.9	0.0	13.00	5.25	13.50	-88	308	219
Spool	Spool 4"		33.00	0.00	90.0	0.0	3.00	4.00	4.12	2	23	24
Spool	Spool 3"		23.00	0.00	90.0	0.0	2.00	3.00	3.19	1	9	10
Spool	Spool 3"		22.00	0.00	90.0	0.0	2.00	3.00	3.19	1	8	9
									Totals:	**35**	**1,825**	**1,860**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	34.79	34.13	13.89	8.35	8.60	15.34	2.38e+6	60.00	57.00	55.50	46,177	**462.54**	**11.36**

Pole Num:	**Pole 16**	Pole Length / Class:	**65 / 1**	Code:	**N/A**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**9.0**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**48.36**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**44.5**	0.0	90.0
Groundline	**44.5**	0.0	90.0
Vertical	**11.6**	36.58	90.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**78,820**	89.9	90.0
Groundline	**78,820**	89.9	90.0
GL Allowable	**179,007**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 89.9°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,427	75.1	**63,201**	80.2	**35.3**	**2,098**	967	5	**2,104**	**35.1**
PowerEquipments	31	1.6	**1,756**	2.2	**1.0**	**58**	335	2	**60**	**1.0**
Pole	338	17.8	**8,662**	11.0	**4.8**	**288**	2,707	15	**302**	**5.0**
Crossarms	11	0.6	**526**	0.7	**0.3**	**18**	478	3	**20**	**0.3**
Streetlights	28	1.4	**1,398**	1.8	**0.8**	**46**	85	0	**47**	**0.8**
Insulators	66	3.5	**3,276**	4.2	**1.8**	**109**	229	1	**110**	**1.8**
Pole Load	1,901	100.0	**78,820**	100.0	**44.0**	**2,617**	4,801	26	**2,643**	**44.0**
Pole Reserve Capacity			**100,187**		**56.0**	**3,383**			**3,357**	**56.0**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 89.9°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,563	82.2	**70,158**	89.0	**39.2**	**2,329**	2,094	11	**2,341**	**39.0**
Pole	338	17.8	**8,662**	11.0	**4.8**	**288**	2,707	15	**302**	**5.0**
Totals:	1,901	100.0	**78,820**	100.0	**44.0**	**2,617**	4,801	26	**2,643**	**44.0**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		57.13	4.30	1.1650	1.24	1.075	108.0	1.0	108.0	3,000	3,146	0	1,822	4,968
Primary	ACSR 954 Rail		57.13	4.30	1.1650	2.60	1.075	188.0	180.0	188.0	3,000	-153	0	3,050	2,898
Primary	ACSR 954 Rail		55.85	57.00	1.0610	1.21	1.075	108.0	1.0	108.0	3,000	3,076	276	1,615	4,967
Primary	ACSR 954 Rail		55.85	57.00	1.0610	2.57	1.075	188.0	180.0	188.0	3,000	-149	480	2,705	3,035
Primary	ACSR 954 Rail		55.85	57.00	1.0610	1.21	1.075	108.0	1.0	108.0	3,000	3,076	-276	1,615	4,416
Primary	ACSR 954 Rail		55.85	57.00	1.0610	2.57	1.075	188.0	180.0	188.0	3,000	-149	-480	2,705	2,076
Primary	ACSR 954 Rail		50.85	18.00	1.0610	1.21	1.075	108.0	1.0	108.0	3,000	2,801	87	1,450	4,338
Primary	ACSR 954 Rail		50.85	18.00	1.0610	2.57	1.075	188.0	180.0	188.0	3,000	-136	152	2,427	2,442
Primary	ACSR 954 Rail		50.85	57.00	1.0610	1.21	1.075	108.0	1.0	108.0	3,000	2,801	276	1,450	4,526
Primary	ACSR 954 Rail		50.85	57.00	1.0610	2.57	1.075	188.0	180.0	188.0	3,000	-136	480	2,427	2,771
Primary	ACSR 954 Rail		50.85	57.00	1.0610	1.21	1.075	108.0	1.0	108.0	3,000	2,801	-276	1,450	3,975
Primary	ACSR 954 Rail		50.85	57.00	1.0610	2.57	1.075	188.0	180.0	188.0	3,000	-136	-480	2,427	1,811

Secondary	DUPLEX 6 AWG	32.00	8.75	0.5370	0.51	0.071	100.0	90.0	100.0	200	6,392	0	0	6,392
Secondary	DUPLEX 6 AWG	31.75	8.77	0.5370	0.51	0.071	100.0	90.0	100.0	200	6,342	0	0	6,342
Secondary	DUPLEX 6 AWG	31.25	8.80	0.5370	0.51	0.071	100.0	90.0	100.0	200	6,242	0	0	6,242
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	30.50	8.84	0.5220	1.49	0.198	108.0	1.0	108.0	600	336	8	398	741
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	30.50	8.84	0.5220	3.03	0.198	188.0	180.0	188.0	600	-16	14	665	662
										Totals:	**36,137**	**260**	**26,205**	**62,603**

PowerEquipment		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Transformer	1PH-15KVA		36.76	22.46	70.0	70.0	335.00	34.00	--	22.00	--	590	1,150	1,739
											Totals:	**590**	**1,150**	**1,739**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		54.50	6.64	0.0	0.0	82.00	5.50	4.50	120.00	0	197	197
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		49.50	6.94	0.0	0.0	82.00	5.50	4.50	120.00	0	176	176
Normal	8' x 3.5" x 4.5" SP - 3 Deadend		45.27	6.70	180.0	180.0	50.00	4.50	3.50	96.00	0	51	51
Normal	8' x 3.5" x 4.5" SP - 3 Deadend		45.27	6.70	0.0	0.0	50.00	4.50	3.50	96.00	0	51	51
Normal	4' x 3.5" x 4.5" SP - 2 Pin		41.94	6.90	0.0	0.0	50.00	4.50	3.50	48.00	0	47	47
										Totals:	**0**	**521**	**521**

Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 10 ft. Arm		27.00	6.06	90.0	90.0	85.00	24.00	20.00	3.00	120.00	642	742	1,385
											Totals:	**642**	**742**	**1,385**

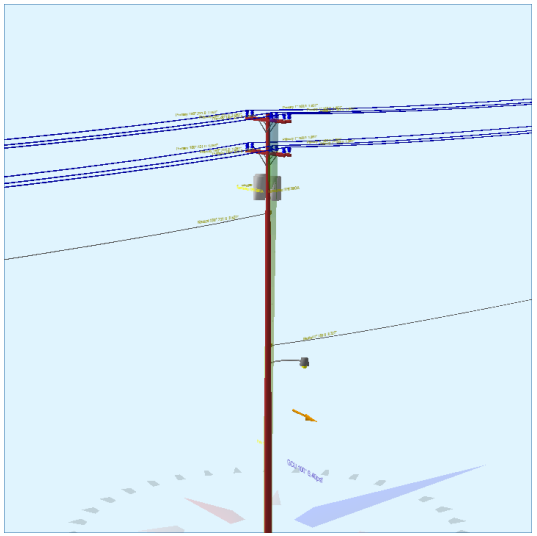
Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		56.00	0.00	0.0	0.0	13.00	5.25	13.50	0	183	183
Post	Post Insulator - 27 kV		54.73	57.00	83.4	0.0	13.00	5.25	13.50	123	355	479
Post	Post Insulator - 27 kV		54.73	-57.00	276.6	0.0	13.00	5.25	13.50	-123	355	232
Post	Post Insulator - 27 kV		49.73	18.00	68.9	0.0	13.00	5.25	13.50	39	319	358
Post	Post Insulator - 27 kV		49.73	57.00	83.1	0.0	13.00	5.25	13.50	123	319	443
Post	Post Insulator - 27 kV		49.73	-57.00	276.9	0.0	13.00	5.25	13.50	-123	319	196
Deadend	Deadend Insulator		45.27	0.00	180.0	0.0	8.99	3.00	30.00	0	181	181
Deadend	Deadend Insulator		45.27	44.00	261.3	0.0	8.99	3.00	30.00	-33	181	148

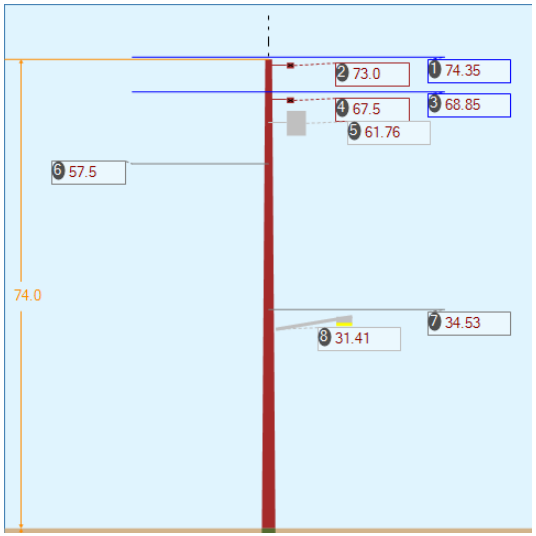
Deadend	Deadend Insulator	45.27	-44.00	98.7	0.0	8.99	3.00	30.00	33	181	214
Deadend	Deadend Insulator	45.27	0.00	0.0	0.0	8.99	3.00	30.00	0	181	181
Deadend	Deadend Insulator	45.27	44.00	81.3	0.0	8.99	3.00	30.00	33	181	214
Deadend	Deadend Insulator	45.27	-44.00	278.7	0.0	8.99	3.00	30.00	-33	181	148
Pin	15 kV Pin Insulator 6" Dia x 8"	42.13	18.00	69.0	0.0	10.00	6.00	8.00	15	89	104
Pin	15 kV Pin Insulator 6" Dia x 8"	42.13	-20.00	289.0	0.0	10.00	6.00	8.00	-17	89	73
Spool	Spool 4"	32.00	0.00	180.0	90.0	3.00	4.00	4.12	0	22	22
Spool	Spool 4"	31.75	0.00	180.0	90.0	3.00	4.00	4.12	0	22	22
Spool	Spool 4"	31.25	0.00	180.0	90.0	3.00	4.00	4.12	0	22	22
Spool	Spool 4"	30.50	0.00	90.0	0.0	3.00	4.00	4.12	2	21	23
								Totals:	**40**	**3,206**	**3,245**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	36.58	34.33	13.87	8.98	8.60	15.40	2.38e+6	60.00	57.00	56.00	41,501	**413.86**	**8.62**

Pole Num:	**Pole 17**	Pole Length / Class:	**85 / 1**	Code:	**N/A**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**11.0**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**53.23**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**48.1**	28.33	100.0
Groundline	**44.6**	0.0	96.3
Vertical	**27.2**	50.5	100.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**60,489**	108.4	100.0
Groundline	**106,386**	102.6	96.3
GL Allowable	**238,747**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 102.6°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,009	58.1	**74,941**	70.4	**31.4**	**1,871**	1,393	6	**1,877**	**31.3**
PowerEquipments	154	8.9	**9,832**	9.2	**4.1**	**245**	1,920	9	**254**	**4.2**
Pole	492	28.3	**16,330**	15.4	**6.8**	**408**	4,089	18	**426**	**7.1**
Crossarms	15	0.8	**1,038**	1.0	**0.4**	**26**	328	1	**27**	**0.5**
Streetlights	25	1.4	**1,250**	1.2	**0.5**	**31**	75	0	**32**	**0.5**
Insulators	41	2.4	**2,994**	2.8	**1.3**	**75**	162	1	**75**	**1.3**
Pole Load	1,736	100.0	**106,386**	100.0	**44.6**	**2,656**	7,967	35	**2,691**	**44.9**
Pole Reserve Capacity			**132,360**		**55.4**	**3,344**			**3,309**	**55.1**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 102.6°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,244	71.7	**90,056**	84.7	**37.7**	**2,248**	3,878	17	**2,265**	**37.8**
Pole	492	28.3	**16,330**	15.4	**6.8**	**408**	4,089	18	**426**	**7.1**
Totals:	1,736	100.0	**106,386**	100.0	**44.6**	**2,656**	7,967	35	**2,691**	**44.9**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		74.35	18.00	1.0610	2.57	1.075	188.0	1.0	188.0	3,000	-44,961	148	3,643	-41,170
Primary	ACSR 954 Rail		74.35	18.00	1.0610	3.49	1.075	231.0	180.0	231.1	3,000	48,770	182	4,371	53,322
Primary	ACSR 954 Rail		74.35	57.00	1.0610	2.57	1.075	188.0	1.0	188.0	3,000	-44,961	468	3,643	-40,850
Primary	ACSR 954 Rail		74.35	57.00	1.0610	3.49	1.075	231.0	180.0	231.1	3,000	48,770	576	4,371	53,716
Primary	ACSR 954 Rail		74.35	57.00	1.0610	2.57	1.075	188.0	1.0	188.0	3,000	-44,961	-468	3,643	-41,787
Primary	ACSR 954 Rail		74.35	57.00	1.0610	3.49	1.075	231.0	180.0	231.1	3,000	48,770	-576	4,371	52,565
Primary	ACSR 954 Rail		68.85	18.00	1.0610	2.57	1.075	188.0	1.0	188.0	3,000	-41,637	148	3,333	-38,156
Primary	ACSR 954 Rail		68.85	18.00	1.0610	3.49	1.075	231.0	180.0	231.1	3,000	45,164	182	3,999	49,345
Primary	ACSR 954 Rail		68.85	57.00	1.0610	2.57	1.075	188.0	1.0	188.0	3,000	-41,637	468	3,333	-37,836
Primary	ACSR 954 Rail		68.85	57.00	1.0610	3.49	1.075	231.0	180.0	231.1	3,000	45,164	576	3,999	49,739
Primary	ACSR 954 Rail		68.85	57.00	1.0610	2.57	1.075	188.0	1.0	188.0	3,000	-41,637	-468	3,333	-38,773
Primary	ACSR 954 Rail		68.85	57.00	1.0610	3.49	1.075	231.0	180.0	231.1	3,000	45,164	-576	3,999	48,588

Neutral	AAC 4/0 AWG 7 STRAND OXLIP	57.50	8.23	0.5220	4.01	0.198	231.0	180.0	231.1	600	7,538	15	1,601	9,155
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	34.53	9.52	0.5220	3.03	0.198	188.0	1.0	188.0	600	-4,174	14	742	-3,417
										Totals:	**25,371**	**689**	**48,381**	**74,442**

PowerEquipment		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Transformer	1PH-50KVA		61.76	22.99	90.0	90.0	640.00	47.00	--	24.00	--	1,196	3,166	4,363
Transformer	1PH-50KVA		61.76	22.99	180.0	180.0	640.00	47.00	--	24.00	--	268	3,166	3,434
Transformer	1PH-50KVA		61.76	22.99	270.0	270.0	640.00	47.00	--	24.00	--	-1,196	3,166	1,970
											Totals:	**268**	**9,499**	**9,766**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		73.00	6.60	0.0	0.0	82.00	5.50	4.50	120.00	0	538	538
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		67.50	6.91	0.0	0.0	82.00	5.50	4.50	120.00	0	493	493
										Totals:	**0**	**1,031**	**1,031**

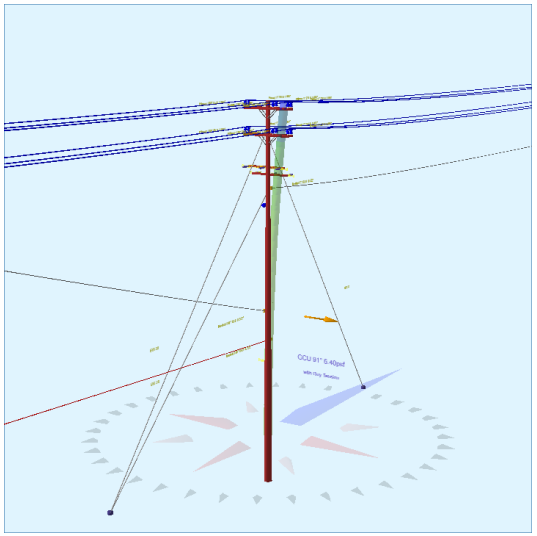
Streetlight		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
General	Streetlight - 8 ft. Arm		31.41	6.70	90.0	90.0	75.00	24.00	20.00	3.00	96.00	458	784	1,242
											Totals:	**458**	**784**	**1,242**

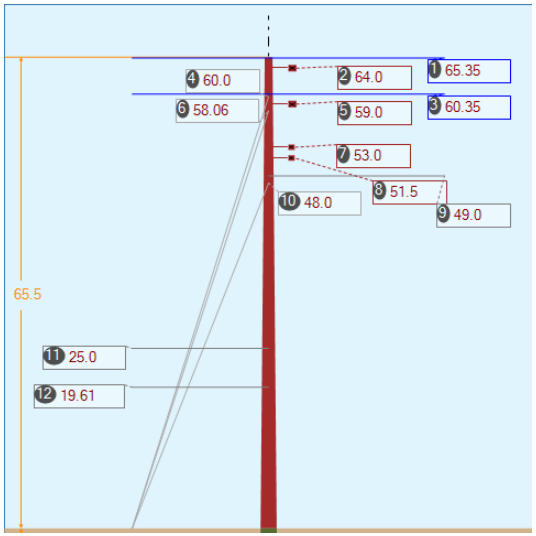
Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		73.23	18.00	69.9	0.0	13.00	5.25	13.50	38	491	530
Post	Post Insulator - 27 kV		73.23	57.00	83.4	0.0	13.00	5.25	13.50	121	491	612
Post	Post Insulator - 27 kV		73.23	-57.00	276.6	0.0	13.00	5.25	13.50	-121	491	371
Post	Post Insulator - 27 kV		67.73	18.00	69.0	0.0	13.00	5.25	13.50	38	450	489
Post	Post Insulator - 27 kV		67.73	57.00	83.1	0.0	13.00	5.25	13.50	121	450	571
Post	Post Insulator - 27 kV		67.73	-57.00	276.9	0.0	13.00	5.25	13.50	-121	450	330
Spool	Spool 4"		57.50	0.00	90.0	0.0	3.00	4.00	4.12	2	43	45
Spool	Spool 4"		34.53	0.00	90.0	0.0	3.00	4.00	4.12	2	24	27
									Totals:	**80**	**2,894**	**2,974**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	50.54	35.05	14.94	12.23	8.60	16.95	2.38e+6	60.00	57.00	74.00	29,317	**292.89**	**3.68**

Pole Num:	**Pole 18**	Pole Length / Class:	**75 / 1**	Code:	**N/A**	Structure Type:	**Guyed Tangent**
Aux Data 1	**Unset**	Species:	**WESTERN RED CEDAR**	NESC Rule:	**-**	Status	**Guy Wires Adequate**
Aux Data 2	**Unset**	Setting Depth (ft):	**9.5**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**56.43**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**6,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**4,500**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**37.9**	25.0	90.5
Groundline	**35.0**	0.0	91.2
Vertical	**2.1**	42.92	270.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**41,037**	81.9	90.5
Groundline	**74,574**	99.5	91.2
GL Allowable	**213,331**		

Guy System Component Summary				Load From Worst Wind Angle on Pole		Individual Maximum Load With Overload Applied	
Description	**Lead Length (ft)**	**Lead Angle (deg)**	**Height (ft)**	**Nominal Capacity (%)**	**Wind Angle (deg)**	**Max* Load Capacity (%)**	**Wind Angle (deg)**
Single Helix Anchor	48.0	180.0		**1.9**	90.5	**6.1**	0.0
EHS 3/8 (Down)			60.0	**1.8**	90.5	**5.2**	0.0
EHS 3/8 (Down)			48.0	**1.0**	90.5	**3.6**	0.0
Single Helix Anchor	39.0	0.0		**0.0**	90.5	**2.0**	180.0
EHS 3/8 (Down)			58.1	**0.0**	90.5	**2.8**	180.0
			System Capacity Summary:	**Adequate**		**Adequate**	

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 99.5°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	950	61.8	**53,347**	71.5	**25.0**	**1,114**	870	3	**1,117**	**24.8**
GuyBraces	66	4.3	**3,690**	5.0	**1.7**	**77**	338	1	**78**	**1.7**
Pole	441	28.7	**12,888**	17.3	**6.0**	**269**	3,280	13	**282**	**6.3**
Crossarms	10	0.6	**592**	0.8	**0.3**	**12**	428	2	**14**	**0.3**
Insulators	69	4.5	**4,057**	5.4	**1.9**	**85**	241	1	**86**	**1.9**
Pole Load	1,536	100.0	**74,574**	100.0	**35.0**	**1,557**	5,157	20	**1,577**	**35.0**
Pole Reserve Capacity			**138,757**		**65.0**	**2,943**			**2,923**	**65.0**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 99.5°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,095	71.3	**61,686**	82.7	**28.9**	**1,288**	1,877	7	**1,295**	**28.8**
Pole	441	28.7	**12,888**	17.3	**6.0**	**269**	3,280	13	**282**	**6.3**
Totals:	1,536	100.0	**74,574**	100.0	**35.0**	**1,557**	5,157	20	**1,577**	**35.0**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		65.35	18.00	1.0610	3.49	1.075	231.0	1.0	231.1	3,000	-28,925	184	3,874	-24,867
Primary	ACSR 954 Rail		65.35	18.00	1.0610	0.90	1.075	85.0	180.0	85.0	3,000	32,307	68	1,523	33,898
Primary	ACSR 954 Rail		65.35	57.00	1.0610	3.49	1.075	231.0	1.0	231.1	3,000	-28,925	582	3,874	-24,469
Primary	ACSR 954 Rail		65.35	57.00	1.0610	0.90	1.075	85.0	180.0	85.0	3,000	32,307	214	1,523	34,045
Primary	ACSR 954 Rail		65.35	57.00	1.0610	3.49	1.075	231.0	1.0	231.1	3,000	-28,925	-582	3,874	-25,633
Primary	ACSR 954 Rail		65.35	57.00	1.0610	0.90	1.075	85.0	180.0	85.0	3,000	32,307	-214	1,523	33,616
Primary	ACSR 954 Rail		60.35	18.00	1.0610	3.49	1.075	231.0	1.0	231.1	3,000	-26,714	184	3,533	-22,997
Primary	ACSR 954 Rail		60.35	18.00	1.0610	0.90	1.075	85.0	180.0	85.0	3,000	29,837	68	1,390	31,295
Primary	ACSR 954 Rail		60.35	57.00	1.0610	3.49	1.075	231.0	1.0	231.1	3,000	-26,714	582	3,533	-22,599
Primary	ACSR 954 Rail		60.35	57.00	1.0610	0.90	1.075	85.0	180.0	85.0	3,000	29,837	214	1,390	31,441
Primary	ACSR 954 Rail		60.35	57.00	1.0610	3.49	1.075	231.0	1.0	231.1	3,000	-26,714	-582	3,533	-23,762
Primary	ACSR 954 Rail		60.35	57.00	1.0610	0.90	1.075	85.0	180.0	85.0	3,000	29,837	-214	1,390	31,013

Neutral	AAC 4/0 AWG 7 STRAND OXLIP	49.00	8.48	0.5220	4.01	0.198	231.0	1.0	231.1	600	-4,334	16	1,370	-2,948
Neutral	AAC 4/0 AWG 7 STRAND OXLIP	25.00	10.19	0.5220	0.33	0.198	85.0	180.0	85.0	600	2,377	128	249	2,754
Neutral	AAC 4 AWG 7 STRAND ROSE	19.61	10.08	0.2320	0.07	0.039	85.0	180.0	85.0	600	1,936	-16	84	2,004
										Totals:	**19,497**	**630**	**32,663**	**52,790**

Crossarm		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Height (in)**	**Unit Depth (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		64.00	6.65	0.0	0.0	82.00	5.50	4.50	120.00	0	242	242
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		59.00	7.01	0.0	0.0	82.00	5.50	4.50	120.00	0	221	221
Normal	8' x 3.5" x 4.5" SP - 3 Deadend		53.00	6.94	180.0	180.0	50.00	4.50	3.50	96.00	5	62	67
Normal	8' x 3.5" x 4.5" SP - 3 Deadend		51.50	7.05	0.0	0.0	50.00	4.50	3.50	96.00	-5	60	56
										Totals:	**0**	**586**	**586**

Insulator		**Owner**	**Height (ft)**	**Horiz. Offset (in)**	**Offset Angle (deg)**	**Rotate Angle (deg)**	**Unit Weight (lbs)**	**Unit Diameter (in)**	**Unit Length (in)**	**Offset Moment* (ft-lb)**	**Wind Moment* (ft-lb)**	**Moment at GL* (ft-lb)**
Post	Post Insulator - 27 kV		64.23	18.00	69.7	0.0	13.00	5.25	13.50	38	420	458
Post	Post Insulator - 27 kV		64.23	57.00	83.3	0.0	13.00	5.25	13.50	122	420	542
Post	Post Insulator - 27 kV		64.23	-57.00	276.7	0.0	13.00	5.25	13.50	-122	420	298
Post	Post Insulator - 27 kV		59.23	18.00	68.7	0.0	13.00	5.25	13.50	38	383	422
Post	Post Insulator - 27 kV		59.23	57.00	83.0	0.0	13.00	5.25	13.50	122	383	505
Post	Post Insulator - 27 kV		59.23	-57.00	277.0	0.0	13.00	5.25	13.50	-122	383	262
Deadend	Deadend Insulator		53.00	0.00	180.0	0.0	8.99	3.00	30.00	5	214	218
Deadend	Deadend Insulator		53.00	44.00	261.0	0.0	8.99	3.00	30.00	-28	214	186
Deadend	Deadend Insulator		53.00	-44.00	99.0	0.0	8.99	3.00	30.00	37	214	251
Deadend	Deadend Insulator		51.50	0.00	0.0	0.0	8.99	3.00	30.00	-5	207	202
Deadend	Deadend Insulator		51.50	44.00	80.9	0.0	8.99	3.00	30.00	28	207	235
Deadend	Deadend Insulator		51.50	-44.00	279.1	0.0	8.99	3.00	30.00	-37	207	170
Spool	Spool 4"		49.00	0.00	90.0	0.0	3.00	4.00	4.12	2	36	38
Post	Post Insulator - 35 kV		45.83	0.00	180.0	180.0	23.00	5.75	16.75	7	197	204
Spool	Spool 4"		25.00	0.00	270.0	180.0	3.00	4.00	4.12	-3	17	14
Spool	Spool 3"		19.61	0.00	90.0	0.0	2.00	3.00	3.19	2	7	9
									Totals:	**85**	**3,930**	**4,015**

Guy Wire and Brace		Owner	Attach Height (ft)	End Height (ft)	Lead/Span Length (ft)	Wire Diameter (in)	Percent Solid (%)	Lead Angle (deg)	Incline Angle (deg)	Wire Weight (lbs/ft)	Rest Length (ft)	Stretch Length (in)
EHS 3/8	Down		60.00	0.00	48.00	0.375	75.00	180.0	51.1	0.273	82.74	0.13
EHS 3/8	Down		48.00	0.00	48.00	0.375	75.00	180.0	44.8	0.273	73.11	0.07
EHS 3/8	Down		58.06	0.00	39.00	0.375	75.00	0.0	55.9	0.273	76.31	0.00

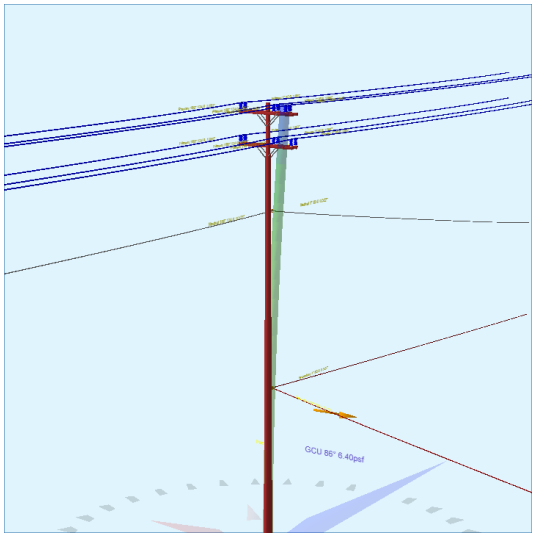
Guy Wire and Brace (Loads and Reactions)		Elastic Modulus (psi)	Rated Tensile Strength (lbs)	Guy Strength Factor	Allowable Tension (lbs)	Initial Tension (lbs)	Loaded Tension*[2] (lbs)	Maximum Tension[2] (lbs)	Applied Tension[3] (lbs)	Vertical Load (lbs)	Shear Load In Guy Dir (lbs)	Shear Load At Report Angle (lbs)	Moment at GL[3] (ft-lb)
EHS 3/8	Down	2.30e+7	15,400	0.90	13,860	700	716	716	248	193	156	26	2,051
EHS 3/8	Down	2.30e+7	15,400	0.90	13,860	700	498	498	141	100	100	17	1,150
EHS 3/8	Down	2.30e+7	15,400	0.90	13,860	700	389	389	0	0	0	0	450
									Totals:	**293**	**256**	**42**	**3,651**

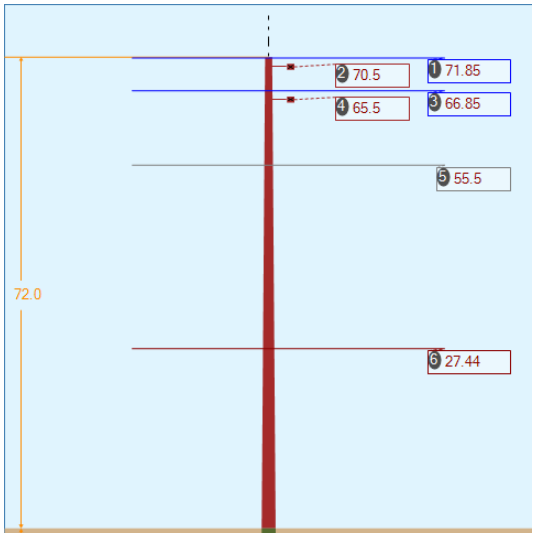
Anchor/Rod Load Summary	Owner	Rod Length AGL (in)	Lead Length (ft)	Lead Angle (deg)	Strength of Assembly (lbs)	Anchor/Rod Strength Factor	Allowable Load (lbs)	Max Load[2] (lbs)	Load at Pole MCU[3] (lbs)	Max Required Capacity[2] (%)
Single Helix Anchor		18.00	48.00	180.0	20,000	1.00	20,000	1,212	389	6.1
Single Helix Anchor		18.00	39.00	0.0	20,000	1.00	20,000	389	0	1.9

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
0.71	42.90	35.12	15.81	6.84	8.60	17.97	1.43e+6	50.00	57.00	65.50	244,838	**2455.68**	**47.62**

Pole Num:	**Pole 19**	Pole Length / Class:	**80 / 1**	Code:	**N/A**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**8.0**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**53.27**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**	Elevation:	**0M**	





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**33.4**	0.0	85.6
Groundline	**33.4**	0.0	85.6
Vertical	**11.2**	41.67	85.6

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**78,914**	84.0	85.6
Groundline	**78,914**	84.0	85.6
GL Allowable	**239,318**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 84.0°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,086	67.3	**59,960**	76.0	**25.1**	**1,488**	838	4	**1,492**	**24.9**
Pole	478	29.6	**15,479**	19.6	**6.5**	**384**	3,983	18	**402**	**6.7**
Crossarms	9	0.6	**613**	0.8	**0.3**	**15**	328	1	**17**	**0.3**
Insulators	41	2.5	**2,862**	3.6	**1.2**	**71**	161	1	**72**	**1.2**
Pole Load	1,614	100.0	**78,914**	100.0	**33.0**	**1,958**	5,310	24	**1,982**	**33.0**
Pole Reserve Capacity			**160,404**		**67.0**	**4,042**			**4,018**	**67.0**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 84.0°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,136	70.4	**63,435**	80.4	**26.5**	**1,574**	1,327	6	**1,580**	**26.3**
Pole	478	29.6	**15,479**	19.6	**6.5**	**384**	3,983	18	**402**	**6.7**
Totals:	1,614	100.0	**78,914**	100.0	**33.0**	**1,958**	5,310	24	**1,982**	**33.0**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		71.85	18.00	1.0610	0.90	1.075	85.0	1.0	85.0	3,000	26,326	68	1,702	28,096
Primary	ACSR 954 Rail		71.85	18.00	1.0610	1.61	1.075	134.0	180.0	134.0	3,000	-22,585	107	2,622	-19,856
Primary	ACSR 954 Rail		71.85	44.00	1.0610	0.90	1.075	85.0	1.0	85.0	3,000	26,326	167	1,702	28,195
Primary	ACSR 954 Rail		71.85	44.00	1.0610	1.61	1.075	134.0	180.0	134.0	3,000	-22,585	263	2,622	-19,700
Primary	ACSR 954 Rail		71.85	57.00	1.0610	0.90	1.075	85.0	1.0	85.0	3,000	26,326	-216	1,702	27,812
Primary	ACSR 954 Rail		71.85	57.00	1.0610	1.61	1.075	134.0	180.0	134.0	3,000	-22,585	-340	2,622	-20,303
Primary	ACSR 954 Rail		66.85	18.00	1.0610	0.90	1.075	85.0	1.0	85.0	3,000	24,495	68	1,566	26,130
Primary	ACSR 954 Rail		66.85	18.00	1.0610	1.61	1.075	134.0	180.0	134.0	3,000	-21,015	107	2,413	-18,494
Primary	ACSR 954 Rail		66.85	57.00	1.0610	0.90	1.075	85.0	1.0	85.0	3,000	24,495	216	1,566	26,277
Primary	ACSR 954 Rail		66.85	57.00	1.0610	1.61	1.075	134.0	180.0	134.0	3,000	-21,015	340	2,413	-18,262
Primary	ACSR 954 Rail		66.85	57.00	1.0610	0.90	1.075	85.0	1.0	85.0	3,000	24,495	-216	1,566	25,846
Primary	ACSR 954 Rail		66.85	57.00	1.0610	1.61	1.075	134.0	180.0	134.0	3,000	-21,015	-340	2,413	-18,942
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		55.50	8.26	0.5220	0.32	0.198	85.0	1.0	85.0	600	4,018	67	624	4,708
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		55.50	8.26	0.5220	1.95	0.198	134.0	180.0	134.0	600	-3,487	9	960	-2,517
Secondary	DUPLEX 6 AWG		27.44	9.38	0.5370	0.22	0.071	85.0	1.0	85.0	357	1,195	14	286	1,494
Secondary	DUPLEX 6 AWG		27.44	9.38	0.5370	1.11	0.071	100.0	110.0	100.0	357	8,804	3	61	8,868
											Totals:	**32,190**	**317**	**26,844**	**59,351**

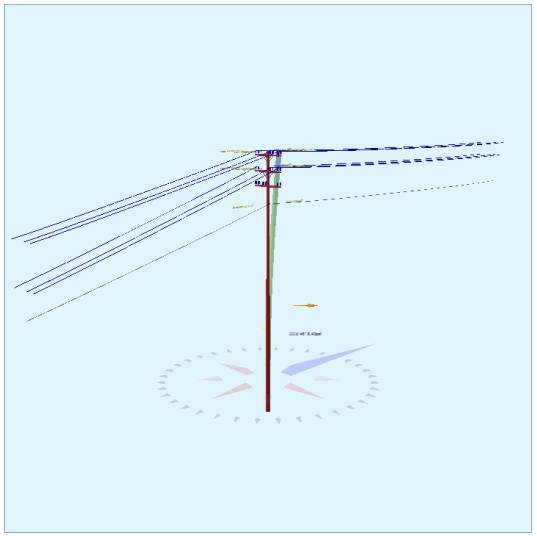
Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		70.50	6.63	0.0	0.0	82.00	5.50	4.50	120.00	0	316	316
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		65.50	6.92	0.0	0.0	82.00	5.50	4.50	120.00	0	291	291
										Totals:	**0**	**607**	**607**

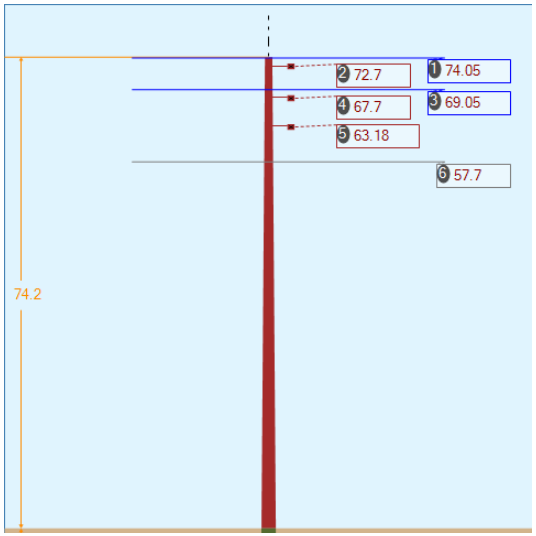
Insulator		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Post	Post Insulator - 27 kV		70.73	18.00	69.8	0.0	13.00	5.25	13.50	39	473	512
Post	Post Insulator - 27 kV		70.73	44.00	81.4	0.0	13.00	5.25	13.50	95	473	568
Post	Post Insulator - 27 kV		70.73	-57.00	276.6	0.0	13.00	5.25	13.50	-123	473	350
Post	Post Insulator - 27 kV		65.73	18.00	69.0	0.0	13.00	5.25	13.50	39	436	475
Post	Post Insulator - 27 kV		65.73	57.00	83.1	0.0	13.00	5.25	13.50	123	436	559
Post	Post Insulator - 27 kV		65.73	-57.00	276.9	0.0	13.00	5.25	13.50	-123	436	313
Spool	Spool 4"		55.50	0.00	90.0	0.0	3.00	4.00	4.12	2	42	44
Spool	Spool 3"		27.44	0.00	90.0	0.0	2.00	3.00	3.19	2	11	13
									Totals:	**53**	**2,780**	**2,833**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	41.72	34.29	15.30	9.82	8.60	16.97	2.38e+6	60.00	57.00	72.00	47,203	**474.13**	**8.93**

Pole Num:	**Pole 20**	Pole Length / Class:	**85 / H1**	Code:	**N/A**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.83**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**56.71**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**36.1**	23.0	45.6
Groundline	**33.9**	0.0	42.7
Vertical	**39.1**	56.83	45.6

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**62,334**	39.8	45.6
Groundline	**97,884**	39.3	42.7
GL Allowable	**288,698**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 39.3°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	885	54.1	**64,882**	66.3	**22.5**	**1,337**	5,530	22	**1,358**	**22.6**
Pole	525	32.1	**17,518**	17.9	**6.1**	**361**	4,676	18	**379**	**6.3**
Crossarms	165	10.1	**11,319**	11.6	**3.9**	**233**	492	2	**235**	**3.9**
Insulators	60	3.7	**4,164**	4.3	**1.4**	**86**	237	1	**87**	**1.4**
Pole Load	1,635	100.0	**97,884**	100.0	**33.9**	**2,017**	10,934	43	**2,059**	**34.3**
Pole Reserve Capacity			**190,814**		**66.1**	**3,983**			**3,941**	**65.7**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 39.3°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,111	67.9	**80,366**	82.1	**27.8**	**1,656**	6,259	24	**1,680**	**28.0**
Pole	525	32.1	**17,518**	17.9	**6.1**	**361**	4,676	18	**379**	**6.3**
Totals:	1,635	100.0	**97,884**	100.0	**33.9**	**2,017**	10,934	43	**2,059**	**34.3**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		74.05	18.00	1.0610	1.61	1.075	134.0	1.0	134.0	3,000	174,360	68	1,193	175,622
Primary	ACSR 954 Rail		74.05	18.00	1.0610	0.33	1.075	83.0	180.0	83.0	3,000	-167,592	669	790	-166,133
Primary	ACSR 954 Rail		74.05	57.00	1.0610	1.61	1.075	134.0	1.0	134.0	3,000	174,360	217	1,193	175,770
Primary	ACSR 954 Rail		74.05	57.00	1.0610	0.33	1.075	83.0	180.0	83.0	3,000	-167,592	2,120	790	-164,682
Primary	ACSR 954 Rail		74.05	57.00	1.0610	1.61	1.075	134.0	1.0	134.0	3,000	174,360	-217	1,193	175,337
Primary	ACSR 954 Rail		74.05	57.00	1.0610	0.33	1.075	83.0	180.0	83.0	3,000	-167,592	-2,120	790	-168,922
Primary	ACSR 954 Rail		69.05	18.00	1.0610	1.61	1.075	134.0	1.0	134.0	3,000	162,595	68	1,101	163,764
Primary	ACSR 954 Rail		69.05	18.00	1.0610	0.34	1.075	83.0	180.0	83.0	3,000	-152,995	882	729	-151,384
Primary	ACSR 954 Rail		69.05	57.00	1.0610	1.61	1.075	134.0	1.0	134.0	3,000	162,595	217	1,101	163,912
Primary	ACSR 954 Rail		69.05	57.00	1.0610	0.34	1.075	83.0	180.0	83.0	3,000	-152,995	2,794	729	-149,472
Primary	ACSR 954 Rail		69.05	57.00	1.0610	1.61	1.075	134.0	1.0	134.0	3,000	162,595	-217	1,101	163,479
Primary	ACSR 954 Rail		69.05	57.00	1.0610	0.34	1.075	83.0	180.0	83.0	3,000	-152,995	-2,794	729	-155,061
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		57.70	8.60	0.5220	1.95	0.198	134.0	1.0	134.0	600	27,155	6	441	27,602
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		57.70	8.60	0.5220	0.31	0.198	83.0	180.0	83.0	600	-25,882	73	292	-25,517
											Totals:	**50,376**	**1,768**	**12,172**	**64,316**

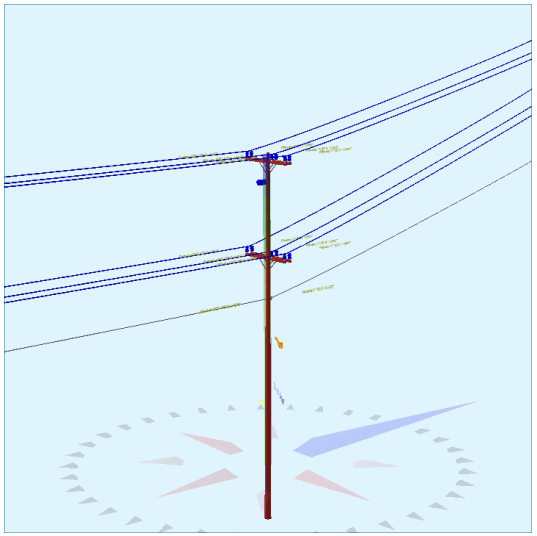
Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		72.70	6.95	0.0	0.0	82.00	5.50	4.50	120.00	0	4,040	4,040
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		67.70	7.25	0.0	0.0	82.00	5.50	4.50	120.00	0	3,730	3,730
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		63.18	7.52	0.0	0.0	82.00	5.50	4.50	120.00	0	3,451	3,451
										Totals:	**0**	**11,221**	**11,221**

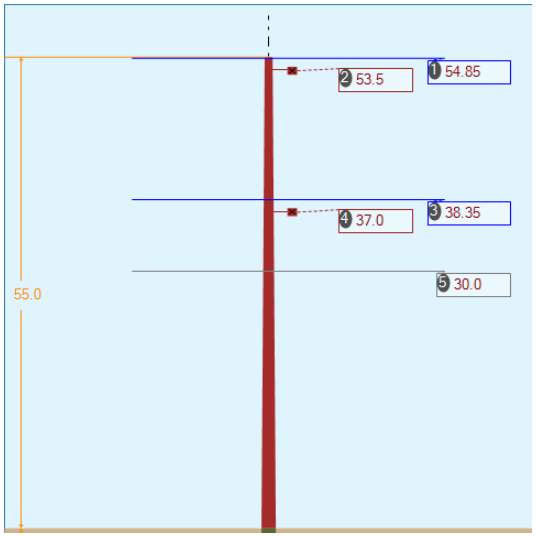
Insulator		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Post	Post Insulator - 27 kV		72.93	18.00	68.9	0.0	13.00	5.25	13.50	25	487	512
Post	Post Insulator - 27 kV		72.93	57.00	83.0	0.0	13.00	5.25	13.50	78	487	565
Post	Post Insulator - 27 kV		72.93	-57.00	277.0	0.0	13.00	5.25	13.50	-78	487	409
Post	Post Insulator - 27 kV		67.93	18.00	68.1	0.0	13.00	5.25	13.50	25	450	474
Post	Post Insulator - 27 kV		67.93	57.00	82.7	0.0	13.00	5.25	13.50	78	450	528
Post	Post Insulator - 27 kV		67.93	-57.00	277.3	0.0	13.00	5.25	13.50	-78	450	371
Post	Post Insulator - 27 kV		63.41	-18.00	292.7	0.0	13.00	5.25	13.50	-25	416	392
Post	Post Insulator - 27 kV		63.41	57.00	82.5	0.0	13.00	5.25	13.50	78	416	495
Post	Post Insulator - 27 kV		63.41	-57.00	277.5	0.0	13.00	5.25	13.50	-78	416	338
Spool	Spool 4"		57.70	0.00	90.0	0.0	3.00	4.00	4.12	1	43	45
									Totals:	**26**	**4,102**	**4,128**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	56.77	35.61	15.65	14.28	9.24	18.06	2.38e+6	60.00	57.00	74.20	27,929	**279.64**	**2.56**

Pole Num:	**Pole 21**	Pole Length / Class:	**65 / 3**	Code:	**N/A**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.0**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**42.11**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**45.7**	0.0	124.1
Groundline	**45.7**	0.0	124.1
Vertical	**0.0**	NaN	124.1

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**53,851**	137.2	124.1
Groundline	**53,851**	137.2	124.1
GL Allowable	**118,217**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 137.2°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	935	69.7	**40,871**	75.9	**34.6**	**2,059**	-3,964	-28	**2,030**	**33.8**
Pole	279	20.8	**6,975**	13.0	**5.9**	**351**	1,988	14	**365**	**6.1**
Crossarms	81	6.0	**3,712**	6.9	**3.1**	**187**	328	2	**189**	**3.2**
Insulators	46	3.4	**2,293**	4.3	**1.9**	**116**	213	2	**117**	**1.9**
Pole Load	1,340	100.0	**53,851**	100.0	**45.6**	**2,712**	-1,435	-10	**2,702**	**45.0**
Pole Reserve Capacity			**64,366**		**54.4**	**3,288**			**3,298**	**55.0**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 137.2°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,061	79.2	**46,876**	87.1	**39.7**	**2,361**	-3,423	-24	**2,337**	**38.9**
Pole	279	20.8	**6,975**	13.0	**5.9**	**351**	1,988	14	**365**	**6.1**
Totals:	1,340	100.0	**53,851**	100.0	**45.6**	**2,712**	-1,435	-10	**2,702**	**45.0**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		54.85	18.00	1.0610	0.33	1.075	83.0	1.0	83.0	3,000	-115,939	-626	715	-115,850
Primary	ACSR 954 Rail		54.85	18.00	1.0610	2.21	1.075	169.0	180.0	169.0	3,000	120,908	93	1,351	122,352
Primary	ACSR 954 Rail		54.85	57.00	1.0610	0.33	1.075	83.0	1.0	83.0	3,000	-115,939	-1,983	715	-117,207
Primary	ACSR 954 Rail		54.85	57.00	1.0610	2.21	1.075	169.0	180.0	169.0	3,000	120,908	293	1,351	122,552
Primary	ACSR 954 Rail		54.85	57.00	1.0610	0.33	1.075	83.0	1.0	83.0	3,000	-115,939	1,983	715	-113,241
Primary	ACSR 954 Rail		54.85	57.00	1.0610	2.21	1.075	169.0	180.0	169.0	3,000	120,908	-293	1,351	121,966
Primary	ACSR 954 Rail		38.35	18.00	1.0610	0.34	1.075	83.0	1.0	83.0	3,000	-79,387	-854	474	-79,767
Primary	ACSR 954 Rail		38.35	18.00	1.0610	2.21	1.075	169.0	180.0	169.0	3,000	84,569	93	894	85,555
Primary	ACSR 954 Rail		38.35	57.00	1.0610	0.34	1.075	83.0	1.0	83.0	3,000	-79,387	-2,705	474	-81,618
Primary	ACSR 954 Rail		38.35	57.00	1.0610	2.21	1.075	169.0	180.0	169.0	3,000	84,569	293	894	85,755
Primary	ACSR 954 Rail		38.35	57.00	1.0610	0.34	1.075	83.0	1.0	83.0	3,000	-79,387	2,705	474	-76,207
Primary	ACSR 954 Rail		38.35	57.00	1.0610	2.21	1.075	169.0	180.0	169.0	3,000	84,569	-293	894	85,169
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		30.00	8.04	0.5220	0.31	0.198	83.0	1.0	83.0	600	-12,565	-65	177	-12,454
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		30.00	8.04	0.5220	2.63	0.198	169.0	180.0	169.0	600	13,214	8	333	13,555
											Totals:	**31,102**	**-1,353**	**10,810**	**40,559**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		53.50	5.99	0.0	0.0	82.00	5.50	4.50	120.00	0	2,219	2,219
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		37.00	6.91	0.0	0.0	82.00	5.50	4.50	120.00	0	1,465	1,465
										Totals:	**0**	**3,684**	**3,684**

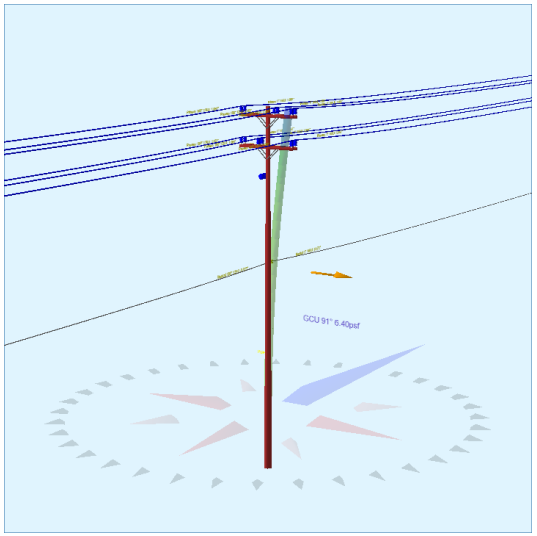
Insulator	Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)

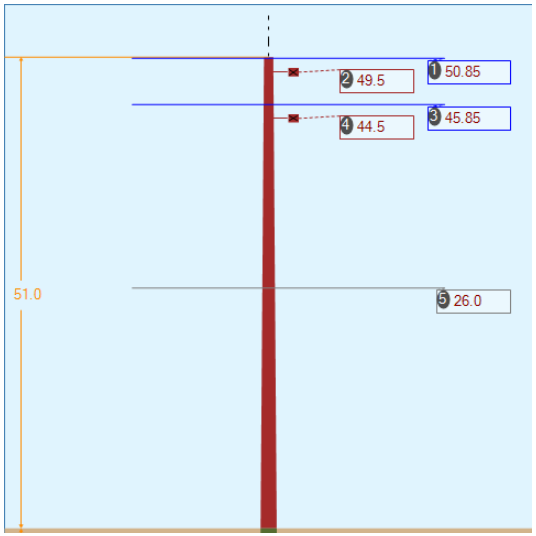
Post	Post Insulator - 27 kV	53.73	18.00	71.6	0.0	13.00	5.25	13.50	26	339	365
Post	Post Insulator - 27 kV	53.73	57.00	84.0	0.0	13.00	5.25	13.50	84	339	423
Post	Post Insulator - 27 kV	53.73	-57.00	276.0	0.0	13.00	5.25	13.50	-84	339	255
Post	Post Insulator - 69 kV	50.04	0.00	180.0	180.0	54.00	7.25	25.38	97	412	509
Post	Post Insulator - 27 kV	37.23	18.00	69.0	0.0	13.00	5.25	13.50	26	225	251
Post	Post Insulator - 27 kV	37.23	57.00	83.1	0.0	13.00	5.25	13.50	84	225	309
Post	Post Insulator - 27 kV	37.23	-57.00	276.9	0.0	13.00	5.25	13.50	-84	225	141
Spool	Spool 4"	30.00	0.00	90.0	0.0	3.00	4.00	4.12	1	20	22
								Totals:	**151**	**2,124**	**2,275**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	25.00	33.09	12.49	0.00	7.32	13.41	2.38e+6	60.00	57.00	55.00	58,441	**-8**	**8**

Pole Num:	**Pole 22**	Pole Length / Class:	**60 / 2**	Code:	**N/A**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**DOUGLAS FIR**	NESC Rule:	**-**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**9.0**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**43.89**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**8,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**6,000**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**36.2**	0.0	91.2
Groundline	**36.2**	0.0	91.2
Vertical	**11.6**	34.83	91.2

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**47,866**	91.1	91.2
Groundline	**47,866**	91.1	91.2
GL Allowable	**133,839**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 91.1°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	817	71.1	**38,881**	81.2	**29.1**	**1,728**	991	6	**1,734**	**28.9**
Pole	279	24.3	**6,509**	13.6	**4.9**	**289**	2,057	13	**303**	**5.0**
Crossarms	7	0.6	**339**	0.7	**0.3**	**15**	328	2	**17**	**0.3**
Insulators	46	4.0	**2,136**	4.5	**1.6**	**95**	199	1	**96**	**1.6**
Pole Load	1,148	100.0	**47,866**	100.0	**35.8**	**2,127**	3,574	23	**2,150**	**35.8**
Pole Reserve Capacity			**85,973**		**64.2**	**3,873**			**3,850**	**64.2**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 91.1°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	869	75.7	**41,357**	86.4	**30.9**	**1,838**	1,518	10	**1,848**	**30.8**
Pole	279	24.3	**6,509**	13.6	**4.9**	**289**	2,057	13	**303**	**5.0**
Totals:	1,148	100.0	**47,866**	100.0	**35.8**	**2,127**	3,574	23	**2,150**	**35.8**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		50.85	18.00	1.0610	2.21	1.075	169.0	1.0	169.0	3,000	-315	136	2,200	2,022
Primary	ACSR 954 Rail		50.85	18.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	2,980	104	1,712	4,796
Primary	ACSR 954 Rail		50.85	57.00	1.0610	2.21	1.075	169.0	1.0	169.0	3,000	-315	431	2,200	2,317
Primary	ACSR 954 Rail		50.85	57.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	2,980	329	1,712	5,021
Primary	ACSR 954 Rail		50.85	57.00	1.0610	2.21	1.075	169.0	1.0	169.0	3,000	-315	-431	2,200	1,454
Primary	ACSR 954 Rail		50.85	57.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	2,980	-329	1,712	4,363
Primary	ACSR 954 Rail		45.85	18.00	1.0610	2.21	1.075	169.0	1.0	169.0	3,000	-284	-136	1,952	1,532
Primary	ACSR 954 Rail		45.85	18.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	2,687	-104	1,519	4,102
Primary	ACSR 954 Rail		45.85	57.00	1.0610	2.21	1.075	169.0	1.0	169.0	3,000	-284	431	1,952	2,100
Primary	ACSR 954 Rail		45.85	57.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	2,687	329	1,519	4,536
Primary	ACSR 954 Rail		45.85	57.00	1.0610	2.21	1.075	169.0	1.0	169.0	3,000	-284	-431	1,952	1,237
Primary	ACSR 954 Rail		45.85	57.00	1.0610	1.53	1.075	129.0	180.0	129.0	3,000	2,687	-329	1,519	3,877
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		26.00	8.45	0.5220	2.63	0.198	169.0	1.0	169.0	600	-32	12	502	482
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		26.00	8.45	0.5220	1.86	0.198	129.0	180.0	129.0	600	304	9	391	704
											Totals:	**15,476**	**21**	**23,045**	**38,542**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		49.50	6.32	0.0	0.0	82.00	5.50	4.50	120.00	0	178	178
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		44.50	6.61	0.0	0.0	82.00	5.50	4.50	120.00	0	158	158
										Totals:	**0**	**336**	**336**

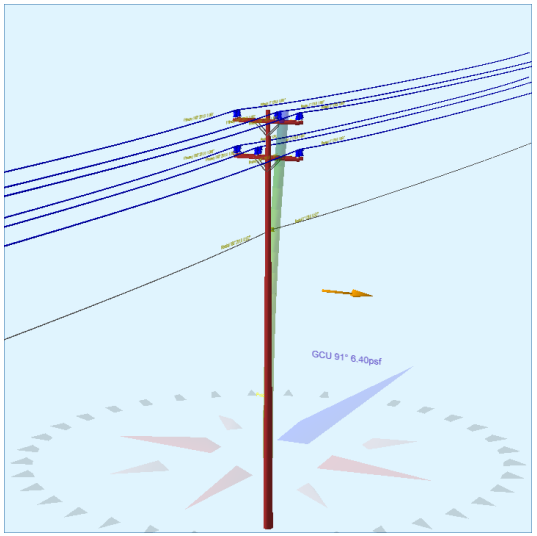
Insulator	Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)

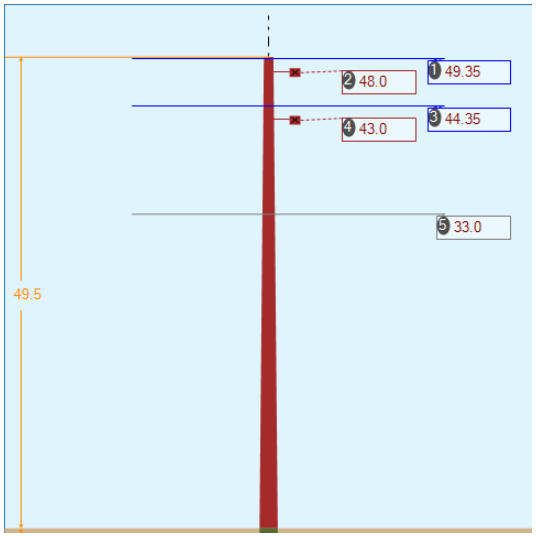
Post	Post Insulator - 27 kV	49.73	18.00	70.7	0.0	13.00	5.25	13.50	39	319	358
Post	Post Insulator - 27 kV	49.73	57.00	83.7	0.0	13.00	5.25	13.50	123	319	443
Post	Post Insulator - 27 kV	49.73	-57.00	276.3	0.0	13.00	5.25	13.50	-123	319	196
Post	Post Insulator - 27 kV	44.73	-18.00	290.2	0.0	13.00	5.25	13.50	-39	284	245
Post	Post Insulator - 27 kV	44.73	57.00	83.4	0.0	13.00	5.25	13.50	123	284	407
Post	Post Insulator - 27 kV	44.73	-57.00	276.6	0.0	13.00	5.25	13.50	-123	284	160
Post	Post Insulator - 55 kV	39.96	0.00	180.0	180.0	40.00	7.00	22.88	2	287	289
Spool	Spool 4"	26.00	0.00	90.0	0.0	3.00	4.00	4.12	2	18	20
								Totals:	**4**	**2,113**	**2,117**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	34.80	34.41	12.56	8.15	7.96	13.98	2.38e+6	60.00	57.00	51.00	30,831	**308.12**	**8.62**

Pole Num:	**Pole 23**	Pole Length / Class:	**60 / 2**	Code:	**N/A**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**WESTERN RED CEDAR**	NESC Rule:	**-**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.5**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**47.92**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**6,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**4,500**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**	Elevation:	**0M**	





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**38.9**	13.33	90.7
Groundline	**37.3**	0.0	90.7
Vertical	**13.9**	34.5	90.7

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**33,259**	90.6	90.7
Groundline	**48,668**	90.6	90.7
GL Allowable	**130,630**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 90.6°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	863	72.3	**40,185**	82.6	**30.8**	**1,372**	1,097	6	**1,378**	**30.6**
Pole	285	23.9	**6,373**	13.1	**4.9**	**218**	1,878	10	**228**	**5.1**
Crossarms	7	0.6	**325**	0.7	**0.3**	**11**	328	2	**13**	**0.3**
Insulators	39	3.2	**1,786**	3.7	**1.4**	**61**	159	1	**62**	**1.4**
Pole Load	1,194	100.0	**48,668**	100.0	**37.3**	**1,662**	3,462	19	**1,680**	**37.3**
Pole Reserve Capacity			**81,962**		**62.7**	**2,838**			**2,820**	**62.7**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 90.6°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	909	76.1	**42,295**	86.9	**32.4**	**1,444**	1,584	9	**1,453**	**32.3**
Pole	285	23.9	**6,373**	13.1	**4.9**	**218**	1,878	10	**228**	**5.1**
Totals:	1,194	100.0	**48,668**	100.0	**37.3**	**1,662**	3,462	19	**1,680**	**37.3**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		49.35	18.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	1,024	104	1,655	2,782
Primary	ACSR 954 Rail		49.35	18.00	1.0610	2.84	1.075	201.0	180.0	201.1	3,000	1,563	162	2,492	4,217
Primary	ACSR 954 Rail		49.35	57.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	1,024	329	1,655	3,008
Primary	ACSR 954 Rail		49.35	57.00	1.0610	2.84	1.075	201.0	180.0	201.1	3,000	1,563	513	2,492	4,568
Primary	ACSR 954 Rail		49.35	57.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	1,024	-329	1,655	2,349
Primary	ACSR 954 Rail		49.35	57.00	1.0610	2.84	1.075	201.0	180.0	201.1	3,000	1,563	-513	2,492	3,542
Primary	ACSR 954 Rail		44.35	18.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	920	-104	1,463	2,279
Primary	ACSR 954 Rail		44.35	18.00	1.0610	2.84	1.075	201.0	180.0	201.1	3,000	1,405	-162	2,203	3,445
Primary	ACSR 954 Rail		44.35	57.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	920	329	1,463	2,712
Primary	ACSR 954 Rail		44.35	57.00	1.0610	2.84	1.075	201.0	180.0	201.1	3,000	1,405	513	2,203	4,120
Primary	ACSR 954 Rail		44.35	57.00	1.0610	1.53	1.075	129.0	1.0	129.0	3,000	920	-329	1,463	2,054
Primary	ACSR 954 Rail		44.35	57.00	1.0610	2.84	1.075	201.0	180.0	201.1	3,000	1,405	-513	2,203	3,094
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		33.00	8.19	0.5220	1.86	0.198	129.0	1.0	129.0	600	137	9	514	660
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		33.00	8.19	0.5220	3.31	0.198	201.0	180.0	201.1	600	209	14	774	996
											Totals:	**15,079**	**22**	**24,724**	**39,825**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		48.00	6.34	0.0	0.0	82.00	5.50	4.50	120.00	0	171	171
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		43.00	6.71	0.0	0.0	82.00	5.50	4.50	120.00	0	151	151
										Totals:	**0**	**322**	**322**

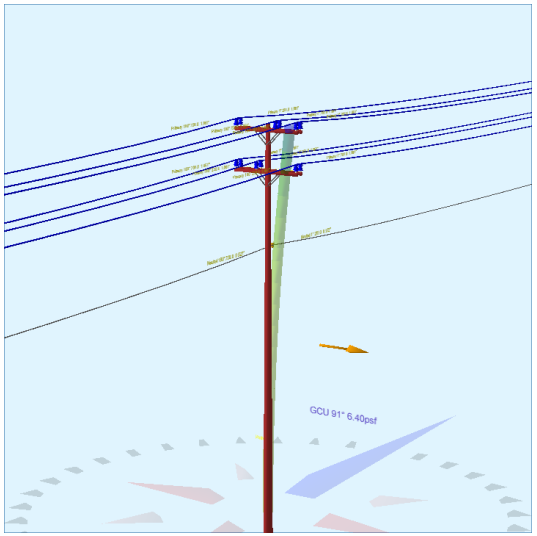
Insulator	Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)

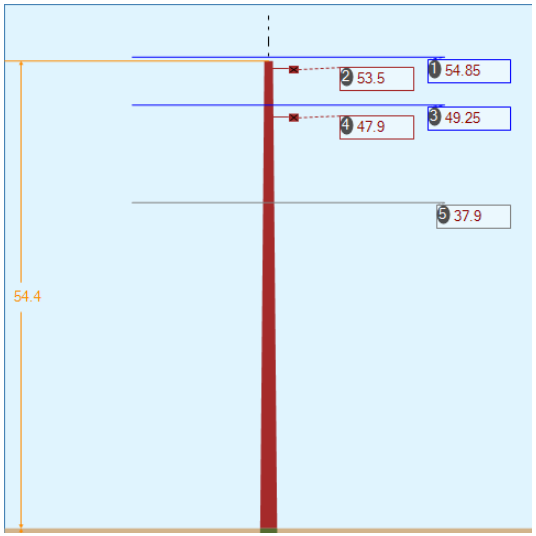
Post	Post Insulator - 27 kV	48.23	18.00	70.6	0.0	13.00	5.25	13.50	39	308	347
Post	Post Insulator - 27 kV	48.23	57.00	83.7	0.0	13.00	5.25	13.50	123	308	432
Post	Post Insulator - 27 kV	48.23	-57.00	276.3	0.0	13.00	5.25	13.50	-123	308	185
Post	Post Insulator - 27 kV	43.23	-18.00	290.4	0.0	13.00	5.25	13.50	-39	273	234
Post	Post Insulator - 27 kV	43.23	57.00	83.3	0.0	13.00	5.25	13.50	123	273	396
Post	Post Insulator - 27 kV	43.23	-57.00	276.7	0.0	13.00	5.25	13.50	-123	273	149
Spool	Spool 4"	33.00	0.00	90.0	0.0	3.00	4.00	4.12	2	23	25
								Totals:	**2**	**1,768**	**1,770**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	34.54	35.01	13.47	9.31	7.96	15.26	1.43e+6	50.00	57.00	49.50	24,894	**249.05**	**7.19**

Pole Num:	**Pole 24**	Pole Length / Class:	**65 / 2**	Code:	**N/A**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**WESTERN RED CEDAR**	NESC Rule:	**-**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**10.58**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**49.43**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**6,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**4,500**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**47.7**	18.33	90.7
Groundline	**44.6**	0.0	90.7
Vertical	**19.0**	38.83	90.7

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**39,164**	90.6	90.7
Groundline	**63,913**	90.6	90.7
GL Allowable	**143,435**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 90.6°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,038	73.7	**53,636**	83.9	**37.4**	**1,670**	1,459	8	**1,677**	**37.3**
Pole	324	23.0	**7,898**	12.4	**5.5**	**246**	2,157	11	**257**	**5.7**
Crossarms	7	0.5	**366**	0.6	**0.3**	**11**	328	2	**13**	**0.3**
Insulators	39	2.8	**2,012**	3.2	**1.4**	**63**	159	1	**63**	**1.4**
Pole Load	1,408	100.0	**63,913**	100.0	**44.6**	**1,990**	4,103	21	**2,011**	**44.7**
Pole Reserve Capacity			**79,522**		**55.4**	**2,510**			**2,489**	**55.3**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 90.6°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,084	77.0	**56,015**	87.6	**39.1**	**1,744**	1,946	10	**1,754**	**39.0**
Pole	324	23.0	**7,898**	12.4	**5.5**	**246**	2,157	11	**257**	**5.7**
Totals:	1,408	100.0	**63,913**	100.0	**44.6**	**1,990**	4,103	21	**2,011**	**44.7**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		54.85	18.00	1.0610	2.84	1.075	201.0	1.0	201.1	3,000	1,110	162	2,816	4,088
Primary	ACSR 954 Rail		54.85	18.00	1.0610	3.65	1.075	238.0	180.0	238.1	3,000	1,765	192	3,286	5,242
Primary	ACSR 954 Rail		54.85	57.00	1.0610	2.84	1.075	201.0	1.0	201.1	3,000	1,110	513	2,816	4,439
Primary	ACSR 954 Rail		54.85	57.00	1.0610	3.65	1.075	238.0	180.0	238.1	3,000	1,765	608	3,286	5,658
Primary	ACSR 954 Rail		54.85	57.00	1.0610	2.84	1.075	201.0	1.0	201.1	3,000	1,110	-513	2,816	3,413
Primary	ACSR 954 Rail		54.85	57.00	1.0610	3.65	1.075	238.0	180.0	238.1	3,000	1,765	-608	3,286	4,443
Primary	ACSR 954 Rail		49.25	18.00	1.0610	2.84	1.075	201.0	1.0	201.1	3,000	997	-162	2,487	3,321
Primary	ACSR 954 Rail		49.25	18.00	1.0610	3.65	1.075	238.0	180.0	238.1	3,000	1,585	-192	2,900	4,293
Primary	ACSR 954 Rail		49.25	57.00	1.0610	2.84	1.075	201.0	1.0	201.1	3,000	997	513	2,487	3,996
Primary	ACSR 954 Rail		49.25	57.00	1.0610	3.65	1.075	238.0	180.0	238.1	3,000	1,585	608	2,900	5,093
Primary	ACSR 954 Rail		49.25	57.00	1.0610	2.84	1.075	201.0	1.0	201.1	3,000	997	-513	2,487	2,970
Primary	ACSR 954 Rail		49.25	57.00	1.0610	3.65	1.075	238.0	180.0	238.1	3,000	1,585	-608	2,900	3,878
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		37.90	8.16	0.5220	3.31	0.198	201.0	1.0	201.1	600	153	14	908	1,074
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		37.90	8.16	0.5220	4.18	0.198	238.0	180.0	238.1	600	244	16	1,058	1,318
											Totals:	**16,764**	**30**	**36,433**	**53,226**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		53.50	6.29	0.0	0.0	82.00	5.50	4.50	120.00	0	193	193
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		47.90	6.69	0.0	0.0	82.00	5.50	4.50	120.00	0	171	171
										Totals:	**0**	**364**	**364**

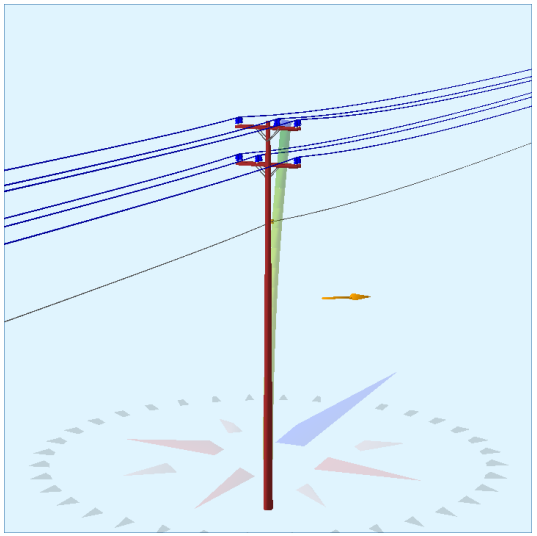
Insulator	Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)

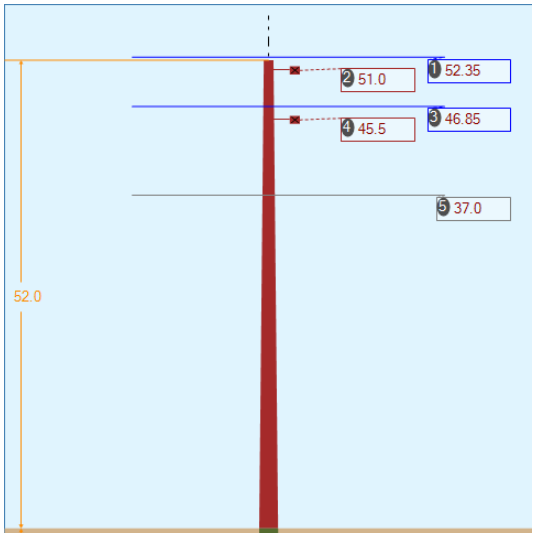
Post	Post Insulator - 27 kV	53.73	18.00	70.7	0.0	13.00	5.25	13.50	39	348	387
Post	Post Insulator - 27 kV	53.73	57.00	83.7	0.0	13.00	5.25	13.50	123	348	472
Post	Post Insulator - 27 kV	53.73	-57.00	276.3	0.0	13.00	5.25	13.50	-123	348	225
Post	Post Insulator - 27 kV	48.13	-18.00	290.4	0.0	13.00	5.25	13.50	-39	308	269
Post	Post Insulator - 27 kV	48.13	57.00	83.3	0.0	13.00	5.25	13.50	123	308	431
Post	Post Insulator - 27 kV	48.13	-57.00	276.7	0.0	13.00	5.25	13.50	-123	308	184
Spool	Spool 4"	37.90	0.00	90.0	0.0	3.00	4.00	4.12	2	27	29
								Totals:	**2**	**1,995**	**1,997**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	38.78	35.29	13.78	10.39	7.96	15.74	1.43e+6	50.00	57.00	54.40	21,623	**215.95**	**5.26**

Pole Num:	**Pole 25**	Pole Length / Class:	**60 / 1**	Code:	**N/A**	Structure Type:	**Unguyed Tangent**
Aux Data 1	**Unset**	Species:	**WESTERN RED CEDAR**	NESC Rule:	**-**	Status	**Unguyed**
Aux Data 2	**Unset**	Setting Depth (ft):	**8.0**	Construction Grade:	**N/A**	Pole Strength Factor:	**0.75**
Aux Data 3	**Unset**	G/L Circumference (in):	**52.52**	Loading District:	**N/A**	Transverse Wind LF:	**1.00**
Aux Data 4	**Unset**	G/L Fiber Stress (psi):	**6,000**	Ice Thickness (in):	**0.00**	Wire Tension LF:	**1.00**
Aux Data 5	**Unset**	Allowable Stress (psi):	**4,500**	Wind Speed (mph):	**50.00**	Vertical LF:	**1.00**
Aux Data 6	**Unset**	Fiber Stress Ht. Reduc:	**No**	Wind Pressure (psf):	**6.40**		
Latitude:	**0° 0' 0" N**	Longitude:		**0° 0' 0" W**		Elevation:	**0M**





Pole Capacity Utilization (%)		Height (ft)	Wind Angle (deg)
Maximum	**49.8**	20.33	57.0
Groundline	**45.6**	0.0	56.3
Vertical	**11.4**	35.17	57.0

Pole Moments (ft-lb)		Load Angle (deg)	Wind Angle (deg)
Max Cap Util	**45,178**	35.4	57.0
Groundline	**78,436**	37.3	56.3
GL Allowable	**171,996**		

Groundline Load Summary - Reporting Angle Mode: Load - Reporting Angle: 37.3°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
Powers	1,270	74.6	**65,271**	83.2	**38.0**	**1,698**	1,147	5	**1,703**	**37.9**
Pole	309	18.2	**7,222**	9.2	**4.2**	**188**	2,349	11	**199**	**4.4**
Crossarms	86	5.0	**4,154**	5.3	**2.4**	**108**	328	1	**110**	**2.4**
Insulators	37	2.1	**1,789**	2.3	**1.0**	**47**	159	1	**47**	**1.1**
Pole Load	1,701	100.0	**78,436**	100.0	**45.6**	**2,041**	3,983	18	**2,059**	**45.8**
Pole Reserve Capacity			**93,560**		**54.4**	**2,459**			**2,441**	**54.2**

Load Summary by Owner - Reporting Angle Mode: Load - Reporting Angle: 37.3°

	Shear Load* (lbs)	Applied Load (%)	Bending Moment (ft-lb)	Applied Moment (%)	Pole Capacity (%)	Bending Stress (+/- psi)	Vertical Load (lbs)	Vertical Stress (psi)	Total Stress (psi)	Pole Capacity (%)
<Undefined>	1,392	81.8	**71,214**	90.8	**41.4**	**1,853**	1,634	7	**1,860**	**41.3**
Pole	309	18.2	**7,222**	9.2	**4.2**	**188**	2,349	11	**199**	**4.4**
Totals:	1,701	100.0	**78,436**	100.0	**45.6**	**2,041**	3,983	18	**2,059**	**45.8**

Detailed Load Components:

Power		Owner	Height (ft)	Horiz. Offset (in)	Cable Diameter (in)	Sag at Max Temp (ft)	Cable Weight (lbs/ft)	Lead/Span Length (ft)	Span Angle (deg)	Wire Length (ft)	Tension (lbs)	Tension Moment* (ft-lb)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Primary	ACSR 954 Rail		52.35	18.00	1.0610	3.65	1.075	238.0	1.0	238.1	3,000	126,651	116	1,529	128,297
Primary	ACSR 954 Rail		52.35	18.00	1.0610	1.41	1.075	107.0	180.0	107.0	2,000	-83,338	52	756	-82,529
Primary	ACSR 954 Rail		52.35	57.00	1.0610	3.65	1.075	238.0	1.0	238.1	3,000	126,651	368	1,529	128,549
Primary	ACSR 954 Rail		52.35	57.00	1.0610	1.20	1.075	107.0	180.0	107.0	3,000	-125,007	166	756	-124,085
Primary	ACSR 954 Rail		52.35	57.00	1.0610	3.65	1.075	238.0	1.0	238.1	3,000	126,651	-368	1,529	127,812
Primary	ACSR 954 Rail		52.35	57.00	1.0610	1.20	1.075	107.0	180.0	107.0	3,000	-125,007	-166	756	-124,416
Primary	ACSR 954 Rail		46.85	18.00	1.0610	3.65	1.075	238.0	1.0	238.1	3,000	113,357	-116	1,345	114,586
Primary	ACSR 954 Rail		46.85	18.00	1.0610	1.20	1.075	107.0	180.0	107.0	3,000	-111,885	-52	665	-111,272
Primary	ACSR 954 Rail		46.85	57.00	1.0610	3.65	1.075	238.0	1.0	238.1	3,000	113,357	368	1,345	115,071
Primary	ACSR 954 Rail		46.85	57.00	1.0610	1.20	1.075	107.0	180.0	107.0	3,000	-111,885	166	665	-111,054
Primary	ACSR 954 Rail		46.85	57.00	1.0610	3.65	1.075	238.0	1.0	238.1	3,000	113,357	-368	1,345	114,334
Primary	ACSR 954 Rail		46.85	57.00	1.0610	1.20	1.075	107.0	180.0	107.0	3,000	-111,885	-166	665	-111,386
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		37.00	8.47	0.5220	4.18	0.198	238.0	1.0	238.1	600	17,886	10	506	18,402
Neutral	AAC 4/0 AWG 7 STRAND OXLIP		37.00	8.47	0.5220	1.47	0.198	107.0	180.0	107.0	600	-17,654	5	250	-17,399
											Totals:	**51,249**	**15**	**13,644**	**64,908**

Crossarm		Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Height (in)	Unit Depth (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		51.00	6.63	0.0	0.0	82.00	5.50	4.50	120.00	0	2,198	2,198
Normal	CROSSARM 3-1/2 X 4-1/2 X 10		45.50	7.05	0.0	0.0	82.00	5.50	4.50	120.00	0	1,933	1,933
										Totals:	**0**	**4,130**	**4,130**

Insulator	Owner	Height (ft)	Horiz. Offset (in)	Offset Angle (deg)	Rotate Angle (deg)	Unit Weight (lbs)	Unit Diameter (in)	Unit Length (in)	Offset Moment* (ft-lb)	Wind Moment* (ft-lb)	Moment at GL* (ft-lb)

Post	Post Insulator - 27 kV	51.23	18.00	69.8	0.0	13.00	5.25	13.50	24	311	334
Post	Post Insulator - 27 kV	51.23	57.00	83.4	0.0	13.00	5.25	13.50	75	311	386
Post	Post Insulator - 27 kV	51.23	-57.00	276.6	0.0	13.00	5.25	13.50	-75	311	236
Post	Post Insulator - 27 kV	45.73	-18.00	291.4	0.0	13.00	5.25	13.50	-24	274	250
Post	Post Insulator - 27 kV	45.73	57.00	82.9	0.0	13.00	5.25	13.50	75	274	349
Post	Post Insulator - 27 kV	45.73	-57.00	277.1	0.0	13.00	5.25	13.50	-75	274	199
Spool	Spool 4"	37.00	0.00	90.0	0.0	3.00	4.00	4.12	1	25	26
								Totals:	**1**	**1,778**	**1,779**

Pole Buckling

Buckling Constant	Buckling Column Height* (ft)	Buckling Section Height (% Buckling Col. Hgt.)	Buckling Section Diameter (in)	Minimum Buckling Diameter at GL (in)	Diameter at Tip (in)	Diameter at GL (in)	Modulus of Elasticity (psi)	Pole Density (pcf)	Ice Density (pcf)	Pole Tip Height (ft)	Buckling Load Capacity at Height (lbs)	Buckling Load Applied at Height (lbs)	Buckling Load Factor of Safety
2.00	35.22	34.94	14.80	9.72	8.60	16.73	1.43e+6	50.00	57.00	52.00	34,853	**349.40**	**8.77**

APPENDIX K

Forensic Pole Photos

Inspection Photos:
Seattle City Light: Pole Yard
East Marginal Way Pole Remnants
May 6, 2019

by Winandy & Associates LLC
www.winandyassociates.com



DSCN9219.jpg

Seattle City Light Pole Yard: Pole Remnants on LEFT (stacked left-to-right) are Poles #1 (closest) to #26 (furthest). Pole remnants in middle (stacked front-to-back) and those on far right are unidentifiable sections of poles #1-26.



DSCN9220.jpg: Unnumbered Pole (SCL#1353078) formerly located 1st pole North of Pole #1 (SCL#1353076)



DSCN9221.jpg: Unnumbered Pole (SCL#1353078) formerly located 1st pole North of Pole #1 (SCL#1353076)



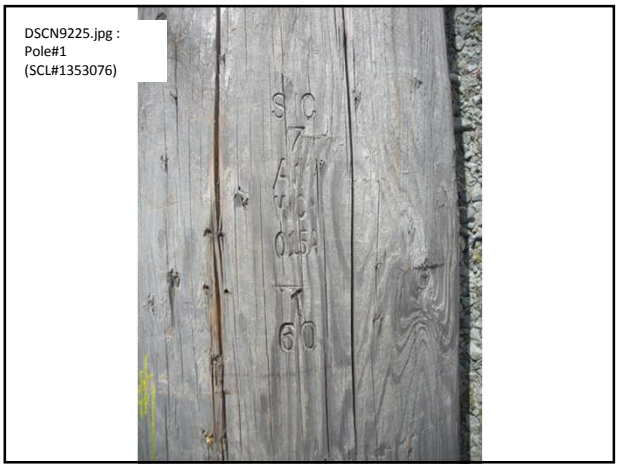
DSCN9222.jpg: Unnumbered Pole (SCL#1353078) formerly located 1st pole North of Pole #1 (SCL#1353076)



DSCN9223.jpg: Unnumbered Pole (SCL#1353078) formerly located 1st pole North of Pole #1 (SCL#1353076)



DSCN9224.jpg : Pole#1 (SCL#1353076)


DSCN9225.jpg : Pole#1 (SCL#1353076)


DSCN9226.jpg : Pole#1 (SCL#1353076). Broke 55-in above Ground line (GL)


DSCN9227.jpg: Pole#1 (SCL#1353076). Note that wood at fracture was yellow (not brown) and fracture surfaces were splintery with no softening or visible sign of decay.



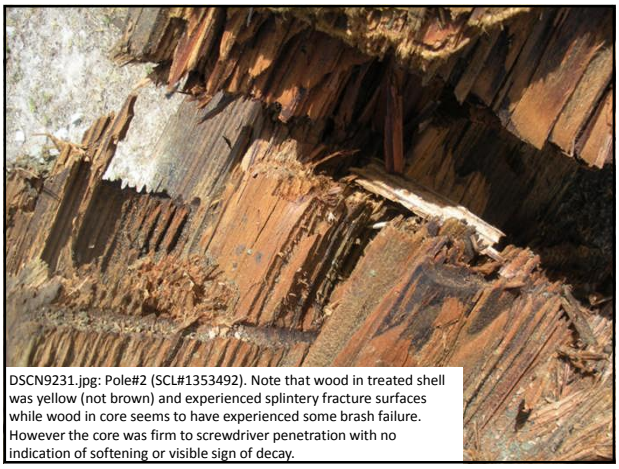
DSCN9228.jpg: Pole#2 (SCL#1353492).



DSCN9229.jpg: Pole#2 (SCL#1353492).

DSCN9230.jpg: Pole#2 (SCL#1353492). Note that wood in treated shell experienced at fracture was yellow (not brown) and splintery fracture surfaces while wood in core seems to have experienced some brash failure. However the core was firm to screwdriver penetration so there was no softening or visible sign of decay.





DSCN9231.jpg: Pole#2 (SCL#1353492). Note that wood in treated shell was yellow (not brown) and experienced splintery fracture surfaces while wood in core seems to have experienced some brash failure. However the core was firm to screwdriver penetration with no indication of softening or visible sign of decay.

DSCN9232.jpg : Pole#3 (SCL#1353082).



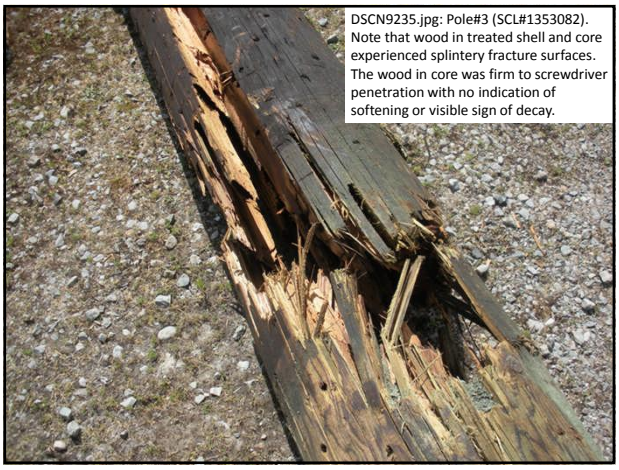
DSCN9233.jpg : Pole#3 (SCL#1353082).



DSCN9234.jpg: Pole#3 (SCL#1353082). Note that wood in treated shell and core experienced splintery fracture surfaces. The wood in core was firm to screwdriver penetration with no indication of softening or visible sign of decay.



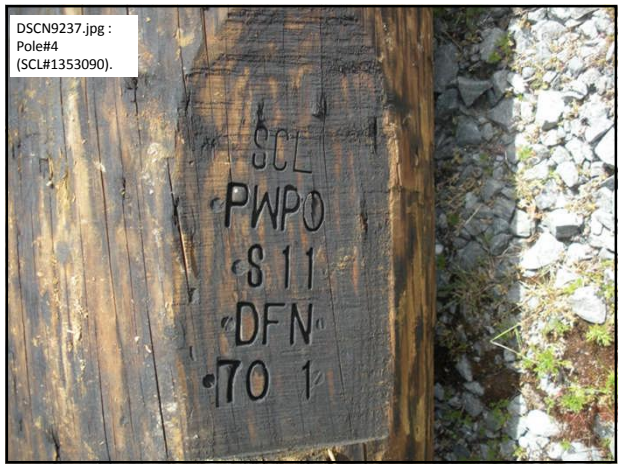
DSCN9235.jpg: Pole#3 (SCL#1353082). Note that wood in treated shell and core experienced splintery fracture surfaces. The wood in core was firm to screwdriver penetration with no indication of softening or visible sign of decay.



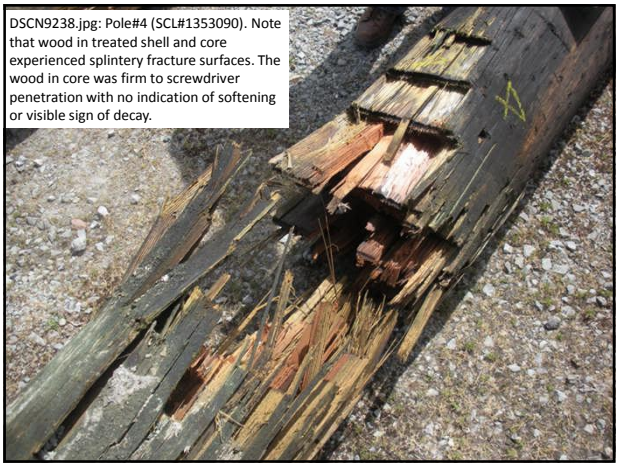
DSCN9236.jpg : Pole#4 (SCL#1353090).



DSCN9237.jpg : Pole#4 (SCL#1353090).



DSCN9238.jpg: Pole#4 (SCL#1353090). Note that wood in treated shell and core experienced splintery fracture surfaces. The wood in core was firm to screwdriver penetration with no indication of softening or visible sign of decay.



DSCN9239.jpg: Pole#4 (SCL#1353090). Note that wood in treated shell and core experienced splintery fracture surfaces. The wood in core was firm to screwdriver penetration with no indication of softening or visible sign of decay.



DSCN9240.jpg: Pole#4 (SCL#1353090). Note that wood in treated shell and core experienced splintery fracture surfaces. The wood in core was firm to screwdriver penetration with no indication of softening or visible sign of decay.



DSCN9241.jpg: Pole #5 (SCL1353061)




DSCN9242.jpg : Pole #5 (SCL1353061)


DSCN9243.jpg : Pole #5 (SCL1353061). Pole had heart rot from 2-10ft above GL.


DSCN9247.jpg : Pole #5 (SCL1353061). Pole had heart rot from 2-10ft above GL.


DSCN9244.jpg : Pole #5 (SCL1353061). Pole had heart rot from 2-10ft above GL.


DSCN9245.jpg : Pole #5 (SCL1353061). Pole had heart rot from 2-10ft above GL.


DSCN9246.jpg : Pole #5 (SCL1353061). Pole had heart rot from 2-10ft above GL. Decay advanced and somewhat powdery with inset bore holes present.



DSCN9248.jpg : Pole #6 (SCL1353097). Pole had no sign of decay or softness. It fractured about 10-ft above GL.

DSCN9249.jpg: Pole #6 (SCL1353097). Pole had no sign of decay or softness. It fractured about 10-ft above GL.





DSCN9250.jpg : Pole #7 (SCL1354861). Penta-treated pole and a heavy bleeder.

DSCN9251.jpg: Pole #7 (SCL1354861). Pole #7 fractured about 12-ft above GL. Untreated interior (core) surfaces fractured in a brash manner.

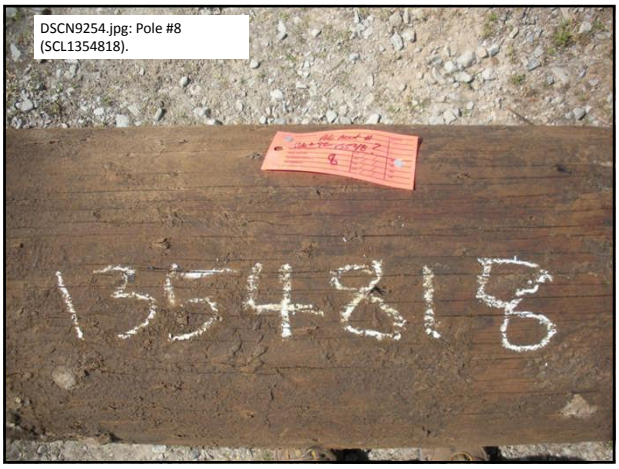




DSCN9252.jpg: Pole #7 (SCL1354861). Pole #7 fractured about 12-ft above GL. Untreated interior (core) surfaces fractured in a brash manner, possibly juvenile wood.

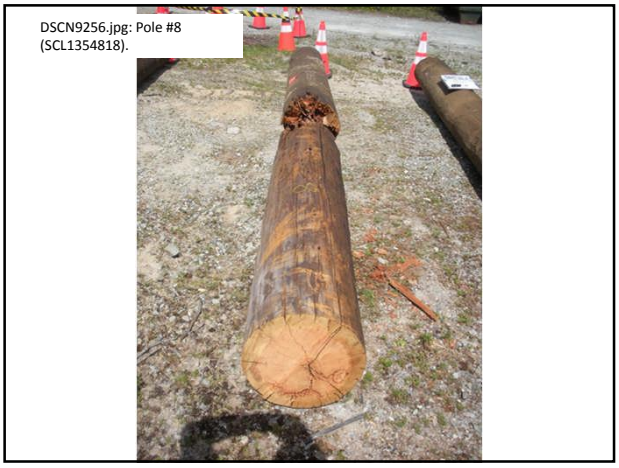


DSCN9253.jpg: Pole #7 (SCL1354861). Pole #7 fractured about 12-ft above GL. Untreated interior (core) surfaces fractured in a brash manner.



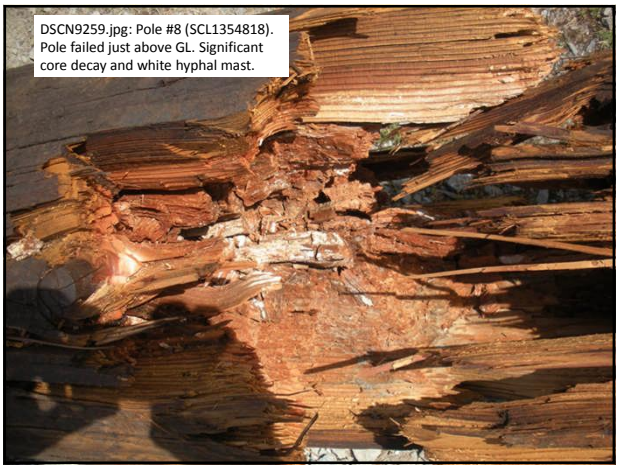
DSCN9254.jpg: Pole #8 (SCL1354818).


DSCN9255.jpg: Pole #8 (SCL1354818).


DSCN9256.jpg: Pole #8 (SCL1354818).


DSCN9257.jpg: Pole #8 (SCL1354818). Pole failed just above GL. Significant core decay and white hyphal mast.


DSCN9258.jpg: Pole #8 (SCL1354818). Pole failed just above GL. Significant core decay and white hyphal mast.


DSCN9259.jpg: Pole #8 (SCL1354818). Pole failed just above GL. Significant core decay and white hyphal mast.

DSCN9260.jpg: Pole #8 (SCL1354818). Pole failed just above GL. Significant core decay and white hyphal mast. Screw-driver penetration into heartwood was 1-2-inches.



DSCN9261.jpg: Pole #9 (SCL1354825).



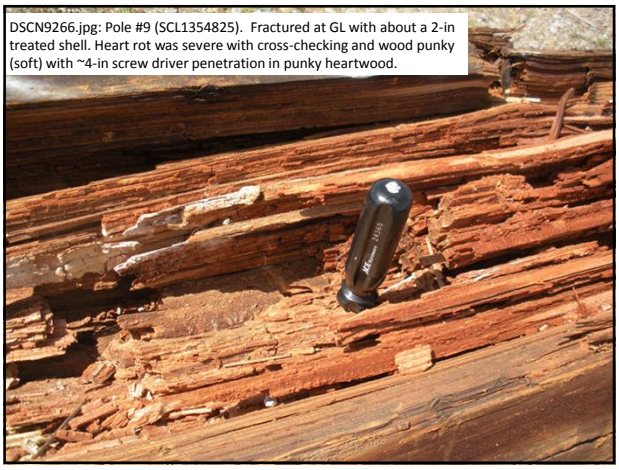
DSCN9262.jpg: Pole #9 (SCL1354825). Fractured at GL.



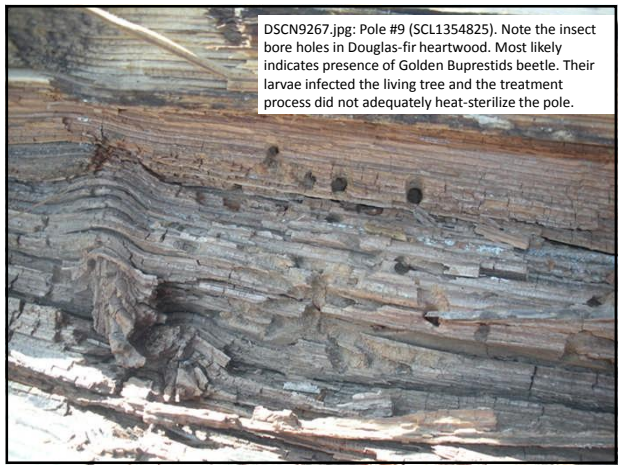


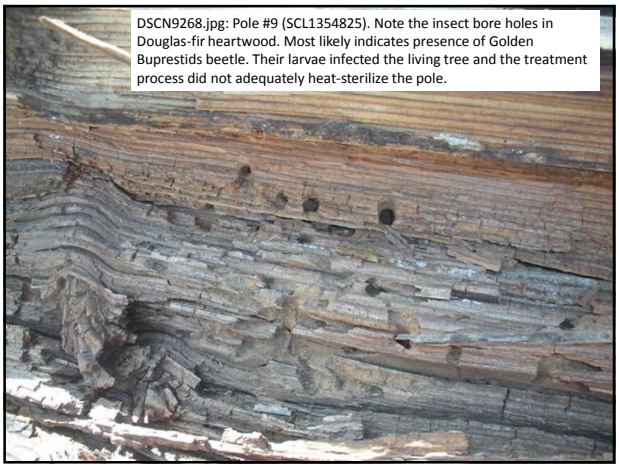
DSCN9263.jpg: Pole #9 (SCL1354825). Fractured at GL with about a 2-in treated shell. Heart rot was severe with cross-checking and wood punky (soft) with ~4-in screw driver penetration in punky heartwood.

DSCN9266.jpg: Pole #9 (SCL1354825). Fractured at GL with about a 2-in treated shell. Heart rot was severe with cross-checking and wood punky (soft) with ~4-in screw driver penetration in punky heartwood.



DSCN9267.jpg: Pole #9 (SCL1354825). Note the insect bore holes in Douglas-fir heartwood. Most likely indicates presence of Golden Buprestids beetle. Their larvae infected the living tree and the treatment process did not adequately heat-sterilize the pole.





DSCN9268.jpg: Pole #9 (SCL1354825). Note the insect bore holes in Douglas-fir heartwood. Most likely indicates presence of Golden Buprestids beetle. Their larvae infected the living tree and the treatment process did not adequately heat-sterilize the pole.



DSCN9269.jpg: Pole #10 (SCL1354807).



DSCN9271.jpg: Pole #10 (SCL1354807). Note the insect bore holes in Douglas-fir heartwood. Most likely indicates presence of Golden Buprestids beetle. Their larvae infected the living tree and the treatment process did not adequately heat-sterilize the pole. Also note likely presence of hyphal material from fungal infection.



DSCN9272.jpg: Pole #10 (SCL1354807). Heartwood core shows decay with cross-grain checking.



DSCN9273.jpg : Pole #10 (SCL1354807). Heartwood core was soft with extensive wood dust residue. Core was easily penetrated with screw-driver and appeared brash in appearance indicating extensive core decay.



DSCN9274.jpg : Pole #10 (SCL1354807). Heartwood core was soft with extensive wood dust residue. Core was easily penetrated with screw-driver and appeared brash in appearance indicating extensive core decay.

DSCN9275.jpg: Pole #11 (SCL 1328778).





DSCN9276.jpg: Pole #11 (SCL 1328778). Pole failed about 5-ft above GL. From 5-10-ft above GL severe heart rot was visibly evident. Core wood internal to treated shell was heavily pulverized to dust.



DSCN9277.jpg: Pole #11 (SCL 1328778). Severe heart rot was visibly evident with significant cross-grain checking and white hyphal matter on decayed wood surface.

DSCN9278.jpg: Pole #11 (SCL 1328778). Severe heart rot was visibly evident with significant cross-grain checking and white hyphal matter on decayed wood surface.





DSCN9279.jpg: Pole #11 (SCL 1328778). Severe heart rot was visibly evident with significant cross-grain checking and white hyphal matter on decayed wood surface.

DSCN9280.jpg: Pole #12 (SCL1354824)





DSCN9281.jpg: Pole #12 (SCL1354824)



DSCN9282.jpg: Pole #12 (SCL1354824). Failed ~5-ft above GL. Had a 2-in thick treated wood shell, but core was heavily decayed and punky.



DSCN9283.jpg: Pole #12 (SCL1354824). Failed ~5-ft above GL. Had a 2-in thick treated wood shell, but core was heavily decayed and punky.



DSCN9284.jpg: Pole #12 (SCL1354824). Failed ~5-ft above GL. Had a 2-in thick treated wood shell, but core was heavily decayed and punky.



DSCN9285.jpg: Pole #12 (SCL1354824). Failed ~5-ft above GL. Had a 2-in thick treated wood shell, but core was heavily decayed and punky. Full screw-driver penetration.



DSCN9286.jpg: Pole #12 (SCL1354824). Had a 2-in thick treated wood shell, but core was heavily decayed and punky. Full screw-driver penetration.



DSCN9287.jpg: Pole #12 (SCL1354824). Failed ~5-ft above GL. Heartwood core was heavily decayed and punky. Full screw-driver penetration.



DSCN9288.jpg: Pole #13 (SCL1354804). Pole failed at GL.



DSCN9289.jpg: Pole #13 (SCL1354804). Pole failed at GL. Severe heart rot was visibly evident with brash fracture surfaces and white hyphal matter on decayed wood surfaces.



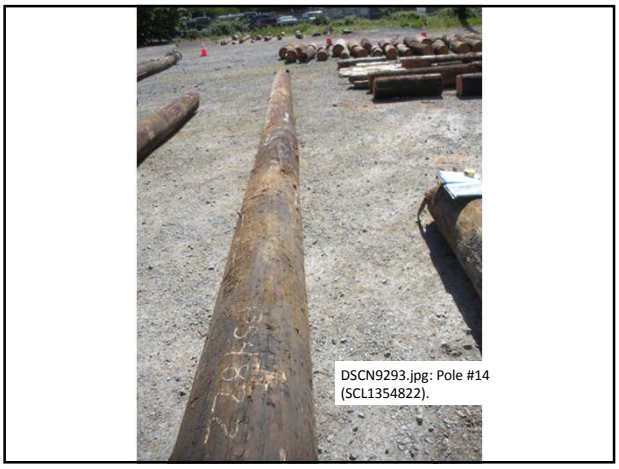
DSCN9290.jpg: Pole #13 (SCL1354804). Pole failed at GL. Severe heart rot was visibly evident with brash fracture surfaces and white hyphal matter on decayed wood surfaces.



DSCN9291.jpg: Pole #13 (SCL1354804). Severe heart rot was visibly evident with brash fracture surfaces and white hyphal matter on decayed wood surface. Full screw-driver penetrated into decayed core.



DSCN9292.jpg: Pole #14 (SCL1354822).



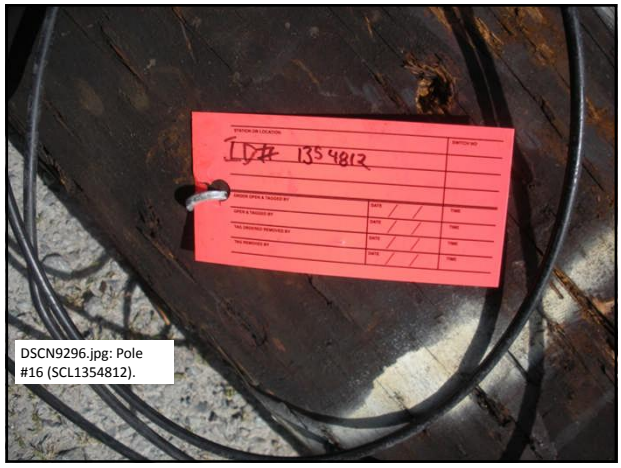
DSCN9293.jpg: Pole #14 (SCL1354822).



DSCN9294.jpg: Pole #14 (SCL1354822). Pole fractured about 25-ft above GL. Fracture surfaces appeared mostly splintery probably indicating sound wood in heart core.



DSCN9295.jpg: Pole #15 (SCL1354806). Pole #15 fractured above two sections identified. Fractured surface not found.



DSCN9296.jpg: Pole #16 (SCL1354812).



DSCN9297.jpg: Pole #16 (SCL1354812). Fractured at top and fracture area not identified. Area 5-12-ft above GL had solid 2-3-in treated shell but had heart rot in core.



DSCN9298.jpg: Pole #16 (SCL1354812). Section 5-12-ft above GL had solid 2-3-in treated shell but had heart rot in core.



DSCN9299.jpg: Pole #17 (SCL1354902).



DSCN9300.jpg : Pole #17 (SCL1354902). Pole #17



DSCN9301.jpg : Pole #17 (SCL1354902). Fractured at GL. Treated shell appeared sound, but inner core showed moderate heart rot.



DSCN9302.jpg: Pole #17 (SCL1354902). Fractured at GL. Treated shell appeared sound, but inner core showed moderate heart rot.



DSCN9303.jpg: Pole #17 (SCL1354902). Fractured at GL. Treated shell appeared sound, but inner core showed moderate heart rot.



DSCN9304.jpg: Pole #18 (SCL1328783).



DSCN9305.jpg: Pole #18 (SCL1328783).



DSCN9306.jpg: Pole #18 (SCL1328783). Fractured at top ~50ft above GL.



DSCN9307.jpg: Pole #18 (SCL1328783). Two Fractures noted. First fracture at top ~50ft above GL. Treated shell appeared sound, but early decay was evident in core.



DSCN9308.jpg Pole #18 (SCL1328783). Two Fractures noted. First fracture at top ~50ft above GL. Treated shell appeared sound, but early decay was evident in core.



DSCN9309.jpg Pole #18 (SCL1328783). Two Fractures noted. First fracture at top ~50ft above GL. Second fracture was ~10ft above the first. Treated shell appeared sound and no decay in core was evident.



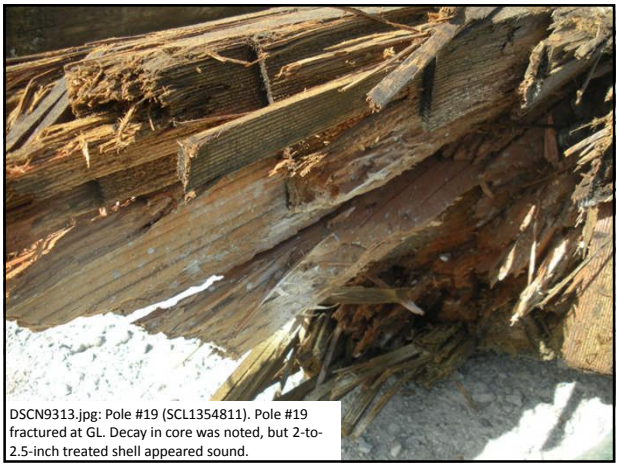
DSCN9310.jpg: Pole #19 (SCL1354811).



DSCN9311.jpg: Pole #19 (SCL1354811).



DSCN9312.jpg: Pole #19 (SCL1354811). Pole #19 fractured at GL. Decay in core was noted, but 2-to-2.5-inch treated shell appeared sound.



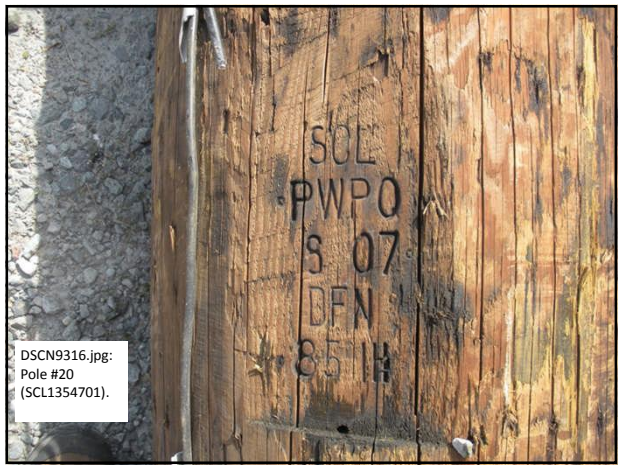
DSCN9313.jpg: Pole #19 (SCL1354811). Pole #19 fractured at GL. Decay in core was noted, but 2-to-2.5-inch treated shell appeared sound.



DSCN9314.jpg : Pole #20 (SCL1354701).



DSCN9315.jpg: Pole #20 (SCL1354701).



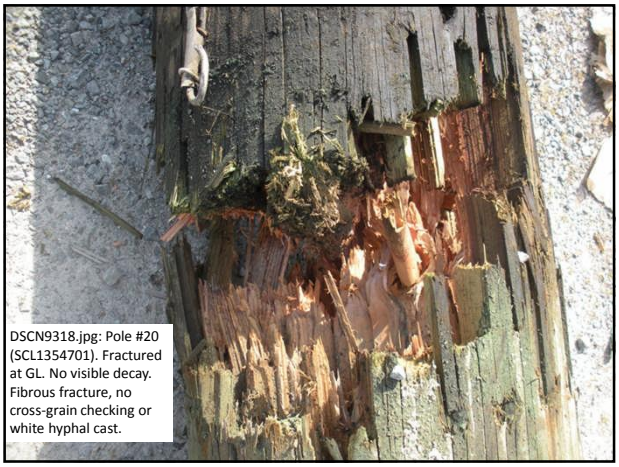
DSCN9316.jpg: Pole #20 (SCL1354701).



DSCN9319.jpg: Pole #20 (SCL1354701). Fractured at GL.



DSCN9317.jpg: Pole #20 (SCL1354701). Fractured at GL. No visible decay. Fibrous fracture, no cross-grain checking or white hyphal cast.



DSCN9318.jpg: Pole #20 (SCL1354701). Fractured at GL. No visible decay. Fibrous fracture, no cross-grain checking or white hyphal cast.



DSCN932.jpg: Pole #21 (SCL1328887).



DSCN9323.jpg: Pole #21. (1328887). Fractured at GL.



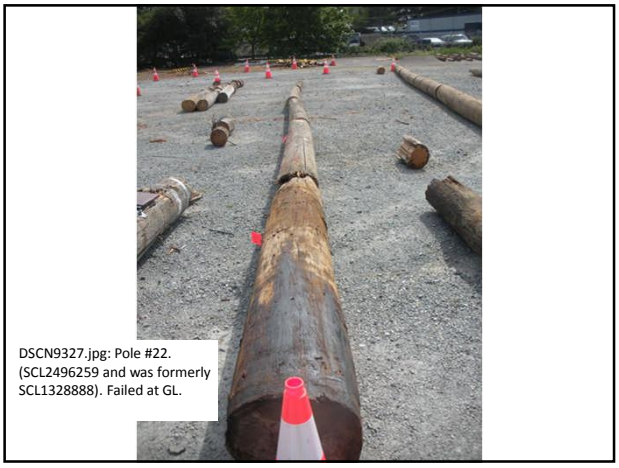
DSCN9321.jpg: Pole #21 (SCL1328887). Fractured at GL. No visible decay. Fibrous fracture in shell, but brash failure in core. However, brash failure may be due to juvenile wood as there was no cross-grain checking or white hyphal cast in core wood.



DSCN9322.jpg: Pole #21 (SCL1328887). Fractured at GL. No visible decay. Fibrous fracture in shell, but brash failure in core. However, brash failure may be due to juvenile wood as there was no cross-grain checking or white hyphal cast in core wood.



DSCN9326.jpg: Pole #22. (SCL2496259 and was formerly SCL1328888).



DSCN9327.jpg: Pole #22. (SCL2496259 and was formerly SCL1328888). Failed at GL.



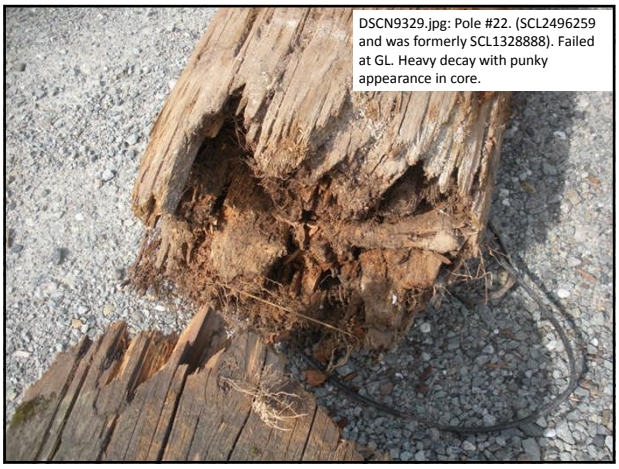
DSCN9324.jpg: Pole #22. (SCL2496259 and was formerly SCL1328888). Failed at GL.



DSCN9325.jpg: Pole #22. (SCL2496259 and was formerly SCL1328888). Failed at GL.



DSCN9328.jpg: Pole #22. (SCL2496259 and was formerly SCL1328888). Failed at GL. Heavy decay with punky appearance in core.



DSCN9329.jpg: Pole #22. (SCL2496259 and was formerly SCL1328888). Failed at GL. Heavy decay with punky appearance in core.



DSCN9330.jpg: Pole #22. (SCL2496259 and was formerly SCL1328888). Failed at GL. Heavy decay with punky appearance in core.



DSCN9331.jpg: Pole #23 (SCL1328886).



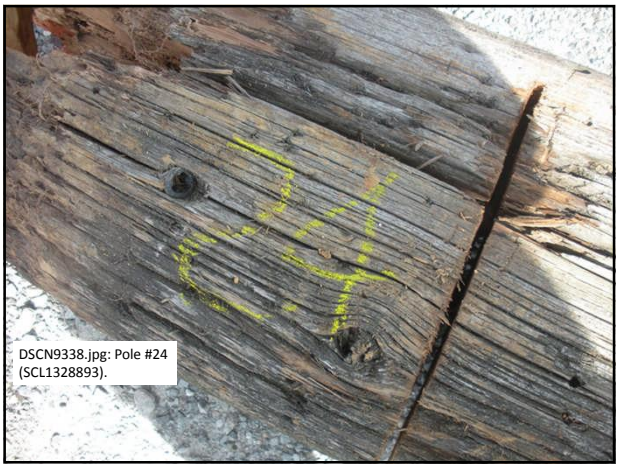
DSCN9332.jpg: Pole #23 (SCL1328886). Pole #23 was trussed as a repair due to earlier core decay. Failed at GL.



DSCN9333.jpg: Pole #23 (SCL1328886). Pole #23 was trussed as a repair due to earlier core decay. Failed at GL.



DSCN9334.jpg: Pole #23 (SCL1328886). Pole #23 exhibited heavy core decay with some evidence of insect boring holes.



DSCN9338.jpg: Pole #24 (SCL1328893).



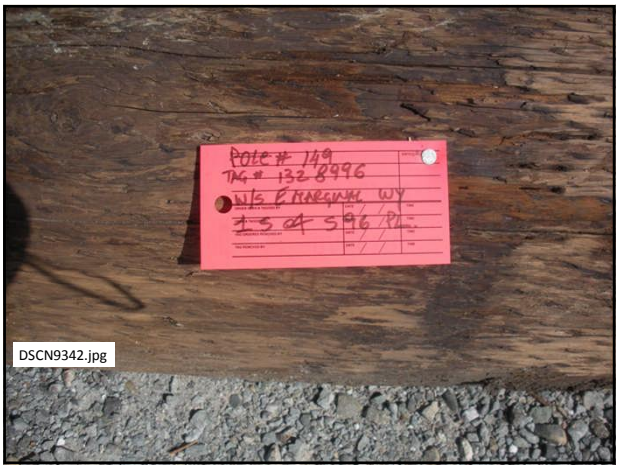
DSCN9339.jpg: Pole #24 (SCL1328893).



DSCN9340.jpg: Pole #24 (SCL1328893). Pole #24 fractured at GL. It showed both exterior surface erosion (probably due to soft rot) and a brashly fractured decayed core.



DSCN9341.jpg: Pole #24 (SCL1328893). Pole #24 fractured at GL. It showed both exterior surface erosion (probably due to soft rot) and a brashly fractured decayed core.



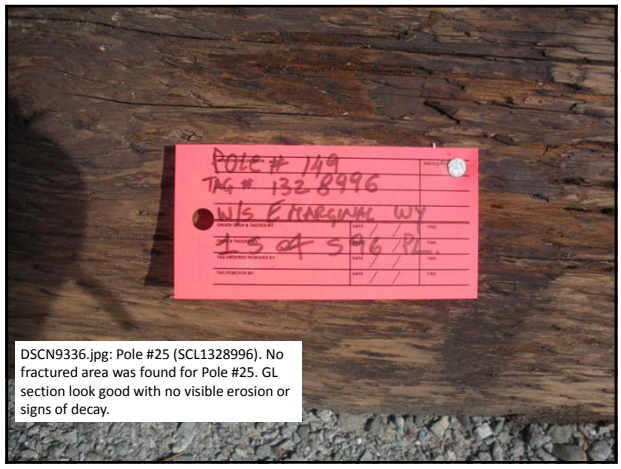
DSCN9342.jpg



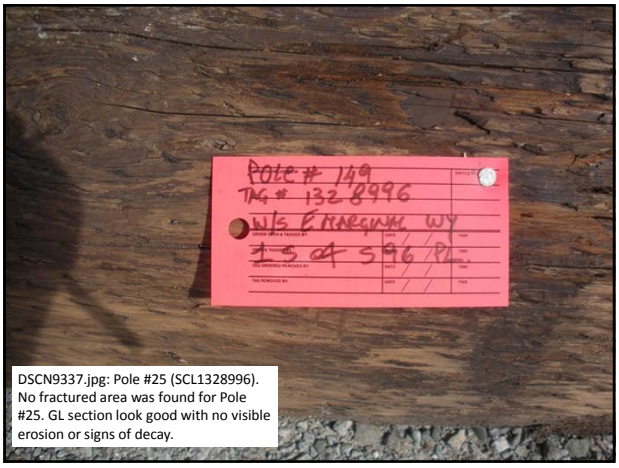
DSCN9343.jpg



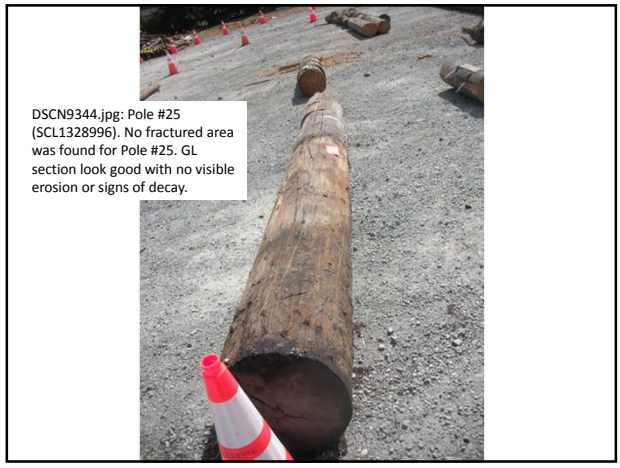
DSCN9335.jpg: Pole #25 (SCL1328996).



DSCN9336.jpg: Pole #25 (SCL1328996). No fractured area was found for Pole #25. GL section look good with no visible erosion or signs of decay.



DSCN9337.jpg: Pole #25 (SCL1328996). No fractured area was found for Pole #25. GL section look good with no visible erosion or signs of decay.



DSCN9344.jpg: Pole #25 (SCL1328996). No fractured area was found for Pole #25. GL section look good with no visible erosion or signs of decay.



DSCN9345.jpg: Pole #25 (SCL1328996). No fractured area was found for Pole #25. GL section look good with no visible erosion or signs of decay.



DSCN9347.jpg: Pole #26 (SCL1328890).



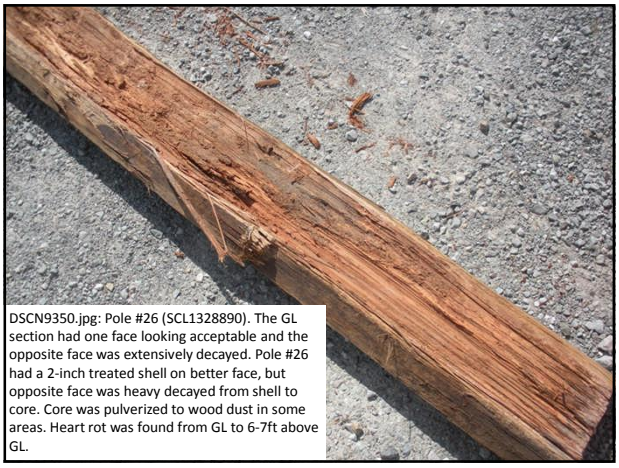
DSCN9348.jpg: Pole #26 (SCL1328890).



DSCN9349.jpg: Pole #26 (SCL1328890). Two sections were found. A GL section and the section just above the GL section (with ID#) .



DSCN9346.jpg: Pole #26 (SCL1328890). The GL section had one face looking acceptable and the opposite face was extensively decayed.



DSCN9350.jpg: Pole #26 (SCL1328890). The GL section had one face looking acceptable and the opposite face was extensively decayed. Pole #26 had a 2-inch treated shell on better face, but opposite face was heavy decayed from shell to core. Core was pulverized to wood dust in some areas. Heart rot was found from GL to 6-7ft above GL.



DSCN9351.jpg: Pole #26 (SCL1328890). Pole #26 had heavy decay in core. Core was pulverized to wood dust in some areas. Heart rot was found from GL to 6-7ft above GL.



DSCN9352.jpg: Pole #26 (SCL1328890). Pole #26 had heavy decay in core. Core was pulverized to wood dust in some areas. Heart rot was found from GL to 6-7ft above GL.



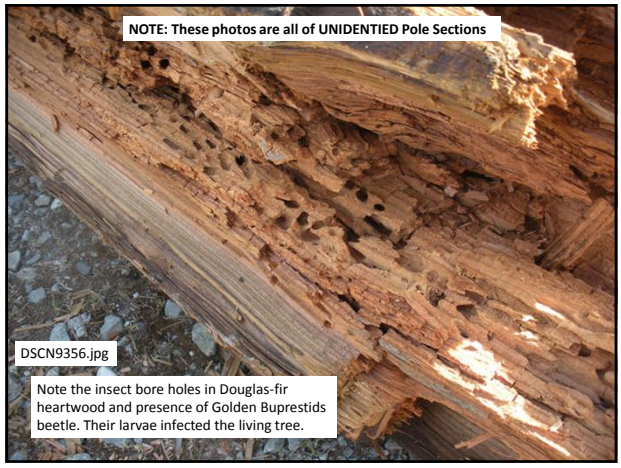
DSCN9353.jpg: Pole #26 (SCL1328890). 2nd section.



DSCN9354.jpg: Pole #26 (SCL1328890). 2nd section above GL section showed heavy core decay with a 2-to-2.5-inch treated shell.



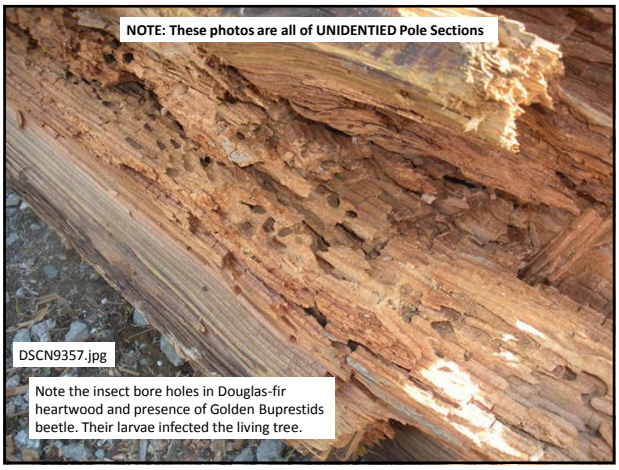
DSCN9355.jpg: Pole #26 (SCL1328890). 2nd section above GL section showed heavy core decay with a 2-to-2.5-inch treated shell.



NOTE: These photos are all of UNIDENTIED Pole Sections

DSCN9356.jpg

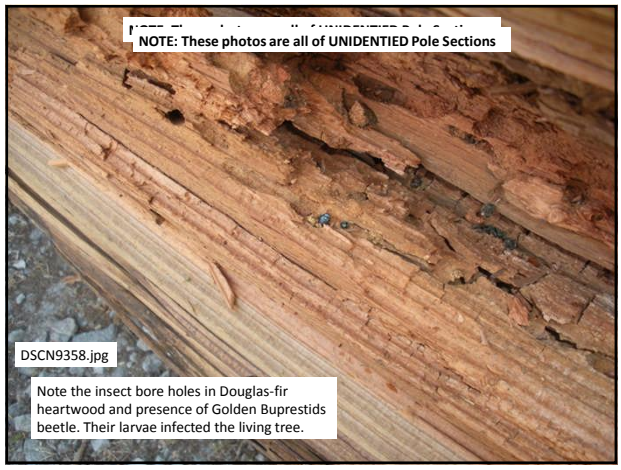
Note the insect bore holes in Douglas-fir heartwood and presence of Golden Buprestids beetle. Their larvae infected the living tree.



NOTE: These photos are all of UNIDENTIED Pole Sections

DSCN9357.jpg

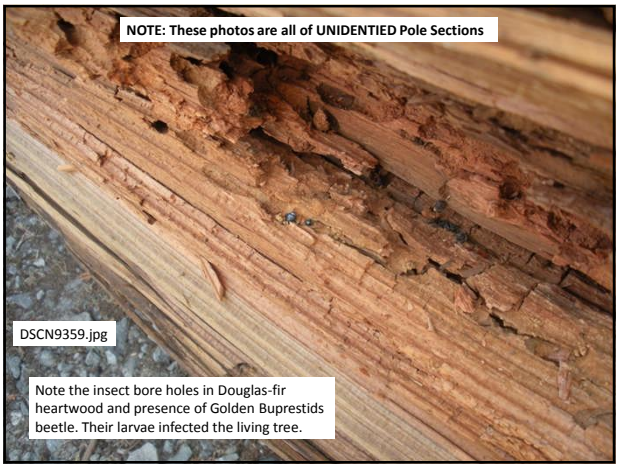
Note the insect bore holes in Douglas-fir heartwood and presence of Golden Buprestids beetle. Their larvae infected the living tree.



NOTE: These photos are all of UNIDENTIED Pole Sections

DSCN9358.jpg

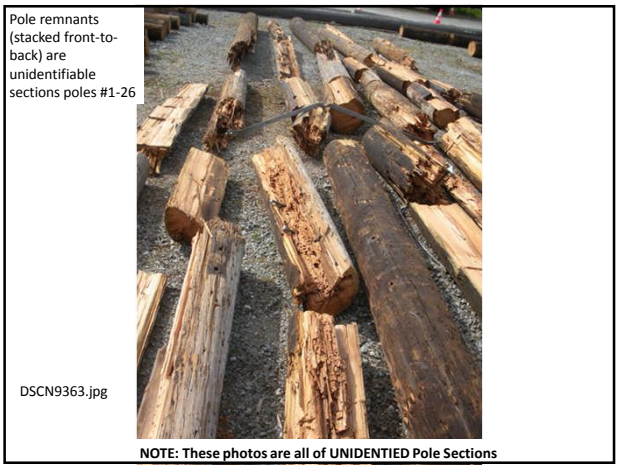
Note the insect bore holes in Douglas-fir heartwood and presence of Golden Buprestids beetle. Their larvae infected the living tree.

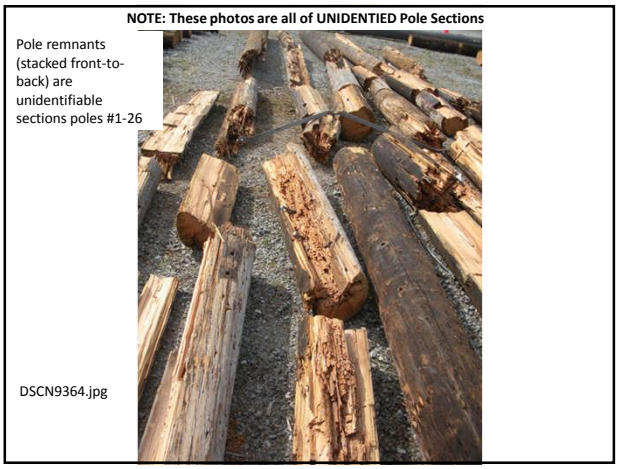

NOTE: These photos are all of UNIDENTIED Pole Sections
DSCN9359.jpg
Note the insect bore holes in Douglas-fir heartwood and presence of Golden Buprestids beetle. Their larvae infected the living tree.


NOTE: These photos are all of UNIDENTIED Pole Sections
DSCN9360.jpg


Pole remnants (stacked front-to-back) are unidentifiable sections poles #1-26
DSCN9361.jpg
NOTE: These photos are all of UNIDENTIED Pole Sections


Pole remnants (stacked front-to-back) are unidentifiable sections poles #1-26
DSCN9362.jpg
NOTE: These photos are all of UNIDENTIED Pole Sections


Pole remnants (stacked front-to-back) are unidentifiable sections poles #1-26
DSCN9363.jpg
NOTE: These photos are all of UNIDENTIED Pole Sections


NOTE: These photos are all of UNIDENTIED Pole Sections
Pole remnants (stacked front-to-back) are unidentifiable sections poles #1-26
DSCN9364.jpg


NOTE: These photos are all of UNIDENTIED Pole Sections
Pole remnants (stacked front-to-back) are unidentifiable sections poles #1-26
DSCN9365.jpg


NOTE: These photos are all of UNIDENTIED Pole Sections
Pole remnants (stacked front-to-back) are unidentifiable sections poles #1-26
DSCN9366.jpg


NOTE: These photos are all of UNIDENTIED Pole Sections
Pole remnants (stacked left-to-right) are more unidentifiable sections of poles #1-26. Note the lack of fractured areas in these sections.
DSCN9367.jpg


NOTE: These photos are all of UNIDENTIED Pole Sections
Pole remnants (stacked left-to-right) are more unidentifiable sections poles #1-26. Note the lack of fractured areas in these sections.
DSCN9368.jpg

APPENDIX L

Wood Pole Strength Report

Dr. Jerrold E. Winandy, Principal, Winandy & Associates LLC **26 August 2019**

Findings: Inspection of Ground-line Condition Assessment

On the morning of May 6, 2019, we conducted a two-phase inspection of both the reconstructed East Marginal Way accident site and then an inspection of the failed poles themselves in an outlying pole yard. In the 1st phase, we inspected the accident site and the new, replaced poles (and former installation locations and some ground line remnants of the old poles) along the west side of East Marginal Way in Tukwila, WA. For purposes of consistency in pole identification, we chose to use the Identification (ID) Numbering system shown in Figure 1.

In the afternoon, we conducted a pole-by-pole inspection of the butt-to-fracture point remnants of the 26 failed poles. Each of the 26 individual pole inspections included measurements, a visual and then a probe assessment of the ground-line and/or the failure-point (if the failure did not occur at ground-line) condition of that pole. This inspection also included appropriate photographs. Annotated photos of my observations from this 2nd phase of the old pole inspections can be found in Appendix K Forensic Pole Photos. Once again, we used the ID numbering system for each pole shown in Figure 1.

The 26 poles that failed varied from 55-to-85 ft. in length, with 18 of 26 being either 60- or 65-ft. We noted that poles number 1,17, 18, 23 & 24 were Western red cedar, either class 1 or unlisted, and either untreated or pressure treated with pentachlorophenol or copper naphthenate wood preservative. The remaining 21 poles were all Douglas-fir class H1-to-3, with most of them being class 1. Except for two treated with pentachlorophenol, the Douglas fir poles were all pressure treated with copper naphthenate wood preservative.

Assessing Residual Condition of Poles

To assess the state of decay in the poles, especially the untreated cores, we used a wood quality condition-rating for the extent of wood decay ranging from 0-10. In this rating system, Descriptive examples of the meanings of various ratings in this decay-condition assessment system for decay ranges from 0-to-10 follow below:

Rating	Description of wood features

0	no probe-indication of decay, change of color or hardness, or surface discontinuity,
1-2	suspect incipient decay based solely on suspected changes in wood color,
3-4	noticeable changes in wood color or with some suspicion of softening of wood density based solely on visual evaluation,
5-6	noticeable changes in wood color or with softening of wood density based on probe evaluation,
7-8	all of 5-6 plus noticeable cross-grain checking of wood surfaces and/or fragmented decayed chards of wood from 1-10 cm long, and
9-10	all of 7-8 rating plus pulverized wood residue.

A listing of our measurements, observations, and assessment of the residual condition of each of these failed poles can be found in Table 1.

An important finding of these wood pole inspections noted in Table 1 was related to beetle infestation. We noted insect bore holes in 3 of the 26 poles that were identified from the original pole location in the line. There were also many unidentified sections of poles that were not linked to the original pole location. Many of these unidentified sections had beetle-boring damage too. We also found metallic green remnants of the dead adult beetle carcasses in a few of the pole sections. After noting that the bore holes in the sections with dead carcasses were identical to the bore holes in pole section not having such carcasses, and after identifying the dead beetle carcasses as the Golden Buprestid (*Buprestis aurulenta*) beetle, we believe that all the bore holes in the Douglas fir poles were from the Golden Buprestid (*Buprestis aurulenta*) beetle. This species of beetle lays its eggs in living trees, especially Douglas fir, and as the larvae bore around within the living tree they create both tunnels and larger cavities. These beetle larvae do create the bore holes, but by themselves the bore hole do not usually cause major strength reductions. However, boring larvae do spread fungal spores throughout these bore holes causing significantly more rapid fungal inoculation of the untreated heartwood. Where such beetle larvae boring holes are found, wood decay was generally more noticeable than in unbored heartwood. Upon maturing, the beetles emerge from the living tree and the life-process repeats.

If such an infected tree is harvested while the larvae inhabit the wood, they will continue to bore and usually fungally infect the wood within that wood pole unless they are killed. That is why AWPA Pole Standard M1 (AWPA 2016c) specifically mandates sterilization of the wood poles either before or during preservative treatment. Such sterilization most often consists of either initial kiln drying or a pre-treatment thermal process capable of achieving a core temperature of 150ºF at the pith center of the pole for at least 1-hour. It has been rumored that some copper naphthenate treaters do not properly sterilize their poles because the diesel co-solvent used with some AWPA HSC carriers (AWPA 2016d) used for copper naphthenate is not compatible with high-temperature pre-treatment thermal conditioning (i.e., Boultonizing). It is impossible to tell without specific treating plant reports, but we suspect that such treaters back off on the Boultonizing cycle to avoid pulling too much diesel co-solvent into their condenser tanks.

In our inspections we found that as many as 18 of 26 poles involved with this wind-related event were partially or significantly decayed at the time of the incident. Another critical factor, noted after both our Phase 1 East Marginal Way site inspections and our Phase 2 Pole Yard inspections, was related to two grouped sections of decayed poles. Specifically, we found two sets of consecutive poles, Poles #8-to-#13 (6 total) and Poles #22-to-#24 and #26 (4 of 5 total) (see Table 1 and Figure 1), that where severely decayed. We believe that these particular two consecutive sets of 6 in a row and 4-of-5 poles in a row, respectfully, were the critical weak links in this East Marginal Way pole line system. Based on their poor condition and their particular locations which were

exposed to potential elevated wind funnels created by large buildings immediately west of their locations, we believe these two sets of consecutive poles were the primary components responsible for the progressive cascading nature of the pole failures in this system.

Pole Strength Summary

We then applied theoretical models for simple short-column flexural performance based on the loss of wood material and its locations to predict the effects of the noted decay on the expected engineering properties of each pole. Using basic theorem from the science of mechanics (Levinson 1970), based on the dimensions, geometric shape and load path for a structural element used as a cantilever beam, such as a utility pole. The load capacity of a sound, undecayed pole is a function of the strength of the wood fiber and its section Modulus (SM_{solid}). For a circular-shaped cylinder structure used as a cantilever, the section modulus (Table 1) can be calculated as:

$$SM_{solid} = (pi * d^3)/32 \qquad (Eqn\ 1)$$

If we assume no remaining residual wood fiber strength in the decayed core of a pole, then the load capacity of such a pole would be related to the residual wood fiber strength then existing in the outer shell and the section modulus of the hollow pole. We can estimate the effect of heart-rot decay on pole capacity by calculating the section modulus of a hollow cylinder such as is the case with pole having a decayed heart center. For a hollow circular object used as a cantilever, the section modulus is:

$$SM_{hollow} = (pi * (d^4-d_i^4))/32d \qquad (Eqn\ 2)$$

The ratio of SM_{hollow} to SM_{solid} gives a ratio representing the residual strength of a hollow pole (Table 1). This concept for an array of geometric shapes has generally become known and termed as the "*Reduced Section Modulus Theory*". Detailed presentations on the theory and use of the "Reduced Section Modulus Theory" for modeling the load-carrying capacity of beams of various uses, sizes and shapes were presented by Winandy and Hernandez (1998) and Hernandez and Winandy (2005). The concept of this theoretical model has recently been adopted in the *National Design Specification for Wood Construction* to predict strength loss in wood products from various machining and manufacturing processes (AWC 2018).

Literature: Reviewed or Referenced for Background or Cited

- ANSI, 2015. American National Standards Institute. ANSI O5.1--American National Standard for Wood Utility Poles: Specifications and Dimensions. Published by American Wood Protection Association, Birmingham, AL. 45pg.
- AWC. 2018. National Design Standard for Wood Construction. American Wood Council ANSI/AWC-NDS-2018 Leesburg, VA.
- AWPA. 2016a. American Wood Protection Association, AWPA Standard U1—Commodity Specification D; Poles, Figure 1. Birmingham, AL.
- AWPA. 2016b. American Wood Protection Association, AWPA Standard T1—Use Category System: Processing and Treating Standard –Section D; Poles, Birmingham, AL.
- AWPA. 2016c. American Wood Protection Association, AWPA Standard M1—Standard for Purchase of Treated Wood Products. Birmingham, AL.

- AWPA. 2016d American Wood Protection Association, AWPA Standard HSA—Standard for Hydrocarbon Solvent-Type A (formerly AWPA Std P9-Type A). Birmingham, AL.
- Every RW, Rudinsky JA. 1973. Golden Buprestid—A wood boring beetle. OSU Extension Circular 713. Agricultural Extension Serv., Oregon State University, Corvallis OR.
- Hernandez R, Winandy JE. 2005. Evaluation of a reduced section modulus model for determining the effects of incising on bending strength and stiffness of structural lumber. Forest Products Journal 55(9):57-65.
- Levinson IJ. 1970. Mechanics of Materials, 2nd Ed. Prentice-Hall. Englewood NJ. 338p.
- Morrell, JJ. 2016. Estimated service life of wood poles. Technical Bulletin No. 16-U-101. North American Wood Pole Council. http://woodpoles.org/ .
- USDA. 2010. Wood Handbook: Wood as an Engineering Material. Gen.Tech.Report GTR-190. Forest Products Laboratory, U.S. Department of Agriculture, Madison, WI.
- Wilcox, W.W. 1978. Review of literature on the effects of early stages of decay on wood strength. Wood and Fiber Science 9(4):252-257.
- Winandy JE, Hernandez R. 1998. An analytical approach to determining the effects of incising on bending strength and stiffness of glue-laminated beams. Proc. American Wood Preservers' Association. Vol. 94:98-115. Granbury, TX.
- Winandy JE, Lebow PK. 2001. Modeling Strength Loss in Wood by Chemical Composition. Part I. An Individual Component Model for Southern Pine. Wood and Fiber Science, 33(2):239-254.
- Winandy JE, Morrell JJ. 1993. Relationship between incipient decay, strength, and chemical composition of Douglas-fir heartwood. 1993. Wood and Fiber Science, 25(3):278-288.
- Zabel RA, Morrell JJ.1992. Wood Microbiology: Decay and its Prevention. Academic Press. San Diego, CA. 476p.

Video Reviewed

BOE_4_5_2019 3_47_36 PM (UTC-07_00).avi	5/4/2019 3:06 PM	Video Clip	826,217 KB
BOE_4_5_2019 3_47_36 PM (UTC-07_00).avi - Shortcut	4/8/2019 11:42 ...	Shortcut	3 KB
MOF_04.05.19.1550.looking west red barn - nw ext ptz.avi	5/4/2019 3:06 PM	Video Clip	7,424 KB
MOF_04.05.19.1550-1551.bicyclist.bridge ext west.avi	5/4/2019 3:06 PM	Video Clip	44,466 KB
MOF_04.05.19.1556.sgb - ext.avi	5/4/2019 3:06 PM	Video Clip	10,919 KB
MOF_04.05.19.power lines and poles fall into east marginal way.sgb - ext.avi	5/4/2019 3:06 PM	Video Clip	9,594 KB
MOF-04.05.19.1549-1550.sgb - main entry.avi	5/4/2019 3:06 PM	Video Clip	24,171 KB
TUK-92nd- 2019-04-08 09.10.05 AM.avi	5/4/2019 3:06 PM	Video Clip	48,485 KB
TUK-94th north- 2019-04-08 09.03.54 AM.avi	5/4/2019 3:06 PM	Video Clip	77,291 KB
TUK-94th South- 2019-04-08 09.07.11 AM.avi	5/4/2019 3:06 PM	Video Clip	33,069 KB
wMOF_04.05.19.1550.north of bridge segment.sgb - ext.avi	5/4/2019 3:06 PM	Video Clip	12,601 KB
wTUK-86th- 2019-04-08 09.13.40 AM.avi	5/4/2019 3:06 PM	Video Clip	57,088 KB
wTUK-87th- 2019-04-08 09.12.25 AM.avi	5/4/2019 3:06 PM	Video Clip	137,726 KB
wwTUK-90th - 2019-04-08 09.11.19 AM.avi	5/4/2019 3:06 PM	Video Clip	37,768 KB

Figure 1. Pole Locations and Spans along East Marginal Way prior to 5 April 2019.



Table 1. SCL--East Marginal Way Failed Pole Condition Assessment (6May2019 by J.E.Winandy)

Pole ID#	SCL ID#	Pole Height (ft)	Pole Class	Min. Pole Class Circ. (in)	SCL Priority Rating -2016	Pole Setting Depth (ft)	Pole Failure AGL (ft)	Core Decay Index 0 = none 10 = extensive		Brash w/o Decay ~Juvenile Wood	Powdery Decay Residue at EMW site	EMTS Est. Min. Treated Shell[1] Thick (in)	RSM Calculated[2] Residual Section Modulus
1	1353076	60	1	48.0	P5	7.4	52.2	0				2	No Decay
2	1353492	60	1	48.0	P5	8.0	0.0	1-2		yes		-	--[3]
3	1353082	65	1	49.5	P5	8.7	0.0	0				1	No Decay
4	1353090	65	1	49.5	P5	8.5	0.0	0				2	No Decay
5	1353061	65	1	49.5	P2	10.5	8.5	8-9				-	--[3]
6	1353097	65	1	49.5	P4	8.1	10.0	No Fracture area ID'd			yes	-	Residue@10'
7	1354816	55	2	43.5	P4	7.3	10.4	0		yes		1	No Decay
8	1354818	65	1	49.5	P5	9.2	1.3	7-8	Avg.Decay		yes	2	57%
9	1354825	65	1	49.5	P2	9.5	0.0	10	Index for		yes	2	57%
10	1354807	65	1	49.5	P2	9.8	0.0	8-9	these 6		yes	-	--[3]
11	1358778	65	1	49.5	P2	8.7	0.0	10	Poles in a		yes	1	33%
12	1354824	65	1	49.5	P2	9.0	4.3	10	row was			2	57%
13	1354804	65	1	49.5	P2	8.8	0.3	9-10	9.25		yes	1	33%
14	1354822	65	1	49.5	P4	10.0	24.0	3-4				1	33%
15	1354806	65	1	49.5	P4	9.5	above	No Fracture area ID'd				-	--[4]
16	1354812	65	1	49.5	P4	9.0	above	7-8				2	57%
17	1354902	85	1	55.0	P4	11.0	0.0	4-5				2	53%
18	1328783	75	1	52.5	P4	8.0	52.2	2-3				2	55%
19	1354811	80	1	54.0	P4	8.8	0.0	4-5				2	54%
--------Location of Museum of Flight Skyway Bridge ----------													
20	1354701	85	H1	58.5	P5	10.8	0.0	0-1				1	No Decay
21	1328887	65	3	43.5	P4	10.0	0.0	1-2		yes		2	62%
22	2496259	60	2	45.0	P0	9.0	0.7	9-10	Avg.Decay			1	36%
23	1328886	60	2	45.0	P2	10.5	0.0	8-9	Index for 4 of			1	36%
24	1328893	65	2	46.5	P4	10.6	0.0	8-9	5 poles			1.5	48%
25	1328996	60	1	48.0	P4	8.0	above	No Fracture area ID'd	averaged 9.0			-	--[4]
26	1328890	60	1	48.0	P2	10.0	above	9-10				0.75	26%

[1] Estimated Minimum Treated Shell (EMTS) was an average estimate with variability of at least +25%. In RSM calculations, EMTS is 75% of the ave

[2] Residual Section Modulus (RSM) calculates the remaining bending strength of a wood pole at ground line. For a sound pole, the formula is: SMsolid = pi*d^3/32. The hollow pole formula is: SM_{hollow} = (pi*(d^4-di^4)) /32*d so the RSM is [SM_{hollow} = (pi * (d^4-di^4)) / 32*d] / [SM_{solid} = pi * d3 / However, this calculation for a hollow pole is still based on failing in bending. Poles with advanced internal decay have a thin outer shell which typic fail due to localized buckling of the thin shell at values less than the pure-bending calculations.

[3] No Residual Section Modulus was estimated because of both an inability to determine the estimated treated wood shell and/or our experience that visually discernable decay was indentified in the untreated heartwood core, then any of that untreated heartwood core must be supected to have experienced decay. Thus any Core Decay Index value above 1.0 leads to an assumption that only the measured Treated Wood Shell thickness contributes to residual strength.

[4] No Residual Section Modulus could be estimated at fracture zone as no fracture surface or section was identified