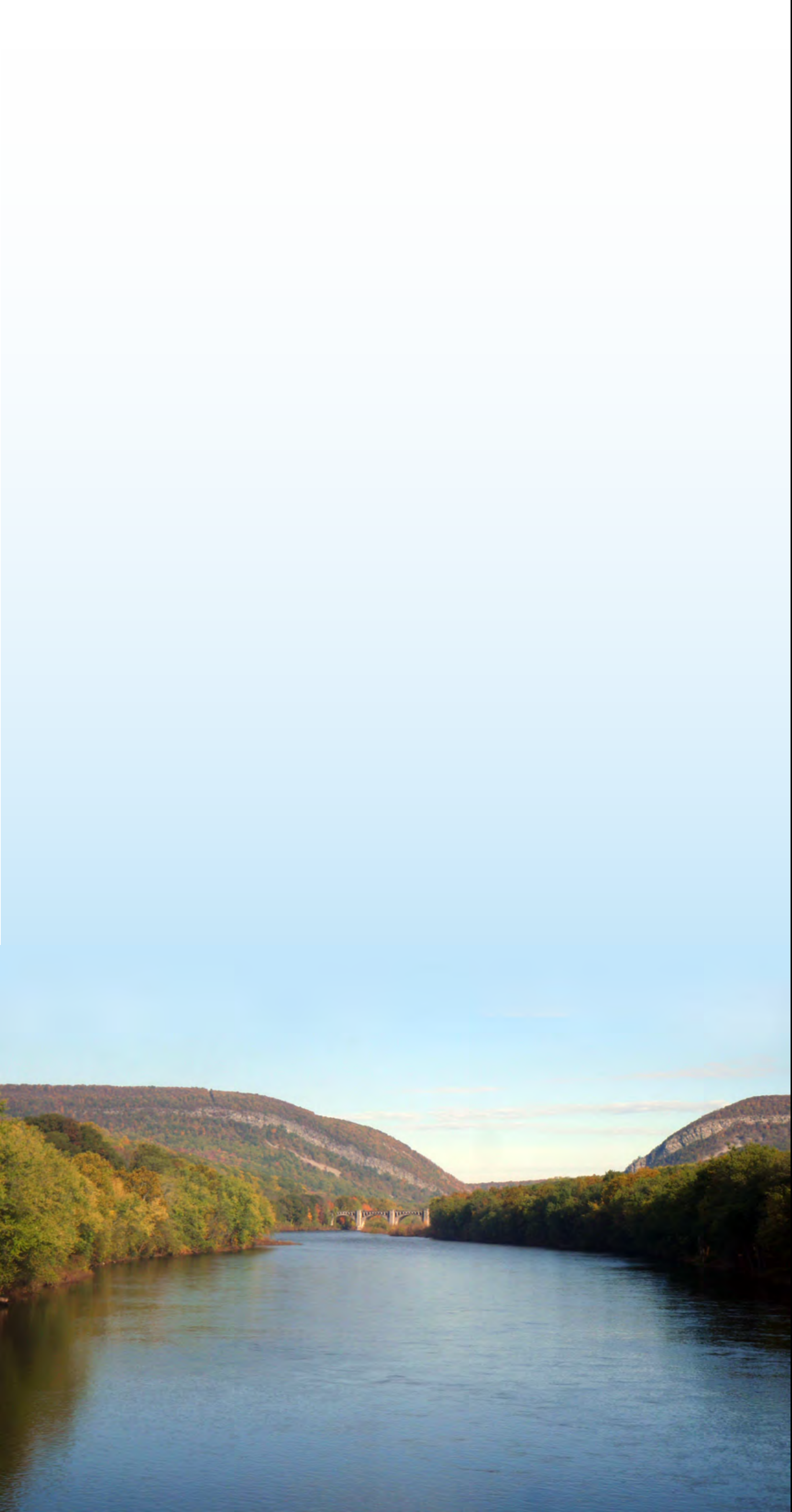


Appendix D

NPS and Applicant Correspondence Regarding Alternative 2b

APPENDIX D:
NPS AND APPLICANT CORRESPONDENCE REGARDING ALTERNATIVE 2B

Gregory J. Smith
Manager-Transmission Expansion

PPL Electric Utilities
Two North Ninth Street, GENN5
Allentown, PA 18101-1179

June 16, 2010
In regards to: SRLINE EIS 25147

Amanda Stein
Delaware Water Gap National Recreation Area
HQ River Road, Off Route 209
Bushkill, PA 18324

Dear Ms. Stein:

The Applicants have reviewed the NPS consultant's analysis of the Existing ROW Alternative, in particular using the existing 100' ROW for several spans in Pennsylvania. It appears that your consultant used a higher wind loading than is required to calculate the blow-out of the conductors. The wind loading used by the Utilities is a 6 psf load. For a detailed explanation of why a 6 psf wind load is appropriate, and the codes referenced to perform the blow-out calculations, see the attached report.

Furthermore, it should be clarified that the Existing ROW Alternative would use PPL EU's existing land rights. Such rights are only limited to 100 feet in five spans, not throughout the entire park in Pennsylvania Using the structure identifiers in your report, this would equate to the spans between structures 3-4, 5-6, 6-7, 7-8, and 9-10.

Sincerely,

Gregory J Smith

Gregory J. Smith
Manager-Transmission Expansion
Enclosure (1)

CC:
John Donahue, Delaware Water Gap National Recreation Area
Pam Underhill, Appalachian National Scenic Trail

For verifying the feasibility of utilizing PPL EU's existing ROW through the Pennsylvania portion of the Susquehanna – Roseland Project within DEWA, NESC regulations and industry standard guidelines set forth in RUS Bulletin 1724E-200 were followed. This includes the section where the existing ROW is 100'. Included below is a summary of calculations performed and references cited by S&L to make the conclusion that the new 500kV circuit construction was feasible for the existing ROW.

Typical ROW widths are established based on required clearances to objects (usually buildings) that are or may in the future exist along the edge of the ROW. The ROW width is calculated using formulas that account for horizontal wire displacement, horizontal wire spacing, structure deflection and horizontal clearance requirements from the wire. The two figures below are taken from the RUS Bulletin as a recommendation for ROW width of a transmission line.

Bulletin 1724E-200
Page 5-8

5.4.1 First Method: This method provides sufficient width to meet clearance requirements to buildings of undetermined height located directly on the edge of the right-of-way. See Figure 5-7.

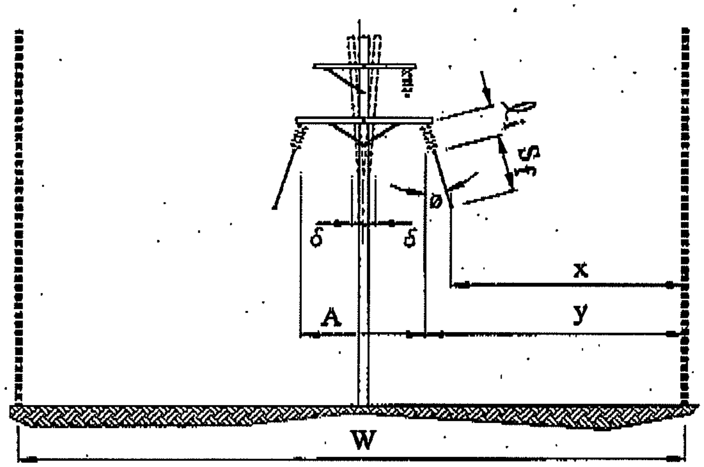


FIGURE 5-8: ROW WIDTH FOR SINGLE LINE OF STRUCTURES (FIRST METHOD)

$$W = A + 2(\ell_i + S_f)\sin\phi + 2\delta + 2x \qquad \text{Eq. 5-3}$$

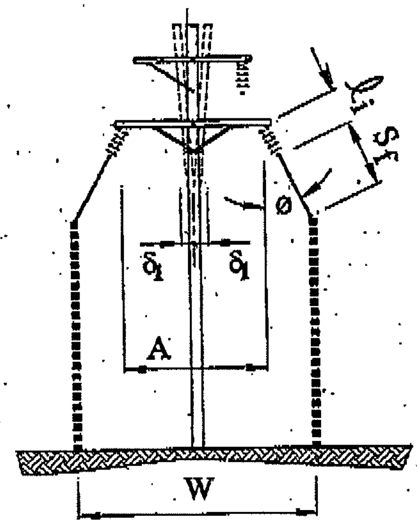


FIGURE 5-9: ROW WIDTH FOR SINGLE LINE OF STRUCTURES (SECOND METHOD)

From Figure 5-9 it can be seen that the formula for the width is:

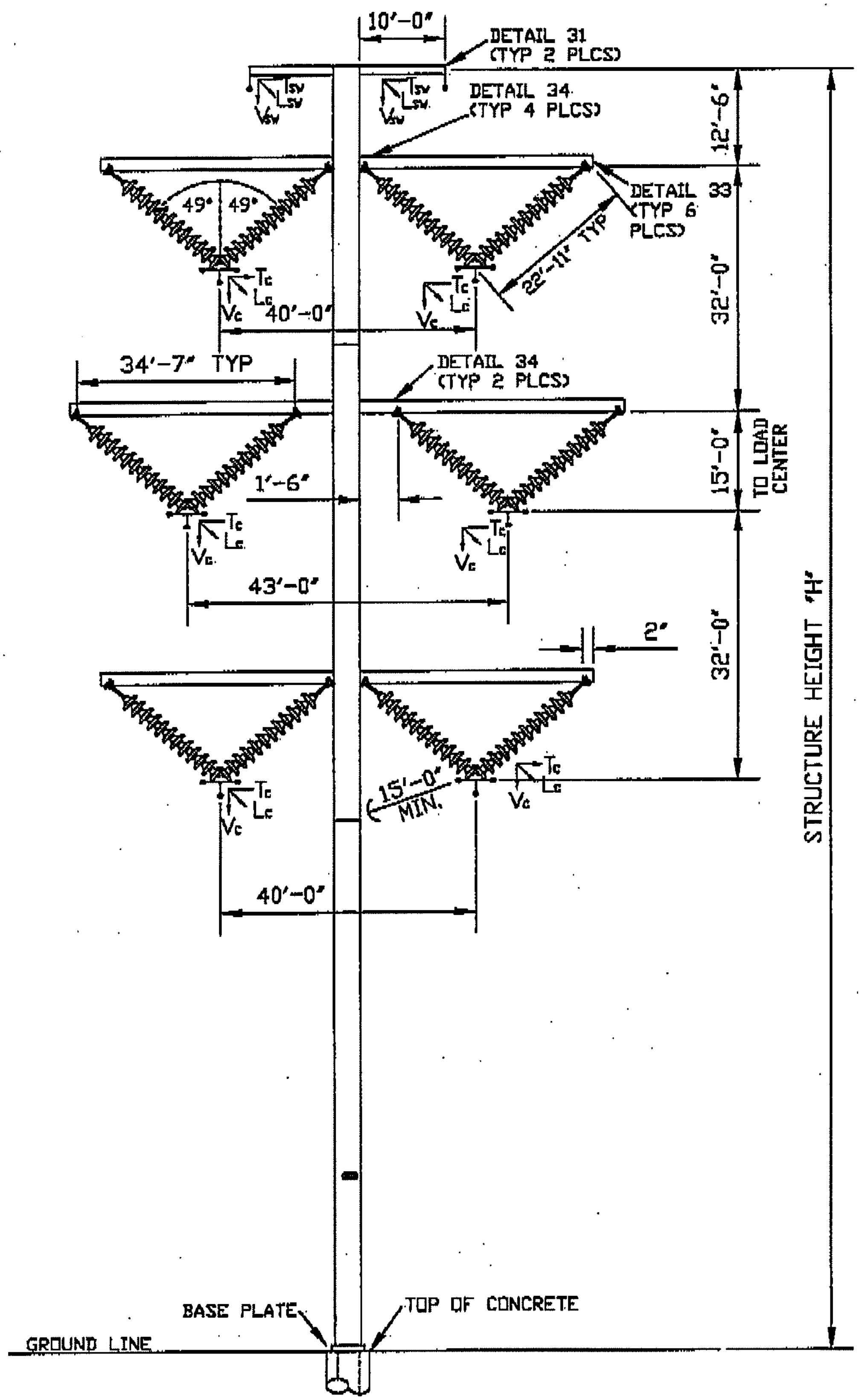
$$W = A + 2(\ell_i + S_f)\sin\phi + 2\delta_1 \qquad \text{Eq. 5-4}$$

As defined in the figures, A represents the horizontal spacing between the outer wires and x represents the required clearance from the conductor to the edge of the ROW. The remaining terms represent the deflection of the structure (δ) and the horizontal displacement of the wire ($\{\ell+S\}\sin\Phi$). The first figure represents the calculation for the ROW width using the wire displacement and clearance values under 6psf wind loading as defined in Rule 234 of the NESC. The second figure represents an alternative method for determining the ROW using higher wind values. The wind values used in this second method are dependant upon the region the line is located in and is established by the transmission line owner during the design phase of the line. Notice that there is no required clearance beyond the conductor position under this method.

As set forth in the approved Design Basis Document dated March 6, 2009, the Horizontal clearance requirement from a wire/conductor displaced by a 6 psf wind to the edge of the ROW is 17'. The basis for this value is established in Rule 234 of the NESC with an additional margin of safety voluntarily included by PPL Electric Utilities. Included below is a standard structure configuration.

Sargent & Lundy LLC 6/11/2010

Segment B17 100' ROW Feasibility Study



During the analysis, structure locations were modified in order to shorten the spans and reduce the maximum horizontal displacement of the wire to allow the line to fit within the existing 100' ROW. It was determined that the Method 1 calculation would be the controlling case for determining the required ROW width. To calculate the required ROW width using method 1, the following parameters were used:

A – 43'
δ – 1' (This value is established as the deflection limit for the structure)
x – 17' (An additional 3' was added to the required NESC value per PPL EU standard procedure)
{ℓ+S}sinΦ – 10' (The maximum conductor blowout of the line under 6 psf wind)

From this calculation, it is apparent that the required width of ROW for this line is 99'. This is less than the 100' existing ROW limitation and therefore represents a feasible option for the new line.

United States Department of the Interior

NATIONAL PARK SERVICE
Delaware Water Gap National Recreation Area
Bushkill, Pennsylvania 18324

IN REPLY REFER TO:

D5015

JUL 14 2010

Mr. Gregory Smith
Manager, Transmission Expansion
PPL Electric Utilities
Two North Street, GENN5
Allentown, Pennsylvania 18101-1179

Dear Mr. Smith:

We are writing in response to your correspondence of June 16, 2010, addressed to Ms. Amanda Stein.

Our consultant, EA Engineering, Science and Technology, Inc. and their sub-contractor, David Evans and Associates, Inc. have provided us with additional materials supporting the assertion that the 100 foot right-of-way in the Delaware Water Gap National Recreation Area is insufficient in maintaining compliance with National Electric Safety Code (NESC) for your proposed transmission line expansion and upgrades.

Once you have reviewed the materials provided with this letter, we suggest holding a meeting or conference call between our respective engineers and staff to resolve any differences in opinion.

Thank you for your attention to this matter.

Sincerely,

John J. Donahue
Superintendent
Delaware Water Gap National Recreation Area &
Middle Delaware National Scenic and
Recreational River
(570) 426-2418

Pamela Underhill
Superintendent
Appalachian National Scenic Trail
(304) 535-6278

Cc:
Andrew Tittler
Patrick Lynch
Kara Deutsch
Sarah Bransom
Amanda Stein

Samuel Reynolds, Chief, Application Section II
U.S. Army Corps of Engineers
Philadelphia District, Regulatory Branch
Wanamaker Building, 100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Wayne Poppich
U.S. Army Corps of Engineers
Pocono Area Field Office
253 State Route 435 STE 4
Clifton Township, Pennsylvania 18424

Denver Service Center - TIC
Attn: SRLINE EIS
12795 W. Alameda Parkway
Denver, CO 80225-0287

Enclosures:

DAVID EVANS AND ASSOCIATES INC

June 24, 2010

Amanda Stein
Delaware Water Gap National Recreation Area
HQ River Rd off Route 209
Bushkill, PA 18324-9999

SUBJECT: SRLine EIS 25147

Dear Ms. Stein:

We recently sent a memo to Suzie Boltz in response to Gregory Smith's June 16^{th} letter. The attached binder includes the reference materials and calculations DEA utilized to verify that a 100' ROW within in the Delaware Water Gap Recreation Area is insufficient to meet the National Electric Safety Code (et al).

Please use for any reference needs you might have and do not hesitate to let us know if further questions arise.

Sincerely,

DAVID EVANS AND ASSOCIATES, INC.

PCapell

Paul Capell
Vice President, Energy

Copies: file
Attachments/Enclosures: Reference Materials Binder
Initials: kaki, mdwi
File Name: C:\Documents and Settings\kaki\Desktop\EAEN Letter.doc
Project Number: EAEN-1

DELAWARE WATER GAP
REFERENCE MATERIALS
INDEX

DAVID EVANS
AND ASSOCIATES INC.

MEMORANDUM

DATE: June 23, 2010

TO: Suzie Boltz, EA Engineering

FROM: Paul Capell

SUBJECT: **SRLINE EIS 25147**

PROJECT: DEWA Transmission Lines

We have the following responses to Gregory Smith's June 16th letter. Please edit with your comments and forward to the other team members.

- The RUS Bulletin 1724E-200 provided by the Applicant as the guide for ROW calculations only references voltages up to 230kV (230,000 volts).
- Please reference the attached table, "Existing PPL ROW Alternative Blowout Report for Spans with 100' ROW". The column entitled "Max. blowout from centerline each side (ft)" fails to represent the required V-string clearance (21.5 feet from the structure's centerline). The actual remaining buffer is 21.5 feet plus blowout, as shown on the DEA edited version of the same table.
- Throughout the ROW width development, the applicant has made reference to ACSR and ACCC conductors. Our models represent the use of Falcon ACSR that was used in the applicant's table, and we have further information and calculations for ACCC, as well.
- NESC minimum clearance from blowout to ROW edge is 17 feet. PJM requires a further 3-foot buffer. Therefore, actual "required clearance to each side of ROW (ft)" should be 17 feet plus 3 feet, or 20 feet.

Ultimately, our findings indicate that constructing the proposed project according to the proposed Plan and Profiles provided by the Applicant for the 100-foot ROW would violate the National Electric Safety Code. Further information is available upon request.

Copies: file
Attachments/Enclosures: Tables
Initials: kaki
File Name: C:\Documents and Settings\kaki\Desktop\EAEN InternalMemorandum.doc
Project Number: EAEN-1

PROVIDED BY: JASON @ BtM

Using Existing PPL ROW Alternative
Blowout Report for spans with 100' ROW

Start Str. #	End Str. #	Cable Type	Voltage (kV)	Weather Case	Cable Condition	Proposed ROW Width (ft)	Max. Blowout from centerline, each side (ft)	Required Clearance to each side of ROW (ft)	Structure Deflection, each side (ft)	Remaining Buffer from tree line, each side (ft)	Minimum Vegetation Management Cycle*
B17-2	B17-2A	FALCON ACSR	500	NESC HORZ CLEAR-6psf	Max Sag FE	100	22.06	17	2	8.94	Every Three Years
B17-3	B17-3A	FALCON ACSR	500	NESC HORZ CLEAR-6psf	Max Sag FE	100	23.09	17	2	7.91	Every Three Years
B17-3A	B17-4	FALCON ACSR	500	NESC HORZ CLEAR-6psf	Max Sag FE	100	29.06	17	1	2.94	Every Year
B17-4	B17-5	FALCON ACSR	500	NESC HORZ CLEAR-6psf	Max Sag FE	100	23.33	17	2	7.67	Every Three Years
B17-5	B17-5A	FALCON ACSR	500	NESC HORZ CLEAR-6psf	Max Sag FE	100	22.87	17	2	8.13	Every Three Years
B17-5A	B17-6	FALCON ACSR	500	NESC HORZ CLEAR-6psf	Max Sag FE	100	24.84	17	2	6.16	Every Three Years

*Assumes a 2' growth per year

Recreated: 6/23/2010 by: mdwi DEA cjb DEA
For: National Park Service

Using Existing PPL ROW Alternative
Blowout Report for Spans with 100' ROW

Start Str. #	End Str. #	Cable Type	Voltage (kV)	Weather Case	Cable Condition	Proposed ROW Width (ft)	Max. Blowout from centerline each side (ft)	Blowout from structure centerline + V-string to ROW edge	Required Clearance to each side of ROW (ft)	Structure Deflection each side (ft)	(Applicant) Remaining Buffer from tree line, each side (ft)	Actual Remaining Buffer from tree line, each side (ft)	Minimum Vegetation Management Cycle
B17-2	B17-2A	FALCON ACSR	500	NESC HORIZ CLEAR-6 psf	Max Sag FE	100	22.06	43.56	17	2	8.94	-10.56	Every three years
B17-3	B17-3A	FALCON ACSR	500	NESC HORIZ CLEAR-6 psf	Max Sag FE	100	23.09	44.59	17	2	7.91	-11.59	Every three years
B17-3A	B17-4	FALCON ACSR	500	NESC HORIZ CLEAR-6 psf	Max Sag FE	100	29.06	50.56	17	1	2.94	-17.56	Every year
B17-4	B17-5	FALCON ACSR	500	NESC HORIZ CLEAR-6 psf	Max Sag FE	100	23.33	44.83	17	2	7.67	-11.83	Every three years
B17-5	B17-5A	FALCON ACSR	500	NESC HORIZ CLEAR-6 psf	Max Sag FE	100	22.87	44.37	17	2	8.13	-11.37	Every three years
B17-5A	B17-6	FALCON ACSR	500	NESC HORIZ CLEAR-6 psf	Max Sag FE	100	24.84	46.34	17	2	6.16	-13.34	Every three years

Gregory J. Smith
Manager-Transmission Expansion

PPL Electric Utilities
Two North Ninth Street, GENN5
Allentown, PA 18101-1179

Discrepancy:

June 16, 2010
In regards to: SRLINE EIS 25147

Amanda Stein
Delaware Water Gap National Recreation Area
HQ River Road, Off Route 209
Bushkill, PA 18324

Dear Ms. Stein:

The Applicants have reviewed the NPS consultant's analysis of the Existing ROW Alternative, in particular using the existing 100' ROW for several spans in Pennsylvania. It appears that your consultant used a higher wind loading than is required to calculate the blow-out of the conductors. The wind loading used by the Utilities is a 6 psf load. For a detailed explanation of why a 6 psf wind load is appropriate, and the codes referenced to perform the blow-out calculations, see the attached report.

Furthermore, it should be clarified that the Existing ROW Alternative would use PPL EU's existing land rights. Such rights are only limited to 100 feet in five spans, not throughout the entire park in Pennsylvania Using the structure identifiers in your report, this would equate to the spans between structures 3-4, 5-6, 6-7, 7-8, and 9-10.

Sincerely,

Gregory J. Smith

Gregory J. Smith
Manager-Transmission Expansion
Enclosure (1)

CC:
John Donahue, Delaware Water Gap National Recreation Area
Pam Underhill, Appalachian National Scenic Trail

For verifying the feasibility of utilizing PPL EU's existing ROW through the Pennsylvania portion of the Susquehanna -- Roseland Project within DEWA, NESC regulations and industry standard guidelines set forth in RUS Bulletin 1724E-200 were followed. This includes the section where the existing ROW is 100'. Included below is a summary of calculations performed and references cited by S&L to make the conclusion that the new 500kV circuit construction was feasible for the existing ROW.

Typical ROW widths are established based on required clearances to objects (usually buildings) that are or may in the future exist along the edge of the ROW. The ROW width is calculated using formulas that account for horizontal wire displacement, horizontal wire spacing, structure deflection and horizontal clearance requirements from the wire. The two figures below are taken from the RUS Bulletin as a recommendation for ROW width of a transmission line.

Bulletin 1724E-200
Page 5-8

5.4.1 First Method: This method provides sufficient width to meet clearance requirements to buildings of undetermined height located directly on the edge of the right-of-way. See Figure 5-7.

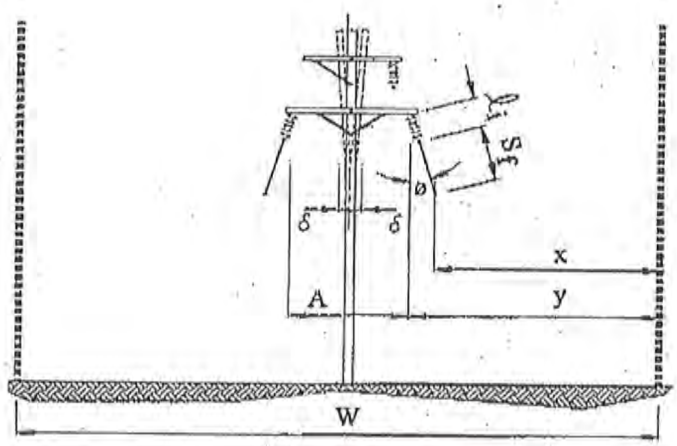


FIGURE 5-8: ROW WIDTH FOR SINGLE LINE OF STRUCTURES (FIRST METHOD)

$$W = A + 2(\ell_i + S_f)\sin\phi + 2\delta + 2x \qquad \text{Eq. 5-3}$$

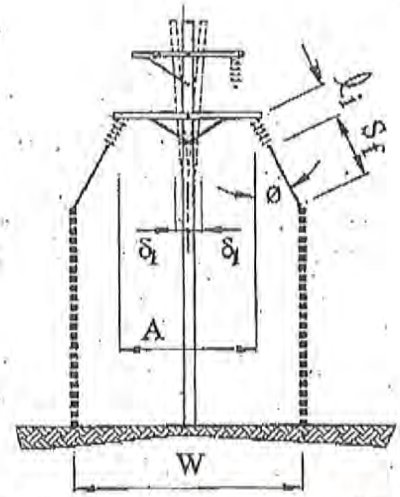


FIGURE 5-9: ROW WIDTH FOR SINGLE LINE OF STRUCTURES (SECOND METHOD)

From Figure 5-9 it can be seen that the formula for the width is:

$$W = A + 2(\ell_i + S_f)\sin\phi + 2\delta_1 \qquad \text{Eq. 5-4}$$

As defined in the figures, A represents the horizontal spacing between the outer wires and x represents the required clearance from the conductor to the edge of the ROW. The remaining terms represent the deflection of the structure (δ) and the horizontal displacement of the wire ({ℓ+S}sinΦ). The first figure represents the calculation for the ROW width using the wire displacement and clearance values under 6psf wind loading as defined in Rule 234 of the NESC. The second figure represents an alternative method for determining the ROW using higher wind values. The wind values used in this second method are dependant upon the region the line is located in and is established by the transmission line owner during the design phase of the line. Notice that there is no required clearance beyond the conductor position under this method.

As set forth in the approved Design Basis Document dated March 6, 2009, the Horizontal clearance requirement from a wire/conductor displaced by a 6 psf wind to the edge of the ROW is 17'. The basis for this value is established in Rule 234 of the NESC with an additional margin of safety voluntarily included by PPL Electric Utilities. Included below is a standard structure configuration.

Sargent & Lundy LLC 6/11/2010

Segment B17 100' ROW Feasibility Study

INCREASE # of STR IN THE AREA

During the analysis, structure locations were modified in order to shorten the spans and reduce the maximum horizontal displacement of the wire to allow the line to fit within the existing 100' ROW. It was determined that the Method 1 calculation would be the controlling case for determining the required ROW width. To calculate the required ROW width using method 1, the following parameters were used:

- A – 43'
- δ – 1' (This value is established as the deflection limit for the structure)
- x – 17' (An additional 3' was added to the required NESC value per PPL EU standard procedure)
- {ℓ+S}sinΦ – 10' (The maximum conductor blowout of the line under 6 psf wind)

? BACK CALC ≠ 10'

From this calculation, it is apparent that the required width of ROW for this line is 99'. This is less than the 100' existing ROW limitation and therefore represents a feasible option for the new line.

$l_i + (S_i)\sin\theta + \delta + X_H$

18.22' for 6 psf

y =

W = A(l_i + S_i) sin θ + X + 2δ

CALCULATIONS

Table:

Wind = 6psf
S_f = 13.5' – 34' (conductor sag)
L_i = 23' (length of insulator)
D_c = 1.545 in (1590 kcmil ACSR "Falcon" 54/19)
W_c = 2.044 lb/ft (1590 kcmil ACSR "Falcon" 54/19)

D_c = 1.361 in (1594 kcmil ACCC "Falcon" 36/7)
W_c = 1.79 lb/ft (1594 kcmil ACCC "Falcon" 36/7)

δ = 2' (1' for deadends)

DAVID EVANS AND ASSOCIATES INC.

JOB DESCRIPTION S-R LINE

CALCULATION FOR 100' ROW

JN. EAEN 01

BY MdW DATE 6/22 2010

SHEET 1 OF SHEETS

CHECKED BY DATE

WIND = 6 PSF $\delta = 2'$

Sf = SEE SAG REPORTS

$l_i = 23'$ USE: $\frac{5}{12}$"

$d_c = 1.545$ in $W_c = 2.044$ lb/ft ACSR

$d_c = 1.361$ in $W_c = 1.79$ lb/ft ACCC

ACSR

$$\theta = \tan^{-1}\left(\frac{(d_c)(F)}{12 W_c}\right)$$

$$= \tan^{-1}\left(\frac{(1.545)(6)}{12(2.044)}\right)$$

$$= 20.7^\circ$$

ACCC

$$\theta = \tan^{-1}\left(\frac{(d_c)(F)}{12 W_c}\right)$$

$$= \tan^{-1}\left(\frac{(1.361)(6)}{12(1.79)}\right)$$

$$= 20.8^\circ$$

RUS Bulletin 1724E-200

$$W = A + 2(l_i + S_f)\sin\theta + 2\delta + 2x$$

$$= 43 + 2\left(\frac{5}{12}" + 24.19\right)\sin 20.7 + 2(2) + 2(20)$$

$= 104.4'$ fails @ 1218' SPAN

$$W = A + 2(l_i + S_f)\sin\theta + 2\delta + 2x$$

$$= 43 + 2\left(\frac{5}{12} + 27.88\right)\sin 20.8 + 2(2) + 2(20)$$

$= 107.1'$ fails @ 1218' SPAN

DAVID EVANS AND ASSOCIATES INC.

JN. EAEN 01
BY mdw DATE 4/22 2010
SHEET 2 OF ____ SHEETS
CHECKED BY ____ DATE ____

JOB DESCRIPTION SR Line Calc
CALCULATION FOR 100' ROW additional spans

ACSR

Span = 839'
S_f = 13.23'
θ = 20.7°

$W = 43 + 2\left(\frac{5}{12} + 13.23\right)\sin 20.7 + 4 + 40$

$= 96.65'$ ok

ACCC

839
11.47'
20.8°

$W = 43 + 2\left(\frac{5}{12} + 11.47\right)\sin 20.8 + 4 + 40$

$= 95.4'$ ok

Span = 1058'
S_f = 21.02'

$W = 43 + 2\left(\frac{5}{12} + 21.02\right)\sin 20.7 + 4 + 40$

$= 102.2'$ fails

1058'
18.24'

$W = 43 + 2\left(\frac{5}{12} + 18.24\right)\sin 20.8 + 4 + 40$

$= 100.25'$ fails

5.3.1 Conductor Blowout

Transmission lines must be designed not only to provide adequate vertical clearance for electrical and safety considerations, but also to allow for adequate horizontal clearance to tall objects and buildings at the edge of the right-of-way (ROW) under high wind conditions. Conductor displacement as a result of high winds is termed conductor blowout. The maximum displacement of the outermost conductors from the center of the ROW under high wind conditions can be one of the most important variables in determining ROW width. Conductor blowout is primarily a function of conductor weight and the wind force perpendicular to the conductor. However, the calculation of conductor blowout should also include the lateral movement of the suspension insulators. The horizontal wind force acting on a conductor may be estimated by the following equation:

$$F_H = 0.00256 \left(\frac{d}{12}\right) (V_w)^2 \tag{5-9}$$

where:

d = *conductor diameter, in*

V_w = *wind speed, mph*

F_H = *horizontal wind force, lbs/ft*

Assuming equilibrium of the moments resulting from the conductor weight and wind force about the attachment point, the angle of conductor blowout, θ, can be determined by:

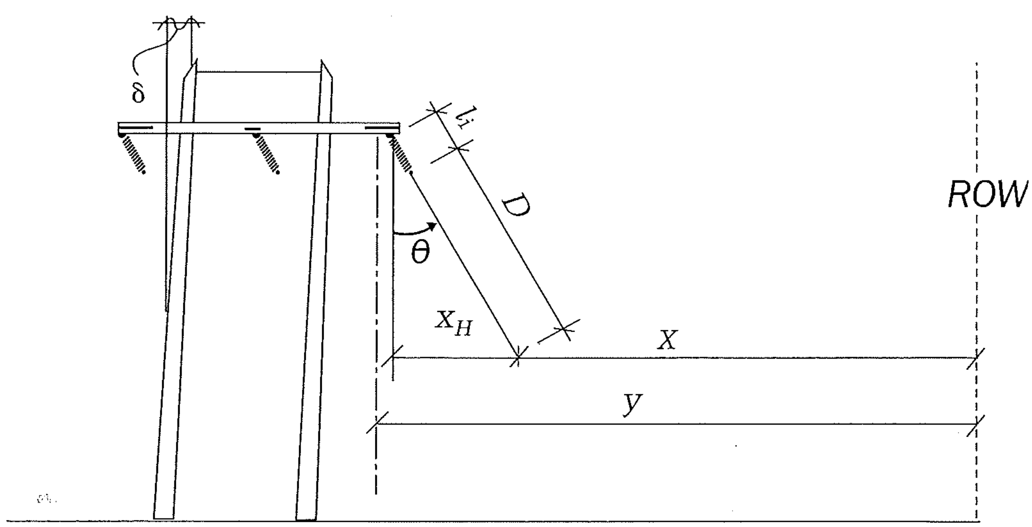
$$\theta = \tan^{-1} \frac{F_H}{w_c} \tag{5-10}$$

where:

w_c = *conductor weight per unit length, lbs/ft*

The blowout angle of the conductor catenary and any suspension insulator are assumed to be the same as those indicated in Figure 5-6[23]. This figure demonstrates how the clearance to the edge of ROW must include structure deflection.

FIGURE 5-6
CALCULATION OF CONDUCTOR BLOWOUT



y = total horizontal distance from insulator suspension point to edge of ROW (under still air)
x = required minimum horizontal clearance to edge of ROW under high wind conditions

The total horizontal blowout of the conductor at the midpoint of the span is:

$$X_H = (l_i + D)\,(\sin\theta) + \delta \qquad (5\text{-}11)$$

where:

X_H = *horizontal deflection at midpoint of span, ft*

l_i = *length of insulator string, ft*

D = *midpoint sag of conductor at specified wind and conductor temperature, ft*

δ = *structure deflection, ft*

At lower voltage levels, ROW width may be determined by the need to maintain adequate horizontal clearance. However, at higher voltage levels, the ROW width is typically determined by minimum requirements for environmental effects.

5.3.2 Aeolian Vibration

Aeolian vibration typically occurs in response to low velocity wind (2 mph to 15 mph) blowing steadily perpendicular to the line, as noted in Table 5-3. The resulting conductor vibration, generally less than a conductor diameter in amplitude, is difficult to detect with the bare eye. Vibration amplitudes of less than an inch however, can result in conductor strand fatigue near attachment points for steel, aluminum and copper conductors. To control aeolian vibration, the design everyday tension (EDS) of the conductor is kept as low as possible, and dampers are added when required. While the cost of dampers is typically small, the cost of using low tension levels as a control technique can be expensive in some design situations. Since aeolian vibration leads to conductor failure through the mechanism of strand fatigue, it can be a major factor in line reliability. Lines exhibiting high vibration levels can be very expensive to operate because of the need to inspect and replace conductors and the need to add reinforcing armor rods or other repair hardware. Factors affiliated with aeolian vibration are described in the following sub-sections.

String Mode Vibration of Conductor

An overhead span (catenary) is supported at each end by suspension or dead-end hardware. This hardware is attached to and supported by ceramic or composite insulator strings, which are supported by wood, metal, concrete or steel structures. The aeolian vibration phenomena of this very complex mechanical system is typically represented by ignoring the hardware, insulators and structures, and assuming that the location of the suspension points are fixed. The vibration of the bare conductor may be represented by the vibrating string equation:

$$m\left(\frac{d^2y}{dt^2}\right) - T\left(\frac{d^2y}{dx^2}\right) = 0 \qquad (5\text{-}12)$$

where:

m = *mass per unit length of conductor, lbs/ft*

T = *conductor tension, lbs*

x,y = *horizontal and vertical displacement, respectively, of cable along span, ft*

t = *time, sec*

Using standard mathematical methods, the solutions to this equation consist of traveling waves (transverse disturbances) which propagate along the conductor with a velocity of:

$$V = \sqrt{\frac{T\,(N)}{m\,(kg/m)}} = \sqrt{\frac{T(lbs)\;[32.2\;(ft/sec^2)]}{w\,(lbs/ft)}} \qquad (5\text{-}13)$$

For a typical bare overhead transmission conductor installed to typical tension levels, this mechanical wave velocity is on the order of 400 ft/sec (120 m/sec). For example, if a 795 kcmil – 26/7 ACSR "Drake" conductor is installed to 4725 lbs (15% RBS), the wave velocity is:

$$\sqrt{\frac{(4725)(32.2)}{1.094}} = 373\;ft/sec$$

Combinations of traveling waves on the conductor can lead to standing waves or string modes having certain discrete frequencies. These natural frequencies are related to both the span length, L, and the wave velocity, V:

$$f_n = \left(\frac{n}{2L}\right)V \qquad (5\text{-}14)$$

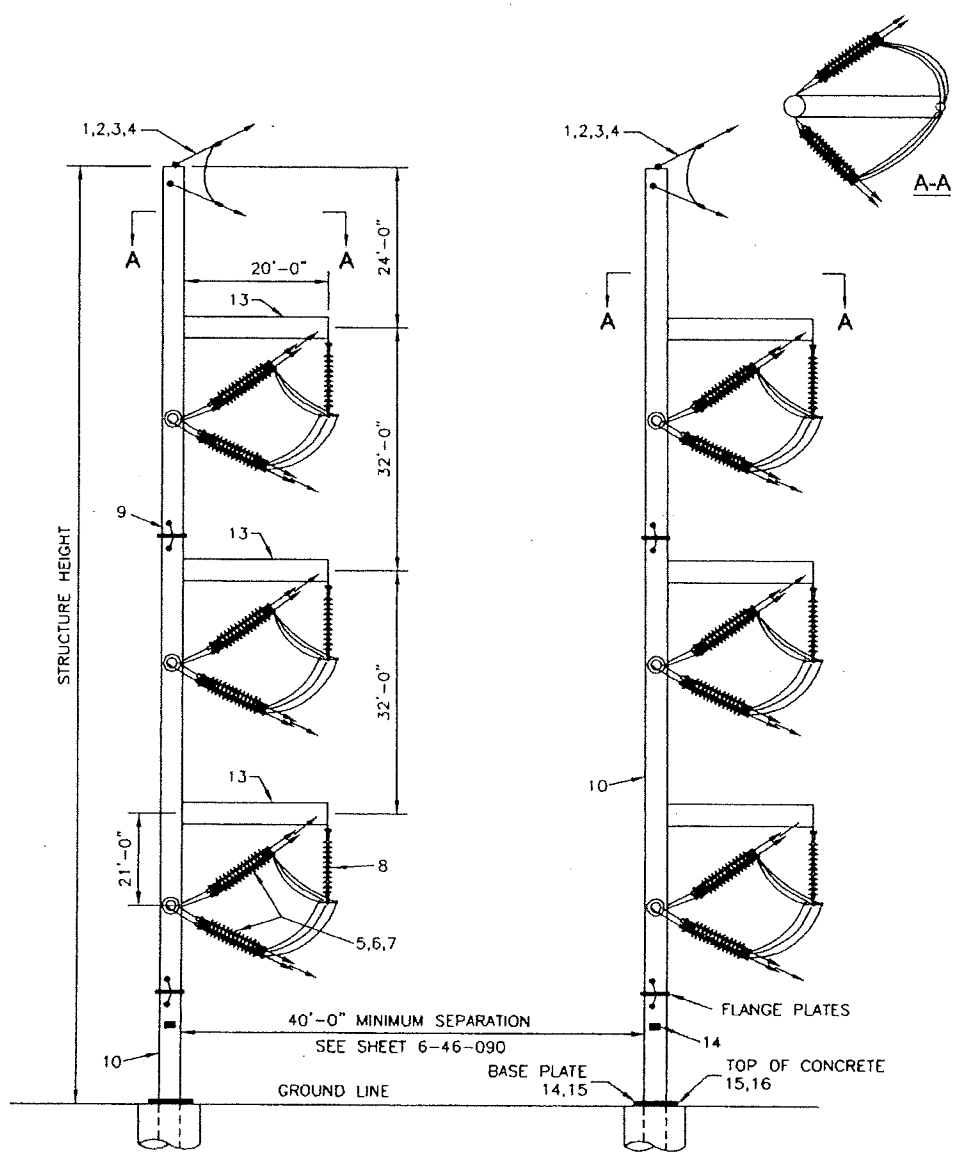
where:

the modal number, n, is a positive whole number

DESIGN BASICS DOCUMENT

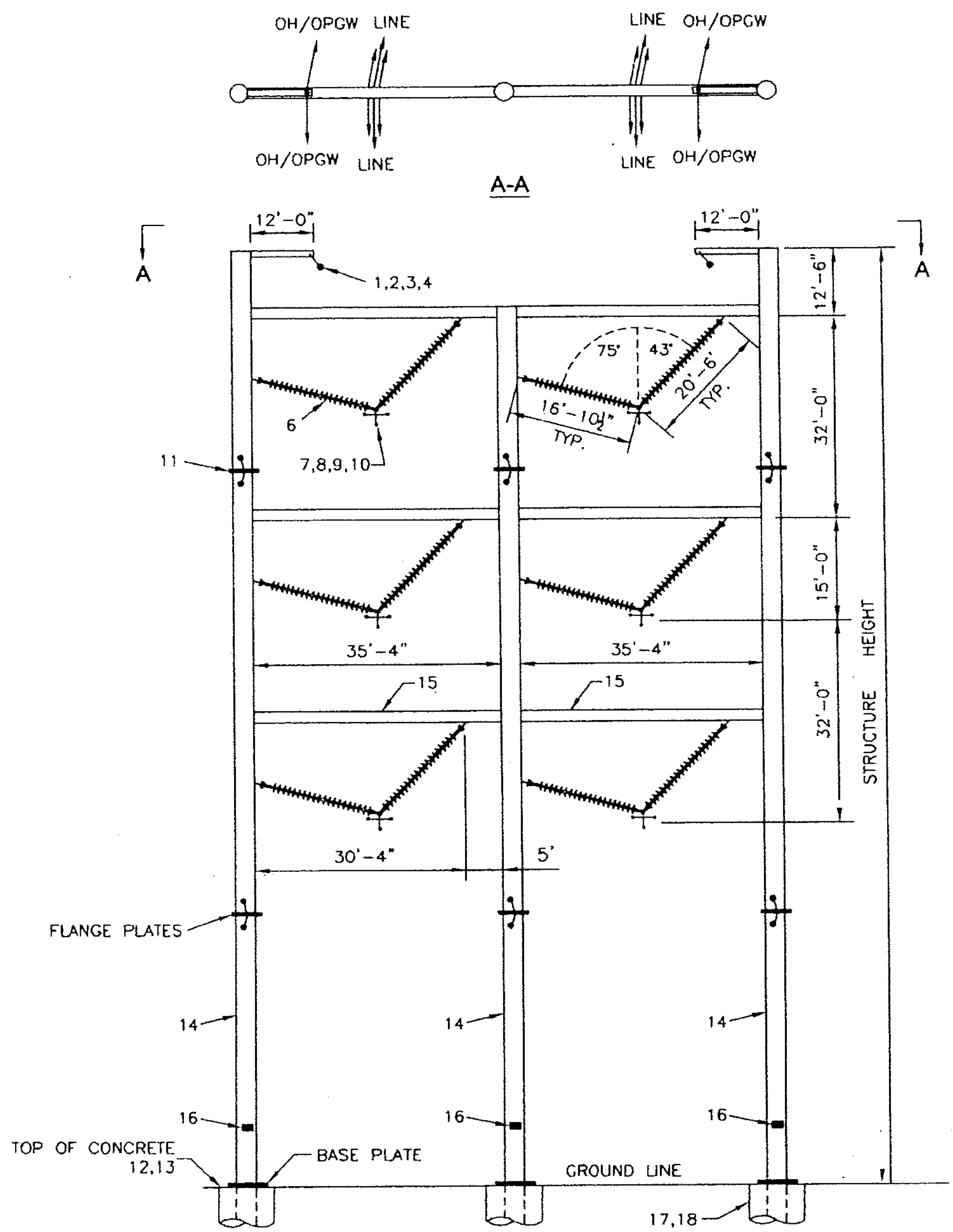
The information in this section was used to create the models for calculating the clearances within the 100' proposed ROW and the PLS CADD models for the blowout reports herein.

6-46-084	500KV STEEL POLE LINE CONSTRUCTION DOUBLE CIRCUIT – TWO POLE DEADEND STRUCTURE	6-46-084
SHEET 1	TYPE 5DMD__ L/R	SHEET 1



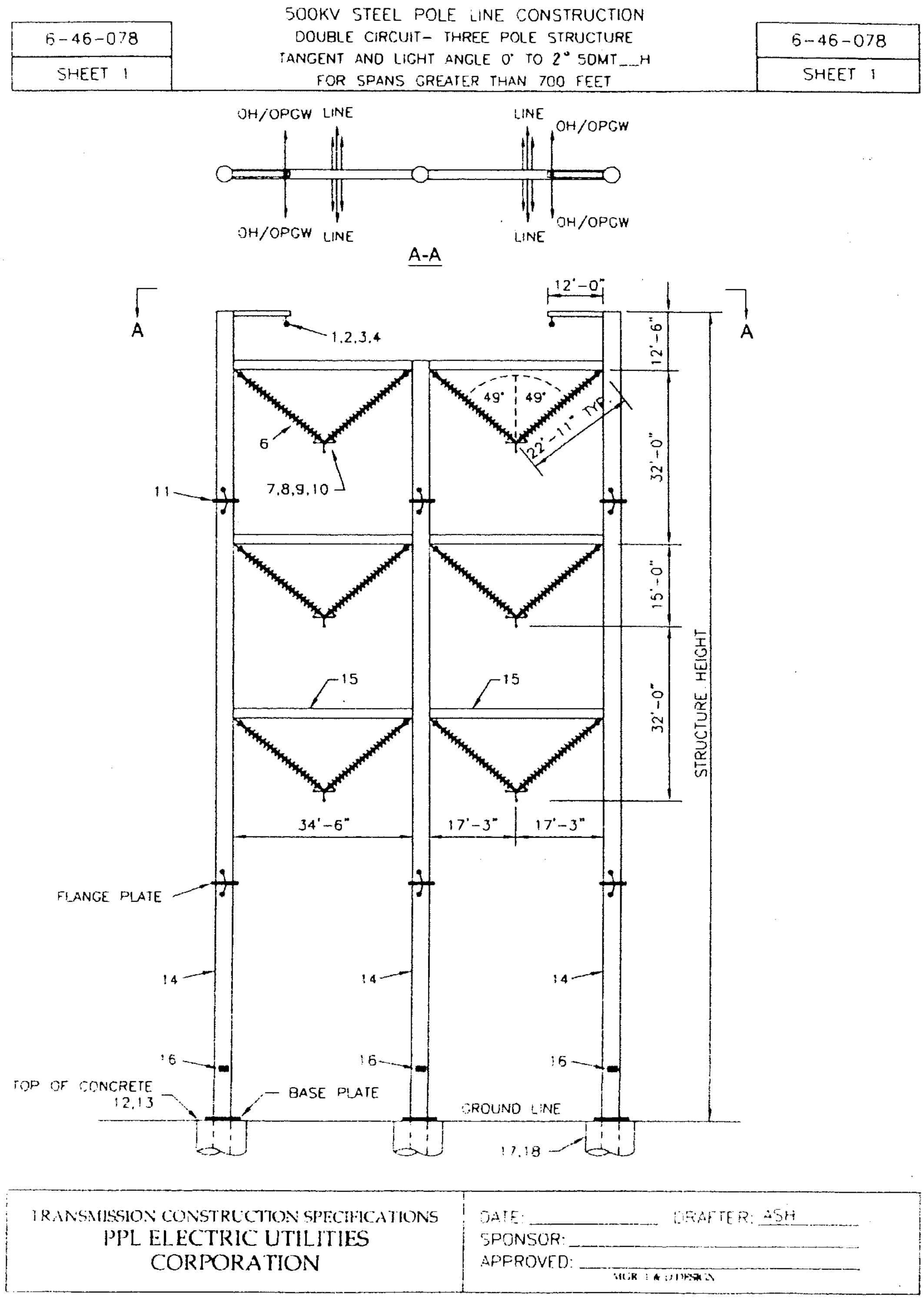
TRANSMISSION CONSTRUCTION SPECIFICATIONS PPL ELECTRIC UTILITIES CORPORATION	DATE:________ DRAFTER: ASH SPONSOR:________ APPROVED:________ MGR. T & D DESIGN

6-46-080	500KV STEEL POLE LINE CONSTRUCTION DOUBLE CIRCUIT-THREE POLE STRUCTURE RUNNING ANGLE STRUCTURE 2° TO 20° 5DMA__H	6-46-080
SHEET 1		SHEET 1



TRANSMISSION CONSTRUCTION SPECIFICATIONS PPL ELECTRIC UTILITIES CORPORATION	DATE: ______ DRAFTER: ASH SPONSOR: ______ APPROVED: ______ MGR. T & D DESIGN

6-46-080_S001.dwg


6-46-078
SHEET 1
500KV STEEL POLE LINE CONSTRUCTION
DOUBLE CIRCUIT- THREE POLE STRUCTURE
TANGENT AND LIGHT ANGLE 0° TO 2° 50MT__H
FOR SPANS GREATER THAN 700 FEET
6-46-078
SHEET 1
OH/OPGW
LINE
LINE
OH/OPGW
OH/OPGW
LINE
LINE
OH/OPGW
A-A
A
A
12'-0"
1,2,3,4
12'-6"
49°
49°
22'-11" TYP.
6
7,8,9,10
11
32'-0"
15'-0"
15
15
32'-0"
STRUCTURE HEIGHT
34'-6"
17'-3"
17'-3"
FLANGE PLATE
14
14
14
16
16
16
TOP OF CONCRETE
12,13
BASE PLATE
GROUND LINE
17,18
TRANSMISSION CONSTRUCTION SPECIFICATIONS
PPL ELECTRIC UTILITIES
CORPORATION
DATE:
DRAFTER: ASH
SPONSOR:
APPROVED:

6-46-076	500KV STEEL POLE LINE CONSTRUCTION DOUBLE CIRCUIT – SINGLE POLE – STRAIGHT ARMS TANGENT AND LIGHT ANGLE 0°-2° 5DPT__H FOR SPANS UP TO 700 FEET	6-46-076
SHEET 1		SHEET 1

* NESC + 3'	w/ Buffer
6 psf Wind 17'	20'
Final Sag 20'	23'
4'	7'

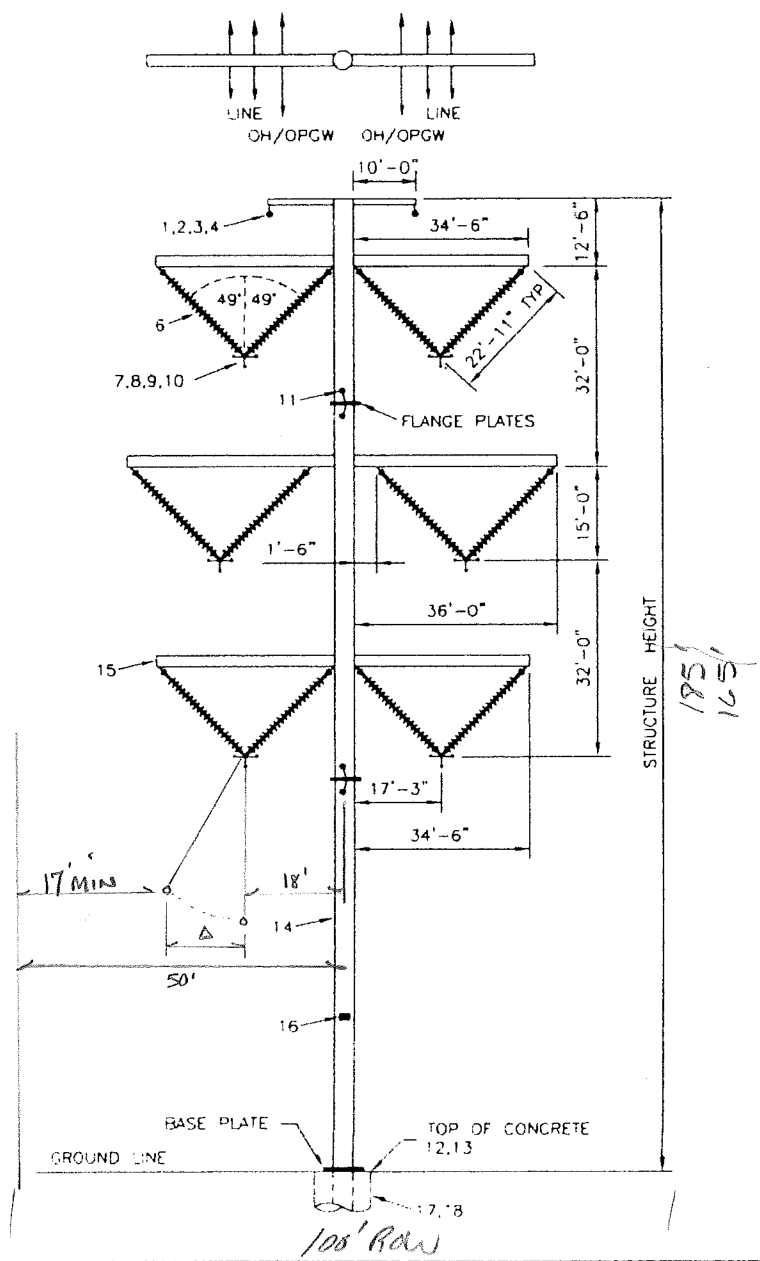
Wire to Str	
235-6	18'

wire to wire			
NESC	232	235	25'

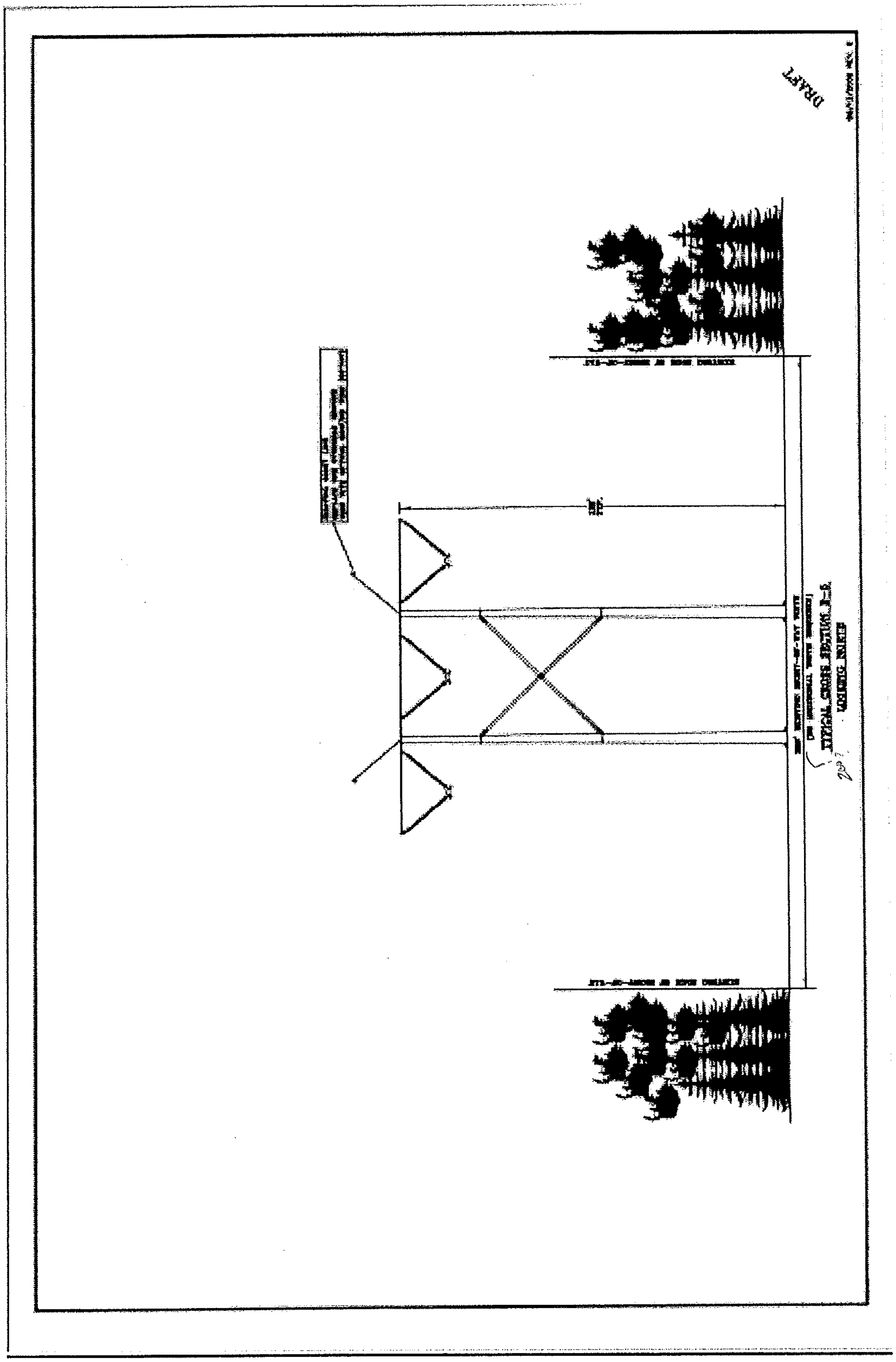
	wire to ground	wire to str/other
NESC	232-1	234

50'
- 17'
- 18'
15'

50'
- 22 Blowout
28'
- 18'
10' < 17' MIN



TRANSMISSION CONSTRUCTION SPECIFICATIONS PPL ELECTRIC UTILITIES CORPORATION	DATE ______ DRAFTER: ASH SPONSOR: ______ APPROVED: ______ MGR. T & D DESIGN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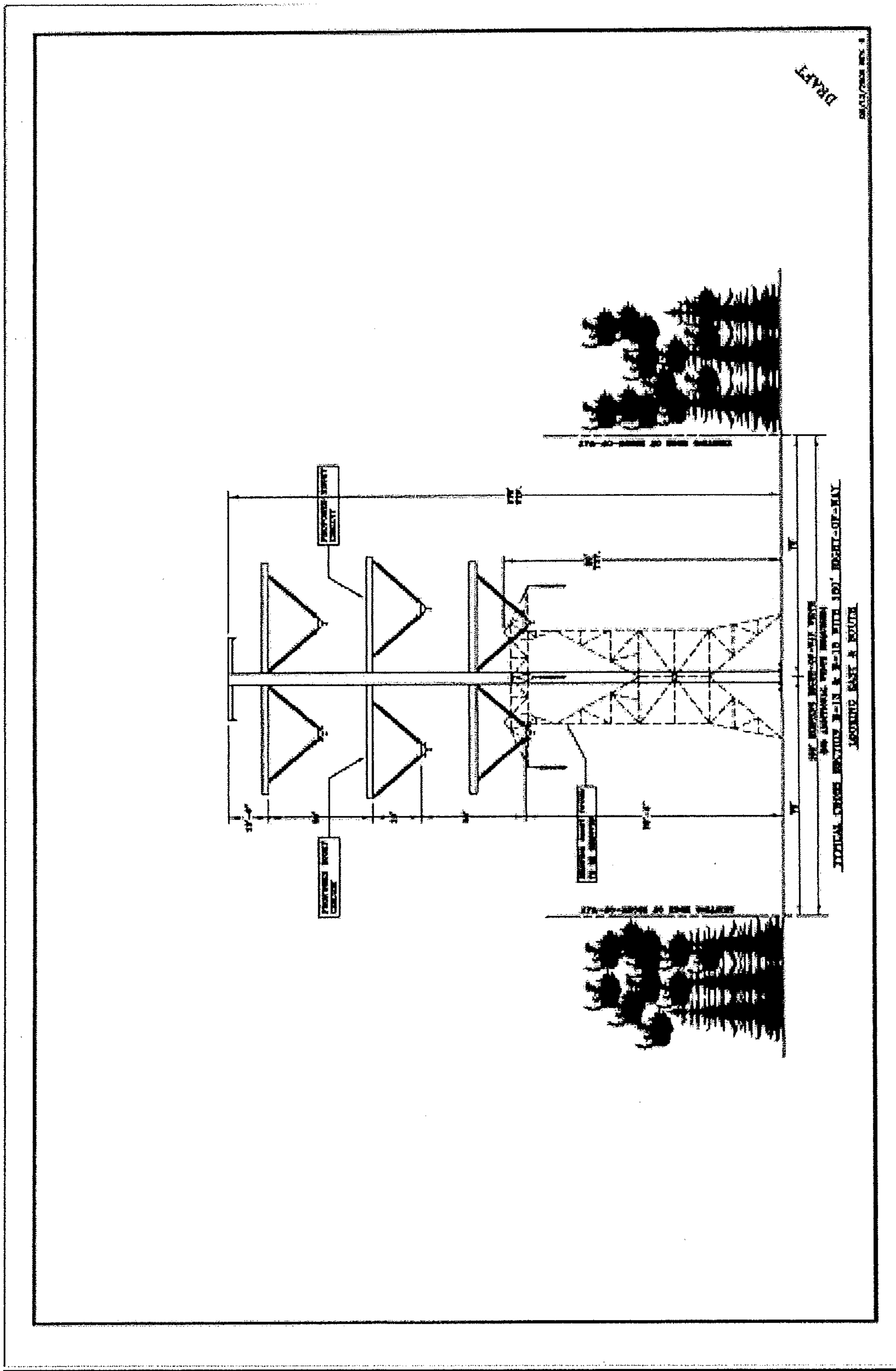
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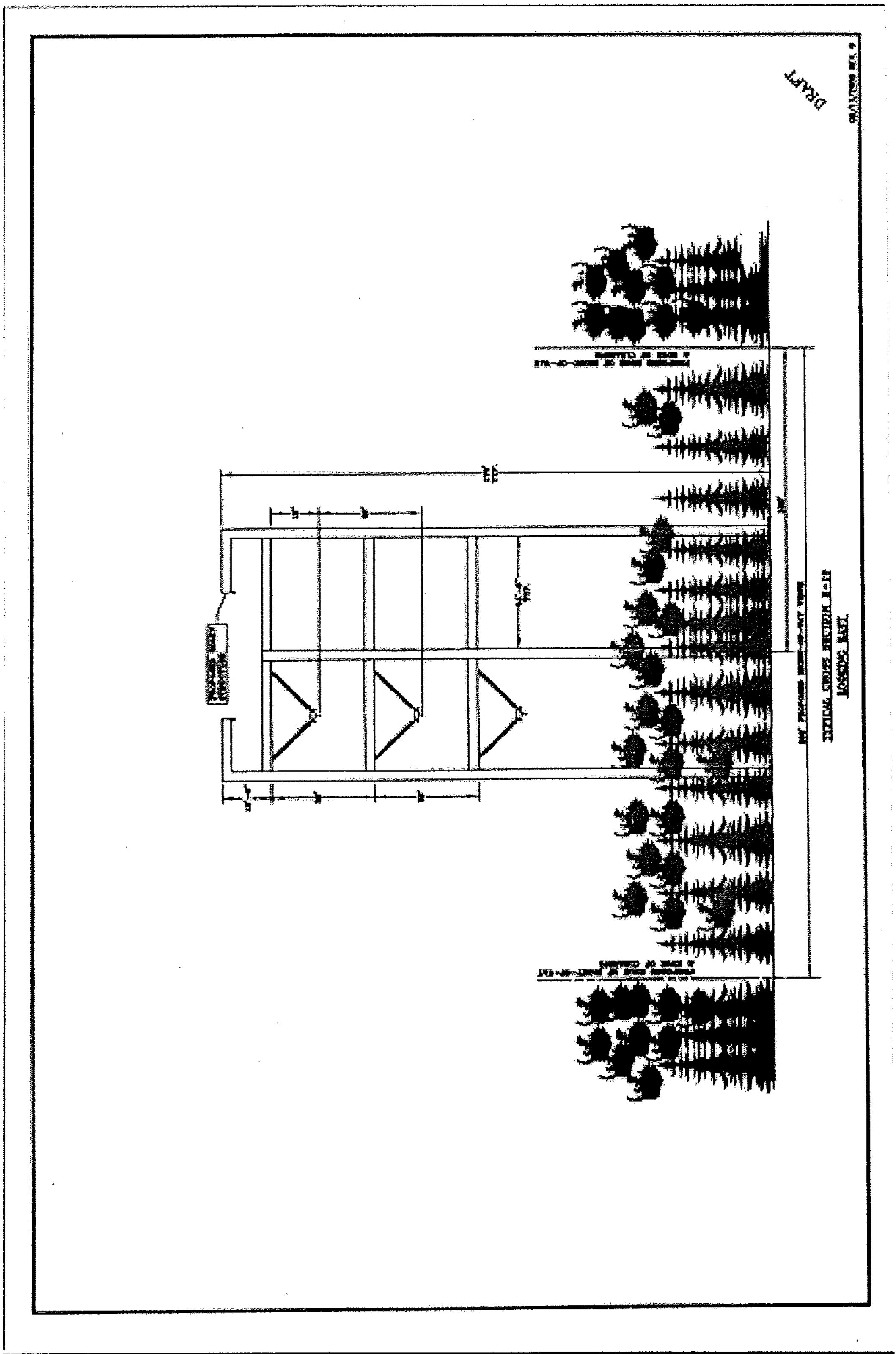
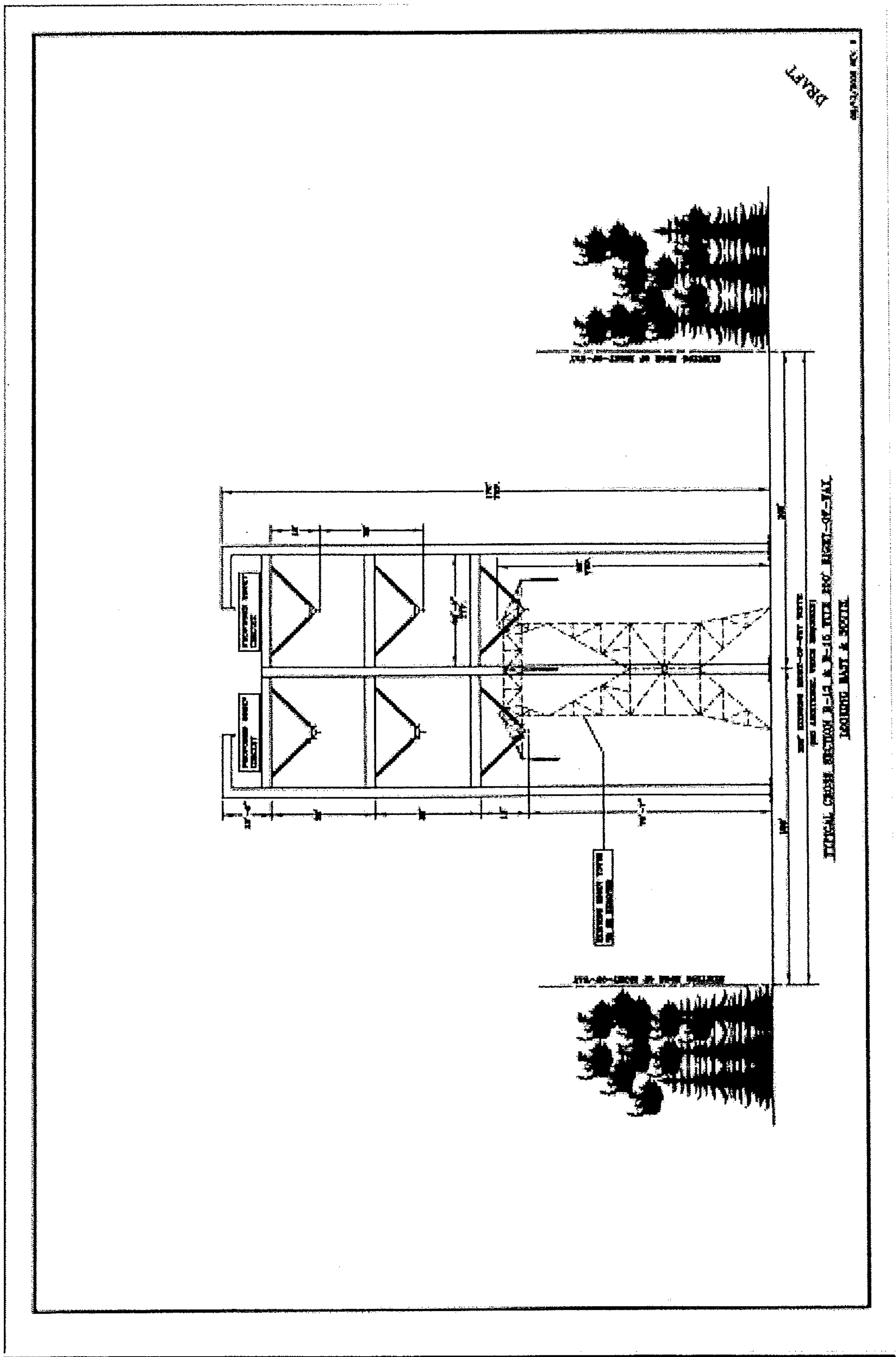
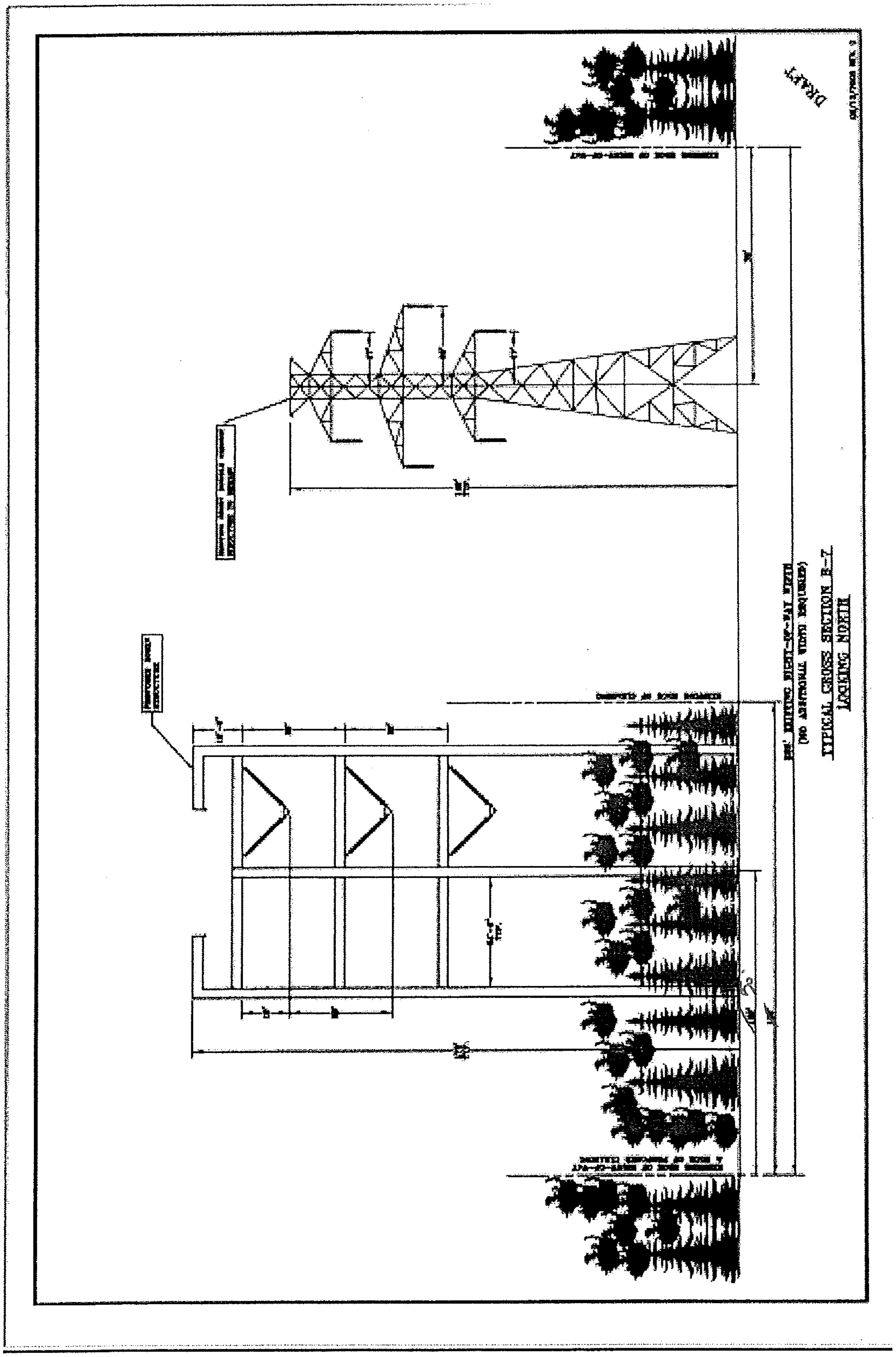

DRAFT





BLOWOUT REPORTS

PLS-CADD Version 10.40 9:25:24 AM Thursday, June 24, 2010
David Evans & Associates
Project Name: 'c:\documents and settings\gabl\desktop\dewa elevations\dewa_alt_bb.DON'

Blowout Report

Offset measured relative to alignment center line.

Start Struct Num	Start Struct Set	Start Struct Phase	End Struct Number	End Struct Set	End Struct Phase	Ahead Span Cable File Name	Volt -age (kV)	Weather Case Description	Cable Condition	Wind From	Max Blowout Station (ft)	Max Blowout Offset (ft)	Leftmost Blowout Station (ft)	Leftmost Blowout Offset (ft)	Leftmost Blowout Station (ft)	Leftmost Blowout Offset (ft)
1	1	1	2	2	1	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Left	571.28	28.09	1173.54	19.06	571.28	28.09
1	1	2	2	2	2	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Left	597.26	28.85	12.49	20.37	597.26	28.85
1	1	3	2	2	3	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Left	584.27	28.47	1173.54	19.83	584.27	28.47
1	1	1	2	2	1	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Right	12.49	19.63	603.25	10.97	12.49	19.63
1	1	2	2	2	2	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Right	1173.54	20.58	577.28	11.73	1173.54	20.58
1	1	3	2	2	3	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Right	1173.54	19.83	590.27	11.36	1173.54	19.83
1	11	1	2	3	1	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Left	12.49	-19.63	12.49	-19.63	603.25	-10.97
1	11	2	2	3	2	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Left	1173.54	-20.58	1173.54	-20.58	577.28	-11.73
1	11	3	2	3	3	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Left	1173.54	-19.83	1173.54	-19.83	590.27	-11.36
1	11	1	2	3	1	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Right	571.28	-28.09	571.28	-28.09	1173.54	-19.06
1	11	2	2	3	2	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Right	597.26	-28.85	597.26	-28.85	12.49	-20.37
1	11	3	2	3	3	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Right	584.27	-28.47	584.27	-28.47	1173.54	-19.83
2	2	1	3	2	1	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Left	1765.97	27.80	1173.54	19.06	1765.97	27.80
2	2	2	3	2	2	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Left	1765.97	29.32	1173.54	20.58	1765.97	29.32
2	2	3	3	2	3	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Left	1765.97	28.56	1173.54	19.83	1765.97	28.56
2	2	1	3	2	1	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Right	2356.90	19.06	1765.97	10.33	2356.90	19.06
2	2	2	3	2	2	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Right	2356.90	20.58	1765.97	11.84	2356.90	20.58
2	2	3	3	2	3	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Right	2356.90	19.83	1765.97	11.09	2356.90	19.83
2	3	1	3	3	1	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Left	1173.54	-19.06	1173.54	-19.06	1765.97	-10.33
2	3	2	3	3	2	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Left	1173.54	-20.58	1173.54	-20.58	1765.97	-11.84
2	3	3	3	3	3	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Left	1173.54	-19.83	1173.54	-19.83	1765.97	-11.09
2	3	1	3	3	1	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Right	1765.97	-27.80	1765.97	-27.80	2356.90	-19.06
2	3	2	3	3	2	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Right	1765.97	-29.32	1765.97	-29.32	2356.90	-20.58
2	3	3	3	3	3	falcon_acsr.wir	500	NESC Blowout 6PSF	Max Sag RS	Right	1765.97	-28.56	1765.97	-28.56	2356.90	-19.83

3	2	1	4	2	1 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	3012.68	29.78	2356.90	19.06	3012.68	29.78
3	2	2	4	2	2 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	3012.68	31.30	2356.90	20.58	3012.68	31.30
3	2	3	4	2	3 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	3012.68	30.54	2356.90	19.83	3012.68	30.54
3	2	1	4	2	1 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	3669.96	19.06	3012.68	8.34	3669.96	19.06
3	2	2	4	2	2 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	3669.96	20.58	3012.68	9.86	3669.96	20.58
3	2	3	4	2	3 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	3669.96	19.83	3012.68	9.11	3669.96	19.83
3	3	1	4	3	1 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	2356.90	-19.06	2356.90	-19.06	3012.68	-8.34
3	3	2	4	3	2 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	2356.90	-20.58	2356.90	-20.58	3012.68	-9.86
3	3	3	4	3	3 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	2356.90	-19.83	2356.90	-19.83	3012.68	-9.11
3	3	1	4	3	1 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	3012.68	-29.78	3012.68	-29.78	3669.96	-19.06
3	3	2	4	3	2 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	3012.68	-31.30	3012.68	-31.30	3669.96	-20.58
3	3	3	4	3	3 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	3012.68	-30.54	3012.68	-30.54	3669.96	-19.83
4	2	1	5	2	1 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	4226.41	26.80	4780.86	19.06	4226.41	26.80
4	2	2	5	2	2 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	4226.41	28.32	4780.86	20.58	4226.41	28.32
4	2	3	5	2	3 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	4226.41	27.56	4780.86	19.83	4226.41	27.56
4	2	1	5	2	1 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	3669.96	19.06	4226.41	11.32	3669.96	19.06
4	2	2	5	2	2 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	3669.96	20.58	4226.41	12.84	3669.96	20.58
4	2	3	5	2	3 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	3669.96	19.83	4226.41	12.09	3669.96	19.83
4	3	1	5	3	1 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	4780.86	-19.06	4780.86	-19.06	4226.41	-11.32
4	3	2	5	3	2 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	4780.86	-20.58	4780.86	-20.58	4226.41	-12.84
4	3	3	5	3	3 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	4780.86	-19.83	4780.86	-19.83	4226.41	-12.09
4	3	1	5	3	1 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	4226.41	-26.80	4226.41	-26.80	3669.96	-19.06
4	3	2	5	3	2 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	4226.41	-28.32	4226.41	-28.32	3669.96	-20.58
4	3	3	5	3	3 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	4226.41	-27.56	4226.41	-27.56	3669.96	-19.83
5	2	1	6	2	1 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	5265.65	24.91	4780.86	19.06	5265.65	24.91
5	2	2	6	2	2 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	5232.68	25.66	5697.99	20.29	5232.68	25.66
5	2	3	6	2	3 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	5249.17	25.28	4780.86	19.83	5249.17	25.28
5	2	1	6	2	1 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	5697.99	19.70	5225.18	14.15	5697.99	19.70
5	2	2	6	2	2 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	4780.86	20.58	5258.16	14.92	4780.86	20.58
5	2	3	6	2	3 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	4780.86	19.83	5241.67	14.54	4780.86	19.83
5	3	1	6	11	1 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	5697.99	-19.70	5697.99	-19.70	5225.18	-14.15
5	3	2	6	11	2 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	4780.86	-20.58	4780.86	-20.58	5258.16	-14.92
5	3	3	6	11	3 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	4780.86	-19.83	4780.86	-19.83	5241.67	-14.54
5	3	1	6	11	1 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	5265.65	-24.91	5265.65	-24.91	4780.86	-19.06
5	3	2	6	11	2 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	5232.68	-25.66	5232.68	-25.66	5697.99	-20.29
5	3	3	6	11	3 falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	5249.17	-25.28	5249.17	-25.28	4780.86	-19.83

6	1	1	7	1	1 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	6630.41	39.48	5722.53	20.51	6630.41	39.48
6	1	2	7	1	2 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	6630.41	39.48	5722.53	20.51	6630.41	39.48
6	1	3	7	1	3 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	6630.41	39.48	5722.53	20.51	6630.41	39.48
6	1	1	7	1	1 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	5722.53	19.49	6630.41	0.52	5722.53	19.49
6	1	2	7	1	2 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	5722.53	19.49	6630.41	0.52	5722.53	19.49
6	1	3	7	1	3 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	5722.53	19.49	6630.41	0.52	5722.53	19.49
6	11	1	7	11	1 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	5722.53	-19.49	5722.53	-19.49	6630.41	-0.52
6	11	2	7	11	2 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	5722.53	-19.49	5722.53	-19.49	6630.41	-0.52
6	11	3	7	11	3 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	5722.53	-19.49	5722.53	-19.49	6630.41	-0.52
6	11	1	7	11	1 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	6630.41	-39.48	6630.41	-39.48	5722.53	-20.51
6	11	2	7	11	2 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	6630.41	-39.48	6630.41	-39.48	5722.53	-20.51
6	11	3	7	11	3 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	6630.41	-39.48	6630.41	-39.48	5722.53	-20.51
7	1	1	8	2	1 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	8255.10	31.42	8982.42	19.06	8255.10	31.42
7	1	2	8	2	2 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	8278.08	32.18	7567.75	20.42	8278.08	32.18
7	1	3	8	2	3 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	8266.59	31.80	8982.42	19.83	8266.59	31.80
7	1	1	8	2	1 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	7567.75	19.58	8283.58	7.64	7567.75	19.58
7	1	2	8	2	2 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	8982.42	20.58	8260.60	8.40	8982.42	20.58
7	1	3	8	2	3 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	8982.42	19.83	8272.09	8.03	8982.42	19.83
7	11	1	8	3	1 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	7567.75	-19.58	7567.75	-19.58	8283.58	-7.64
7	11	2	8	3	2 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	8982.42	-20.58	8982.42	-20.58	8260.60	-8.40
7	11	3	8	3	3 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	8982.42	-19.83	8982.42	-19.83	8272.09	-8.03
7	11	1	8	3	1 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	8255.10	-31.42	8255.10	-31.42	8982.42	-19.06
7	11	2	8	3	2 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	8278.08	-32.18	8278.08	-32.18	7567.75	-20.42
7	11	3	8	3	3 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	8266.59	-31.80	8266.59	-31.80	8982.42	-19.83
8	2	1	9	2	1 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	9750.75	32.95	8982.42	19.06	9750.75	32.95
8	2	2	9	2	2 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	9750.75	34.47	8982.42	20.58	9750.75	34.47
8	2	3	9	2	3 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	9750.75	33.72	8982.42	19.83	9750.75	33.72
8	2	1	9	2	1 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	10515.07	19.06	9750.75	5.17	10515.07	19.06
8	2	2	9	2	2 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	10515.07	20.58	9750.75	6.69	10515.07	20.58
8	2	3	9	2	3 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	10515.07	19.83	9750.75	5.93	10515.07	19.83
8	3	1	9	3	1 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	8982.42	-19.06	8982.42	-19.06	9750.75	-5.17
8	3	2	9	3	2 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	8982.42	-20.58	8982.42	-20.58	9750.75	-6.69
8	3	3	9	3	3 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Left	8982.42	-19.83	8982.42	-19.83	9750.75	-5.93
8	3	1	9	3	1 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	9750.75	-32.95	9750.75	-32.95	10515.07	-19.06
8	3	2	9	3	2 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	9750.75	-34.47	9750.75	-34.47	10515.07	-20.58
8	3	3	9	3	3 falcon_acsr.wir 500 NESC Blowout 6PSF Max Sag RS	Right	9750.75	-33.72	9750.75	-33.72	10515.07	-19.83

9	2	1	10	2	1	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	11263.45	32.11	12011.34	19.06	11263.45	32.11
9	2	2	10	2	2	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	11263.45	33.63	12011.34	20.58	11263.45	33.63
9	2	3	10	2	3	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	11263.45	32.87	12011.34	19.83	11263.45	32.87
9	2	1	10	2	1	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	10515.07	19.06	11263.45	6.01	10515.07	19.06
9	2	2	10	2	2	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	10515.07	20.58	11263.45	7.53	10515.07	20.58
9	2	3	10	2	3	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	10515.07	19.83	11263.45	6.78	10515.07	19.83
9	3	1	10	3	1	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	12011.34	-19.06	12011.34	-19.06	11263.45	-6.01
9	3	2	10	3	2	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	12011.34	-20.58	12011.34	-20.58	11263.45	-7.53
9	3	3	10	3	3	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	12011.34	-19.83	12011.34	-19.83	11263.45	-6.78
9	3	1	10	3	1	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	11263.45	-32.11	11263.45	-32.11	10515.07	-19.06
9	3	2	10	3	2	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	11263.45	-33.63	11263.45	-33.63	10515.07	-20.58
9	3	3	10	3	3	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	11263.45	-32.87	11263.45	-32.87	10515.07	-19.83
10	2	1	11	2	1	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	12758.10	32.15	13506.87	19.06	12758.10	32.15
10	2	2	11	2	2	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	12758.10	33.67	13506.87	20.58	12758.10	33.67
10	2	3	11	2	3	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	12758.10	32.91	13506.87	19.83	12758.10	32.91
10	2	1	11	2	1	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	12011.34	19.06	12758.10	5.98	12011.34	19.06
10	2	2	11	2	2	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	12011.34	20.58	12758.10	7.49	12011.34	20.58
10	2	3	11	2	3	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	12011.34	19.83	12758.10	6.74	12011.34	19.83
10	3	1	11	3	1	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	13506.87	-19.06	13506.87	-19.06	12758.10	-5.98
10	3	2	11	3	2	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	13506.87	-20.58	13506.87	-20.58	12758.10	-7.49
10	3	3	11	3	3	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	13506.87	-19.83	13506.87	-19.83	12758.10	-6.74
10	3	1	11	3	1	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	12758.10	-32.15	12758.10	-32.15	12011.34	-19.06
10	3	2	11	3	2	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	12758.10	-33.67	12758.10	-33.67	12011.34	-20.58
10	3	3	11	3	3	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	12758.10	-32.91	12758.10	-32.91	12011.34	-19.83
11	2	1	12	2	1	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	14238.28	31.52	13506.87	19.06	14238.28	31.52
11	2	2	12	2	2	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	14238.28	33.04	13506.87	20.58	14238.28	33.04
11	2	3	12	2	3	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	14238.28	32.28	13506.87	19.83	14238.28	32.28
11	2	1	12	2	1	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	14968.19	19.06	14238.28	6.60	14968.19	19.06
11	2	2	12	2	2	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	14968.19	20.58	14238.28	8.12	14968.19	20.58
11	2	3	12	2	3	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	14968.19	19.83	14238.28	7.37	14968.19	19.83
11	3	1	12	3	1	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	13506.87	-19.06	13506.87	-19.06	14238.28	-6.60
11	3	2	12	3	2	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	13506.87	-20.58	13506.87	-20.58	14238.28	-8.12
11	3	3	12	3	3	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Left	13506.87	-19.83	13506.87	-19.83	14238.28	-7.37
11	3	1	12	3	1	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	14238.28	-31.52	14238.28	-31.52	14968.19	-19.06
11	3	2	12	3	2	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	14238.28	-33.04	14238.28	-33.04	14968.19	-20.58
11	3	3	12	3	3	falcon_acsr.wir	500 NESC Blowout 6PSF Max Sag RS	Right	14238.28	-32.28	14238.28	-32.28	14968.19	-19.83

12	2	1	13	2	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	15830.12	36.57	16686.56	19.06	15830.12	36.57
12	2	2	13	2	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	15830.12	38.09	16686.56	20.58	15830.12	38.09
12	2	3	13	2	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	15830.12	37.33	16686.56	19.83	15830.12	37.33
12	2	1	13	2	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	14968.19	19.06	15830.12	1.55	14968.19	19.06
12	2	2	13	2	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	14968.19	20.58	15830.12	3.07	14968.19	20.58
12	2	3	13	2	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	14968.19	19.83	15830.12	2.32	14968.19	19.83
12	3	1	13	3	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	16686.56	-19.06	16686.56	-19.06	15830.12	-1.55
12	3	2	13	3	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	16686.56	-20.58	16686.56	-20.58	15830.12	-3.07
12	3	3	13	3	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	16686.56	-19.83	16686.56	-19.83	15830.12	-2.32
12	3	1	13	3	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	15830.12	-36.57	15830.12	-36.57	14968.19	-19.06
12	3	2	13	3	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	15830.12	-38.09	15830.12	-38.09	14968.19	-20.58
12	3	3	13	3	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	15830.12	-37.33	15830.12	-37.33	14968.19	-19.83
13	2	1	14	2	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	17596.92	38.60	18500.78	19.06	17596.92	38.60
13	2	2	14	2	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	17596.92	40.12	18500.78	20.58	17596.92	40.12
13	2	3	14	2	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	17596.92	39.37	18500.78	19.83	17596.92	39.37
13	2	1	14	2	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	16686.56	19.06	17596.92	-0.48	16686.56	19.06
13	2	2	14	2	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	16686.56	20.58	17596.92	1.04	16686.56	20.58
13	2	3	14	2	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	16686.56	19.83	17596.92	0.28	16686.56	19.83
13	3	1	14	3	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	18500.78	-19.06	18500.78	-19.06	17596.92	0.48
13	3	2	14	3	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	18500.78	-20.58	18500.78	-20.58	17596.92	-1.04
13	3	3	14	3	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	18500.78	-19.83	18500.78	-19.83	17596.92	-0.28
13	3	1	14	3	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	17596.92	-38.60	17596.92	-38.60	16686.56	-19.06
13	3	2	14	3	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	17596.92	-40.12	17596.92	-40.12	16686.56	-20.58
13	3	3	14	3	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	17596.92	-39.37	17596.92	-39.37	16686.56	-19.83
14	2	1	15	2	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	19185.70	30.07	18500.78	19.06	19185.70	30.07
14	2	2	15	2	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	19185.70	31.59	18500.78	20.58	19185.70	31.59
14	2	3	15	2	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	19185.70	30.84	18500.78	19.83	19185.70	30.84
14	2	1	15	2	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	19868.11	19.06	19185.70	8.05	19868.11	19.06
14	2	2	15	2	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	19868.11	20.58	19185.70	9.57	19868.11	20.58
14	2	3	15	2	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	19868.11	19.83	19185.70	8.81	19868.11	19.83
14	3	1	15	3	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	18500.78	-19.06	18500.78	-19.06	19185.70	-8.05
14	3	2	15	3	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	18500.78	-20.58	18500.78	-20.58	19185.70	-9.57
14	3	3	15	3	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	18500.78	-19.83	18500.78	-19.83	19185.70	-8.81
14	3	1	15	3	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	19185.70	-30.07	19185.70	-30.07	19868.11	-19.06
14	3	2	15	3	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	19185.70	-31.59	19185.70	-31.59	19868.11	-20.58
14	3	3	15	3	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	19185.70	-30.84	19185.70	-30.84	19868.11	-19.83

15	2	1	16	2	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	20572.92	31.43	19868.11	19.06	20572.92	31.43
15	2	2	16	2	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	20572.92	32.95	19868.11	20.58	20572.92	32.95
15	2	3	16	2	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	20572.92	32.20	19868.11	19.83	20572.92	32.20
15	2	1	16	2	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	21284.23	19.06	20572.92	6.69	21284.23	19.06
15	2	2	16	2	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	21284.23	20.58	20572.92	8.21	21284.23	20.58
15	2	3	16	2	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	21284.23	19.83	20572.92	7.45	21284.23	19.83
15	3	1	16	3	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	19868.11	-19.06	19868.11	-19.06	20572.92	-6.69
15	3	2	16	3	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	19868.11	-20.58	19868.11	-20.58	20572.92	-8.21
15	3	3	16	3	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	19868.11	-19.83	19868.11	-19.83	20572.92	-7.45
15	3	1	16	3	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	20572.92	-31.43	20572.92	-31.43	21284.23	-19.06
15	3	2	16	3	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	20572.92	-32.95	20572.92	-32.95	21284.23	-20.58
15	3	3	16	3	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	20572.92	-32.20	20572.92	-32.20	21284.23	-19.83

16	2	1	17	2	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	22195.63	38.43	21284.23	19.06	22195.63	38.43
16	2	2	17	2	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	22177.65	39.18	23072.07	20.52	22177.65	39.18
16	2	3	17	2	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	22186.64	38.80	21284.23	19.83	22186.64	38.80
16	2	1	17	2	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	23072.07	19.48	22173.66	0.64	23072.07	19.48
16	2	2	17	2	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	21284.23	20.58	22191.64	1.40	21284.23	20.58
16	2	3	17	2	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	21284.23	19.83	22182.65	1.02	21284.23	19.83
16	3	1	17	11	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	23072.07	-19.48	23072.07	-19.48	22173.66	-0.64
16	3	2	17	11	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	21284.23	-20.58	21284.23	-20.58	22191.64	-1.40
16	3	3	17	11	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Left	21284.23	-19.83	21284.23	-19.83	22182.65	-1.02
16	3	1	17	11	1	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	22195.63	-38.43	22195.63	-38.43	21284.23	-19.06
16	3	2	17	11	2	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	22177.65	-39.18	22177.65	-39.18	23072.07	-20.52
16	3	3	17	11	3	falcon_acsr.wir	500	NESC Blowout 6PSF Max Sag RS	Right	22186.64	-38.80	22186.64	-38.80	21284.23	-19.83

For 500kV wires between structures 1 and 17, maximum offset is 40.12 (ft), the leftmost offset is -40.12 (ft), rightmost offset is 40.12 (ft)

Recreated: 6/23/2010 by: mdwi DEA cjb DEA
For: ***National Park Service***

Using Existing PPL ROW Alternative
Blowout Report for Spans with 100' ROW

Start Str. #	End Str. #	Cable Type	Voltage (kV)	Weather Case	Cable Condition	Proposed ROW Width (ft)	Max. Blowout from centerline each side (ft)	Blowout from structure centerline + V-string to ROW edge	Required Clearance to each side of ROW (ft)	Structure Deflection each side (ft)	(Applicant) Remaining Buffer from tree line, each side (ft)	Actual Remaining Buffer from tree line, each side (ft)	Minimum Vegetation Management Cycle
B17-2	B17-2A	FALCON ACSR	500	NESC HORIZ CLEAR-6 psf	Max Sag FE	100	22.06	**43.56**	17	2	8.94	**-10.56**	Every three years
B17-3	B17-3A	FALCON ACSR	500	NESC HORIZ CLEAR-6 psf	Max Sag FE	100	23.09	**44.59**	17	2	7.91	**-11.59**	Every three years
B17-3A	B17-4	FALCON ACSR	500	NESC HORIZ CLEAR-6 psf	Max Sag FE	100	29.06	**50.56**	17	1	2.94	**-17.56**	Every year
B17-4	B17-5	FALCON ACSR	500	NESC HORIZ CLEAR-6 psf	Max Sag FE	100	23.33	**44.83**	17	2	7.67	**-11.83**	Every three years
B17-5	B17-5A	FALCON ACSR	500	NESC HORIZ CLEAR-6 psf	Max Sag FE	100	22.87	**44.37**	17	2	8.13	**-11.37**	Every three years
B17-5A	B17-6	FALCON ACSR	500	NESC HORIZ CLEAR-6 psf	Max Sag FE	100	24.84	**46.34**	17	2	6.16	**-13.34**	Every three years

Notes: The column above titled: "Max. Blowout from centerline each side (ft)" fails to represent the required V-strings clearance which is 21.5' from structure centerline. 21.5'+ blowout equals actual remaining buffer.

NESC minimum clearance from blowout to ROW edge is 17' and PJM requires a 3' buffer, therefore actual "Required Clearance to each side of ROW (ft)" is 17'+ 3' = 20'

Throughout the ROW width development, the applicant has made reference to ACSR and ACCC conductor. Our models represent what is provided here, and we have information and calculations for ACCC as well.

Applicant has provided two different Plan & Profiles; one from Seargant & Lundy and Burns & McDonald. Each plan & profile were prepared with different spans and structure types.

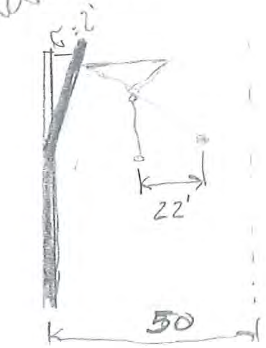
RUS Bulletin 1724E-200 only references voltages upto 230kV (230,000 volts).

No consideration for "Broken Insulators" per NESC 2007

Several Geometry errors in structure provided by applicant. May cause an error in ROW clearance calculation.

Provided By Jason @ B&M

No from ROW ≥17'
max ϕ to ROW edge!



3' Buffer PJM!
pg 18

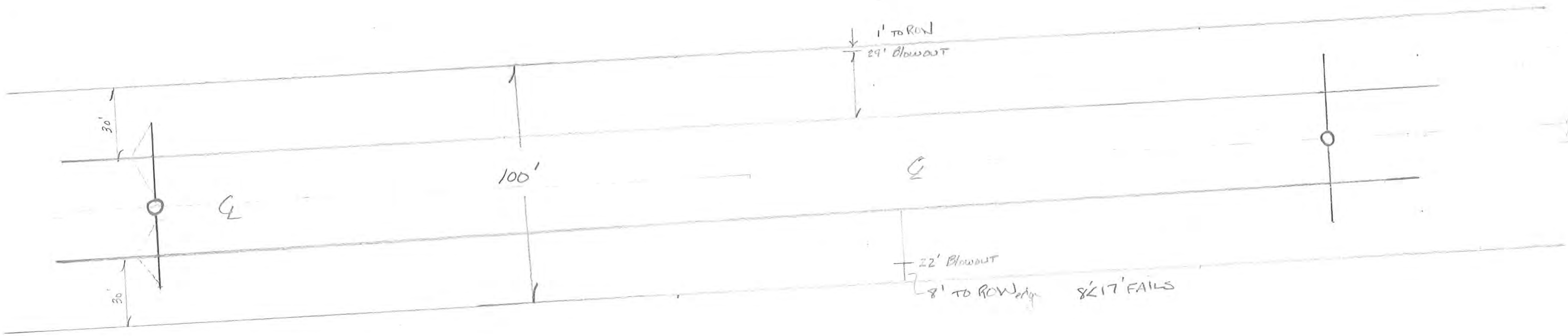
Using Existing PPL ROW Alternative
Blowout Report for spans with 100' ROW

Start Str. #	End Str. #	Cable Type	Voltage (kV)	Weather Case	Cable Condition	Proposed ROW Width (ft)	Max. Blowout from centerline, each side (ft)	Required Clearance to each side of ROW (ft)	Structure Deflection, each side (ft)	Remaining Buffer from tree line, each side (ft)	Minimum Vegetation Management Cycle*
B17-2	B17-2A	FALCON ACSR	500	NESC HORZ CLEAR-6psf	Max Sag FE	100	22.06	17	2	8.94	Every Three Years
B17-3	B17-3A	FALCON ACSR	500	NESC HORZ CLEAR-6psf	Max Sag FE	100	23.09	17	2	7.91	Every Three Years
B17-3A	B17-4	FALCON ACSR	500	NESC HORZ CLEAR-6psf	Max Sag FE	100	29.06	17	1	2.94	Every Year
B17-4	B17-5	FALCON ACSR	500	NESC HORZ CLEAR-6psf	Max Sag FE	100	23.33	17	2	7.67	Every Three Years
B17-5	B17-5A	FALCON ACSR	500	NESC HORZ CLEAR-6psf	Max Sag FE	100	22.87	17	2	8.13	Every Three Years
B17-5A	B17-6	FALCON ACSR	500	NESC HORZ CLEAR-6psf	Max Sag FE	100	24.84	17	2	6.16	Every Three Years

Σ wind
24.06 +8.94
25.09
30.06
25.33
24.87
26.8

*Assumes a 2' growth per year

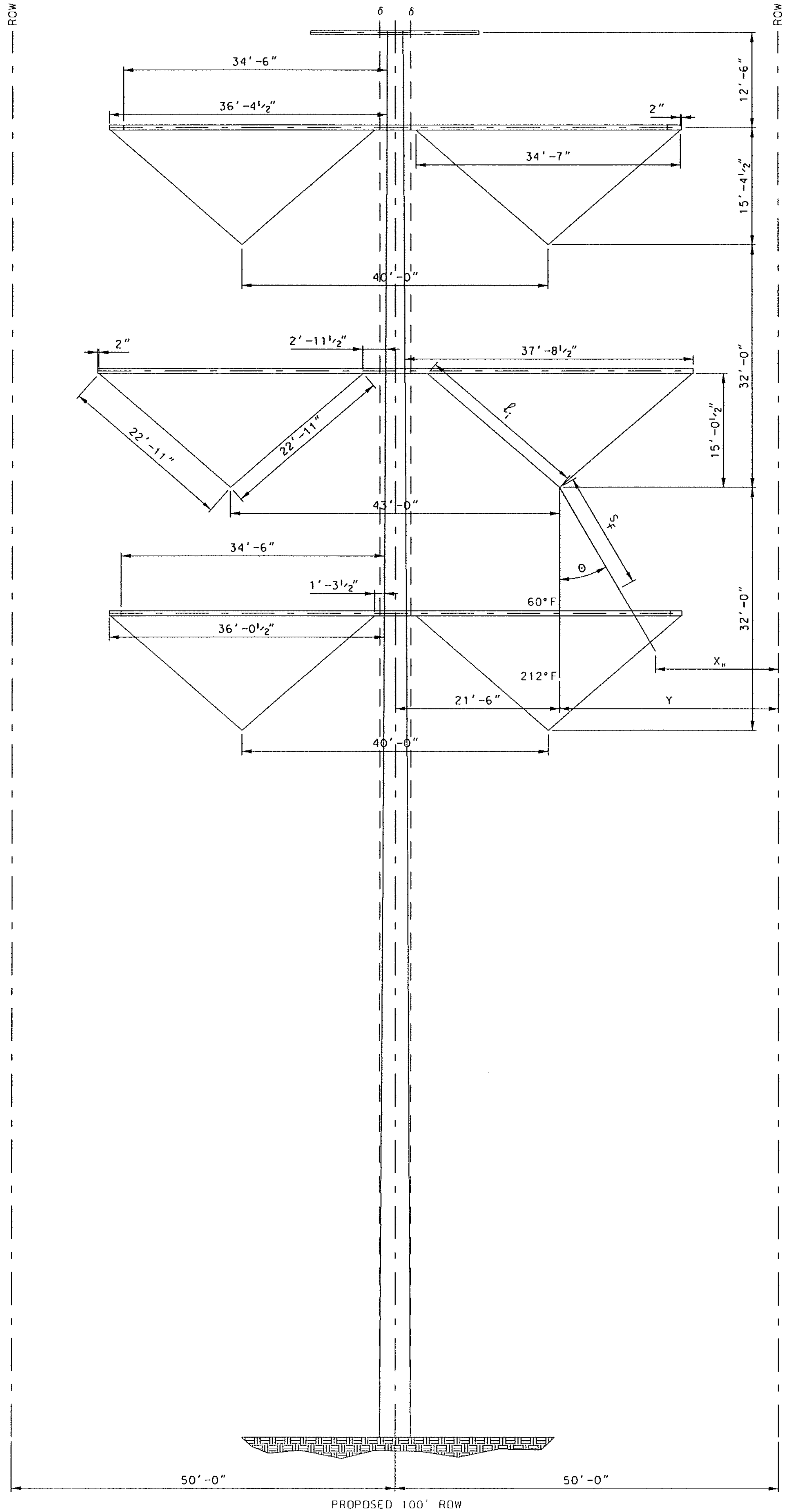
17'+3'
20'



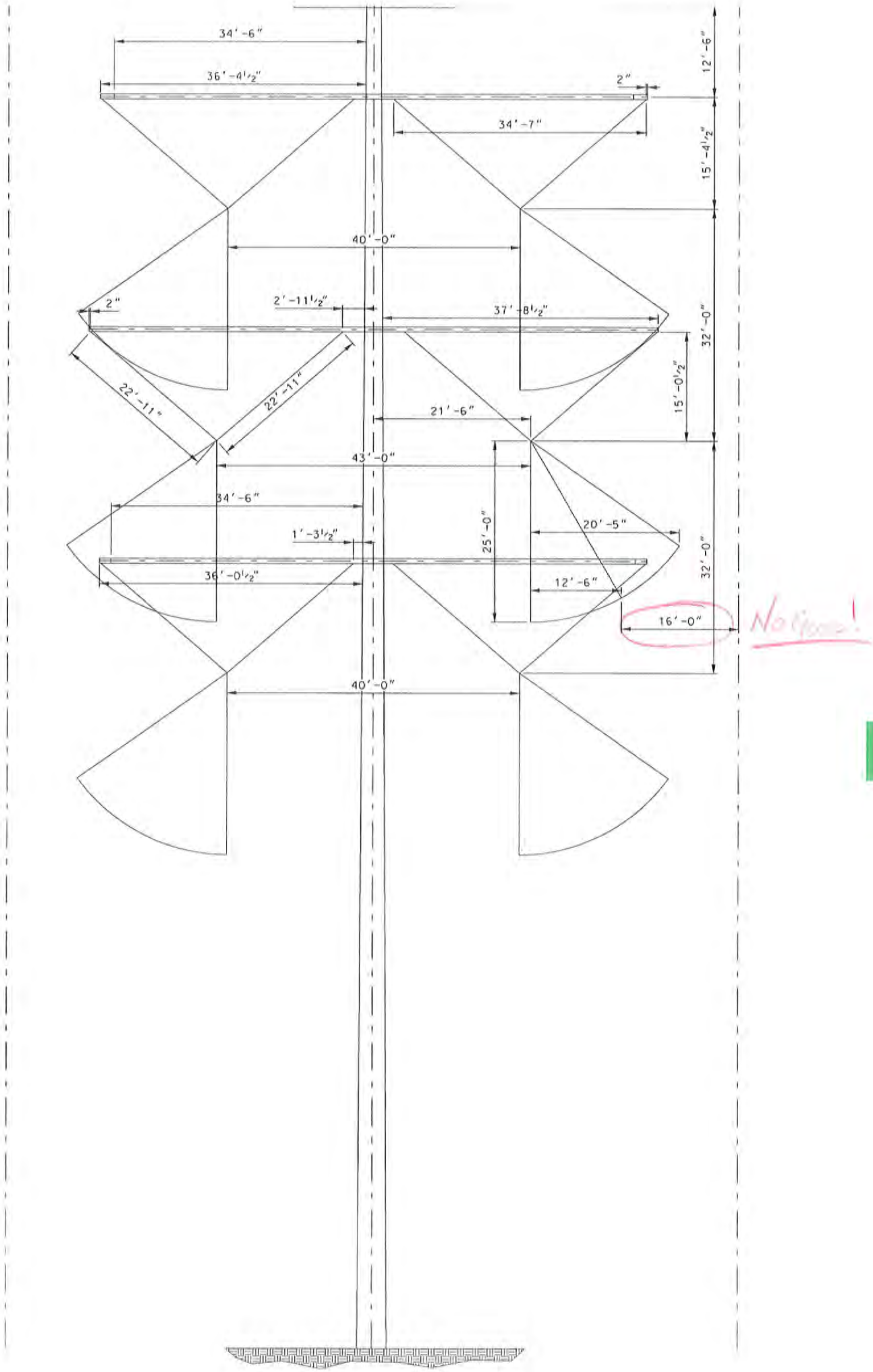
MIN NESC ϕ to ROW edge

MIN NESC ϕ to ROW edge

STRUCTURE MODELS



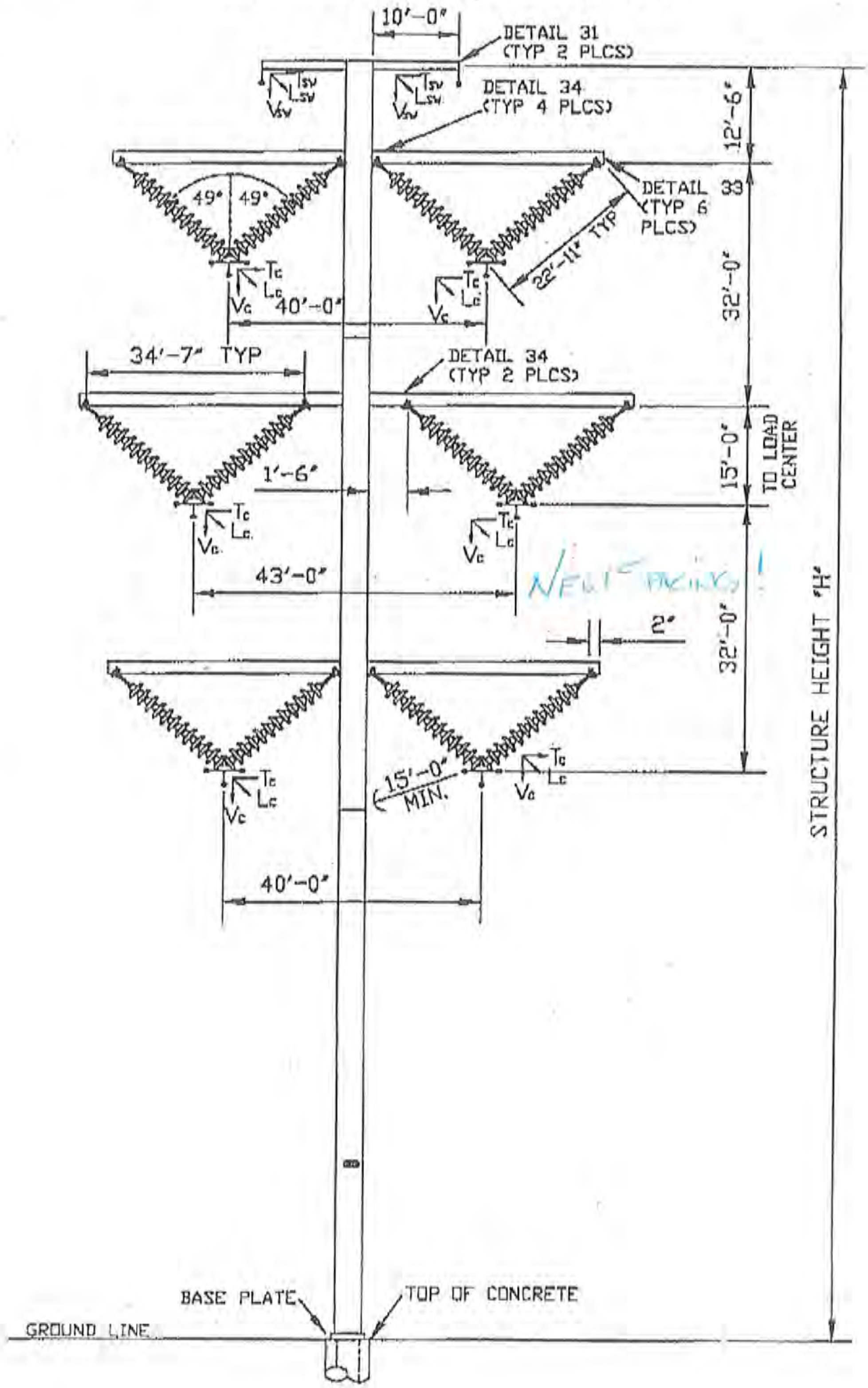
PROPOSED 100' ROW
SR LINE



34'-6"
36'-4½"
2"
12'-6"
34'-7"
15'-4½"
40'-0"
2"
2'-11½"
37'-8½"
32'-0"
22'-11"
22'-11"
15'-0½"
21'-6"
43'-0"
34'-6"
25'-0"
20'-5"
1'-3½"
36'-0½"
12'-6"
32'-0"
16'-0"
No flows!
40'-0"

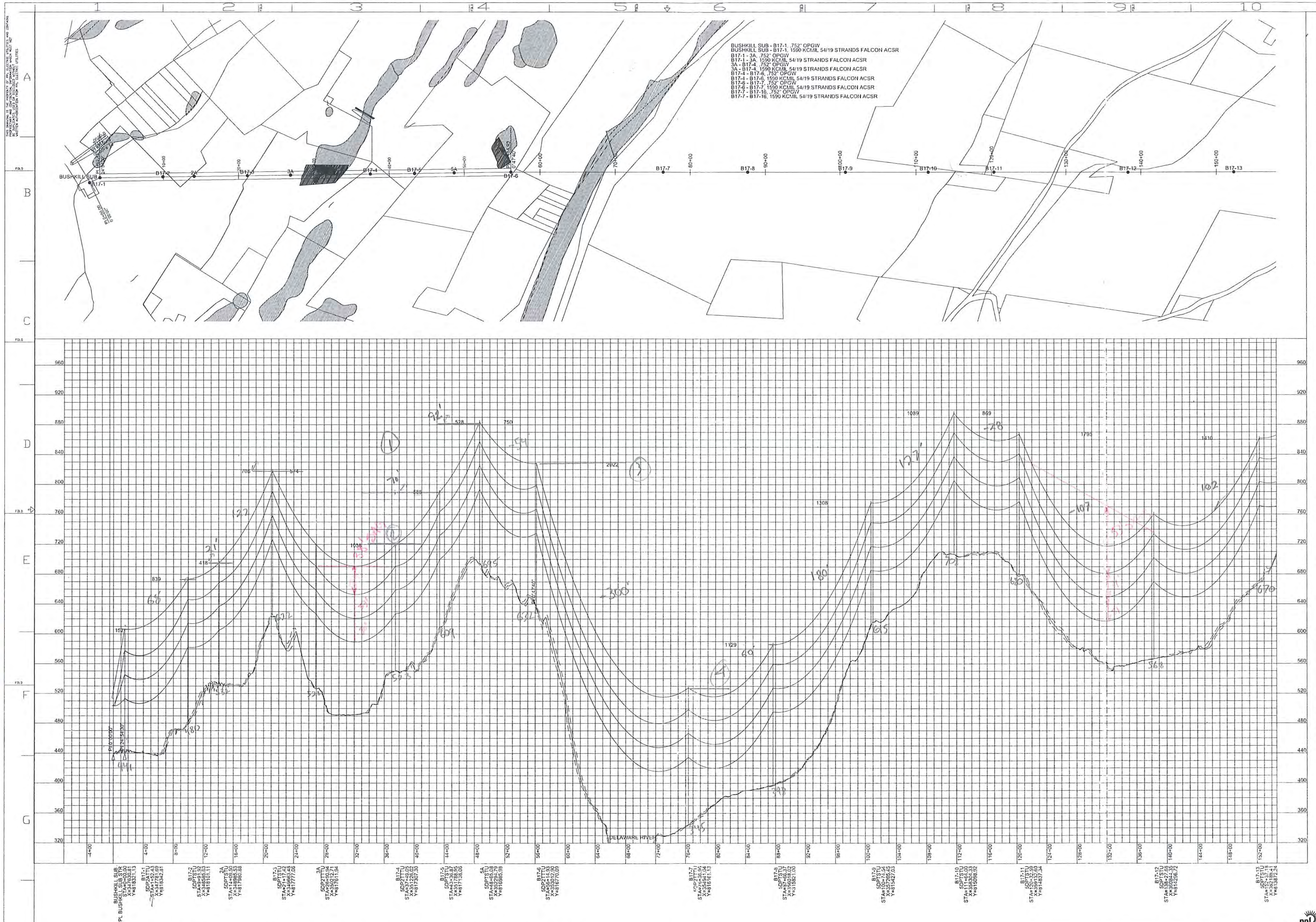
Sargent & Lundy LLC 6/11/2010

Segment B17 100' ROW Feasibility Study



PLAN AND PROFILES
By others

The plan & profiles by S&L and B&M attached in this section were used to verify span lengths, conductor sag and distance to edge of ROW.



Temperature ?

PRELIMINARY - NOT FOR CONSTRUCTION

Horiz. Scale 400.0 ft.

Vert. Scale 40.0 ft.

REV	DATE	DESCRIPTION	PREPARED	REVIEWED	APPROVED
0	11/4/09	ISSUED FOR INFORMATION	KS/CD	RAS	SR

Sargent & Lundy Engineers, Ltd.
55 EAST MONROE ST., CHICAGO ILLINOIS

ANY MODIFICATION OR ADDITION TO THIS DRAWING BY ANY ORGANIZATION OTHER THAN SARGENT & LUNDY IS NOT THE RESPONSIBILITY OF SARGENT & LUNDY

PROJ. No. 12397-016

NO | DATE | ACCT | REVISION | BY | REVIEWED | APPROVED

LOCATION CODES | SORTS

REFERENCE TITLE | NUMBER | REFERENCE TITLE | NUMBER

FRACTIONAL | DECIMAL

LEGEND

- NEW POLE
- EXISTING TOWER TO BE REMOVED
- WETLAND

ACCT-
SCALE-
BY-
REVIEWED

500 kV TRANSMISSION LINE
BUSHKILL - KITTATINY (500 kV)
BUSHKILL - ROSELAND (500kV)
PLAN & PROFILE

APPROVED | DATE

PPL ELECTRIC UTILITIES

PPL DRAWING NO. E-374752

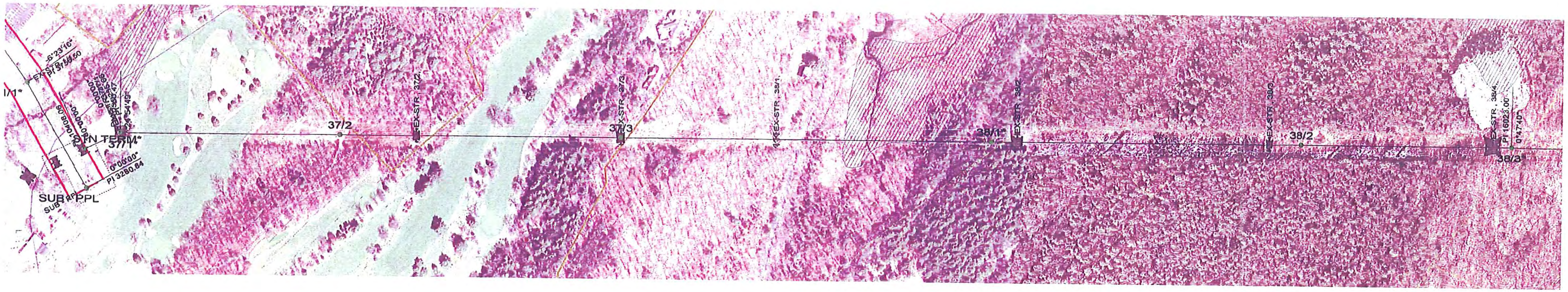
SHEET NO 1 OF 2

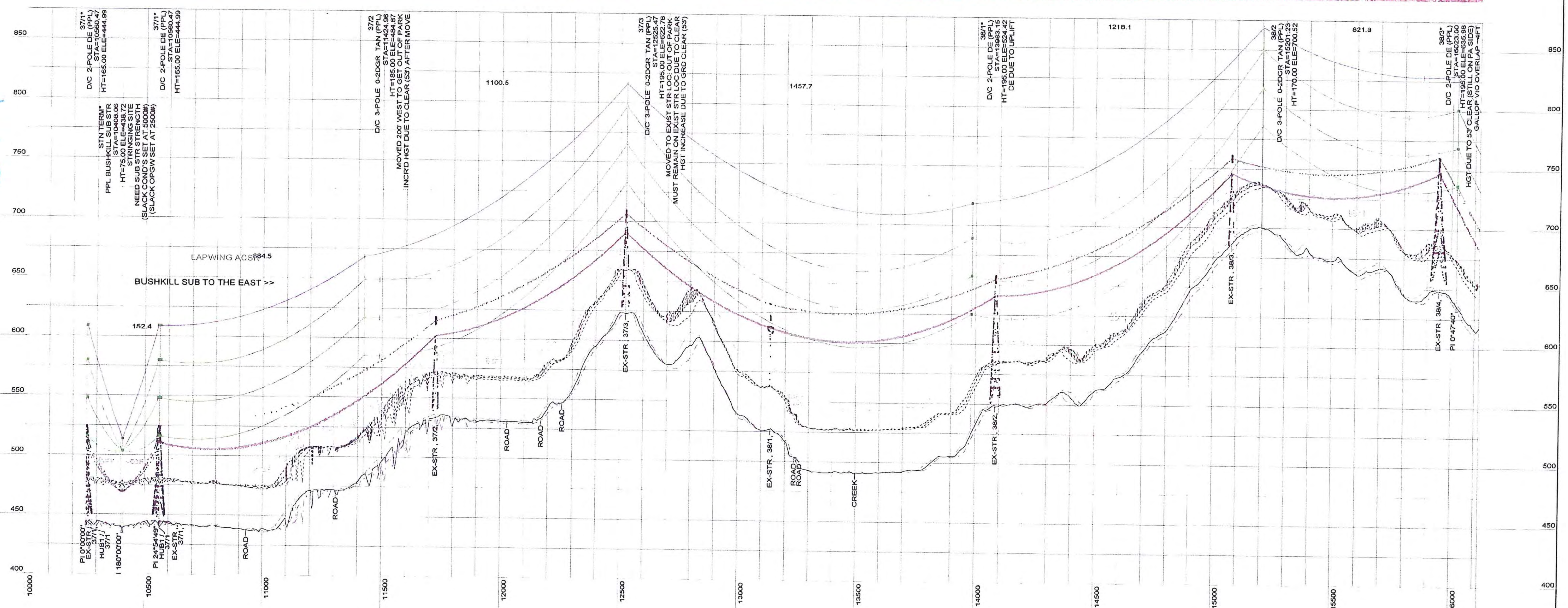
REV. 0

PC CAD

PRINTED: 10/17/2008

PLS-CADD DRAWING





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NWI WETLANDS	ACCESS ROADS
MORRIS CO RIP BUFFER	TAX LOTS
RIP BUFFER FOR CAT 1	T-LINE R.O.W.
RIP BUFFER FOR TROUT	EXIST. 230KV
SUSSEX CO RIP BUFFER	COUNTIES
WETLAND BUFFER	NPS BOUNDARIES
SUSSEX CO T&E RIP BUFFER	PARCELS
WARREN CO T&E RIP BUFFER	RIVERS

200.0 FT. HORIZ. SCALE

40.0 FT. VERT. SCALE

NORTH

PENNSYLVANIA POWER AND LIGHT / PUBLIC SERVICE ELECTRIC & GAS CO.

PROPOSED FOR PERMIT 9/19/2008

DATE 10/17/2008

500 KV TRANSMISSION LINES

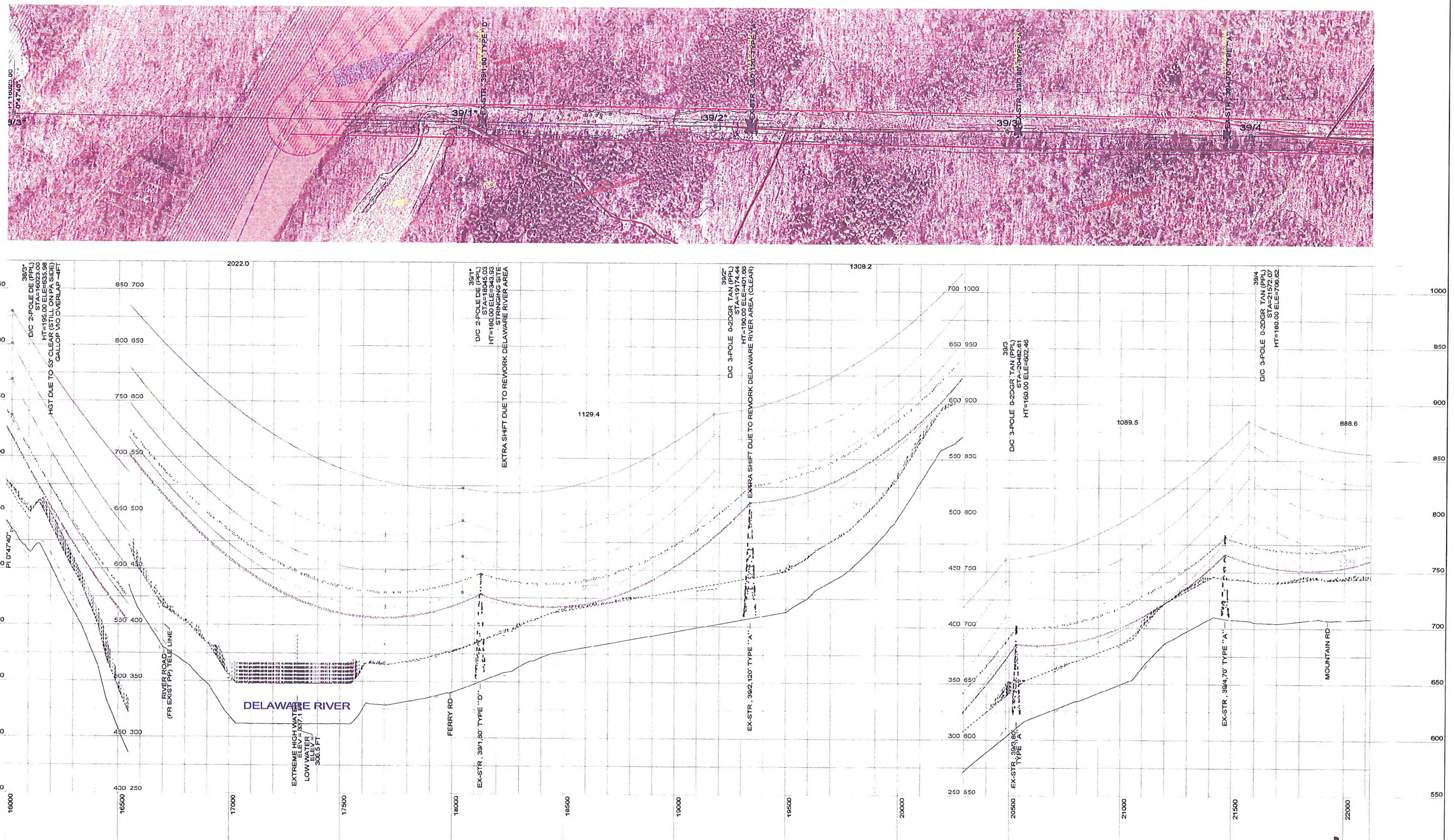
SUSQUEHANNA RIVER TO ROSELAND
CROSSING THE DELWARE WATER GAP
NATIONAL RECREATION AREA
K-1019

PLAN AND PROFILE

SHEET 3

PRINTED: 10/17/2008

PLS-CADD DRAWING



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NWI WETLANDS	ACCESS ROADS
MORRIS CO RIP BUFFER	TAX LOTS
RIP BUFFER FOR CAT 1	T-LINE R.O.W.
RIP BUFFER FOR TROUT	EXIST. 230KV
SUSSEX CO RIP BUFFER	COUNTIES
WETLAND BUFFER	NPS BOUNDARIES
SUSSEX CO T&E RIP BUFFER	PARCELS
WARREN CO T&E RIP BUFFER	RIVERS

200.0 FT. HORIZ. SCALE

40.0 FT. VERT. SCALE

NORTH

PENNSYLVANIA POWER AND LIGHT / PUBLIC SERVICE ELECTRIC & GAS CO.

PROPOSED FOR PERMIT 9/19/2008

DATE 10/17/2008

500 KV TRANSMISSION LINES

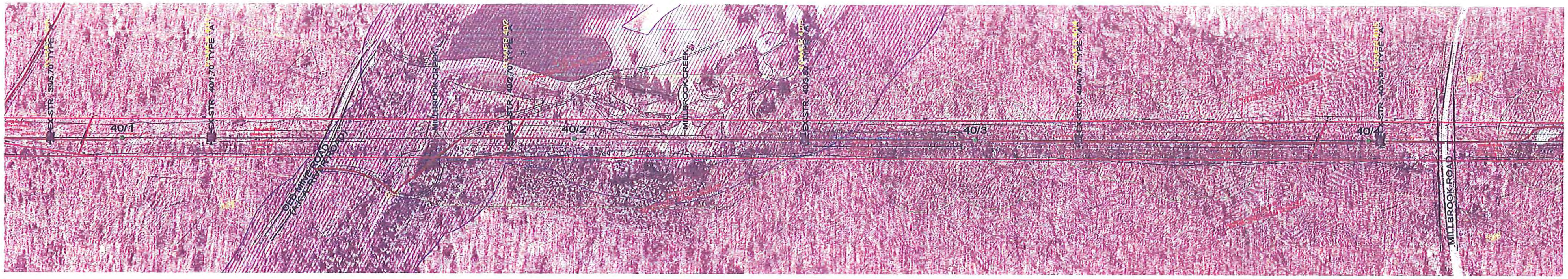
SUSQUEHANNA RIVER TO ROSELAND
CROSSING THE DELWARE WATER GAP
NATIONAL RECREATION AREA
K-1019

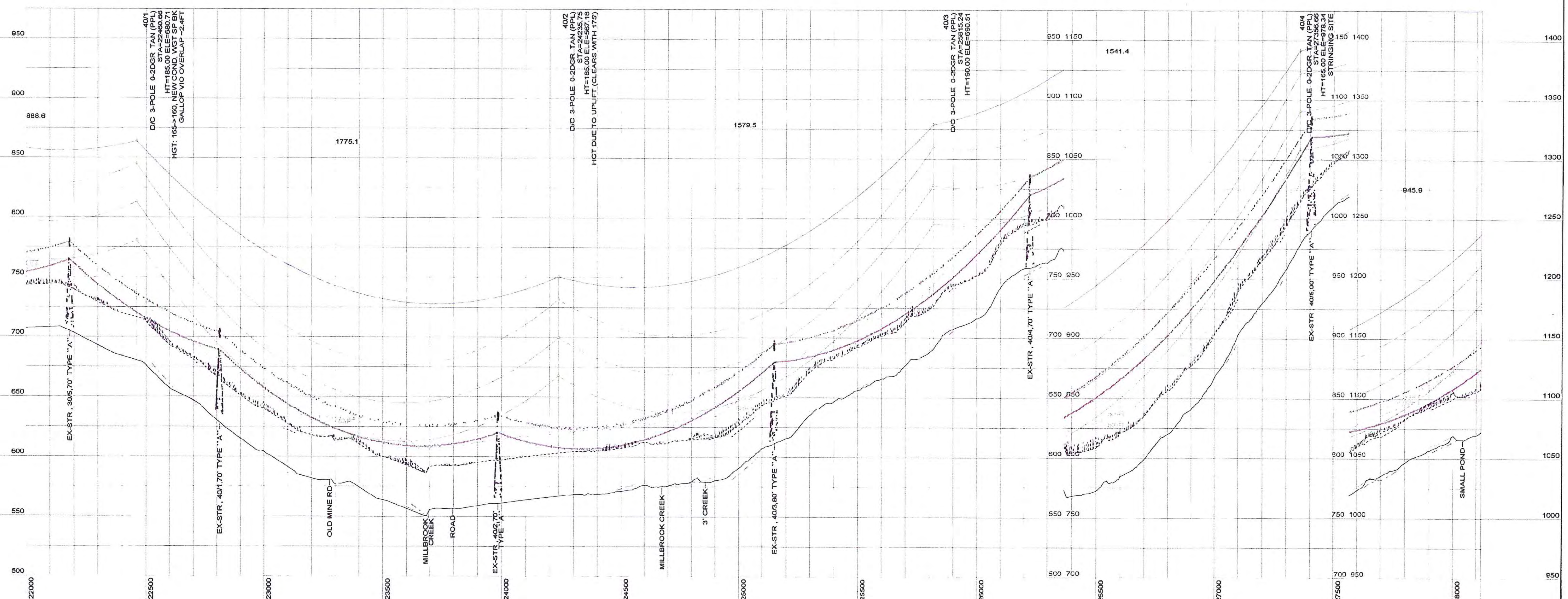
PLAN AND PROFILE

SHEET 4

PRINTED: 10/17/2008

PLS-CADD DRAWING





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Legend			
	NWI WETLANDS		ACCESS ROADS
	MORRIS CO RIP BUFFER		TAX LOTS
	RIP BUFFER FOR CAT 1		T-LINE R.O.W.
	RIP BUFFER FOR TROUT		EXIST. 230KV
	SUSSEX CO RIP BUFFER		COUNTIES
	WETLAND BUFFER		NPS BOUNDARIES
	SUSSEX CO T&E RIP BUFFER		PARCELS
	WARREN CO T&E RIP BUFFER		RIVERS

200.0 FT. HORIZ. SCALE

40.0 FT. VERT. SCALE

NORTH

PENNSYLVANIA POWER AND LIGHT / PUBLIC SERVICE ELECTRIC & GAS CO.

PROPOSED FOR PERMIT 9/19/2008

DATE 10/17/2008

500 KV TRANSMISSION LINES

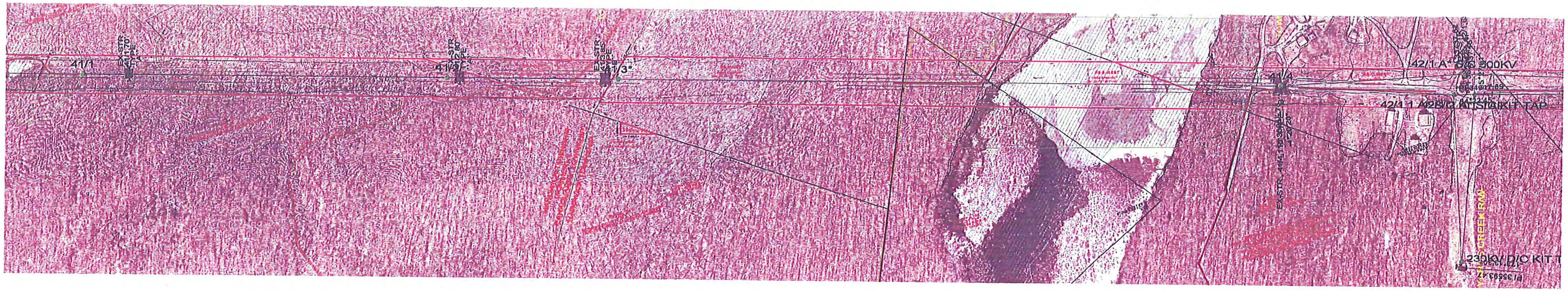
SUSQUEHANNA RIVER TO ROSELAND
CROSSING THE DELWARE WATER GAP
NATIONAL RECREATION AREA
K-1019

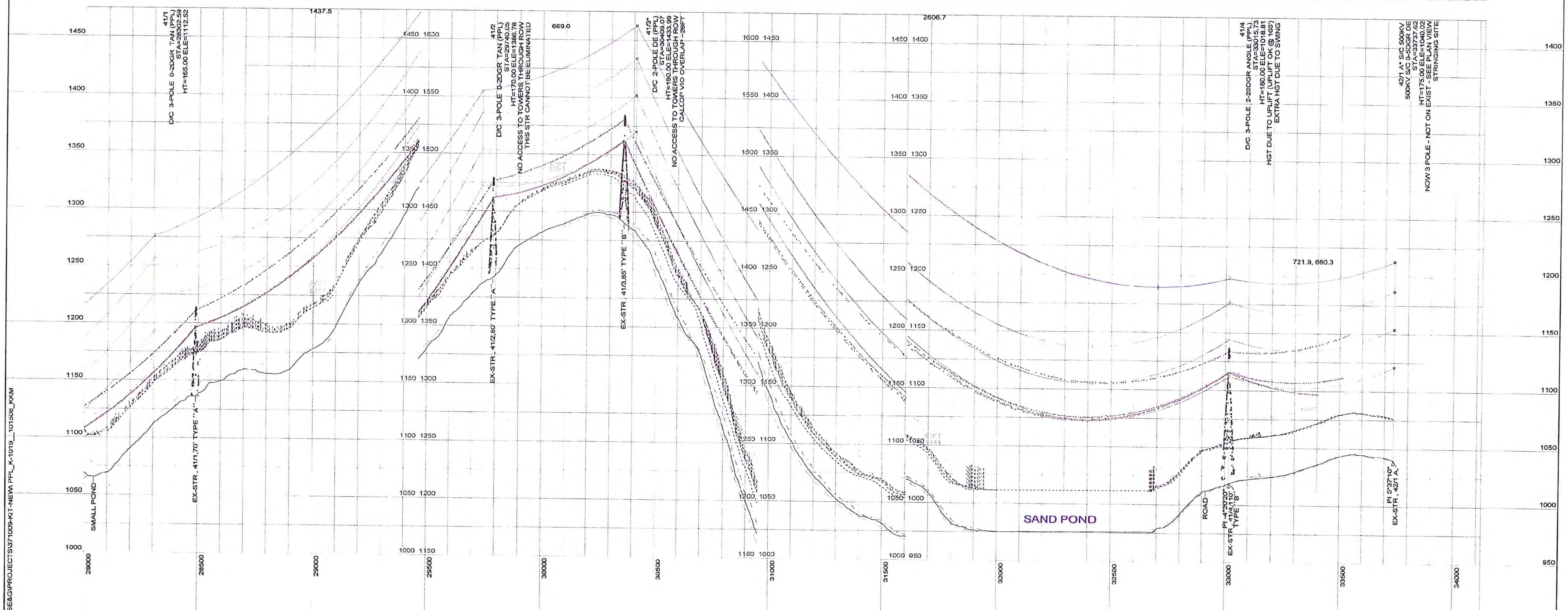
PLAN AND PROFILE

SHEET 5

PRINTED: 10/17/2008

PLS-CADD DRAWING





NWI WETLANDS
MORRIS CO RIP BUFFER
RIP BUFFER FOR CAT 1
RIP BUFFER FOR TROUT
SUSSEX CO RIP BUFFER
WETLAND BUFFER
SUSSEX CO T&E RIP BUFFER
WARREN CO T&E RIP BUFFER

ACCESS ROADS
TAX LOTS
T-LINE R.O.W.
EXIST. 230KV
COUNTIES
NPS BOUNDARIES
PARCELS
RIVERS

200.0 FT. HORIZ. SCALE

40.0 FT. VERT. SCALE

NORTH

PENNSYLVANIA POWER AND LIGHT / PUBLIC SERVICE ELECTRIC & GAS CO.

PROPOSED FOR PERMIT 9/19/2008

DATE 10/17/2008

500 KV TRANSMISSION LINES

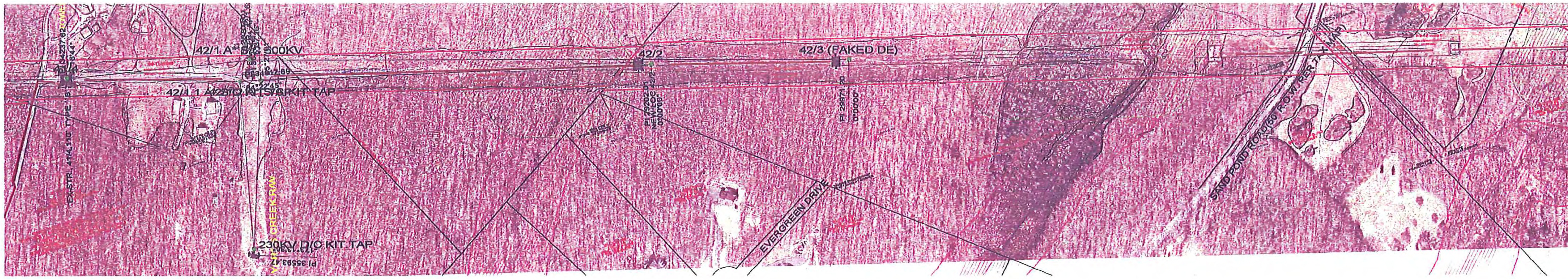
SUSQUEHANNA RIVER TO ROSELAND
CROSSING THE DELWARE WATER GAP
NATIONAL RECREATION AREA
K-1019

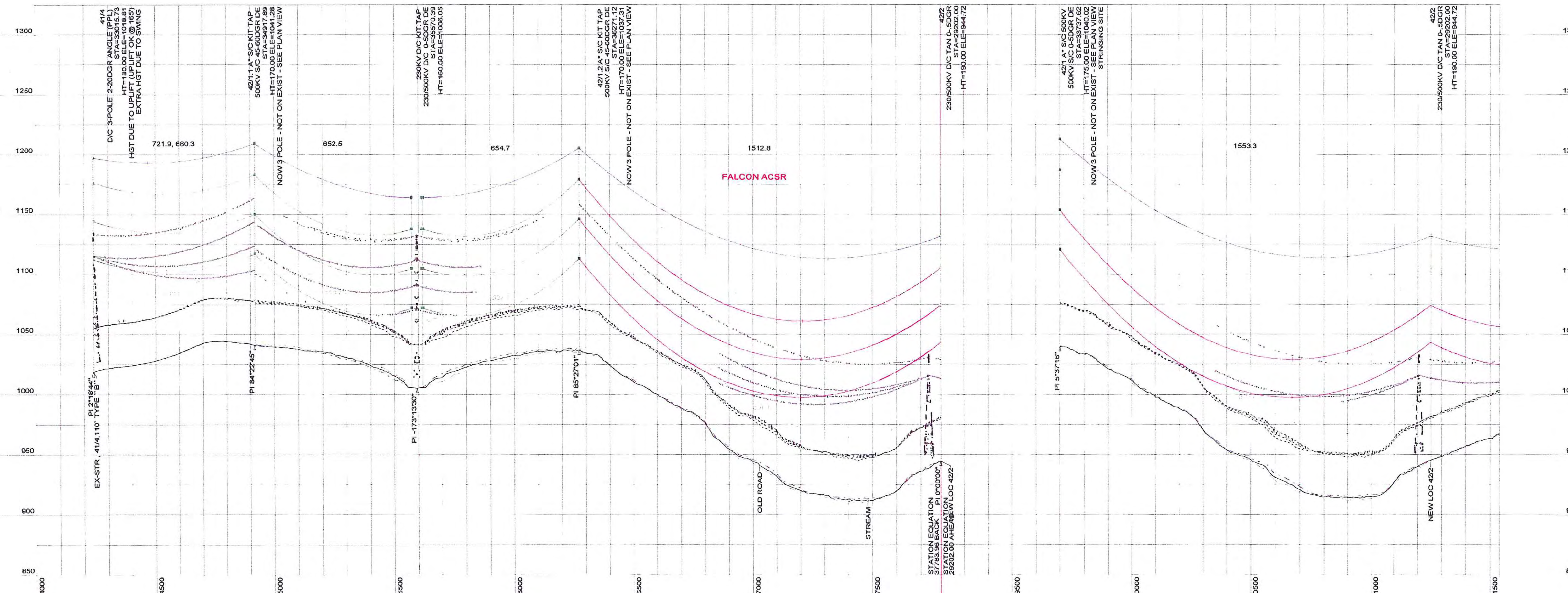
PLAN AND PROFILE

SHEET 6

PLS-CADD DRAWING

PRINTED: 10/17/2008





FILE: M:\PLS\CLIENTS\PSE&G\PROJECTS\371009-KIT-NEW PPL_K-1019_101508_KKM

NWI WETLANDS	ACCESS ROADS
MORRIS CO RIP BUFFER	TAX LOTS
RIP BUFFER FOR CAT 1	T-LINE R.O.W.
RIP BUFFER FOR TROUT	EXIST. 230KV
SUSSEX CO RIP BUFFER	COUNTIES
WETLAND BUFFER	NPS BOUNDARIES
SUSSEX CO T&E RIP BUFFER	PARCELS
WARREN CO T&E RIP BUFFER	RIVERS

200.0 FT. HORIZ. SCALE

40.0 FT. VERT. SCALE

NORTH

PENNSYLVANIA POWER AND LIGHT / PUBLIC SERVICE ELECTRIC & GAS CO.

PROPOSED FOR PERMIT 9/19/2008

DATE 10/17/2008

500 KV TRANSMISSION LINES

SUSQUEHANNA RIVER TO ROSELAND CROSSING THE DELWARE WATER GAP NATIONAL RECREATION AREA K-1019

PLAN AND PROFILE

SHEET 7

SOUTHWIRE SAG 10

The Southwire Sag 10 reports provided alternate verification to the PLS CADD sag reports to assure accuracy in the blowout calculations.

Southwire SAG10™

6/22/2010
David Evans and Associates

Susquehanna - Roseland 500kV
B&M P&P

Conductor: 1594.0 Kcmil 54/19 Stranding ACCR "FALCON"

Area = 1.4110 Sq. in Diameter = 1.547 in Weight = 1.745 lb/ft RTS = 53600 lb
Data from Chart No. 4-1100
English Units
Limits and Outputs in Average Tensions.

Span = 152.4 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	0.37	20230	0.34	22495
32.0	0.25	0.00	0.00	2.304	0.38	17655	0.32	21064
0.0	0.00	0.00	0.00	1.745	0.23	22348	0.21	23629
15.0	0.00	0.00	0.00	1.745	0.25	20091	0.23	22421
30.0	0.00	0.00	0.00	1.745	0.28	17843	0.24	21180
60.0	0.00	0.00	0.00	1.745	0.38	13399*	0.27	18603
90.0	0.00	0.00	0.00	1.745	0.55	9142	0.32	15907
120.0	0.00	0.00	0.00	1.745	0.68	7491	0.39	13112
167.0	0.00	0.00	0.00	1.745	0.76	6648	0.59	8653
212.0	0.00	0.00	0.00	1.745	0.86	5871	0.83	6101

* Design Condition

Span = 864.5 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	12.09	20123	11.21	21697
32.0	0.25	0.00	0.00	2.304	12.19	17672	10.81	19924
0.0	0.00	0.00	0.00	1.745	8.81	18505	7.92	20588
15.0	0.00	0.00	0.00	1.745	9.58	17027	8.33	19573
30.0	0.00	0.00	0.00	1.745	10.40	15682	8.78	18572
60.0	0.00	0.00	0.00	1.745	12.18	13400*	9.80	16639
90.0	0.00	0.00	0.00	1.745	14.04	11622	10.99	14848
120.0	0.00	0.00	0.00	1.745	15.92	10256	12.32	13247
167.0	0.00	0.00	0.00	1.745	17.34	9414	14.61	11173
212.0	0.00	0.00	0.00	1.745	18.06	9040	16.91	9657

* Design Condition

Span = 1100.5 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	19.63	20092	18.44	21392
32.0	0.25	0.00	0.00	2.304	19.76	17676	17.91	19497
0.0	0.00	0.00	0.00	1.745	15.40	17168	13.79	19167
15.0	0.00	0.00	0.00	1.745	16.46	16068	14.44	18308

30.0	0.00	0.00	0.00	1.745	17.54	15079	15.13	17478
60.0	0.00	0.00	0.00	1.745	19.74	13400*	16.61	15920
90.0	0.00	0.00	0.00	1.745	21.94	12059	18.22	14518
120.0	0.00	0.00	0.00	1.745	24.10	10983	19.92	13282
167.0	0.00	0.00	0.00	1.745	26.28	10075	22.68	11669
212.0	0.00	0.00	0.00	1.745	27.14	9757	25.35	10445

* Design Condition

Span = 1457.7 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	34.54	20059	32.96	21018
32.0	0.25	0.00	0.00	2.304	34.69	17680	32.29	18986
0.0	0.00	0.00	0.00	1.745	29.41	15786	26.77	17340
15.0	0.00	0.00	0.00	1.745	30.74	15105	27.73	16739
30.0	0.00	0.00	0.00	1.745	32.06	14485	28.71	16167
60.0	0.00	0.00	0.00	1.745	34.67	13400*	30.73	15109
90.0	0.00	0.00	0.00	1.745	37.21	12489	32.79	14162
120.0	0.00	0.00	0.00	1.745	39.68	11716	34.88	13319
167.0	0.00	0.00	0.00	1.745	42.89	10843	38.15	12183
212.0	0.00	0.00	0.00	1.745	43.93	10589	41.24	11275

* Design Condition

Span = 1218.1 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	24.08	20080	22.74	21257
32.0	0.25	0.00	0.00	2.304	24.21	17678	22.16	19310
0.0	0.00	0.00	0.00	1.745	19.48	16630	17.50	18505
15.0	0.00	0.00	0.00	1.745	20.65	15692	18.27	17733
30.0	0.00	0.00	0.00	1.745	21.83	14846	19.06	16993
60.0	0.00	0.00	0.00	1.745	24.19	13400*	20.75	15615
90.0	0.00	0.00	0.00	1.745	26.52	12226	22.53	14383
120.0	0.00	0.00	0.00	1.745	28.80	11264	24.38	13296
167.0	0.00	0.00	0.00	1.745	31.34	10355	27.33	11865
212.0	0.00	0.00	0.00	1.745	32.26	10061	30.16	10759

* Design Condition

Span = 821.8 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	10.92	20129	10.11	21755
32.0	0.25	0.00	0.00	2.304	11.01	17671	9.73	20007
0.0	0.00	0.00	0.00	1.745	7.85	18777	7.07	20845
15.0	0.00	0.00	0.00	1.745	8.55	17227	7.44	19807
30.0	0.00	0.00	0.00	1.745	9.32	15811	7.85	18778
60.0	0.00	0.00	0.00	1.745	11.00	13400*	8.78	16781
90.0	0.00	0.00	0.00	1.745	12.79	11525	9.88	14916
120.0	0.00	0.00	0.00	1.745	14.61	10096	11.13	13240
167.0	0.00	0.00	0.00	1.745	15.90	9279	13.33	11066
212.0	0.00	0.00	0.00	1.745	16.59	8893	15.55	9487

* Design Condition

Span = 2022.0 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb

15.0	0.25	4.00	0.20	2.603	66.69	20030	64.72	20635
32.0	0.25	0.00	0.00	2.304	66.86	17684	63.95	18483
0.0	0.00	0.00	0.00	1.745	60.93	14690	57.35	15601
15.0	0.00	0.00	0.00	1.745	62.44	14338	58.57	15277
30.0	0.00	0.00	0.00	1.745	63.93	14006	59.79	14967
60.0	0.00	0.00	0.00	1.745	66.84	13400*	62.24	14384
90.0	0.00	0.00	0.00	1.745	69.68	12859	64.67	13847
120.0	0.00	0.00	0.00	1.745	72.45	12372	67.09	13352
167.0	0.00	0.00	0.00	1.745	76.65	11702	70.84	12652
212.0	0.00	0.00	0.00	1.745	78.19	11473	74.37	12057

* Design Condition

Span = 1129.4 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	20.68	20089	19.45	21358
32.0	0.25	0.00	0.00	2.304	20.81	17677	18.91	19450
0.0	0.00	0.00	0.00	1.745	16.35	17028	14.65	19000
15.0	0.00	0.00	0.00	1.745	17.44	15970	15.33	18163
30.0	0.00	0.00	0.00	1.745	18.55	15018	16.04	17355
60.0	0.00	0.00	0.00	1.745	20.79	13400*	17.58	15842
90.0	0.00	0.00	0.00	1.745	23.03	12103	19.23	14483
120.0	0.00	0.00	0.00	1.745	25.21	11056	20.97	13286
167.0	0.00	0.00	0.00	1.745	27.49	10147	23.78	11720
212.0	0.00	0.00	0.00	1.745	28.36	9835	26.49	10527

* Design Condition

Span = 1308.2 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	27.79	20071	26.35	21161
32.0	0.25	0.00	0.00	2.304	27.93	17679	25.74	19179
0.0	0.00	0.00	0.00	1.745	22.96	16276	20.72	18035
15.0	0.00	0.00	0.00	1.745	24.20	15446	21.56	17330
30.0	0.00	0.00	0.00	1.745	25.44	14695	22.44	16656
60.0	0.00	0.00	0.00	1.745	27.91	13400*	24.26	15407
90.0	0.00	0.00	0.00	1.745	30.33	12335	26.16	14292
120.0	0.00	0.00	0.00	1.745	32.68	11451	28.11	13306
167.0	0.00	0.00	0.00	1.745	35.48	10551	31.19	11996
212.0	0.00	0.00	0.00	1.745	36.45	10273	34.12	10970

* Design Condition

Span = 1089.5 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	19.24	20093	18.06	21406
32.0	0.25	0.00	0.00	2.304	19.36	17676	17.53	19515
0.0	0.00	0.00	0.00	1.745	15.05	17223	13.47	19231
15.0	0.00	0.00	0.00	1.745	16.09	16107	14.11	18365
30.0	0.00	0.00	0.00	1.745	17.16	15103	14.78	17526
60.0	0.00	0.00	0.00	1.745	19.35	13400*	16.25	15950
90.0	0.00	0.00	0.00	1.745	21.54	12042	17.84	14531
120.0	0.00	0.00	0.00	1.745	23.68	10954	19.52	13281
167.0	0.00	0.00	0.00	1.745	25.83	10047	22.26	11649
212.0	0.00	0.00	0.00	1.745	26.68	9727	24.92	10413

* Design Condition

Span = 888.6 Feet NESC Medium Load Zone

Creep IS a Factor   Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	12.78	20119	11.87	21664
32.0	0.25	0.00	0.00	2.304	12.88	17672	11.45	19878
0.0	0.00	0.00	0.00	1.745	9.39	18354	8.43	20442
15.0	0.00	0.00	0.00	1.745	10.19	16917	8.86	19441
30.0	0.00	0.00	0.00	1.745	11.04	15612	9.34	18456
60.0	0.00	0.00	0.00	1.745	12.86	13400*	10.41	16561
90.0	0.00	0.00	0.00	1.745	14.77	11674	11.64	14811
120.0	0.00	0.00	0.00	1.745	16.68	10342	13.01	13251
167.0	0.00	0.00	0.00	1.745	18.18	9488	15.35	11231
212.0	0.00	0.00	0.00	1.745	18.92	9121	17.69	9749

* Design Condition

Span = 1775.1 Feet   NESC Medium Load Zone
Creep IS a Factor   Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	51.32	20040	49.49	20776
32.0	0.25	0.00	0.00	2.304	51.48	17683	48.76	18665
0.0	0.00	0.00	0.00	1.745	45.76	15059	42.50	16210
15.0	0.00	0.00	0.00	1.745	47.22	14598	43.64	15789
30.0	0.00	0.00	0.00	1.745	48.65	14170	44.78	15387
60.0	0.00	0.00	0.00	1.745	51.46	13400*	47.09	14638
90.0	0.00	0.00	0.00	1.745	54.20	12728	49.40	13958
120.0	0.00	0.00	0.00	1.745	56.86	12138	51.70	13340
167.0	0.00	0.00	0.00	1.745	60.85	11348	55.27	12483
212.0	0.00	0.00	0.00	1.745	62.01	11138	58.64	11772

* Design Condition

Span = 1579.5 Feet   NESC Medium Load Zone
Creep IS a Factor   Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	40.58	20051	38.90	20916
32.0	0.25	0.00	0.00	2.304	40.74	17681	38.20	18850
0.0	0.00	0.00	0.00	1.745	35.26	15464	32.34	16853
15.0	0.00	0.00	0.00	1.745	36.65	14881	33.39	16329
30.0	0.00	0.00	0.00	1.745	38.02	14346	34.44	15829
60.0	0.00	0.00	0.00	1.745	40.72	13400*	36.59	14905
90.0	0.00	0.00	0.00	1.745	43.34	12593	38.76	14073
120.0	0.00	0.00	0.00	1.745	45.89	11898	40.94	13328
167.0	0.00	0.00	0.00	1.745	49.42	11053	44.34	12312
212.0	0.00	0.00	0.00	1.745	50.51	10818	47.55	11487

* Design Condition

Span = 1541.4 Feet   NESC Medium Load Zone
Creep IS a Factor   Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	38.64	20054	36.99	20947
32.0	0.25	0.00	0.00	2.304	38.79	17681	36.30	18890
0.0	0.00	0.00	0.00	1.745	33.37	15558	30.54	16998
15.0	0.00	0.00	0.00	1.745	34.74	14947	31.56	16450
30.0	0.00	0.00	0.00	1.745	36.10	14387	32.59	15929
60.0	0.00	0.00	0.00	1.745	38.77	13400*	34.70	14965
90.0	0.00	0.00	0.00	1.745	41.37	12562	36.84	14100
120.0	0.00	0.00	0.00	1.745	43.90	11844	38.99	13325
167.0	0.00	0.00	0.00	1.745	47.33	10990	42.35	12274

212.0	0.00	0.00	0.00	1.745	48.40	10749	45.52	11424

* Design Condition

Span = 945.9 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp	Ice	Wind	K	Weight	Sag	Tension	Sag	Tension
°F	in	psf	lb/ft	lb/ft	Ft	lb	Ft	lb
15.0	0.25	4.00	0.20	2.603	14.49	20111	13.49	21588
32.0	0.25	0.00	0.00	2.304	14.59	17673	13.04	19770
0.0	0.00	0.00	0.00	1.745	10.84	18008	9.72	20093
15.0	0.00	0.00	0.00	1.745	11.72	16666	10.21	19128
30.0	0.00	0.00	0.00	1.745	12.64	15452	10.74	18182
60.0	0.00	0.00	0.00	1.745	14.58	13400*	11.92	16377
90.0	0.00	0.00	0.00	1.745	16.57	11791	13.26	14725
120.0	0.00	0.00	0.00	1.745	18.55	10535	14.73	13260
167.0	0.00	0.00	0.00	1.745	20.24	9658	17.20	11362
212.0	0.00	0.00	0.00	1.745	21.01	9305	19.64	9956

* Design Condition

Span = 1437.5 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp	Ice	Wind	K	Weight	Sag	Tension	Sag	Tension
°F	in	psf	lb/ft	lb/ft	Ft	lb	Ft	lb
15.0	0.25	4.00	0.20	2.603	33.58	20061	32.02	21036
32.0	0.25	0.00	0.00	2.304	33.73	17680	31.36	19010
0.0	0.00	0.00	0.00	1.745	28.49	15846	25.90	17427
15.0	0.00	0.00	0.00	1.745	29.81	15147	26.85	16813
30.0	0.00	0.00	0.00	1.745	31.12	14510	27.82	16228
60.0	0.00	0.00	0.00	1.745	33.71	13400*	29.81	15146
90.0	0.00	0.00	0.00	1.745	36.24	12470	31.85	14178
120.0	0.00	0.00	0.00	1.745	38.69	11684	33.92	13317
167.0	0.00	0.00	0.00	1.745	41.85	10806	37.17	12160
212.0	0.00	0.00	0.00	1.745	42.88	10549	40.24	11237

* Design Condition

Span = 669.0 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp	Ice	Wind	K	Weight	Sag	Tension	Sag	Tension
°F	in	psf	lb/ft	lb/ft	Ft	lb	Ft	lb
15.0	0.25	4.00	0.20	2.603	7.23	20153	6.63	21965
32.0	0.25	0.00	0.00	2.304	7.30	17667	6.35	20306
0.0	0.00	0.00	0.00	1.745	4.94	19785	4.49	21726
15.0	0.00	0.00	0.00	1.745	5.43	17990	4.74	20618
30.0	0.00	0.00	0.00	1.745	5.99	16315	5.01	19505
60.0	0.00	0.00	0.00	1.745	7.29	13400*	5.65	17298
90.0	0.00	0.00	0.00	1.745	8.78	11122	6.44	15173
120.0	0.00	0.00	0.00	1.745	10.36	9431	7.39	13211
167.0	0.00	0.00	0.00	1.745	11.16	8754	9.19	10629
212.0	0.00	0.00	0.00	1.745	11.75	8318	11.12	8792

* Design Condition

Span = 2606.7 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp	Ice	Wind	K	Weight	Sag	Tension	Sag	Tension
°F	in	psf	lb/ft	lb/ft	Ft	lb	Ft	lb
15.0	0.25	4.00	0.20	2.603	111.26	20014	109.06	20411
32.0	0.25	0.00	0.00	2.304	111.44	17686	108.24	18201
0.0	0.00	0.00	0.00	1.745	105.22	14177	101.23	14730
15.0	0.00	0.00	0.00	1.745	106.80	13971	102.55	14543
30.0	0.00	0.00	0.00	1.745	108.35	13773	103.86	14361

60.0	0.00	0.00	0.00	1.745	111.42	13400*	106.48	14012
90.0	0.00	0.00	0.00	1.745	114.42	13054	109.09	13682
120.0	0.00	0.00	0.00	1.745	117.36	12731	111.68	13369
167.0	0.00	0.00	0.00	1.745	121.86	12269	115.70	12911
212.0	0.00	0.00	0.00	1.745	124.17	12044	119.50	12507

* Design Condition

Span = 721.9 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	8.42	20145	7.75	21892
32.0	0.25	0.00	0.00	2.304	8.50	17668	7.43	20202
0.0	0.00	0.00	0.00	1.745	5.85	19433	5.31	21430
15.0	0.00	0.00	0.00	1.745	6.42	17720	5.59	20343
30.0	0.00	0.00	0.00	1.745	7.05	16134	5.90	19258
60.0	0.00	0.00	0.00	1.745	8.49	13400*	6.64	17119
90.0	0.00	0.00	0.00	1.745	10.09	11272	7.54	15082
120.0	0.00	0.00	0.00	1.745	11.76	9679	8.60	13221
167.0	0.00	0.00	0.00	1.745	12.73	8943	10.54	10790
212.0	0.00	0.00	0.00	1.745	13.35	8526	12.58	9049

* Design Condition

Southwire SAG10™

6/24/2010

David Evans and Associates

Susquehanna - Roseland 500kV
S&L P&P

Conductor: 1590.0 Kcmil 54/19 Stranding ACSR "FALCON"

Area = 1.4070 Sq. in Diameter = 1.545 in Weight = 2.044 lb/ft RTS = 54500 lb
Data from Chart No. 1-1009
English Units
Limits and Outputs in Average Tensions.

Span = 152.4 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	0.44	18860	0.37	22902
32.0	0.25	0.00	0.00	2.602	0.47	16232	0.35	21520
0.0	0.00	0.00	0.00	2.044	0.28	21011	0.25	23991
15.0	0.00	0.00	0.00	2.044	0.32	18699	0.26	22840
30.0	0.00	0.00	0.00	2.044	0.36	16403	0.27	21639
60.0	0.00	0.00	0.00	2.044	0.50	11905	0.31	19074*
90.0	0.00	0.00	0.00	2.044	0.76	7768	0.36	16279
120.0	0.00	0.00	0.00	2.044	1.07	5561	0.45	13246
167.0	0.00	0.00	0.00	2.044	1.31	4529	0.73	8171
212.0	0.00	0.00	0.00	2.044	1.61	3697	1.39	4277

* Design Condition

Span = 864.5 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	13.54	19964	11.43	23628
32.0	0.25	0.00	0.00	2.602	13.78	17653	11.04	22025
0.0	0.00	0.00	0.00	2.044	10.37	18421	8.30	23018
15.0	0.00	0.00	0.00	2.044	11.23	17022	8.68	22017
30.0	0.00	0.00	0.00	2.044	12.13	15758	9.09	21006
60.0	0.00	0.00	0.00	2.044	14.03	13625*	10.07	18979
90.0	0.00	0.00	0.00	2.044	15.99	11958	11.24	16998
120.0	0.00	0.00	0.00	2.044	17.94	10663	12.62	15141
167.0	0.00	0.00	0.00	2.044	20.88	9168	15.13	12636
212.0	0.00	0.00	0.00	2.044	22.52	8504	17.75	10776

* Design Condition

Span = 1105.5 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	22.34	19790	19.35	22845
32.0	0.25	0.00	0.00	2.602	22.66	17574	18.85	21116
0.0	0.00	0.00	0.00	2.044	18.35	17032	14.73	21214
15.0	0.00	0.00	0.00	2.044	19.49	16040	15.37	20327

30.0	0.00	0.00	0.00	2.044	20.64	15147	16.07	19451
60.0	0.00	0.00	0.00	2.044	22.96	13625*	17.60	17759
90.0	0.00	0.00	0.00	2.044	25.24	12395	19.32	16185
120.0	0.00	0.00	0.00	2.044	27.47	11394	21.18	14765
167.0	0.00	0.00	0.00	2.044	30.82	10163	24.29	12881
212.0	0.00	0.00	0.00	2.044	33.51	9352	27.34	11448

* Design Condition

Span = 1455.0 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	39.09	19621	35.03	21880
32.0	0.25	0.00	0.00	2.602	39.47	17499	34.46	20029
0.0	0.00	0.00	0.00	2.044	34.42	15749	28.76	18836
15.0	0.00	0.00	0.00	2.044	35.79	15149	29.79	18186
30.0	0.00	0.00	0.00	2.044	37.15	14598	30.86	17562
60.0	0.00	0.00	0.00	2.044	39.82	13625*	33.06	16393
90.0	0.00	0.00	0.00	2.044	42.41	12797	35.35	15337
120.0	0.00	0.00	0.00	2.044	44.93	12085	37.69	14391
167.0	0.00	0.00	0.00	2.044	48.72	11153	41.37	13116
212.0	0.00	0.00	0.00	2.044	52.17	10421	44.88	12099

* Design Condition

Span = 1218.1 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	27.23	19727	23.85	22506
32.0	0.25	0.00	0.00	2.602	27.56	17545	23.31	20730
0.0	0.00	0.00	0.00	2.044	22.96	16534	18.61	20389
15.0	0.00	0.00	0.00	2.044	24.19	15694	19.39	19573
30.0	0.00	0.00	0.00	2.044	25.43	14934	20.21	18776
60.0	0.00	0.00	0.00	2.044	27.88	13625*	21.99	17259
90.0	0.00	0.00	0.00	2.044	30.29	12548	23.93	15869
120.0	0.00	0.00	0.00	2.044	32.62	11655	25.97	14624
167.0	0.00	0.00	0.00	2.044	36.13	10531	29.30	12970
212.0	0.00	0.00	0.00	2.044	39.29	9688	32.52	11693

* Design Condition

Span = 821.8 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	12.26	19914	10.32	23652
32.0	0.25	0.00	0.00	2.602	12.50	17590	9.96	22069
0.0	0.00	0.00	0.00	2.044	9.28	18605	7.44	23192
15.0	0.00	0.00	0.00	2.044	10.08	17136	7.78	22177
30.0	0.00	0.00	0.00	2.044	10.93	15805	8.16	21149
60.0	0.00	0.00	0.00	2.044	12.74	13557	9.05	19075*
90.0	0.00	0.00	0.00	2.044	14.63	11808	10.14	17033
120.0	0.00	0.00	0.00	2.044	16.52	10462	11.43	15105
167.0	0.00	0.00	0.00	2.044	19.37	8928	13.83	12494
212.0	0.00	0.00	0.00	2.044	20.83	8306	16.36	10563

* Design Condition

Span = 2022.0 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb

15.0	0.25	4.00	0.20	2.890	76.28	19471	71.17	20854
32.0	0.25	0.00	0.00	2.602	76.72	17433	70.60	18929
0.0	0.00	0.00	0.00	2.044	71.16	14752	63.79	16441
15.0	0.00	0.00	0.00	2.044	72.68	14447	65.15	16100
30.0	0.00	0.00	0.00	2.044	74.18	14158	66.52	15772
60.0	0.00	0.00	0.00	2.044	77.11	13625*	69.25	15155
90.0	0.00	0.00	0.00	2.044	79.98	13143	71.98	14587
120.0	0.00	0.00	0.00	2.044	82.78	12704	74.68	14063
167.0	0.00	0.00	0.00	2.044	87.02	12093	78.88	13324
212.0	0.00	0.00	0.00	2.044	90.95	11579	82.82	12698

* Design Condition

Span = 1129.4 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	23.34	19776	20.26	22771
32.0	0.25	0.00	0.00	2.602	23.66	17568	19.75	21032
0.0	0.00	0.00	0.00	2.044	19.28	16919	15.50	21036
15.0	0.00	0.00	0.00	2.044	20.45	15961	16.18	20163
30.0	0.00	0.00	0.00	2.044	21.62	15099	16.90	19304
60.0	0.00	0.00	0.00	2.044	23.96	13625*	18.49	17649
90.0	0.00	0.00	0.00	2.044	26.28	12430	20.25	16115
120.0	0.00	0.00	0.00	2.044	28.53	11453	22.15	14733
167.0	0.00	0.00	0.00	2.044	31.91	10246	25.31	12901
212.0	0.00	0.00	0.00	2.044	34.71	9426	28.40	11504

* Design Condition

Span = 1308.2 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	31.48	19682	27.83	22253
32.0	0.25	0.00	0.00	2.602	31.84	17526	27.27	20445
0.0	0.00	0.00	0.00	2.044	27.04	16198	22.15	19763
15.0	0.00	0.00	0.00	2.044	28.34	15460	23.03	19009
30.0	0.00	0.00	0.00	2.044	29.62	14790	23.95	18279
60.0	0.00	0.00	0.00	2.044	32.17	13625*	25.91	16900
90.0	0.00	0.00	0.00	2.044	34.65	12653	28.00	15647
120.0	0.00	0.00	0.00	2.044	37.06	11835	30.17	14526
167.0	0.00	0.00	0.00	2.044	40.69	10789	33.64	13031
212.0	0.00	0.00	0.00	2.044	43.98	9988	36.98	11862

* Design Condition

Span = 1089.5 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	21.69	19800	18.75	22895
32.0	0.25	0.00	0.00	2.602	22.00	17579	18.25	21174
0.0	0.00	0.00	0.00	2.044	17.74	17111	14.23	21335
15.0	0.00	0.00	0.00	2.044	18.87	16095	14.85	20438
30.0	0.00	0.00	0.00	2.044	20.00	15181	15.52	19551
60.0	0.00	0.00	0.00	2.044	22.30	13625*	17.02	17835
90.0	0.00	0.00	0.00	2.044	24.56	12371	18.70	16234
120.0	0.00	0.00	0.00	2.044	26.78	11353	20.54	14787
167.0	0.00	0.00	0.00	2.044	30.10	10107	23.61	12868
212.0	0.00	0.00	0.00	2.044	32.72	9301	26.64	11411

* Design Condition

Span = 888.6 Feet

NESC Medium Load Zone

Creep IS a Factor　　　　Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	14.32	19944	12.12	23549
32.0	0.25	0.00	0.00	2.602	14.57	17644	11.72	21931
0.0	0.00	0.00	0.00	2.044	11.05	18263	8.84	22842
15.0	0.00	0.00	0.00	2.044	11.94	16909	9.24	21850
30.0	0.00	0.00	0.00	2.044	12.87	15687	9.68	20850
60.0	0.00	0.00	0.00	2.044	14.82	13625*	10.71	18851
90.0	0.00	0.00	0.00	2.044	16.82	12010	11.94	16910
120.0	0.00	0.00	0.00	2.044	18.80	10749	13.37	15099
167.0	0.00	0.00	0.00	2.044	21.79	9283	15.95	12665
212.0	0.00	0.00	0.00	2.044	23.53	8597	18.62	10854

* Design Condition

Span = 1775.1 Feet　　　　NESC Medium Load Zone
Creep IS a Factor　　　　Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	58.56	19523	53.82	21227
32.0	0.25	0.00	0.00	2.602	58.97	17456	53.23	19322
0.0	0.00	0.00	0.00	2.044	53.58	15081	46.74	17271
15.0	0.00	0.00	0.00	2.044	55.05	14680	48.01	16819
30.0	0.00	0.00	0.00	2.044	56.50	14306	49.28	16387
60.0	0.00	0.00	0.00	2.044	59.35	13625*	51.85	15579
90.0	0.00	0.00	0.00	2.044	62.12	13023	54.44	14844
120.0	0.00	0.00	0.00	2.044	64.82	12487	57.02	14176
167.0	0.00	0.00	0.00	2.044	68.90	11756	61.04	13251
212.0	0.00	0.00	0.00	2.044	72.65	11156	64.82	12486

* Design Condition

Span = 1579.5 Feet　　　　NESC Medium Load Zone
Creep IS a Factor　　　　Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	46.19	19578	41.84	21600
32.0	0.25	0.00	0.00	2.602	46.58	17480	41.25	19723
0.0	0.00	0.00	0.00	2.044	41.38	15447	35.18	18153
15.0	0.00	0.00	0.00	2.044	42.80	14938	36.32	17587
30.0	0.00	0.00	0.00	2.044	44.20	14467	37.48	17045
60.0	0.00	0.00	0.00	2.044	46.95	13625*	39.86	16034
90.0	0.00	0.00	0.00	2.044	49.62	12897	42.28	15119
120.0	0.00	0.00	0.00	2.044	52.22	12261	44.73	14296
167.0	0.00	0.00	0.00	2.044	56.13	11414	48.56	13175
212.0	0.00	0.00	0.00	2.044	59.71	10737	52.19	12268

* Design Condition

Span = 1541.4 Feet　　　　NESC Medium Load Zone
Creep IS a Factor　　　　Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	43.95	19590	39.69	21682
32.0	0.25	0.00	0.00	2.602	44.34	17485	39.11	19812
0.0	0.00	0.00	0.00	2.044	39.18	15533	33.14	18351
15.0	0.00	0.00	0.00	2.044	40.59	14998	34.25	17760
30.0	0.00	0.00	0.00	2.044	41.98	14504	35.38	17194
60.0	0.00	0.00	0.00	2.044	44.70	13625*	37.71	16137
90.0	0.00	0.00	0.00	2.044	47.35	12868	40.09	15181
120.0	0.00	0.00	0.00	2.044	49.93	12210	42.51	14323
167.0	0.00	0.00	0.00	2.044	53.80	11338	46.30	13158

212.0	0.00	0.00	0.00	2.044	57.34	10645	49.89	12219

* Design Condition

Span = 945.9 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp	Ice	Wind	K	Weight	Sag	Tension	Sag	Tension
°F	in	psf	lb/ft	lb/ft	Ft	lb	Ft	lb
15.0	0.25	4.00	0.20	2.890	16.26	19899	13.85	23359
32.0	0.25	0.00	0.00	2.602	16.53	17623	13.42	21710
0.0	0.00	0.00	0.00	2.044	12.78	17903	10.20	22416
15.0	0.00	0.00	0.00	2.044	13.74	16652	10.66	21447
30.0	0.00	0.00	0.00	2.044	14.74	15526	11.17	20475
60.0	0.00	0.00	0.00	2.044	16.80	13625*	12.33	18551
90.0	0.00	0.00	0.00	2.044	18.88	12125	13.70	16705
120.0	0.00	0.00	0.00	2.044	20.94	10940	15.25	15002
167.0	0.00	0.00	0.00	2.044	24.02	9541	17.99	12728
212.0	0.00	0.00	0.00	2.044	26.02	8812	20.77	11030

* Design Condition

Span = 1437.5 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp	Ice	Wind	K	Weight	Sag	Tension	Sag	Tension
°F	in	psf	lb/ft	lb/ft	Ft	lb	Ft	lb
15.0	0.25	4.00	0.20	2.890	38.14	19627	34.13	21921
32.0	0.25	0.00	0.00	2.602	38.51	17502	33.55	20075
0.0	0.00	0.00	0.00	2.044	33.49	15797	27.92	18939
15.0	0.00	0.00	0.00	2.044	34.86	15182	28.93	18277
30.0	0.00	0.00	0.00	2.044	36.21	14618	29.98	17641
60.0	0.00	0.00	0.00	2.044	38.86	13625*	32.16	16449
90.0	0.00	0.00	0.00	2.044	41.45	12781	34.43	15370
120.0	0.00	0.00	0.00	2.044	43.95	12058	36.75	14406
167.0	0.00	0.00	0.00	2.044	47.72	11113	40.41	13106
212.0	0.00	0.00	0.00	2.044	51.16	10373	43.89	12073

* Design Condition

Span = 669.0 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp	Ice	Wind	K	Weight	Sag	Tension	Sag	Tension
°F	in	psf	lb/ft	lb/ft	Ft	lb	Ft	lb
15.0	0.25	4.00	0.20	2.890	8.28	19532	6.90	23431
32.0	0.25	0.00	0.00	2.602	8.49	17166	6.65	21908
0.0	0.00	0.00	0.00	2.044	6.00	19075	4.88	23450
15.0	0.00	0.00	0.00	2.044	6.59	17367	5.11	22388
30.0	0.00	0.00	0.00	2.044	7.24	15799	5.37	21301
60.0	0.00	0.00	0.00	2.044	8.72	13128	6.00	19075*
90.0	0.00	0.00	0.00	2.044	10.33	11078	6.80	16830
120.0	0.00	0.00	0.00	2.044	11.99	9553	7.80	14659
167.0	0.00	0.00	0.00	2.044	14.35	7986	9.80	11683
212.0	0.00	0.00	0.00	2.044	15.32	7478	12.01	9534

* Design Condition

Span = 2606.8 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp	Ice	Wind	K	Weight	Sag	Tension	Sag	Tension
°F	in	psf	lb/ft	lb/ft	Ft	lb	Ft	lb
15.0	0.25	4.00	0.20	2.890	127.79	19394	122.12	20277
32.0	0.25	0.00	0.00	2.602	128.25	17400	121.58	18338
0.0	0.00	0.00	0.00	2.044	122.49	14300	114.48	15283
15.0	0.00	0.00	0.00	2.044	124.06	14122	115.95	15093
30.0	0.00	0.00	0.00	2.044	125.61	13951	117.41	14907

60.0	0.00	0.00	0.00	2.044	128.67	13625*	120.33	14552
90.0	0.00	0.00	0.00	2.044	131.67	13320	123.22	14216
120.0	0.00	0.00	0.00	2.044	134.63	13034	126.09	13898
167.0	0.00	0.00	0.00	2.044	139.15	12619	130.54	13434
212.0	0.00	0.00	0.00	2.044	143.37	12256	134.73	13024

* Design Condition

Southwire SAG10™

6/22/2010

David Evans and Associates

Susquehanna - Roseland 500kV
B&M P&P

Conductor: 1594.0 Kcmil 54/19 Stranding ACCR "FALCON"

Area = 1.4110 Sq. in Diameter = 1.547 in Weight = 1.745 lb/ft RTS = 53600 lb
Data from Chart No. 4-1100
English Units
Limits and Outputs in Average Tensions.

Span = 152.4 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp	Ice	Wind	K	Weight	Sag	Tension	Sag	Tension
°F	in	psf	lb/ft	lb/ft	Ft	lb	Ft	lb
15.0	0.25	4.00	0.20	2.603	0.37	20230	0.34	22495
32.0	0.25	0.00	0.00	2.304	0.38	17655	0.32	21064
0.0	0.00	0.00	0.00	1.745	0.23	22348	0.21	23629
15.0	0.00	0.00	0.00	1.745	0.25	20091	0.23	22421
30.0	0.00	0.00	0.00	1.745	0.28	17843	0.24	21180
60.0	0.00	0.00	0.00	1.745	0.38	13399*	0.27	18603
90.0	0.00	0.00	0.00	1.745	0.55	9142	0.32	15907
120.0	0.00	0.00	0.00	1.745	0.68	7491	0.39	13112
167.0	0.00	0.00	0.00	1.745	0.76	6648	0.59	8653
212.0	0.00	0.00	0.00	1.745	0.86	5871	0.83	6101

* Design Condition

Span = 839.0 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp	Ice	Wind	K	Weight	Sag	Tension	Sag	Tension
°F	in	psf	lb/ft	lb/ft	Ft	lb	Ft	lb
15.0	0.25	4.00	0.20	2.603	11.39	20126	10.54	21731
32.0	0.25	0.00	0.00	2.304	11.48	17671	10.15	19973
0.0	0.00	0.00	0.00	1.745	8.23	18666	7.40	20742
15.0	0.00	0.00	0.00	1.745	8.96	17145	7.79	19713
30.0	0.00	0.00	0.00	1.745	9.75	15758	8.22	18695
60.0	0.00	0.00	0.00	1.745	11.47	13400*	9.19	16723
90.0	0.00	0.00	0.00	1.745	13.29	11565	10.32	14888
120.0	0.00	0.00	0.00	1.745	15.13	10162	11.60	13243
167.0	0.00	0.00	0.00	1.745	16.47	9334	13.84	11109
212.0	0.00	0.00	0.00	1.745	17.18	8953	16.09	9556

* Design Condition

Span = 418.0 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp	Ice	Wind	K	Weight	Sag	Tension	Sag	Tension
°F	in	psf	lb/ft	lb/ft	Ft	lb	Ft	lb
15.0	0.25	4.00	0.20	2.603	2.82	20196	2.55	22280
32.0	0.25	0.00	0.00	2.304	2.85	17660	2.42	20757
0.0	0.00	0.00	0.00	1.745	1.79	21324	1.66	22913
15.0	0.00	0.00	0.00	1.745	1.98	19224	1.75	21734

30.0	0.00	0.00	0.00	1.745	2.22	17186	1.86	20534
60.0	0.00	0.00	0.00	1.745	2.84	13400*	2.11	18080
90.0	0.00	0.00	0.00	1.745	3.72	10243	2.44	15596
120.0	0.00	0.00	0.00	1.745	4.56	8371	2.90	13157
167.0	0.00	0.00	0.00	1.745	4.92	7747	3.92	9722
212.0	0.00	0.00	0.00	1.745	5.30	7194	5.19	7353

* Design Condition

Span = 708.0 Feet — NESC Medium Load Zone
Creep IS a Factor — Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	8.10	20147	7.45	21912
32.0	0.25	0.00	0.00	2.304	8.17	17668	7.14	20230
0.0	0.00	0.00	0.00	1.745	5.60	19526	5.08	21509
15.0	0.00	0.00	0.00	1.745	6.15	17791	5.36	20416
30.0	0.00	0.00	0.00	1.745	6.76	16181	5.66	19323
60.0	0.00	0.00	0.00	1.745	8.16	13400*	6.37	17166
90.0	0.00	0.00	0.00	1.745	9.74	11234	7.24	15106
120.0	0.00	0.00	0.00	1.745	11.38	9616	8.28	13218
167.0	0.00	0.00	0.00	1.745	12.31	8894	10.18	10749
212.0	0.00	0.00	0.00	1.745	12.92	8473	12.19	8983

* Design Condition

Span = 574.0 Feet — NESC Medium Load Zone
Creep IS a Factor — Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	5.32	20169	4.85	22092
32.0	0.25	0.00	0.00	2.304	5.37	17665	4.63	20487
0.0	0.00	0.00	0.00	1.745	3.52	20404	3.23	22222
15.0	0.00	0.00	0.00	1.745	3.89	18476	3.41	21081
30.0	0.00	0.00	0.00	1.745	4.32	16649	3.61	19929
60.0	0.00	0.00	0.00	1.745	5.37	13400*	4.08	17612
90.0	0.00	0.00	0.00	1.745	6.64	10823	4.69	15337
120.0	0.00	0.00	0.00	1.745	8.05	8932	5.45	13190
167.0	0.00	0.00	0.00	1.745	8.57	8392	6.97	10314
212.0	0.00	0.00	0.00	1.745	9.08	7920	8.69	8280

* Design Condition

Span = 1058.0 Feet — NESC Medium Load Zone
Creep IS a Factor — Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	18.14	20097	17.00	21444
32.0	0.25	0.00	0.00	2.304	18.26	17675	16.49	19569
0.0	0.00	0.00	0.00	1.745	14.06	17384	12.58	19417
15.0	0.00	0.00	0.00	1.745	15.06	16221	13.19	18528
30.0	0.00	0.00	0.00	1.745	16.11	15174	13.83	17665
60.0	0.00	0.00	0.00	1.745	18.24	13400*	15.24	16040
90.0	0.00	0.00	0.00	1.745	20.39	11991	16.77	14571
120.0	0.00	0.00	0.00	1.745	22.50	10869	18.41	13276
167.0	0.00	0.00	0.00	1.745	24.55	9966	21.10	11591
212.0	0.00	0.00	0.00	1.745	25.39	9639	23.71	10320

* Design Condition

Span = 588.0 Feet — NESC Medium Load Zone
Creep IS a Factor — Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb

15.0	0.25	4.00	0.20	2.603	5.58	20167	5.10	22073
32.0	0.25	0.00	0.00	2.304	5.64	17665	4.87	20461
0.0	0.00	0.00	0.00	1.745	3.71	20314	3.40	22153
15.0	0.00	0.00	0.00	1.745	4.10	18405	3.59	21016
30.0	0.00	0.00	0.00	1.745	4.54	16600	3.80	19868
60.0	0.00	0.00	0.00	1.745	5.63	13400*	4.29	17567
90.0	0.00	0.00	0.00	1.745	6.94	10869	4.93	15313
120.0	0.00	0.00	0.00	1.745	8.38	9011	5.72	13194
167.0	0.00	0.00	0.00	1.745	8.94	8447	7.28	10363
212.0	0.00	0.00	0.00	1.745	9.46	7980	9.03	8360

* Design Condition

Span = 528.0 Feet	NESC Medium Load Zone
Creep IS a Factor	Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	4.50	20177	4.10	22150
32.0	0.25	0.00	0.00	2.304	4.55	17663	3.90	20571
0.0	0.00	0.00	0.00	1.745	2.94	20691	2.71	22444
15.0	0.00	0.00	0.00	1.745	3.25	18707	2.86	21290
30.0	0.00	0.00	0.00	1.745	3.62	16812	3.02	20121
60.0	0.00	0.00	0.00	1.745	4.54	13400*	3.42	17758
90.0	0.00	0.00	0.00	1.745	5.71	10663	3.95	15416
120.0	0.00	0.00	0.00	1.745	6.94	8766	4.61	13181
167.0	0.00	0.00	0.00	1.745	7.41	8208	6.00	10148
212.0	0.00	0.00	0.00	1.745	7.89	7715	7.60	8007

* Design Condition

Span = 750.0 Feet	NESC Medium Load Zone
Creep IS a Factor	Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	9.09	20140	8.38	21854
32.0	0.25	0.00	0.00	2.304	9.17	17669	8.04	20147
0.0	0.00	0.00	0.00	1.745	6.38	19247	5.77	21269
15.0	0.00	0.00	0.00	1.745	6.98	17579	6.08	20194
30.0	0.00	0.00	0.00	1.745	7.65	16040	6.42	19124
60.0	0.00	0.00	0.00	1.745	9.16	13400*	7.21	17023
90.0	0.00	0.00	0.00	1.745	10.82	11347	8.16	15034
120.0	0.00	0.00	0.00	1.745	12.53	9802	9.28	13226
167.0	0.00	0.00	0.00	1.745	13.59	9041	11.30	10871
212.0	0.00	0.00	0.00	1.745	14.23	8633	13.39	9178

* Design Condition

Span = 2024.0 Feet	NESC Medium Load Zone
Creep IS a Factor	Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	66.83	20030	64.85	20634
32.0	0.25	0.00	0.00	2.304	67.00	17684	64.08	18482
0.0	0.00	0.00	0.00	1.745	61.06	14687	57.48	15597
15.0	0.00	0.00	0.00	1.745	62.57	14336	58.70	15274
30.0	0.00	0.00	0.00	1.745	64.06	14005	59.92	14964
60.0	0.00	0.00	0.00	1.745	66.98	13400*	62.37	14382
90.0	0.00	0.00	0.00	1.745	69.82	12859	64.80	13846
120.0	0.00	0.00	0.00	1.745	72.59	12374	67.22	13352
167.0	0.00	0.00	0.00	1.745	76.78	11705	70.97	12653
212.0	0.00	0.00	0.00	1.745	78.33	11476	74.50	12059

* Design Condition

Span = 1129.0 Feet	NESC Medium Load Zone

Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	20.67	20089	19.44	21358
32.0	0.25	0.00	0.00	2.304	20.79	17676	18.89	19450
0.0	0.00	0.00	0.00	1.745	16.34	17029	14.64	19002
15.0	0.00	0.00	0.00	1.745	17.42	15971	15.32	18165
30.0	0.00	0.00	0.00	1.745	18.53	15019	16.03	17356
60.0	0.00	0.00	0.00	1.745	20.78	13400*	17.57	15843
90.0	0.00	0.00	0.00	1.745	23.01	12102	19.22	14483
120.0	0.00	0.00	0.00	1.745	25.20	11055	20.96	13286
167.0	0.00	0.00	0.00	1.745	27.47	10146	23.77	11719
212.0	0.00	0.00	0.00	1.745	28.34	9834	26.47	10525

* Design Condition

Span = 1308.0 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	27.78	20072	26.34	21161
32.0	0.25	0.00	0.00	2.304	27.92	17679	25.73	19179
0.0	0.00	0.00	0.00	1.745	22.96	16277	20.71	18036
15.0	0.00	0.00	0.00	1.745	24.19	15446	21.56	17331
30.0	0.00	0.00	0.00	1.745	25.43	14695	22.43	16657
60.0	0.00	0.00	0.00	1.745	27.90	13400*	24.25	15408
90.0	0.00	0.00	0.00	1.745	30.32	12335	26.15	14292
120.0	0.00	0.00	0.00	1.745	32.67	11451	28.10	13306
167.0	0.00	0.00	0.00	1.745	35.47	10551	31.18	11996
212.0	0.00	0.00	0.00	1.745	36.44	10273	34.11	10970

* Design Condition

Span = 1089.0 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	19.22	20094	18.04	21407
32.0	0.25	0.00	0.00	2.304	19.34	17676	17.52	19517
0.0	0.00	0.00	0.00	1.745	15.03	17225	13.46	19234
15.0	0.00	0.00	0.00	1.745	16.07	16109	14.09	18368
30.0	0.00	0.00	0.00	1.745	17.14	15104	14.77	17529
60.0	0.00	0.00	0.00	1.745	19.33	13400*	16.23	15952
90.0	0.00	0.00	0.00	1.745	21.52	12041	17.82	14532
120.0	0.00	0.00	0.00	1.745	23.66	10953	19.50	13281
167.0	0.00	0.00	0.00	1.745	25.81	10046	22.24	11649
212.0	0.00	0.00	0.00	1.745	26.66	9726	24.90	10412

* Design Condition

Span = 869.0 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	12.22	20122	11.33	21691
32.0	0.25	0.00	0.00	2.304	12.32	17672	10.93	19916
0.0	0.00	0.00	0.00	1.745	8.92	18476	8.01	20560
15.0	0.00	0.00	0.00	1.745	9.69	17006	8.43	19548
30.0	0.00	0.00	0.00	1.745	10.52	15668	8.88	18550
60.0	0.00	0.00	0.00	1.745	12.30	13400*	9.91	16624
90.0	0.00	0.00	0.00	1.745	14.18	11632	11.11	14841
120.0	0.00	0.00	0.00	1.745	16.06	10272	12.44	13248
167.0	0.00	0.00	0.00	1.745	17.50	9428	14.75	11184

212.0	0.00	0.00	0.00	1.745	18.22	9056	17.05	9674

* Design Condition

Span = 1795.0 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	52.49	20040	50.64	20763
32.0	0.25	0.00	0.00	2.304	52.65	17683	49.91	18649
0.0	0.00	0.00	0.00	1.745	46.91	15024	43.61	16154
15.0	0.00	0.00	0.00	1.745	48.37	14573	44.76	15741
30.0	0.00	0.00	0.00	1.745	49.81	14154	45.91	15348
60.0	0.00	0.00	0.00	1.745	52.63	13400*	48.23	14614
90.0	0.00	0.00	0.00	1.745	55.37	12740	50.55	13947
120.0	0.00	0.00	0.00	1.745	58.04	12159	52.86	13341
167.0	0.00	0.00	0.00	1.745	62.07	11377	56.45	12499
212.0	0.00	0.00	0.00	1.745	63.24	11168	59.83	11798

* Design Condition

Span = 1410.0 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	32.30	20063	30.77	21062
32.0	0.25	0.00	0.00	2.304	32.45	17680	30.12	19044
0.0	0.00	0.00	0.00	1.745	27.26	15930	24.74	17550
15.0	0.00	0.00	0.00	1.745	28.57	15206	25.67	16917
30.0	0.00	0.00	0.00	1.745	29.86	14547	26.62	16314
60.0	0.00	0.00	0.00	1.745	32.43	13400*	28.58	15198
90.0	0.00	0.00	0.00	1.745	34.94	12443	30.60	14201
120.0	0.00	0.00	0.00	1.745	37.37	11637	32.64	13315
167.0	0.00	0.00	0.00	1.745	40.46	10754	35.85	12127
212.0	0.00	0.00	0.00	1.745	41.47	10493	38.89	11184

* Design Condition

Span = 669.0 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	7.23	20153	6.63	21965
32.0	0.25	0.00	0.00	2.304	7.30	17667	6.35	20306
0.0	0.00	0.00	0.00	1.745	4.94	19785	4.49	21726
15.0	0.00	0.00	0.00	1.745	5.43	17990	4.74	20618
30.0	0.00	0.00	0.00	1.745	5.99	16315	5.01	19505
60.0	0.00	0.00	0.00	1.745	7.29	13400*	5.65	17298
90.0	0.00	0.00	0.00	1.745	8.78	11122	6.44	15173
120.0	0.00	0.00	0.00	1.745	10.36	9431	7.39	13211
167.0	0.00	0.00	0.00	1.745	11.16	8754	9.19	10629
212.0	0.00	0.00	0.00	1.745	11.75	8318	11.12	8792

* Design Condition

Span = 2606.7 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	111.26	20014	109.06	20411
32.0	0.25	0.00	0.00	2.304	111.44	17686	108.24	18201
0.0	0.00	0.00	0.00	1.745	105.22	14177	101.23	14730
15.0	0.00	0.00	0.00	1.745	106.80	13971	102.55	14543
30.0	0.00	0.00	0.00	1.745	108.35	13773	103.86	14361

60.0	0.00	0.00	0.00	1.745	111.42	13400*	106.48	14012
90.0	0.00	0.00	0.00	1.745	114.42	13054	109.09	13682
120.0	0.00	0.00	0.00	1.745	117.36	12731	111.68	13369
167.0	0.00	0.00	0.00	1.745	121.86	12269	115.70	12911
212.0	0.00	0.00	0.00	1.745	124.17	12044	119.50	12507

* Design Condition

Span = 721.9 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.603	8.42	20145	7.75	21892
32.0	0.25	0.00	0.00	2.304	8.50	17668	7.43	20202
0.0	0.00	0.00	0.00	1.745	5.85	19433	5.31	21430
15.0	0.00	0.00	0.00	1.745	6.42	17720	5.59	20343
30.0	0.00	0.00	0.00	1.745	7.05	16134	5.90	19258
60.0	0.00	0.00	0.00	1.745	8.49	13400*	6.64	17119
90.0	0.00	0.00	0.00	1.745	10.09	11272	7.54	15082
120.0	0.00	0.00	0.00	1.745	11.76	9679	8.60	13221
167.0	0.00	0.00	0.00	1.745	12.73	8943	10.54	10790
212.0	0.00	0.00	0.00	1.745	13.35	8526	12.58	9049

* Design Condition

Southwire SAG10™

6/22/2010

David Evans and Associates

Susquehanna - Roseland 500kV
B&M P&P

Conductor: 1590.0 Kcmil 54/19 Stranding ACSR "FALCON"

Area = 1.4070 Sq. in Diameter = 1.545 in Weight = 2.044 lb/ft RTS = 54500 lb
Data from Chart No. 1-1009
English Units
Limits and Outputs in Average Tensions.

Span = 152.4 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	0.44	18860	0.37	22902
32.0	0.25	0.00	0.00	2.602	0.47	16232	0.35	21520
0.0	0.00	0.00	0.00	2.044	0.28	21011	0.25	23991
15.0	0.00	0.00	0.00	2.044	0.32	18699	0.26	22840
30.0	0.00	0.00	0.00	2.044	0.36	16403	0.27	21639
60.0	0.00	0.00	0.00	2.044	0.50	11905	0.31	19074*
90.0	0.00	0.00	0.00	2.044	0.76	7768	0.36	16279
120.0	0.00	0.00	0.00	2.044	1.07	5561	0.45	13246
167.0	0.00	0.00	0.00	2.044	1.31	4529	0.73	8171
212.0	0.00	0.00	0.00	2.044	1.61	3697	1.39	4277

* Design Condition

Span = 839.0 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	12.75	19960	10.75	23677
32.0	0.25	0.00	0.00	2.602	12.99	17639	10.37	22087
0.0	0.00	0.00	0.00	2.044	9.70	18560	7.77	23162
15.0	0.00	0.00	0.00	2.044	10.51	17117	8.12	22153
30.0	0.00	0.00	0.00	2.044	11.38	15811	8.51	21131
60.0	0.00	0.00	0.00	2.044	13.23	13604	9.43	19075*
90.0	0.00	0.00	0.00	2.044	15.15	11885	10.55	17056
120.0	0.00	0.00	0.00	2.044	17.07	10556	11.88	15153
167.0	0.00	0.00	0.00	2.044	19.95	9034	14.32	12578
212.0	0.00	0.00	0.00	2.044	21.48	8394	16.88	10670

* Design Condition

Span = 418.0 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	3.31	19056	2.73	23113
32.0	0.25	0.00	0.00	2.602	3.43	16571	2.62	21675
0.0	0.00	0.00	0.00	2.044	2.22	20076	1.88	23788
15.0	0.00	0.00	0.00	2.044	2.48	17996	1.97	22669

30.0	0.00	0.00	0.00	2.044	2.79	16007	2.08	21509
60.0	0.00	0.00	0.00	2.044	3.59	12439	2.34	19075*
90.0	0.00	0.00	0.00	2.044	4.63	9637	2.70	16511
120.0	0.00	0.00	0.00	2.044	5.82	7674	3.21	13893
167.0	0.00	0.00	0.00	2.044	6.91	6471	4.43	10091
212.0	0.00	0.00	0.00	2.044	7.60	5881	6.02	7426

* Design Condition

Span = 708.0 Feet — NESC Medium Load Zone
Creep IS a Factor — Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	9.23	19625	7.71	23486
32.0	0.25	0.00	0.00	2.602	9.45	17272	7.43	21948
0.0	0.00	0.00	0.00	2.044	6.76	18943	5.48	23387
15.0	0.00	0.00	0.00	2.044	7.41	17297	5.74	22336
30.0	0.00	0.00	0.00	2.044	8.11	15792	6.02	21264
60.0	0.00	0.00	0.00	2.044	9.68	13238	6.72	19075*
90.0	0.00	0.00	0.00	2.044	11.37	11274	7.59	16882
120.0	0.00	0.00	0.00	2.044	13.09	9799	8.67	14776
167.0	0.00	0.00	0.00	2.044	15.66	8197	10.77	11901
212.0	0.00	0.00	0.00	2.044	16.67	7698	13.07	9812

* Design Condition

Span = 574.0 Feet — NESC Medium Load Zone
Creep IS a Factor — Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	6.16	19324	5.11	23302
32.0	0.25	0.00	0.00	2.602	6.34	16920	4.91	21814
0.0	0.00	0.00	0.00	2.044	4.33	19431	3.57	23592
15.0	0.00	0.00	0.00	2.044	4.79	17573	3.74	22505
30.0	0.00	0.00	0.00	2.044	5.32	15844	3.94	21388
60.0	0.00	0.00	0.00	2.044	6.55	12860	4.41	19075*
90.0	0.00	0.00	0.00	2.044	7.97	10572	5.04	16704
120.0	0.00	0.00	0.00	2.044	9.46	8909	5.86	14370
167.0	0.00	0.00	0.00	2.044	11.32	7446	7.58	11120
212.0	0.00	0.00	0.00	2.044	12.20	6912	9.57	8807

* Design Condition

Span = 1058.0 Feet — NESC Medium Load Zone
Creep IS a Factor — Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	20.43	19820	17.60	22995
32.0	0.25	0.00	0.00	2.602	20.73	17588	17.12	21288
0.0	0.00	0.00	0.00	2.044	16.58	17271	13.27	21571
15.0	0.00	0.00	0.00	2.044	17.67	16207	13.85	20657
30.0	0.00	0.00	0.00	2.044	18.78	15250	14.49	19750
60.0	0.00	0.00	0.00	2.044	21.02	13625*	15.92	17986
90.0	0.00	0.00	0.00	2.044	23.26	12322	17.53	16332
120.0	0.00	0.00	0.00	2.044	25.44	11270	19.31	14831
167.0	0.00	0.00	0.00	2.044	28.71	9991	22.31	12839
212.0	0.00	0.00	0.00	2.044	31.20	9199	25.29	11334

* Design Condition

Span = 588.0 Feet — NESC Medium Load Zone
Creep IS a Factor — Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb

15.0	0.25	4.00	0.20	2.890	6.46	19353	5.36	23321
32.0	0.25	0.00	0.00	2.602	6.64	16955	5.15	21827
0.0	0.00	0.00	0.00	2.044	4.56	19376	3.75	23572
15.0	0.00	0.00	0.00	2.044	5.04	17540	3.93	22489
30.0	0.00	0.00	0.00	2.044	5.58	15835	4.13	21376
60.0	0.00	0.00	0.00	2.044	6.85	12899	4.63	19075*
90.0	0.00	0.00	0.00	2.044	8.30	10649	5.28	16723
120.0	0.00	0.00	0.00	2.044	9.82	9008	6.13	14413
167.0	0.00	0.00	0.00	2.044	11.75	7528	7.89	11206
212.0	0.00	0.00	0.00	2.044	12.65	6998	9.92	8919

* Design Condition

Span = 528.0 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	5.24	19234	4.33	23242
32.0	0.25	0.00	0.00	2.602	5.40	16808	4.17	21770
0.0	0.00	0.00	0.00	2.044	3.63	19615	3.01	23655
15.0	0.00	0.00	0.00	2.044	4.03	17688	3.16	22557
30.0	0.00	0.00	0.00	2.044	4.49	15880	3.32	21426
60.0	0.00	0.00	0.00	2.044	5.60	12732	3.74	19075*
90.0	0.00	0.00	0.00	2.044	6.91	10310	4.28	16644
120.0	0.00	0.00	0.00	2.044	8.32	8570	5.01	14227
167.0	0.00	0.00	0.00	2.044	9.95	7171	6.58	10830
212.0	0.00	0.00	0.00	2.044	10.77	6623	8.46	8426

* Design Condition

Span = 750.0 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	10.31	19730	8.63	23547
32.0	0.25	0.00	0.00	2.602	10.53	17388	8.32	21992
0.0	0.00	0.00	0.00	2.044	7.64	18810	6.17	23317
15.0	0.00	0.00	0.00	2.044	8.35	17230	6.45	22279
30.0	0.00	0.00	0.00	2.044	9.11	15791	6.77	21223
60.0	0.00	0.00	0.00	2.044	10.77	13357	7.54	19075*
90.0	0.00	0.00	0.00	2.044	12.54	11477	8.49	16938
120.0	0.00	0.00	0.00	2.044	14.32	10052	9.65	14900
167.0	0.00	0.00	0.00	2.044	17.01	8465	11.86	12127
212.0	0.00	0.00	0.00	2.044	18.17	7928	14.25	10100

* Design Condition

Span = 2024.0 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	76.44	19470	71.32	20851
32.0	0.25	0.00	0.00	2.602	76.87	17433	70.75	18926
0.0	0.00	0.00	0.00	2.044	71.32	14749	63.94	16436
15.0	0.00	0.00	0.00	2.044	72.83	14445	65.30	16095
30.0	0.00	0.00	0.00	2.044	74.33	14157	66.67	15767
60.0	0.00	0.00	0.00	2.044	77.27	13625*	69.40	15152
90.0	0.00	0.00	0.00	2.044	80.13	13144	72.13	14585
120.0	0.00	0.00	0.00	2.044	82.93	12706	74.84	14063
167.0	0.00	0.00	0.00	2.044	87.18	12095	79.03	13325
212.0	0.00	0.00	0.00	2.044	91.11	11582	82.97	12700

* Design Condition

Span = 1129.0 Feet NESC Medium Load Zone

Creep IS a Factor   Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	23.32	19776	20.25	22772
32.0	0.25	0.00	0.00	2.602	23.64	17567	19.74	21033
0.0	0.00	0.00	0.00	2.044	19.27	16921	15.49	21039
15.0	0.00	0.00	0.00	2.044	20.43	15962	16.16	20166
30.0	0.00	0.00	0.00	2.044	21.60	15099	16.88	19306
60.0	0.00	0.00	0.00	2.044	23.95	13625*	18.47	17650
90.0	0.00	0.00	0.00	2.044	26.26	12429	20.23	16116
120.0	0.00	0.00	0.00	2.044	28.51	11452	22.14	14733
167.0	0.00	0.00	0.00	2.044	31.89	10244	25.30	12901
212.0	0.00	0.00	0.00	2.044	34.69	9425	28.38	11503

* Design Condition

Span = 1308.0 Feet   NESC Medium Load Zone
Creep IS a Factor   Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	31.47	19682	27.82	22254
32.0	0.25	0.00	0.00	2.602	31.83	17526	27.26	20445
0.0	0.00	0.00	0.00	2.044	27.03	16199	22.14	19764
15.0	0.00	0.00	0.00	2.044	28.33	15461	23.02	19011
30.0	0.00	0.00	0.00	2.044	29.61	14791	23.94	18280
60.0	0.00	0.00	0.00	2.044	32.16	13625*	25.90	16901
90.0	0.00	0.00	0.00	2.044	34.64	12653	27.99	15647
120.0	0.00	0.00	0.00	2.044	37.05	11835	30.16	14527
167.0	0.00	0.00	0.00	2.044	40.67	10788	33.63	13031
212.0	0.00	0.00	0.00	2.044	43.97	9987	36.97	11862

* Design Condition

Span = 1089.0 Feet   NESC Medium Load Zone
Creep IS a Factor   Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	21.67	19801	18.73	22897
32.0	0.25	0.00	0.00	2.602	21.98	17579	18.24	21176
0.0	0.00	0.00	0.00	2.044	17.72	17113	14.21	21338
15.0	0.00	0.00	0.00	2.044	18.85	16097	14.83	20441
30.0	0.00	0.00	0.00	2.044	19.98	15182	15.51	19554
60.0	0.00	0.00	0.00	2.044	22.28	13625*	17.00	17837
90.0	0.00	0.00	0.00	2.044	24.54	12370	18.69	16235
120.0	0.00	0.00	0.00	2.044	26.76	11352	20.52	14787
167.0	0.00	0.00	0.00	2.044	30.08	10105	23.59	12867
212.0	0.00	0.00	0.00	2.044	32.70	9300	26.62	11410

* Design Condition

Span = 869.0 Feet   NESC Medium Load Zone
Creep IS a Factor   Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	13.68	19961	11.56	23614
32.0	0.25	0.00	0.00	2.602	13.93	17652	11.17	22008
0.0	0.00	0.00	0.00	2.044	10.50	18391	8.40	22985
15.0	0.00	0.00	0.00	2.044	11.36	17001	8.78	21986
30.0	0.00	0.00	0.00	2.044	12.26	15745	9.20	20978
60.0	0.00	0.00	0.00	2.044	14.18	13625*	10.18	18956
90.0	0.00	0.00	0.00	2.044	16.14	11968	11.37	16982
120.0	0.00	0.00	0.00	2.044	18.10	10679	12.76	15134
167.0	0.00	0.00	0.00	2.044	21.04	9190	15.28	12642

212.0	0.00	0.00	0.00	2.044	22.70	8521	17.91	10791

* Design Condition

Span = 1795.0 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp	Ice	Wind	K	Weight	Sag	Tension	Sag	Tension
°F	in	psf	lb/ft	lb/ft	Ft	lb	Ft	lb
15.0	0.25	4.00	0.20	2.890	59.90	19518	55.13	21193
32.0	0.25	0.00	0.00	2.602	60.31	17454	54.54	19286
0.0	0.00	0.00	0.00	2.044	54.91	15050	48.02	17193
15.0	0.00	0.00	0.00	2.044	56.38	14658	49.29	16752
30.0	0.00	0.00	0.00	2.044	57.84	14292	50.57	16329
60.0	0.00	0.00	0.00	2.044	60.70	13625*	53.16	15539
90.0	0.00	0.00	0.00	2.044	63.48	13034	55.76	14820
120.0	0.00	0.00	0.00	2.044	66.18	12507	58.36	14166
167.0	0.00	0.00	0.00	2.044	70.27	11786	62.39	13258
212.0	0.00	0.00	0.00	2.044	74.04	11195	66.19	12505

* Design Condition

Span = 1410.0 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp	Ice	Wind	K	Weight	Sag	Tension	Sag	Tension
°F	in	psf	lb/ft	lb/ft	Ft	lb	Ft	lb
15.0	0.25	4.00	0.20	2.890	36.67	19638	32.73	21989
32.0	0.25	0.00	0.00	2.602	37.04	17506	32.16	20150
0.0	0.00	0.00	0.00	2.044	32.06	15875	26.62	19106
15.0	0.00	0.00	0.00	2.044	33.41	15236	27.61	18425
30.0	0.00	0.00	0.00	2.044	34.75	14652	28.63	17769
60.0	0.00	0.00	0.00	2.044	37.39	13625*	30.77	16539
90.0	0.00	0.00	0.00	2.044	39.95	12756	33.00	15425
120.0	0.00	0.00	0.00	2.044	42.44	12014	35.29	14430
167.0	0.00	0.00	0.00	2.044	46.17	11048	38.92	13092
212.0	0.00	0.00	0.00	2.044	49.58	10295	42.37	12032

* Design Condition

Span = 669.0 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp	Ice	Wind	K	Weight	Sag	Tension	Sag	Tension
°F	in	psf	lb/ft	lb/ft	Ft	lb	Ft	lb
15.0	0.25	4.00	0.20	2.890	8.28	19532	6.90	23431
32.0	0.25	0.00	0.00	2.602	8.49	17166	6.65	21908
0.0	0.00	0.00	0.00	2.044	6.00	19075	4.88	23450
15.0	0.00	0.00	0.00	2.044	6.59	17367	5.11	22388
30.0	0.00	0.00	0.00	2.044	7.24	15799	5.37	21301
60.0	0.00	0.00	0.00	2.044	8.72	13128	6.00	19075*
90.0	0.00	0.00	0.00	2.044	10.33	11078	6.80	16830
120.0	0.00	0.00	0.00	2.044	11.99	9553	7.80	14659
167.0	0.00	0.00	0.00	2.044	14.35	7986	9.80	11683
212.0	0.00	0.00	0.00	2.044	15.32	7478	12.01	9534

* Design Condition

Span = 2606.7 Feet NESC Medium Load Zone
Creep IS a Factor Rolled Rod

Design Points					Final		Initial	
Temp	Ice	Wind	K	Weight	Sag	Tension	Sag	Tension
°F	in	psf	lb/ft	lb/ft	Ft	lb	Ft	lb
15.0	0.25	4.00	0.20	2.890	127.78	19394	122.11	20277
32.0	0.25	0.00	0.00	2.602	128.24	17400	121.57	18338
0.0	0.00	0.00	0.00	2.044	122.48	14300	114.47	15284
15.0	0.00	0.00	0.00	2.044	124.05	14122	115.94	15093
30.0	0.00	0.00	0.00	2.044	125.60	13951	117.41	14907

60.0	0.00	0.00	0.00	2.044	128.66	13625*	120.32	14552
90.0	0.00	0.00	0.00	2.044	131.67	13320	123.22	14216
120.0	0.00	0.00	0.00	2.044	134.62	13034	126.09	13898
167.0	0.00	0.00	0.00	2.044	139.14	12619	130.53	13434
212.0	0.00	0.00	0.00	2.044	143.36	12256	134.73	13024

* Design Condition

Span = 721.9 Feet
Creep IS a Factor

NESC Medium Load Zone
Rolled Rod

Design Points					Final		Initial	
Temp °F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag Ft	Tension lb	Sag Ft	Tension lb
15.0	0.25	4.00	0.20	2.890	9.58	19660	8.01	23507
32.0	0.25	0.00	0.00	2.602	9.80	17310	7.72	21963
0.0	0.00	0.00	0.00	2.044	7.05	18898	5.70	23364
15.0	0.00	0.00	0.00	2.044	7.71	17274	5.97	22318
30.0	0.00	0.00	0.00	2.044	8.44	15791	6.27	21250
60.0	0.00	0.00	0.00	2.044	10.04	13277	6.98	19075*
90.0	0.00	0.00	0.00	2.044	11.75	11342	7.88	16901
120.0	0.00	0.00	0.00	2.044	13.49	9884	8.99	14818
167.0	0.00	0.00	0.00	2.044	16.12	8275	11.13	11977
212.0	0.00	0.00	0.00	2.044	17.16	7775	13.46	9909

* Design Condition

CONDUCTOR CUT SHEETS

The information in this section was used to determine the insulator swing angle Θ. See calculations tab for detailed information.

TransPowr™ ACCC/TW Bare Overhead Conductor

Trapezoidal Aluminum Conductor Composite Core Concentric-Lay-Stranded

ACSR vs ACSS vs ACSS/TW vs ACCC/TW CONDUCTORS - COMPARISON OF PHYSICAL PROPERTIES OF EQUIVALENT SIZES

CODE WORD (1)	SIZE	TYPE	NO. OF ALUM.	CORE	CORE O.D.	CROSS-SECTIONAL AREA (in²)		NOMINAL O.D.	NOMINAL WEIGHT lb/1000 ft			RATED STRENGTH lb (3)			AMPS 75°C	AMPS 200°C	PERCENT BY WEIGHT		STANDARD PACKAGE (6)		
	kcmil	(2)	WIRES		INCHES	TOTAL	ALUM.	INCHES	TOTAL	ALUM.	CORE	CTC CORE	GA/MA STEEL	HS/MS STEEL	(4)	(5)	ALUM.	CORE	REEL SIZE	WGHT. Pounds	LNGTH. Feet
LINNET ACSR	336.4	16	26	7x0.0884	0.2652	0.3071	0.2641	0.720	462	317	145	-	14100	14900	530	-	68.5	31.5	RMT 84.36	7580	10390
LINNET ACSS	336.4	16	26	7x0.0884	0.2652	0.3071	0.2641	0.720	462	317	145	-	11200	12300	535	945	68.5	31.5	RMT 84.36	7590	16100
LINNET ACSS/TW	336.4	16	18	7x0.0884	0.2652	0.3071	0.2641	0.663	462	316	145	-	11200	12300	525	920	68.5	31.5	RMT 84.36	7880	17080
LINNET ACSS/TW	398.7	16	18	7x0.0952	0.2856	0.3641	0.3132	0.720	547	375	172	-	13000	14300	580	1030	68.5	31.5	RMT 84.36	7880	14410
LINNET ACCC/TW	**431**	**A**	**16**	**1x0.2350**	**0.2350**	**0.3819**	**0.3385**	**0.720**	**441**	**405**	**36**	**16300**	**-**	**-**	**600**	**1060***	**92.1**	**7.9**	**RM 78.48**	**5010**	**11400**
HAWK ACSR	477	16	26	7x0.1053	0.3159	0.4353	0.3744	0.858	656	449	205	-	19500	20700	660	-	68.5	31.5	RMT 84.36	7580	11560
HAWK ACSS	477	16	26	7x0.1053	0.3159	0.4353	0.3744	0.858	656	449	205	-	15600	17100	665	940	68.5	31.5	RMT 84.36	7590	11560
HAWK ACSS/TW	477	16	18	7x0.1053	0.3159	0.4353	0.3745	0.789	655	448	206	-	15600	17100	650	1160	68.5	31.5	RMT 84.36	7890	12050
CALUMENT ACSS/TW	555.3	16	20	7x0.1146	0.3438	0.5161	0.4138	0.858	776	531	244	-	18100	20200	725	1295	68.5	31.5	RMT 84.36	8760	11300
HAWK ACCC/TW	**611**	**A**	**16**	**1x0.2800**	**0.2800**	**0.5415**	**0.4799**	**0.858**	**624**	**574**	**51**	**23200**	**-**	**-**	**745**	**1330***	**92.1**	**7.9**	**RM 78.48**	**3420**	**5500**
DOVE ACSR	556.5	16	26	7x0.1138	0.3414	0.5083	0.4371	0.927	765	524	241	-	22600	24000	726	-	68.5	31.5	RMT 84.36	7580	9010
DOVE ACSS	556.5	16	26	7x0.1138	0.3414	0.5083	0.4371	0.927	765	524	241	-	18200	20000	735	1315	68.5	31.5	RMT 84.36	7590	9910
DOVE ACSS/TW	556.5	16	20	7x0.1138	0.3414	0.5083	0.4371	0.850	764	523	241	-	18200	19900	720	1280	68.4	31.6	RMT 84.36	8760	11470
OSWEGO ACSS/TW	664.8	16	20	7x0.1244	0.3732	0.6073	0.5222	0.927	913	625	288	-	21700	23400	800	1440	68.4	31.6	RMT 84.36	8770	9510
DOVE ACCC/TW	**713**	**A**	**18**	**1x0.3050**	**0.3050**	**0.6328**	**0.5597**	**0.927**	**728**	**669**	**59**	**27500**	**-**	**-**	**820**	**1470***	**92.0**	**8.0**	**RM 78.48**	**3850**	**5350**
GROSBEAK ACSR	636	16	26	7x0.1216	0.3648	0.5907	0.4994	0.990	874	599	275	-	25200	25900	790	-	68.5	31.5	RMT 84.36	7580	8670
GROSBEAK ACSS	636	16	26	7x0.1216	0.3648	0.5907	0.4994	0.990	874	599	275	-	20600	22400	800	1435	68.5	31.5	RMT 84.36	7590	8670
GROSBEAK ACSS/TW	636	16	20	7x0.1216	0.3648	0.5809	0.4996	0.908	873	598	275	-	20800	22400	780	1400	68.5	31.5	RMT 84.36	8760	10040
WABASH ACSS/TW	762.8	16	20	7x0.1331	0.3993	0.6963	0.5989	0.990	1046	717	330	-	24900	26800	875	1570	68.5	31.5	RMT 84.36	8760	8370
GROSBEAK ACCC/TW	**816**	**A**	**19**	**1x0.3200**	**0.3200**	**0.7215**	**0.6411**	**0.990**	**832**	**766**	**66**	**30400**	**-**	**-**	**890**	**1610***	**92.3**	**7.7**	**RM 78.48**	**4730**	**5700**
DRAKE ACSR	795	16	26	7x0.1360	0.4080	0.7263	0.6246	1.107	1093	749	344	-	31500	33500	905	-	68.5	31.5	RMT 84.36	7590	6910
DRAKE ACSS	795	16	26	7x0.1360	0.4080	0.7263	0.6246	1.107	1093	749	344	-	26000	28000	915	1660	68.5	31.5	RMT 84.36	7590	6940
DRAKE ACSS/TW	795	16	20	7x0.1360	0.4080	0.7259	0.6242	1.010	1091	747	344	-	25900	28000	895	1615	68.5	31.5	RMT 84.36	8760	8030
SUWANNEE ACSS/TW	959.6	16	22	7x0.1493	0.4479	0.8764	0.7539	1.108	1317	902	415	-	30700	33100	1005	1825	68.5	31.5	RMT 84.36	9540	7320
DRAKE ACCC/TW	**1020**	**A**	**22**	**1x0.3750**	**0.3750**	**0.9112**	**0.8014**	**1.108**	**1046**	**957**	**89**	**41100**	**-**	**-**	**1025**	**1865***	**91.6**	**8.4**	**RM 78.48**	**5960**	**5700**
CARDINAL ACSR	954	13	54	7x0.1329	0.3987	0.8462	0.7491	1.196	1227	899	329	-	33800	35700	995	-	73.2	26.8	RMT 90.45	11780	9500
CARDINAL ACSS	954	13	54	7x0.1329	0.3987	0.8462	0.7491	1.196	1227	899	329	-	26000	28000	1005	1824	73.2	26.8	RMT 90.45	11780	9500
CARDINAL ACSS/TW	954	13	21	7x0.1329	0.3987	0.8463	0.7492	1.084	1224	895	329	-	26000	28000	995	1805	73.1	26.9	RMT 84.36	8620	7040
HUDSON ACSS/TW	1158.4	13	26	7x0.1467	0.4401	1.0279	0.9096	1.196	1488	1087	401	-	31100	33500	1120	2050	73.1	26.9	RMT 84.36	10670	7170
CARDINAL ACCC/TW	**1222**	**B**	**36**	**1x0.3450**	**0.3450**	**1.0536**	**0.9601**	**1.196**	**1228**	**1152**	**76**	**37100**	**-**	**-**	**1140**	**2080***	**94.0**	**6.0**	**RM 78.48**	**6930**	**5700**
BITTERN ACSR	1272	7	45	7x0.1121	0.3363	1.0679	0.9988	1.345	1432	1198	234	-	34100	35400	1165	-	83.7	16.3	RMT 90.45	10740	7500
BITTERN ACSS	1272	7	45	7x0.1121	0.3363	1.0679	0.9986	1.345	1432	1198	234	-	22500	24000	1195	2200	83.7	16.3	RMT 90.45	10740	7900
BITTERN ACSS/TW	1272	7	33	7x0.1121	0.3363	1.0685	0.9994	1.215	1432	1198	234	-	22300	24100	1165	2130	83.7	16.3	RMT 84.36	11830	8260
POTOMAC ACSS/TW	1557.4	7	36	7x0.1241	0.3723	1.3084	1.2237	1.345	1754	1467	287	-	27400	29000	1330	2430	83.7	16.3	RMT 84.45	12910	7350
BITTERN ACCC/TW	**1572**	**B**	**39**	**1x0.3450**	**0.3450**	**1.3283**	**1.2348**	**1.345**	**1554**	**1478**	**76**	**39300**	**-**	**-**	**1320**	**2440***	**95.3**	**4.7**	**RMT 90.45**	**8850**	**5700**
LAPWING ACSR	1590	7	45	7x0.1253	0.3759	1.3353	1.2490	1.504	1790	1498	292	-	42200	43900	1365	-	83.7	16.3	RMT 90.45	10740	6000
LAPWING ACSS	1590	7	36	7x0.1253	0.3759	1.3361	1.2488	1.361	1790	1498	292	-	27400	29100	1330	2545	83.7	16.3	RMT 90.45	10740	6000
LAPWING ACSS/TW	1590	7	36	7x0.1253	0.3759	1.3361	1.2488	1.361	1790	1498	292	-	27900	29600	1330	2460	83.7	16.3	RMT 84.45	12900	7210
ATHABASKA ACSS/TW	1949.6	7	56	7x0.1382	0.4146	1.6967	1.5317	1.502	2195	1840	355	-	34000	36100	1505	2815	83.8	16.2	RMT 96.60	20010	9130
LAPWING ACCC/TW	**1966**	**B**	**56**	**1x0.3850**	**0.3850**	**1.6608**	**1.5444**	**1.504**	**1960**	**1864**	**96**	**49000**	**-**	**-**	**1500**	**2805***	**95.3**	**4.7**	**RMT 90.45**	**11150**	**5700**
CHUKAR ACSR	1780	8	84	19x0.0874	0.4370	1.5112	1.3974	1.601	2071	1685	387	-	51000	53100	1450	-	81.3	18.7	RMT 96.60	19030	9200
CHUKAR ACSS	1780	8	84	19x0.0874	0.4370	1.5112	1.3974	1.601	2071	1685	387	-	35300	38200	1465	2750	81.3	18.7	RMT 96.60	19030	9200
CHUKAR ACSS/TW	1780	8	38	19x0.0874	0.4370	1.5122	1.3982	1.447	2061	1674	387	-	35400	38200	1420	2630	81.2	18.8	RMT 84.45	14030	6810
POWDER ACSS/TW	2153.8	8	61	19x0.0961	0.4805	1.8293	1.3916	1.602	2510	2042	467	-	42100	45500	1600	3010	81.4	18.6	RMT 96.60	23593	9400
CHUKAR ACCC/TW	**2242**	**B**	**56**	**1x0.3950**	**0.3950**	**1.883**	**1.761**	**1.602**	**2225**	**2126**	**99**	**52700**	**-**	**-**	**1610**	**3045***	**95.7**	**4.3**	**RMT 90.45**	**12670**	**5700**
BLUEBIRD ACSR	2156	8	84	19x0.0961	0.4805	1.8309	1.6930	1.762	2508	2041	467	-	60300	62800	1620	-	81.4	18.6	RMT 96.60	18910	7500
BLUEBIRD ACSS	2156	8	84	19x0.0961	0.4805	1.8309	1.6930	1.762	2508	2041	467	-	42100	45500	1640	3110	81.4	18.6	RMT 96.60	18910	7500
BLUEBIRD ACSS/TW	2156	8	64	19x0.0961	0.4805	1.8312	1.6934	1.612	2512	2045	467	-	42100	45500	1600	3010	81.4	18.6	RMT 96.60	23590	9390
SANTEE ACSS/TW	2627.3	8	64	19x0.1063	0.5310	2.2327	2.0643	1.762	3062	2492	571	-	51400	55600	1785	3405	81.4	18.6	RMT 96.60	23610	7710
BLUEBIRD ACCC/TW	**2727**	**B**	**64**	**1x0.4150**	**0.4150**	**2.277**	**2.1424**	**1.762**	**2696**	**2586**	**110**	**59800**	**-**	**-**	**1790**	**3430***	**96.1**	**3.9**	**RMT 96.60**	**15350**	**5700**

* The continuous temperature rating for the TransPowr ACCC/TW conductor is 180°C. The 200°C temperature is a short-duration emergency operation temperature.

Footnotes

(1) [illegible]

(2) [illegible]

(3) [illegible]

(4) (5) [illegible]

(6) [illegible]

BULLETIN 1724E-200
SECTION 5

This section was used to determine and calculate the ROW width required based on the conductor swing angle (blowout) calculations using the formulas tabbed herein.

5. HORIZONTAL CLEARANCES FROM LINE CONDUCTORS TO OBJECTS AND RIGHT-OF-WAY WIDTH

5.1 General: The preliminary comments and assumptions in Chapter 4 of this bulletin also apply to this chapter.

5.2 Minimum Horizontal Clearance of Conductor to Objects: Recommended design horizontal clearances of conductors to various objects are provided in Table 5-1 and minimum radial operating clearances of conductors to vegetation in Table 5-2. The clearances apply only for lines that are capable of automatically clearing line-to-ground faults.

Clearance values provided in Table 5-1are recommended design values. In order to provide an additional margin of safety, the recommended design values exceed the minimum clearances in the 2007 NESC. Clearance values provided in Table 5-2 are minimum operating clearances to be used by the designer to determine appropriate design clearances for vegetation maintenance management.

5.2.1 Conditions Under Which Horizontal Clearances to Other Supporting Structures, Buildings and Other Installations Apply:

Conductors at Rest (No Wind Displacement): When conductors are at rest the clearances apply for the following conditions: (a) 167°F but not less than 120°F, final sag, (b) the maximum operating temperature the line is designed to operate, final sag, (c) 32°F, final sag with radial thickness of ice for the loading district (0 in., ¼ in., or ½ in.).

Conductors Displaced by 6 psf Wind: The clearances apply when the conductor is displaced by 6 lbs. per sq. ft. at final sag at 60°F. See Figure 5-1.

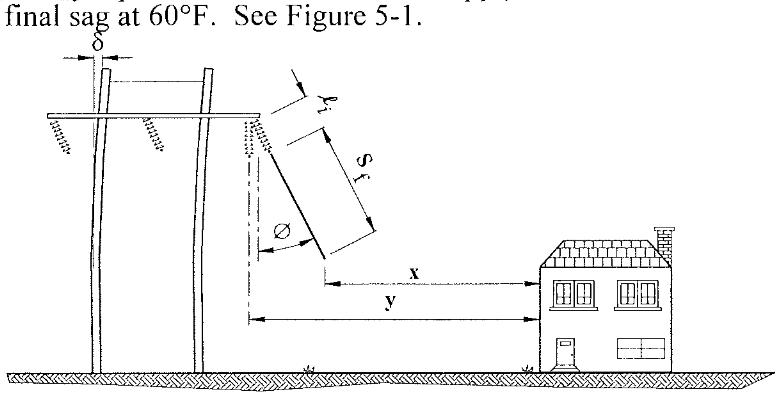


FIGURE 5-1: HORIZONTAL CLEARANCE REQUIREMENT TO BUILDINGS

where:

ϕ = conductor swing out angle in degrees under 6 psf. of wind

S_f = conductor final sag at 60°F with 6 psf. of wind

x = horizontal clearance required per Tables 5-1 for conductors displaced by 6 psf wind (include altitude correction if necessary)

ℓ_i = insulator string length ($\ell_i = 0$ for post insulators or restrained suspension insulators).

y = total horizontal distance from insulator suspension point (conductor attachment point for post insulators) to structure with conductors at rest

δ = structure deflection with a 6 psf. Wind

TABLE 5-1
RECOMMENDED DESIGN HORIZONTAL CLEARANCES (in feet) FROM CONDUCTORS AT REST AND DISPLACED BY 6 PSF WIND TO OTHER SUPPORTING STRUCTURES, BUILDINGS AND OTHER INSTALLATIONS
(NESC Rules 234B, 234C, 234D, 234E, 234F, 234I, Tables 234-1, 234-2, 234-3)

Conditions under which clearances apply:

No wind: When the conductor is at rest the clearances apply at the following conditions: (a) 120°F, final sag, (b) the maximum operating temperature the line is designed to operate, final sag, (c) 32°F, final sag with radial thickness of ice for the loading district (1/4 in. for Medium or 1/2 in. Heavy).

Displaced by Wind: Horizontal clearances are to be applied with the conductor displaced from rest by a 6 psf wind at final sag at 60°F. The displacement of the conductor is to include deflection of suspension insulators and deflection of flexible structures.

The clearances shown are for the displaced conductors and do not provide for the horizontal distance required to account for blowout of the conductor and the insulator string. This distance is to be added to the required clearance. See Equation 5-1.

Clearances are based on the Maximum Operating Voltage

Nominal voltage, Phase to Phase, kV_{L-L}		**34.5 & 46**	**69**	**115**	**138**	**161**	**230**
Max. Operating Voltage, Phase to Phase, kV_{L-L}		----	72.5	120.8	144.9	169.1	241.5
Max. Operating Voltage, Phase to Ground, kV_{L-G}		----	41.8	69.7	83.7	97.6	139.4
Horizontal Clearances - (Notes 1,2,3)	NESC Basic Clear	Clearances in feet					
1.0 From a lighting support, traffic signal support or supporting structure of another line							
At rest (NESC Rule 234B1a)	5.0	6.5	6.5	7.2	7.6	8.1	9.5
Displaced by wind (NESC Rule 234B1b)	4.5	6.2	6.7	7.6	8.1	8.5	9.9
2.0 From buildings, walls, projections, guarded windows, windows not designed to open, balconies, and areas accessible to pedestrians							
At rest (NESC Rule 234C1a)	7.5	9.2	9.7	10.6	11.1	11.5	12.9
Displaced by wind (NESC Rule 234C1b)	4.5	6.2	6.7	7.6	8.1	8.5	9.9
3.0 From signs, chimneys, billboards, radio, & TV antennas, tanks & other installations not classified as buildings							
At rest (NESC Rule 234C1a)	7.5	9.2	9.7	10.6	11.1	11.5	12.9
Displaced by wind (NESC Rule 234C1b)	4.5	6.2	6.7	7.6	8.1	8.5	9.9
4.0 From portions of bridges which are readily accessible and supporting structures are not attached							
At rest (NESC Rule 234D1a)	7.5	9.2	9.7	10.6	11.1	11.5	12.9
Displaced by wind (NESC Rule 234D1b)	4.5	6.2	6.7	7.6	8.1	8.5	9.9
5.0 From portions of bridges which are ordinarily inaccessible and supporting structures are not attached							
At rest (NESC Rule 234D1a)	6.5	8.2	8.7	9.6	10.1	10.5	11.9
Displaced by wind (NESC Rule 234D1b)	4.5	6.2	6.7	7.6	8.1	8.5	9.9

TABLE 5-1 (continued)
RECOMMENDED DESIGN HORIZONTAL CLEARANCES (in feet) FROM CONDUCTORS AT REST AND DISPLACED BY 6 PSF WIND TO OTHER SUPPORTING STRUCTURES, BUILDINGS AND OTHER INSTALLATIONS
(NESC Rules 234B, 234C, 234D, 234E, 234F, 234I, Tables 234-1, 234-2, 234-3)

Conditions under which clearances apply:

No wind: When the conductor is at rest the clearances apply at the following conditions: (a) 120°F, final sag, (b) the maximum operating temperature the line is designed to operate, final sag, (c) 32°F, final sag with radial thickness of ice for the loading district (1/4 in. for Medium or 1/2 in. Heavy).

Displaced by Wind: Horizontal clearances are to be applied with the conductor displaced from rest by a 6 psf wind at final sag at 60°Funder extreme wind conditions (such as the 50 or 100-year mean wind) at final sag at 60°F. The displacement of the conductor is to include deflection of suspension insulators and deflection of flexible structures.

The clearances shown are for the displaced conductors and do not provide for the horizontal distance required to account for blowout of the conductor and the insulator string. This distance is to be added to the required clearance. See Equation 5-1.

Clearances are based on the Maximum Operating Voltage

Nominal voltage, Phase to Phase, kV_{L-L}		**34.5 & 46**	**69**	**115**	**138**	**161**	**230**
Max. Operating Voltage, Phase to Phase, kV_{L-L}		----	72.5	120.8	144.9	169.1	241.5
Max. Operating Voltage, Phase to Ground, kV_{L-G}		----	41.8	69.7	83.7	97.6	139.4
Horizontal Clearances - (Notes 1,2,3)	NESC Basic Clear	Clearances in feet					
6.0 Swimming pools – see section 4.4.3 of Chapter 4 and item 9 of Table 4–2. (NESC Rule 234E)							
Clearance in any direction from swimming pool edge (Clearance A, Figure 4-2 of this bulletin)	25.0	27.2	27.7	28.6	29.1	29.5	30.9
Clearance in any direction from diving structures (Clearance B, Figure 4-2 of this bulletin)	17.0	19.2	19.7	20.6	21.1	21.5	22.9
7.0 From grain bins loaded with permanently attached conveyor							
At rest (**NESC Rule 234F1b**)	15.0	17.2	17.7	18.6	19.1	19.5	20.9
Displaced by wind (**NESC Rule 234C1b**)	4.5	6.7	7.2	8.1	8.6	9.0	10.4
8.0 From grain bins loaded with a portable conveyor. Height 'V' of highest filling or probing port on bin must be added to clearance shown. Clearances for 'at rest' and not displaced by the wind. See NESC Figure 234-4 for other requirements.							
Horizontal clearance envelope (includes area of sloped clearance per NESC Figure 234-4b)		(24+V) + 1.5V (Note 3)					
9.0 From rail cars (Applies only to lines parallel to tracks) See Figure 234-5 and section 234I (Eye) of the NESC							
Clearance measured to the nearest rail		14.1	14.1	15.1	15.6	16.0	17.5
ALTITUDE CORRECTION TO BE ADDED TO VALUES ABOVE							
Additional feet of clearance per 1000 feet of altitude above 3300 feet		.02	.02	.05	.07	.08	.12

Notes:
1. Clearances for categories 1-5 in the table are approximately 1.5 feet greater than NESC clearances.
2. Clearances for categories 6 to 9 in the table are approximately 2.0 feet greater than NESC clearances.
3. "V" is the height of the highest filling or probing port on a grain bin. Clearance is for the highest voltage of 230 kV.

5.2.2 Considerations in Establishing Radial and Horizontal Clearances to Vegetation:

The designer should identify and document clearances between vegetation and any overhead, ungrounded supply conductors, taking into consideration transmission line voltage, the effects of ambient temperature on conductor sag under maximum design loading, and the effects of wind velocities on conductor sway. Specifically, the designer should establish clearances to be achieved at the time of vegetation management work and should also establish and maintain a set of clearances to prevent flashover between vegetation and overhead ungrounded supply conductors. As a mimimum, these clearances should apply to all transmission lines operated at 200 kV phase-to-phase and above and to any lower voltage lines designated as critical (refer to NERC FAC 003).

The designer should determine and document appropriate clearance distances to be achieved at the time of transmission vegetation management work based upon local conditions and the expected time frame in which the Transmission Owner plans to return for future vegetation management work. Local conditions may include, but are not limited to: operating voltage, appropriate vegetation management techniques, fire risk, reasonably anticipated tree and conductor movement, species types and growth rates, species failure characteristics, local climate and rainfall patterns, line terrain and elevation, location of the vegetation within the span, and worker approach distance requirements.

The designer should determine and document specific radial clearances to be maintained between vegetation and conductors under all rated electrical operating conditions. These minimum clearance distances are necessary to prevent flashover between vegetation and conductors and will vary due to such factors as altitude and operating voltage. These specific minimum clearance distances should be no less than those set forth in the Institute of Electrical and Electronics Engineers (IEEE) Standard 516-2003 (Guide for Maintenance Methods on Energized Power Lines) and as specified in its Section 4.2.2.3, Minimum Air Insulation Distances without Tools in the Air Gap. Where transmission system transient overvoltage factors are not known, clearances shall be derived from Table 5, IEEE 516-2003, phase-to-ground distances, with appropriate altitude correction factors applied.Where transmission system transient overvoltage factors are known, clearances shall be derived from Table 7, IEEE 516-2003, phase-to-phase voltages, with appropriate altitude correction factors applied. Table 5-2 contains radial clearances determined from Table 5, IEEE 516-2003, where transmission system transient overvoltage factors are not known.

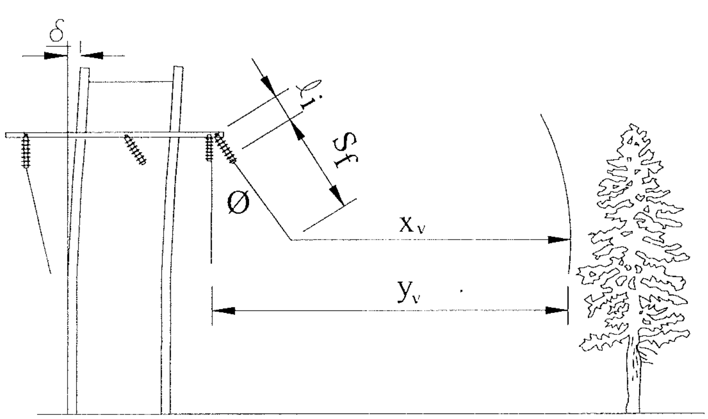


FIGURE 5-2: RADIAL CLEARANCE REQUIREMENT TO VEGETATION

where:

ϕ	=	conductor swing out angle in degrees under all rated operating conditions
S_f	=	conductor final sag at all rated operating conditions
X_v	=	radial clearance (include altitude correction if necessary)
ℓ_i	=	insulator string length ($\ell_i = 0$ for post insulators or restrained suspension insulators).
y_v	=	horizontal clearance at the time of vegetation management work
δ	=	structure deflection at all rated operating conditions

TABLE 5-2
RADIAL OPERATING CLEARANCES (in feet) FROM IEEE 516 FOR USE IN DETERMINING CLEARANCES TO VEGETATION FROM CONDUCTORS
(NERC Standard FAC-003.1 Transmission Vegetation Management Program, IEEE 516, Guideline For Maintenance Methods Of Energized Power Lines)

Conditions under which clearances apply:

Displaced by Wind: Radial operating clearances are to be applied at all rated operating conditions.The designer should determine applicable conductor temperature and wind conditions for all rated operating conditions. The displacement of the conductor is to include deflection of suspension insulators and deflection of flexible structures.

The operating clearances shown are for the displaced conductors and do not provide for the horizontal distance required to account for blowout of the conductor and the insulator string. This distance is to be added to the required clearance. See Equation 5-1.

Clearances are based on the Maximum Operating Voltage.

Nominal voltage, Phase to Phase, kV_{L-L}	**34.5 & 46[1]**	**69[1]**	**115[1]**	**138[1]**	**161[1]**	**230[1,2]**
Max. Operating Voltage, Phase to Phase, kV_{L-L}	----	72.5	120.8	144.9	169.1	241.5
Max. Operating Voltage, Phase to Ground, kV_{L-G}	----	41.8	69.7	83.7	97.6	139.4
Radial Table 5 IEEE Standard 516 Operating Clearances	Clearances in feet					
Operating clearance at all rated operating conditions	1.8	1.8	1.9	2.3	2.5	2.7
Design adder for survey and installation tolerance	1.5 feet for all voltages					
Design adder for vegetation	Determined by designer (see Note 3 below)					
ALTITUDE CORRECTION TO BE ADDED TO VALUES ABOVE						
Additional feet of clearance per 1000 feet of altitude above 3300 feet	.02	.02	.05	.07	.08	.12

Notes:
1. These clearances apply to all transmission lines operated at 200 kV phase-to-phase and above and to any lower voltage lines designated as critical (refer to NERC FAC 003).
2. The 230 kV clearance is based on 3.0 Per Unit switching surge.
3. The design adder for vegetation, applied to conductors displaced by wind, should account for reasonably anticipated tree movement, species types and growth rates, species failure characteristics, and local climate and rainfall patterns. The design adder for vegetation, applied to conductors at rest, should account for worker approach distances in addition to the aforementioned factors.

5.2.3 Clearances to Grain Bins: The NESC has defined clearances from grain bins based on grain bins that are loaded by permanent or by portable augers, conveyers, or elevator systems.

In NESC Figure 234-4(a), the horizontal clearance envelope for permanent loading equipment is graphically displayed and shown Figure 5-2.

P = probe clearance, item 7, Table 4-2
H = horizontal clearance, item 7, Table 5-1
T = transition clearance
V_1 = vertical clearance, item 2&3, Table 4-2
V_2 = vertical clearance, Table 4-1

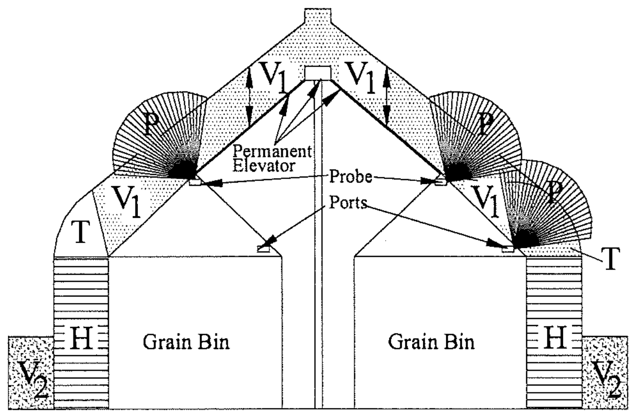


FIGURE 5-3: CLEARANCE TO GRAIN BINS
NESC FIGURE 234-4a

Because the vertical distance from the probe in Table 4-2, item 7.0, is greater than the horizontal distance, (see Table 5-1, item 7.0), the user may want to simplify design and use this distance as the horizontal clearance distance as shown below:

FIGURE 5-4: HORIZONTAL CLEARANCE TO GRAIN BINS, CONDUCTORS AT REST
P = clearance from item 7, Table 4-2

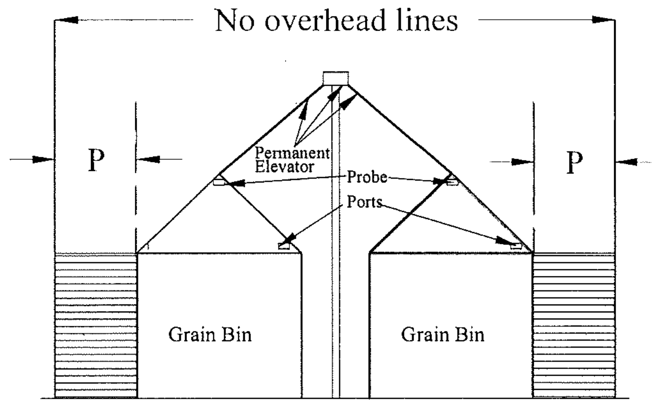
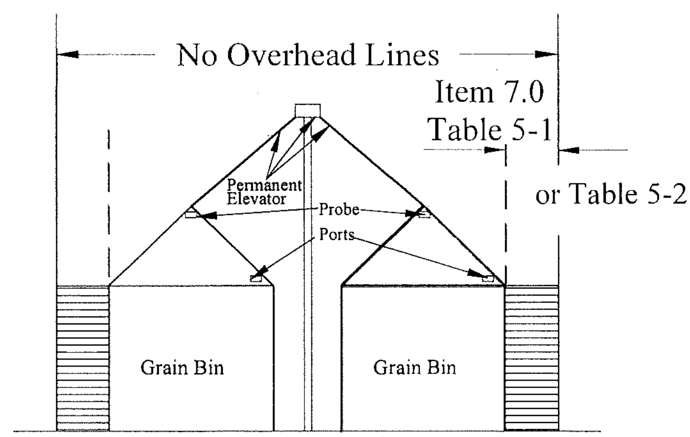


FIGURE 5-5: HORIZONTAL CLEARANCE TO GRAIN BINS, CONDUCTORS DISPLACED BY 6 PSF WIND



The clearance envelope for portable loading equipment from NESC Figure 234(b), is shown in Figure 5-6.

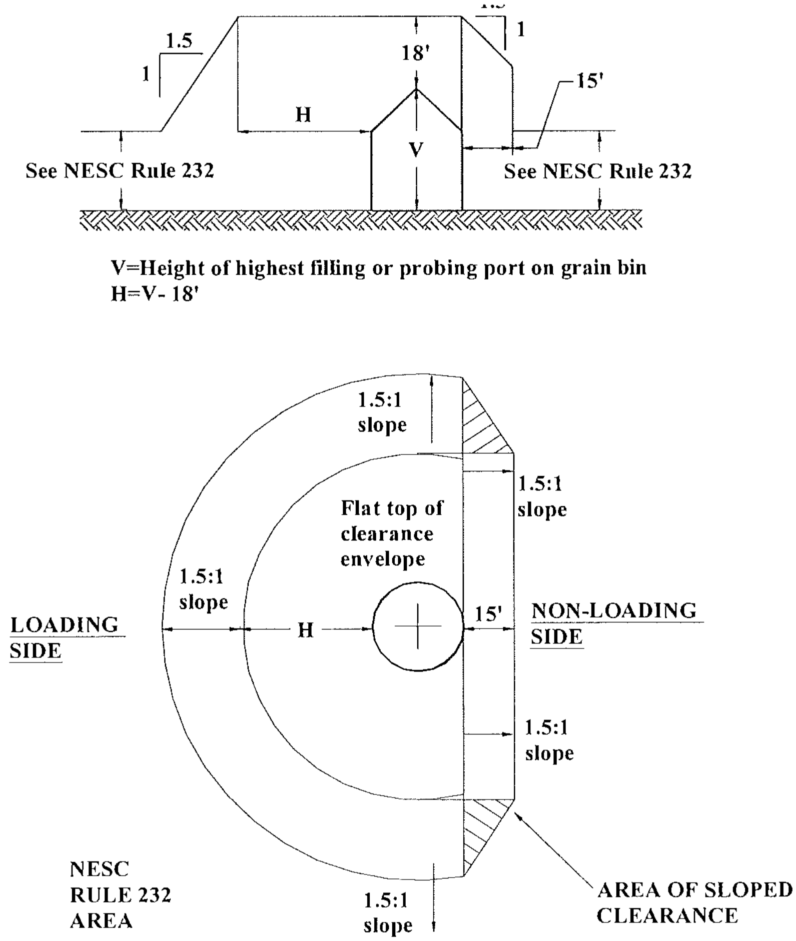


FIGURE 5-6: NESC CLEARANCE TO GRAIN BINS WITH PORTABLE LOADING EQUIPMENT

In order to simplify the clearance envelope, the horizontal clearances in category 8 of Table 5-1 is shown as 'H' in the drawing below:

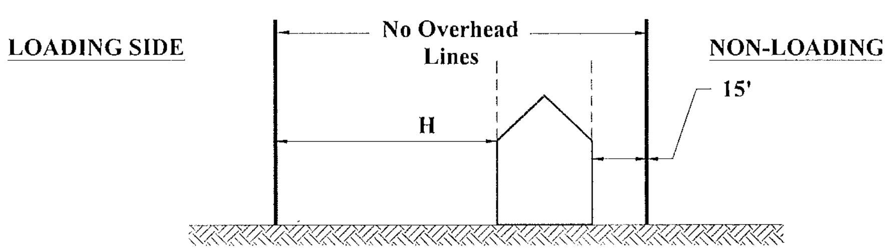


FIGURE 5-7: SIMPLIFIED RECOMMENDATIONS FOR CLEARANCES TO GRAIN BINS WITH PORTABLE LOADING EQUIPMENT

5.2.4 Altitude Greater Than 3300 Feet: If the altitude of the transmission line or portion thereof is greater than 3300 feet, an additional clearance as indicated in Table 5-1 and 5-2 has to be added to the base clearance given.

5.2.5 <u>Total Horizontal Clearance to Point of Insulator Suspension to Object</u>: As can be seen from Figure 5-1, the total horizontal clearance (y) is:

$$y = \left(\ell_i + S_f\right)\sin\phi + x + \delta \qquad \text{Eq. 5-1}$$

Symbols are defined in Section 5.2.1 and figure 5-1. The factor "δ" indicates that structure deflection should be taken into account.

For the sake of simplicity when determining **horizontal** clearances, the insulator string should be assumed to have the same swing angle as the conductor. This assumption should be made only in this chapter as its use in calculations elsewhere may not be appropriate.

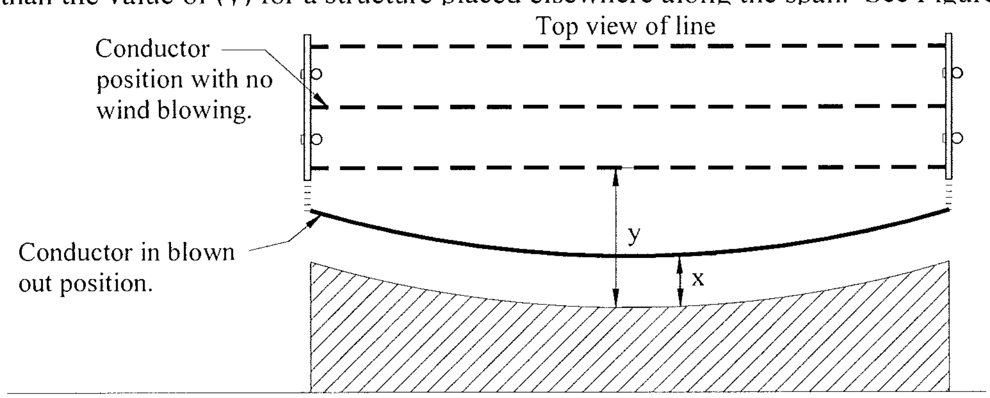
The conductor swing angle (ϕ) under wind can be determined from the formula.

$$\phi = \tan^{-1}\left(\frac{(d_c)(F)}{12\ w_c}\right) \qquad \text{Eq. 5-2}$$

where:

d_c = conductor diameter in inches
w_c = weight of conductor in lbs./ft.
F = wind force;

The total horizontal distance (y) at a particular point in the span depends upon the conductor sag at that point. The value of (y) for a structure adjacent to the maximum sag point will be greater than the value of (y) for a structure placed elsewhere along the span. See Figure 5-7.



x = clearance from wind-displaced conductor, y= total horizontal clearance from conductor at rest

FIGURE 5-8: A TOP VIEW OF A LINE SHOWING TOTAL HORIZONTAL CLEARANCE REQUIREMENTS

5.2.6 <u>Examples of Horizontal Clearance Calculations</u>: The following examples demonstrate the derivation of the horizontal clearance in Table 5-1 of this bulletin.

To determine the horizontal clearance of a 115 kV line to a building (category 2.0 of Table 5-1), the clearance is based on NESC Table 234-1 and NESC Rule 234.

At rest:

NESC Horizontal Clear. = NESC Basic Clearance(Table 234-1) + .4(kV_{L-G} – 22)/12
= 7.5 feet + .4(69.7-22)/12 feet
= 7.5 feet + 1.59 feet
NESC Horizontal Clear. = 9.09 feet

Recommended Clearance = NESC Horizontal Clearance + Adder
= 9.09 feet + 1.5 feet
y = 10.59 feet (10.60 feet in Table 5-1)

Conductors displaced by 6 psf wind:

NESC Horizontal Clear. = NESC Basic Clearance (Table 234-1) + .4(kV_{L-G} – 22)/12
= 4.5 feet + .4(69.7-22)/12 feet
= 4.5 feet + 1.59 feet
NESC Horizontal Clear. = 6.09 feet

Recommended Clearance = NESC Horizontal Clearance + Adder
= 6.09 feet + 1.5 feet
x = 7.59 feet (7.6 feet in Table 5-1)

5.3 <u>Right-of-Way (ROW) Width</u>: For transmission lines, a right-of-way provides an environment allows the line to be operated and maintained safely and reliably. Determination of the right-of-way width is a task that requires the consideration of a variety of judgmental, technical, and economic factors.

Typical right-of-way widths (predominantly H-frames) that have been used by agency borrowers in the past are shown in Table 5-2. In many cases a range of widths is provided. The actual width used will depend upon the particulars of the line design.

TABLE 5-3
TYPICAL RIGHT-OF-WAY WIDTHS

	Nominal Line-to-Line Voltage in kV				
	69	115	138	161	230
ROW Width, ft.	75-100	100	100-150	100-150	125-200

5.4 <u>Calculation of Right-of-Way Width for a Single Line of Structures on a Right-of-Way</u>: Right-of-way widths can be calculated using the method described below. The calculated values for right-of-way widths are directly related to the particular parameters of the line design. This method provides sufficient width to meet clearance requirements to buildings of undetermined height or vegetation located directly on the edge of the right-of-way. See Figures 5-8 and 5-9.

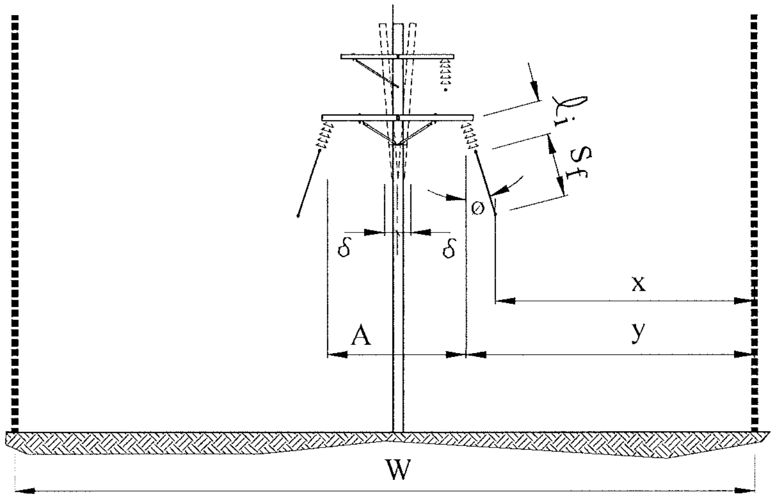


FIGURE 5-9: ROW WIDTH FOR SINGLE LINE OF STRUCTURES

$$W = A + 2(\ell_i + S_f)\sin\phi + 2\delta + 2x \qquad \text{Eq. 5-3}$$

where:

W = total right-of-way width required
A = separation between points of suspension of insulator strings for outer two phases
x = clearance required per Table 5-1 and appropriate clearance derived from Table 5-2 of this bulletin (include altitude correction if necessary)
y = clearance required per Section 5.2.1 and Table 5-1 and appropriate clearance derived from Section 5.2.2. and Table 5-2 of this bulletin (include altitude correction if necessary)

Other symbols are as previously defined. In some instances, clearance "x" may control. In other instances, clearance "y" may control.

There are two ways of choosing the length (and thus the sag) on which the right-of-way width is based. One is to use a width based on the maximum span length in the line. The other way is to base the width on a relatively long span, (the ruling span, for instance), but not the longest span. For those spans that exceed this base span, additional width is added as appropriate.

5.5 <u>Right-of-Way Width for a Line Directly Next to a Road</u>: The right-of-way width for a line next to a road can be calculated based on the two previous sections with one exception. No ROW is needed on the road side of the line as long as the appropriate clearances to existing or possible future structures on the road side of the line are met.

If a line is to be placed next to a roadway, consideration should be given to the possibility that the road may be widened. If the line is on the road right-of-way, the borrower would generally be expected to pay for moving the line. If the right-of-way is on private land, the highway department should pay. Considerations involved in placing a line on a road right-of-way should also include evaluation of local ordinances and requirements.

5.6 <u>Right-of-Way Width for Two or More Lines of Structures on a Single Right-of-Way</u>: To determine the right-of-way width when the right ROW contains two parallel lines, start by calculating the distance from the outside phases of the lines to the ROW edge (see Section 5.4). The distance between the two lines is governed by the two criteria provided in section 5.6.1. If one of the lines involved is an extra high voltage (EHV) line (345 kV and above), the NESC should be referred to for additional applicable clearance rules not covered in this bulletin.

5.6.1 <u>Separation Between Lines as Dictated by Minimum Clearance Between Conductors Carried on Different Supports</u>: The horizontal clearance between a phase conductor of one line to a phase conductor of another line shall meet the larger of C_1, or C_2 below, under the following conditions: (a) both phase conductors displaced by a 6 psf wind at 60°F, final sag; (b) if insulators are free to swing, one should be assumed to be displaced by a 6 lbs/sq. ft. wind while the other should be assumed to be unaffected by the wind (see Figure 5-10). The assumed wind direction should be that which results in the greatest separation requirement. It should be noted that in the Equations 5-5, and 5-6, the 'δ_1-δ_2' term, (the differential structure deflection between the two lines of structures involved), is to be taken into account. An additional 1.5 feet have been added to the NESC clearance to obtain design clearances 'C_1'and 'C_2'. Note Equation 5-6 has been revised from previous versions due to the voltage adder change in the 2007 NESC edition.

$$C_1 = 6.5 + (\delta_1 - \delta_2) \text{ (NESC Rule 233B1)} \qquad \text{Eq. 5-5}$$

$$C_2 = 6.5 + \frac{.4}{12}\left[(kV_{LG1} + kV_{LG2}) - 22\right] + (\delta_1 - \delta_2) \text{ (NESC Rule 233B1)} \qquad \text{Eq. 5-6}$$

where:

C_1, C_2 = clearance requirements between conductors on different lines in feet (largest value governs)
kV_{LG1} = maximum line-to-ground voltage in kV of line 1
kV_{LG2} = maximum line-to-ground voltage in kV of line 2
δ_1 = deflection of the upwind structure in feet
δ_2 = deflection of the downwind structure in feet

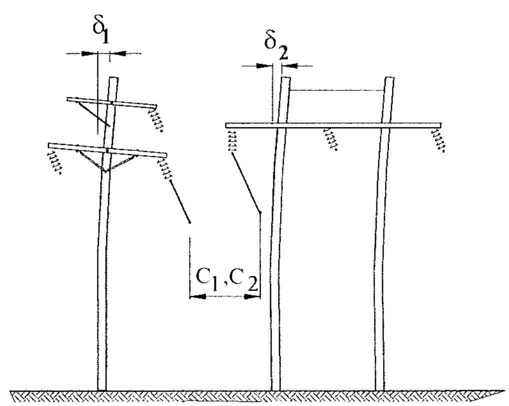


FIGURE 5-10: CLEARANCE BETWEEN CONDUCTORS OF ONE LINE TO CONDUCTOR OF ANOTHER LINE

5.6.2 <u>Separation Between Lines as Dictated by Minimum Clearance of Conductors From One Line to the Supporting Structure of Another</u>: The horizontal clearance of a phase conductor of one line to the supporting structure of another when the conductor and insulator are displaced by a 6 psf wind at 60°F final sag should meet Equation 5-7.

$$C_3 = 6' + \frac{.4}{12}\left(kV_{LG} - 22\right) + \left(\delta_1 - \delta_2\right) \qquad \text{Eq. 5-7}$$

where:

kV_{LG} = the maximum line-to-ground voltage in kV
C_3 = the clearance of conductors of one line to structure of another in feet

Other symbols are defined in Figure 5-1.

Additional 1.5 feet have been added to the NESC clearance and included in equation 5-7 to obtain the design clearance 'C_3'.

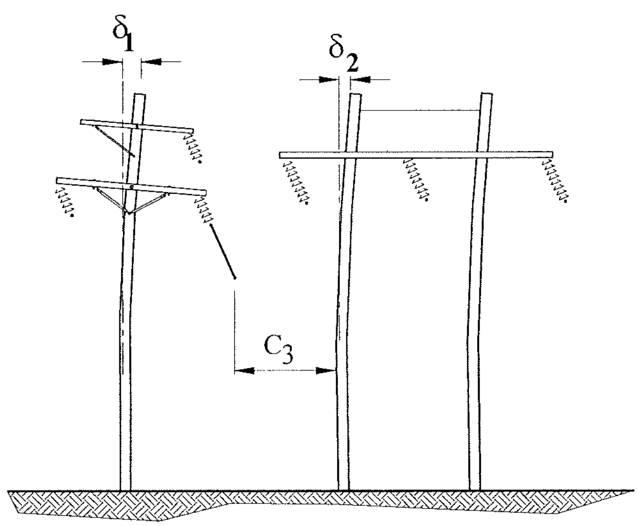


FIGURE 5-11: CLEARANCE BETWEEN CONDUCTORS OF ONE LINE AND STRUCTURE OF ANOTHER

The separation between lines will depend upon the spans and sags of the lines as well as how structures of one line match up with structures of another. In order to avoid the unreasonable task of determining separation of structures span-by-span, a standard separation value should be used, based on a worst case analysis. Thus if structures of one line do not always line up with those of the other, the separation determined in section 5.6.2 should be based on the assumption that the structure of one line is located next to the mid-span point of the line that has the most sag.

5.6.3 <u>Other Factors</u>: Galloping should be taken into account in determining line separation. In fact, it may be the determining factor in line separation. See Chapter 6 for a discussion of galloping.

Standard phase spacing should also be taken into account. For example, if two lines of the same voltage using the same type structures and phase conductors are on a single ROW, a logical separation of the two closest phases of the two lines should be at least the standard phase separation of the structure.

5.6.4 Altitude Greater than 3300 Feet: If the altitude at which the lines included in the design are installed greater than 3300 feet, NESC Section 23 rules provide additional separation requirements.

NESC MINIMUM CLEARANCE PRACTICES BY OTHERS

The information in this section provides a summary of the standard practices used in the industry. If required other utility standards can be provided.

Clearances—from Buildings, Bridges, and Other Installations (NESC 234)

A. Scope

This Standard provides the ***minimum*** clearances of wires, conductors, cables and equipment from buildings, bridges, swimming pools, and other installations as required by the National Electric Safety Code (NESC) Rule 234. These clearances apply to all PacifiCorp transmission facilities, with the exception of facilities in the states of California and Washington.

B. General

The vertical and horizontal clearances specified in this standard apply under whichever conditions of conductor temperature and loading that produce the minimum clearance (refer also to TC 011, C2).

1. Horizontal Clearances (with Wind Displacement)

   For horizontal clearances, conductors or cables shall be considered to be displaced from rest toward the installation by a 6 pound per square foot (psf) wind at a 60 degree F (15 degrees C) final sag. The displacement of a conductor or cable shall include the deflection of suspension insulators and structures.

2. Transition between Horizontal and Vertical Clearances.

   The horizontal clearance governs above the level of the roof or top of an installation to the point where the diagonal equals the vertical clearance requirement. Similarly, the horizontal clearance governs above or below projections from installations to the point where the diagonal equals the vertical clearance requirement. From this point, the transitional clearance shall equal the vertical clearance, as shown in Figure 1.

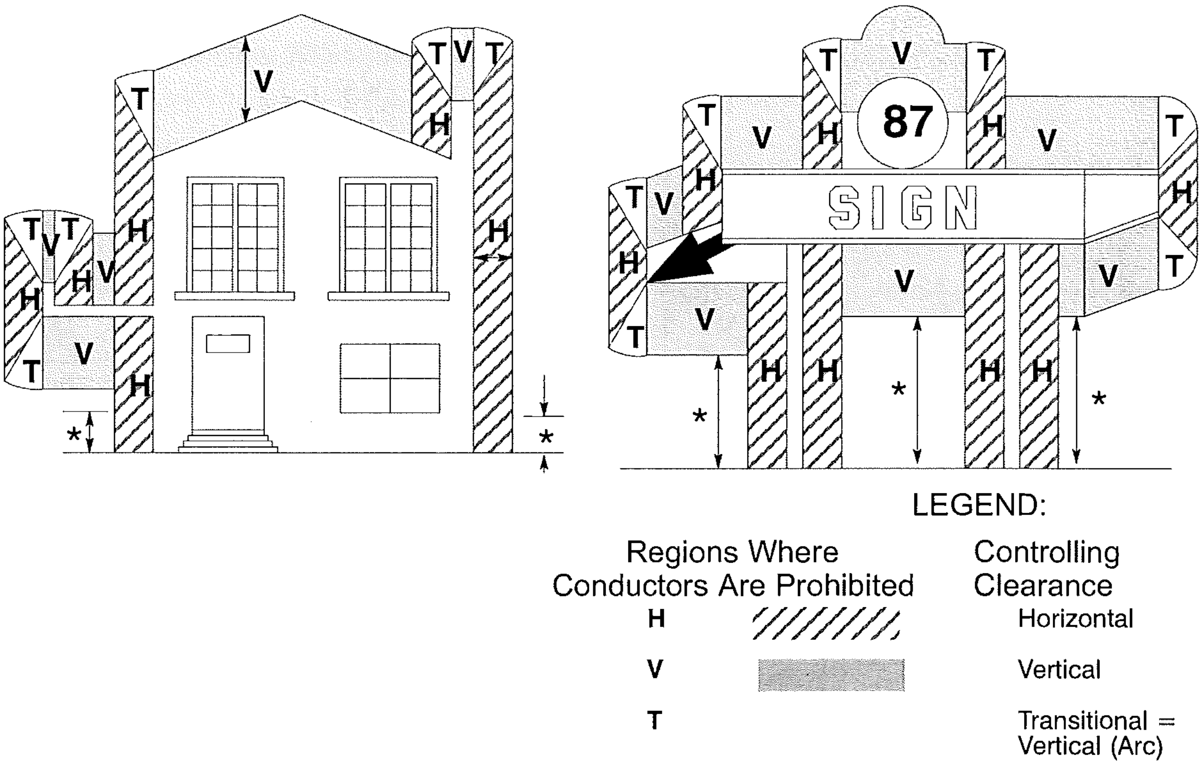


Figure 1 – Clearance Diagram for Buildings and Other Structures

C. Minimum Clearances of Conductors from Other Supporting Structures

Wires, conductors or cables passing near supporting structures of another line, lighting, or traffic signal circuits without being attached, shall have the minimum horizontal and vertical clearances summarized in Table 1.

The horizontal clearances shall be applied with the conductor having a wind displacement indicated in paragraph B.2.

Table 1 – Minimum Clearances of Conductors from Other Supporting Structures

Conductor or Cable	Clearances (Feet) Horizontal	Vertical
Guys, Messengers, Neutrals	3.0	2.0
Cables – 0 to 300 V	3.0	2.0
Cables – 301 to 750 V	3.5	4.5
Cables – Above 750 V	3.5	4.5
Open Supply Lines – 0 to 750 V	3.5	4.5
Open Supply Lines – 751 V to 22 kV	4.5	4.5

The wind displacement does not need to be considered for communication conductors.

D. Minimum Clearances of Conductors and Rigid Live Parts Adjacent But Not Attached to Buildings

The minimum vertical and horizontal clearances of conductors not attached to buildings are summarized in Clearance Tables 3a–3d. Clearances with six pounds per square foot wind are summarized in Clearance Tables 4a–4d.

E. Minimum Clearances of Conductors and Rigid Live Parts From Bridges

The minimum vertical and horizontal clearances of conductors or rigid live parts located adjacent to or within a bridge structure, are summarized in Clearance Tables 5a–5d and 6a–6d. No wire, conductor, cable or live part shall be closer to a bridge structure.

F. Minimum Clearances from Swimming Areas

Where wires, conductors, or cables cross over a swimming pool or the surrounding area, the clearances in any direction shall not be less than Clearance Tables 7a–7d. These horizontal clearances shall also be met under wind conditions. The clearances are illustrated in Figure 3.

In general, avoid placing lines near swimming areas whenever possible.

Swimming areas where rescue poles are not used or waterways subject to water skiing, shall conform to TC 111 (NESC 232).

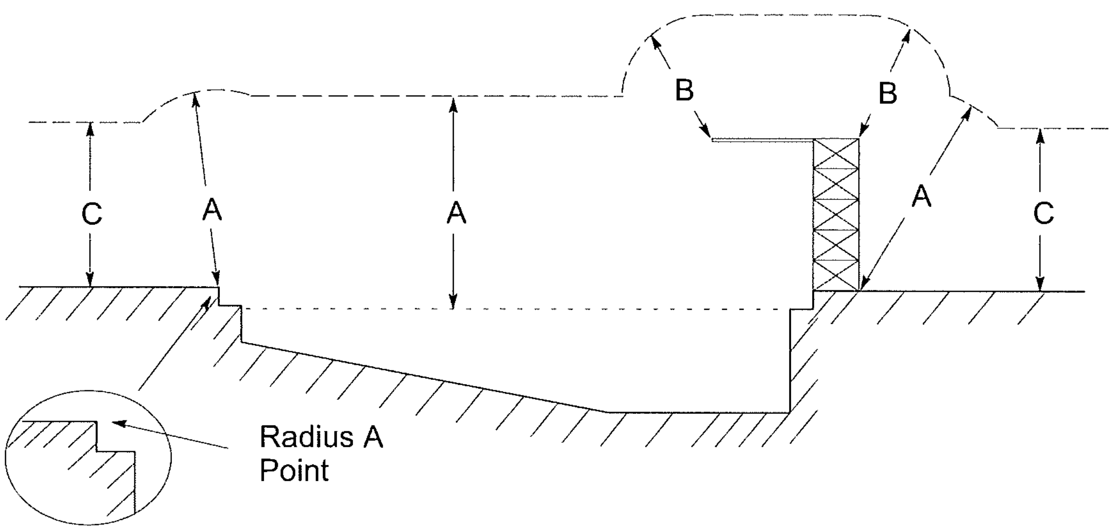


Figure 2 – Swimming Pool Clearances

G. Clearances of Conductors and Rigid Live Parts from Grain Bins

Refer to NESC 234F for the special requirement which apply to grain bins.

H. Additional Clearances for Voltages Exceeding 22 kV for Conductors and Unguarded Rigid Live Parts

For voltages between 22 and 470 kV, the clearances specified in paragraphs C, D, F, G, H, and J shall be increased at the rate of 0.4 inch per kV in excess of 22 kV.

For voltages exceeding 50 kV, the additional clearance specified above shall be increased 3 percent for each 1000 feet in excess of 3300 feet above mean sea level.

I. Clearances of Conductors to Rail Cars

Where overhead wires, conductors, or cables run along railroad tracks, the clearance in any direction shall be not less than that shown in Figure 4. The Values of V and H are as defined below:

V = Vertical clearance from the wire, conductor, or cable above the top of the rail as specified in TC 111 (Rule 232) minus 20 feet, the assumed height of the rail car

H = Horizontal clearance from the wire, conductor, or cable to the nearest rail, which is equal to the required vertical clearance above the rail minus 15 feet.

Refer to NESC 234 I for rail cars smaller than standard freight cars.

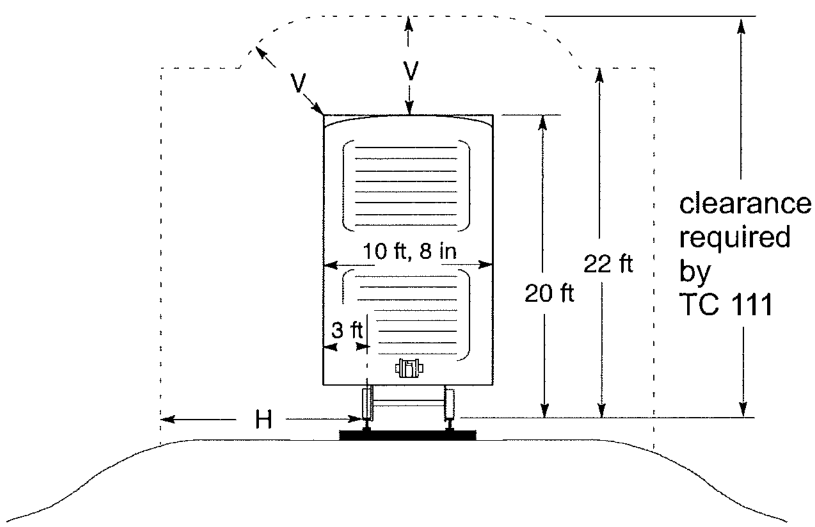


Figure 3 – Rail Car Clearances

Table 1 – PacifiCorp Standard Practice (NESC Table 234–1)
Clearances of Wires, Conductors, and Cables, and Unguarded Rigid Live Parts Adjacent but Not Attached to Buildings and Other Installations Except Bridges

Clearances are with NO WIND. See NESC Rules 233C1 and 233C2a.

Elevation range for table: Sea Level to 3300
Construction tolerance: 4 feet

Clearances of	Insulated communication conductors and cables messengers; surge protection wires; grounded guys; natural conductors meeting Rule 230E1; supply cables meeting Rule 230C1 (feet)	Supply cables cables of 0 to750 V meeting Rules 230C2 or 230C3 (feet)	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors: over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 27 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
1. Buildings													
a. Horizontal													
(1). To walls, projection, and guarded windows.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.1)	14.0 (9.6)	15.0 (10.0)	16.0 (11.4)	18.0 (13.8)	22.0 (17.4) +3 Rim Buffer (min.)
(2) To unguarded windows.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.1)	14.0 (9.6)	15.0 (10.0)	16.0 (11.4)	18.0 (13.8)	22.0 (17.4)
(3) To balconies and areas readily accessible to pedestrians.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.1)	14.0 (9.6)	15.0 (10.0)	16.0 (11.4)	18.0 (13.8)	22.0 (17.4)
b. Vertical													
(1) Over or under roofs or projections not readily accessible to pedestrians.	7.0 (3.0)	8.0 (3.5)	14.0 (10.0)	15.0 (10.5)	17.0 (12.5)	17.0 (12.7)	18.0 (13.2)	19.0 (14.1)	19.0 (14.6)	20.0 (15.0)	21.0 (16.4)	23.0 (18.8)	27.0 (22.4)
(2) Over or under balconies and roofs readily accessible to pedestrians.	15.0 (10.5)	15.0 (11.0)	15.0 (11.0)	16.0 (11.5)	18.0 (13.5)	18.0 (13.7)	19.0 (14.2)	20.0 (15.1)	20.0 (15.6)	21.0 (16.0)	22.0 (17.4)	24.0 (19.8)	28.0 (23.4)
(3) Over roofs accessible to vehicles but not subject to truck traffic.	15.0 (10.5)	15.0 (11.0)	15.0 (11.0)	16.0 (11.5)	18.0 (13.5)	18.0 (13.7)	19.0 (14.2)	20.0 (15.1)	20.0 (15.6)	21.0 (16.0)	22.0 (17.4)	24.0 (19.8)	28.0 (23.4)
(4) Over roofs accessible to truck traffic.	20.0 (15.5)	20.0 (16.0)	20.0 (16.0)	21.0 (16.5)	23.0 (18.5)	23.0 (18.7)	24.0 (19.2)	25.0 (20.1)	25.0 (20.6)	26.0 (21.0)	27.0 (22.4)	29.0 (24.8)	33.0 (28.4)
2. Signs, chimneys, billboards, radio and television antennas, tanks, and other installations not classified as buildings or bridges.													
a. Horizontal	7.0 (3.0)	8.0 (3.5)	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.1)	14.0 (9.6)	15.0 (10.0)	16.0 (11.4)	18.0 (13.8)	22.0 (17.4)
b. Vertical over or under	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (6.0)	12.0 (8.0)	13.0 (8.2)	13.0 (8.7)	14.0 (9.6)	15.0 (10.1)	15.0 (10.5)	16.0 (11.9)	19.0 (14.3)	22.0 (17.9)
3. Other supporting structures, wires, conductors, or cables of one line passing near a lighting support, traffic signal support, or a supporting structure of a second line, without being attached thereto.													
a. Horizontal	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	10.0 (5.7)	11.0 (6.1)	11.0 (6.6)	12.0 (8.0)	15.0 (10.3)	18.0 (13.9)
b. Vertical	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	10.0 (5.5)	10.0 (5.5)	10.0 (5.5)	11.0 (6.2)	11.0 (6.6)	12.0 (7.1)	13.0 (8.5)	15.0 (10.8)	19.0 (14.4)

Table 2 – PacifiCorp Standard Practice (NESC Table 234–1)
Clearances of Wires, Conductors, and Cables, and Unguarded Rigid Live Parts Adjacent but Not Attached to Buildings and Other Installations Except Bridges

Clearances are with NO WIND. See NESC Rules 233C1 and 233C2a.

Elevation range for table: 3300 6300
Construction tolerance: 4 feet

Clearances of	Insulated communication conductors and cables messengers; surge protection wires; grounded guys; natural conductors meeting Rule 230E1; supply cables meeting Rule 230C1 (feet)	Supply cables cables of 0 to750 V meeting Rules 230C2 or 230C3 (feet)	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors: over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 27 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
1. Buildings													
a. Horizontal													
(1). To walls, projection, and guarded windows.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.2)	14.0 (9.8)	15.0 (10.3)	16.0 (11.8)	19.0 (14.3)	23.0 (18.3)
(2) To unguarded windows.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.2)	14.0 (9.8)	15.0 (10.3)	16.0 (11.8)	19.0 (14.3)	23.00 (18.3)
(3) To balconies and areas readily accessible to pedestrians.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.2)	14.0 (9.8)	15.0 (10.3)	16.0 (11.8)	19.0 (14.3)	23.0 (18.3)
b. Vertical													
(1) Over or under roofs or projections not readily accessible to pedestrians.	7.0 (3.0)	8.0 (3.5)	14.0 (10.0)	15.0 (10.5)	17.0 (12.5)	17.0 (12.7)	18.0 (13.2)	19.0 (14.2)	19.0 (14.8)	20.0 (15.3)	21.0 (16.8)	24.0 (19.3)	28.0 (23.3)
(2) Over or under balconies and roofs readily accessible to pedestrians.	15.0 (10.5)	15.0 (11.0)	15.0 (11.0)	16.0 (11.5)	18.0 (13.5)	18.0 (13.7)	19.0 (14.2)	20.0 (15.2)	20.0 (15.8)	21.0 (16.3)	22.0 (17.8)	25.0 (20.3)	29.0 (24.3)
(3) Over roofs accessible to vehicles but not subject to truck traffic.	15.0 (10.5)	15.0 (11.0)	15.0 (11.0)	16.0 (11.5)	18.0 (13.5)	18.0 (13.7)	19.0 (14.2)	20.0 (15.2)	20.0 (15.8)	21.0 (16.3)	22.0 (17.8)	25.0 (20.3)	29.0 (24.3)
(4) Over roofs accessible to truck traffic.	20.0 (15.5)	20.0 (16.0)	20.0 (16.0)	21.0 (16.5)	23.0 (18.5)	23.0 (18.7)	24.0 (19.2)	25.0 (20.2)	25.0 (20.8)	26.0 (21.3)	27.0 (22.8)	30.0 (25.3)	34.0 (29.3)
2. Signs, chimneys, billboards, radio and television antennas, tanks, and other installations not classified as buildings or bridges.													
a. Horizontal	7.0 (3.0)	8.0 (3.5)	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.2)	14.0 (9.8)	15.0 (10.3)	16.0 (11.8)	19.0 (14.3)	23.0 (18.3)
b. Vertical over or under	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (6.0)	12.0 (8.0)	13.0 (8.2)	13.0 (8.7)	14.0 (9.7)	15.0 (10.3)	15.0 (10.8)	17.0 (12.3)	19.0 (14.8)	23.0 (18.8)
3. Other supporting structures, wires, conductors, or cables of one line passing near a lighting support, traffic signal support, or a supporting structure of a second line, without being attached thereto.													
a. Horizontal	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	10.0 (5.7)	11.0 (6.2)	11.0 (6.7)	13.0 (8.3)	15.0 (10.8)	19.0 (14.7)
b. Vertical	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	10.0 (5.5)	10.0 (5.5)	10.0 (5.5)	11.0 (6.2)	11.0 (6.7)	12.0 (7.2)	13.0 (8.8)	16.0 (11.3)	20.0 (15.2)

Table 3 – PacifiCorp Standard Practice (NESC Table 234–1)
Clearances of Wires, Conductors, and Cables, and Unguarded Rigid Live Parts Adjacent but Not Attached to Buildings and Other Installations Except Bridges

Clearances are with NO WIND. See NESC Rules 233C1 and 233C2a.

Elevation range for table: 6300 9300
Construction tolerance: 4 feet

Clearances of	Insulated communication conductors and cables messengers; surge protection wires; grounded guys; natural conductors meeting Rule 230E1; supply cables meeting Rule 230C1 (feet)	Supply cables cables of 0 to750 V meeting Rules 230C2 or 230C3 (feet)	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors: over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 27 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
1. Buildings													
a. Horizontal													
(1). To walls, projection, and guarded windows.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.4)	14.0 (9.9)	15.0 (10.5)	17.0 (12.1)	19.0 (14.9)	24.0 (19.1)
(2) To unguarded windows.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.4)	14.0 (9.9)	15.0 (10.5)	17.0 (12.1)	19.0 (14.9)	24.0 (19.1)
(3) To balconies and areas readily accessible to pedestrians.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.4)	14.0 (9.9)	15.0 (10.5)	17.0 (12.1)	19.0 (14.9)	24.0 (19.1)
b. Vertical													
(1) Over or under roofs or projections not readily accessible to pedestrians.	7.0 (3.0)	8.0 (3.5)	14.0 (10.0)	15.0 (10.5)	17.0 (12.5)	17.0 (12.7)	18.0 (13.2)	19.0 (14.4)	19.0 (14.9)	20.0 (15.5)	22.0 (17.1)	24.0 (19.9)	29.0 (24.1)
(2) Over or under balconies and roofs readily accessible to pedestrians.	15.0 (10.5)	15.0 (11.0)	15.0 (11.0)	16.0 (11.5)	18.0 (13.5)	18.0 (13.7)	19.0 (14.2)	20.0 (15.4)	20.0 (15.9)	21.0 (16.5)	23.0 (18.1)	25.0 (20.9)	30.0 (25.1)
(3) Over roofs accessible to vehicles but not subject to truck traffic.	15.0 (10.5)	15.0 (11.0)	15.0 (11.0)	16.0 (11.5)	18.0 (13.5)	18.0 (13.7)	19.0 (14.2)	20.0 (15.4)	20.0 (15.9)	21.0 (16.5)	23.0 (18.1)	25.0 (20.9)	30.0 (25.1)
(4) Over roofs accessible to truck traffic.	20.0 (15.5)	20.0 (16.0)	20.0 (16.0)	21.0 (16.5)	23.0 (18.5)	23.0 (18.7)	24.0 (19.2)	25.0 (20.4)	25.0 (20.9)	26.0 (21.5)	28.0 (23.1)	30.0 (25.9)	35.0 (30.1)
2. Signs, chimneys, billboards, radio and television antennas, tanks, and other installations not classified as buildings or bridges.													
a. Horizontal	7.0 (3.0)	8.0 (3.5)	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.4)	14.0 (9.9)	15.0 (10.5)	17.0 (12.1)	19.0 (14.9)	24.0 (19.1)
b. Vertical over or under	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (6.0)	12.0 (8.0)	13.0 (8.2)	13.0 (8.7)	14.0 (9.9)	15.0 (10.4)	15.0 (11.0)	17.0 (12.6)	20.0 (15.4)	24.0 (19.6)
3. Other supporting structures, wires, conductors, or cables of one line passing near a lighting support, traffic signal support, or a supporting structure of a second line, without being attached thereto.													
a. Horizontal	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	10.0 (5.8)	11.0 (6.3)	11.0 (6.9)	13.0 (8.6)	16.0 (11.3)	20.0 (15.5)
b. Vertical	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	10.0 (5.5)	10.0 (5.5)	10.0 (5.5)	11.0 (6.3)	11.0 (6.8)	12.0 (7.4)	14.0 (9.0)	16.0 (11.8)	21.0 (16.0)

Table 4 – PacifiCorp Standard Practice (NESC Table 234–1)
Clearances of Wires, Conductors, and Cables, and Unguarded Rigid Live Parts Adjacent but Not Attached to Buildings and Other Installations Except Bridges

Clearances are with NO WIND. See NESC Rules 233C1 and 233C2a.

Elevation range for table: 9300 12300
Construction tolerance: 4 feet

Clearances of	Insulated communication conductors and cables messengers; surge protection wires; grounded guys; natural conductors meeting Rule 230E1; supply cables meeting Rule 230C1 (feet)	Supply cables cables of 0 to750 V meeting Rules 230C2 or 230C3 (feet)	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors: over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 27 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
1. Buildings													
a. Horizontal													
(1). To walls, projection, and guarded windows.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.5)	15.0 (10.1)	15.0 (10.7)	17.0 (12.5)	20.0 (15.5)	25.0 (20.0)
(2) To unguarded windows.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.5)	15.0 (10.1)	15.0 (10.7)	17.0 (12.5)	20.0 (15.5)	25.0 (20.0)
(3) To balconies and areas readily accessible to pedestrians.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.5)	15.0 (10.1)	15.0 (10.7)	17.0 (12.5)	20.0 (15.5)	25.0 (20.0)
b. Vertical													
(1) Over or under roofs or projections not readily accessible to pedestrians.	7.0 (3.0)	8.0 (3.5)	14.0 (10.0)	15.0 (10.5)	17.0 (12.5)	17.0 (12.7)	18.0 (13.2)	19.0 (14.5)	20.0 (15.1)	20.0 (15.7)	22.0 (17.5)	25.0 (20.5)	30.0 (25.0)
(2) Over or under balconies and roofs readily accessible to pedestrians.	15.0 (10.5)	15.0 (11.0)	15.0 (11.0)	16.0 (11.5)	18.0 (13.5)	18.0 (13.7)	19.0 (14.2)	20.0 (15.5)	21.0 (16.1)	21.0 (16.7)	23.0 (18.5)	26.0 (21.5)	31.0 (26.0)
(3) Over roofs accessible to vehicles but not subject to truck traffic.	15.0 (10.5)	15.0 (11.0)	15.0 (11.0)	16.0 (11.5)	18.0 (13.5)	18.0 (13.7)	19.0 (14.2)	20.0 (15.5)	21.0 (16.1)	21.0 (16.7)	23.0 (18.5)	26.0 (21.5)	31.0 (26.0)
(4) Over roofs accessible to truck traffic.	20.0 (15.5)	20.0 (16.0)	20.0 (16.0)	21.0 (16.5)	23.0 (18.5)	23.0 (18.7)	24.0 (19.2)	25.0 (20.5)	26.0 (21.1)	26.0 (21.7)	28.0 (23.5)	31.0 (26.5)	36.0 (31.0)
2. Signs, chimneys, billboards, radio and television antennas, tanks, and other installations not classified as buildings or bridges.													
a. Horizontal	7.0 (3.0)	8.0 (3.5)	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.5)	15.0 (10.1)	15.0 (10.7)	17.0 (12.5)	20.0 (15.5)	25.0 (20.0)
b. Vertical over or under	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (6.0)	12.0 (8.0)	13.0 (8.2)	13.0 (8.7)	15.0 (10.0)	15.0 (10.6)	16.0 (11.2)	17.0 (13.0)	20.0 (16.0)	25.0 (20.5)
3. Other supporting structures, wires, conductors, or cables of one line passing near a lighting support, traffic signal support, or a supporting structure of a second line, without being attached thereto.													
a. Horizontal	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	9.0 (5.0)	10.0 (6.8)	11.0 (6.4)	12.0 (7.0)	13.0 (8.8)	16.0 (11.8)	21.0 (16.3)
b. Vertical	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	10.0 (5.5)	10.0 (5.5)	10.0 (5.5)	11.0 (6.3)	11.0 (6.9)	12.0 (7.5)	14.0 (9.3)	17.0 (12.3)	21.0 (16.8)

Table 5 – PacifiCorp Standard Practice (NESC Table 234–1)

Clearances of Wires, Conductors, and Cables, and Unguarded Rigid Live Parts Adjacent but Not Attached to Buildings and Other Installations Except Bridges

Clearances are with 6 lb/sf WIND. See NESC Rules 233C1 and 233C2a.

Elevation range for table: Sea Level to 3300
Construction tolerance: 4 feet

Clearances of	Insulated communication conductors and cables messengers; surge protection wires; grounded guys; natural conductors meeting Rule 230E1; supply cables meeting Rule 230C1 (feet)	Supply cables cables of 0 to750 V meeting Rules 230C2 or 230C3 (feet)	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors								
					over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 27 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
1. Buildings													
a. Horizontal													
(1). To walls, projection, and guarded windows.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.1)	11.0 (6.3)	12.0 (7.0)	13.0 (8.4)	15.0 (10.8)	19.0 ~~(14.4)~~ +3' Psm Buffer min.
(2) To unguarded windows.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.1)	11.0 (6.6)	12.0 (7.0)	13.0 (8.4)	15.0 (10.8)	19.0 (14.4)
(3) To balconies and areas readily accessible to pedestrians.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.1)	11.0 (6.6)	12.0 (7.0)	13.0 (8.4)	15.0 (10.8)	19.0 (14.4)
b. Vertical													
(1) Over or under roofs or projections not readily accessible to pedestrians.	7.0 (3.0)	8.0 (3.5)	14.0 (10.0)	15.0 (10.5)	17.0 (12.5)	17.0 (12.7)	18.0 (13.2)	19.0 (14.1)	19.0 (14.6)	20.0 (15.0)	21.0 (16.4)	23.0 (18.8)	27.0 (22.4)
(2) Over or under balconies and roofs readily accessible to pedestrians.	15.0 (10.5)	15.0 (11.0)	15.0 (11.0)	16.0 (11.5)	18.0 (13.5)	18.0 (13.7)	19.0 (14.2)	20.0 (15.1)	20.0 (15.6)	21.0 (16.0)	22.0 (17.4)	24.0 (19.8)	28.0 (23.4)
(3) Over roofs accessible to vehicles but not subject to truck traffic.	15.0 (10.5)	15.0 (11.0)	15.0 (11.0)	16.0 (11.5)	18.0 (13.5)	18.0 (13.7)	19.0 (14.2)	20.0 (15.1)	20.0 (15.6)	21.0 (16.0)	22.0 (17.4)	24.0 (19.8)	28.0 (23.4)
(4) Over roofs accessible to truck traffic.	20.0 (15.5)	20.0 (16.0)	20.0 (16.0)	21.0 (16.5)	23.0 (18.5)	23.0 (18.5)	24.0 (19.2)	25.0 (20.1)	25.0 (20.6)	26.0 (21.0)	27.0 (22.4)	29.0 (24.8)	33.0 (28.4)
2. Signs, chimneys, billboards, radio and television antennas, tanks, and other installations not classified as buildings or bridges.													
a. Horizontal	7.0 (3.0)	8.0 (3.5)	8.0 (3.5)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.1)	11.0 (6.6)	12.0 (7.0)	13.0 (8.4)	15.0 (10.8)	19.0 (14.4)
b. Vertical over or under	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (6.0)	12.0 (8.0)	13.0 (8.2)	13.0 (8.7)	14.0 (9.6)	15.0 (10.1)	15.0 (10.5)	16.0 (11.9)	19.0 (14.3)	22.0 (17.9)
3. Other supporting structures, wires, conductors, or cables of one line passing near a lighting support, traffic signal support, or a supporting structure of a second line, without being attached thereto.													
a. Horizontal	8.0 (3.5)	8.0 (3.5)	8.0 (3.5)	8.0 (3.5)	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	10.0 (5.2)	10.0 (5.6)	11.0 (6.1)	12.0 (7.5)	14.0 (9.8)	18.0 (13.4)
b. Vertical	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	10.0 (5.5)	10.0 (5.5)	10.0 (5.5)	11.0 (6.2)	11.0 (6.6)	12.0 (7.1)	13.0 (8.6)	15.0 (10.8)	19.0 (14.4)

Table 6 – PacifiCorp Standard Practice (NESC Table 234–1)
Clearances of Wires, Conductors, and Cables, and Unguarded Rigid Live Parts Adjacent but Not Attached to Buildings and Other Installations Except Bridges

Clearances are with 6 lb/sf WIND. See NESC Rules 233C1 and 233C2a.

Elevation range for table: 3300 6300
Construction tolerance: 4 feet

Clearances of	Insulated communication conductors and cables messengers; surge protection wires; grounded guys; natural conductors meeting Rule 230E1; supply cables meeting Rule 230C1 (feet)	Supply cables cables of 0 to750 V meeting Rules 230C2 or 230C3 (feet)	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors: over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 27 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
1. Buildings													
a. Horizontal													
(1). To walls, projection, and guarded windows.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.2)	11.0 (6.3)	12.0 (7.3)	13.0 (8.8)	16.0 (11.3)	20.0 (15.3)
(2) To unguarded windows.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.2)	11.0 (7.2)	12.0 (7.7)	13.0 (9.2)	16.0 (11.7)	20.0 (15.3)
(3) To balconies and areas readily accessible to pedestrians.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.2)	11.0 (6.8)	12.0 (7.3)	13.0 (8.8)	16.0 (11.3)	20.0 (15.3)
b. Vertical													
(1) Over or under roofs or projections not readily accessible to pedestrians.	7.0 (3.0)	8.0 (3.5)	14.0 (10.0)	15.0 (10.5)	17.0 (12.5)	17.0 (12.7)	18.0 (13.2)	19.0 (14.2)	19.0 (14.8)	20.0 (15.3)	21.0 (16.8)	24.0 (19.3)	28.0 (23.3)
(2) Over or under balconies and roofs readily accessible to pedestrians.	15.0 (10.5)	15.0 (11.0)	15.0 (11.0)	16.0 (11.5)	18.0 (13.5)	18.0 (13.7)	19.0 (14.2)	20.0 (15.2)	20.0 (15.8)	21.0 (16.3)	22.0 (17.8)	25.0 (20.3)	29.0 (24.3)
(3) Over roofs accessible to vehicles but not subject to truck traffic.	15.0 (10.5)	15.0 (11.0)	15.0 (11.0)	16.0 (11.5)	18.0 (13.5)	18.0 (13.7)	19.0 (14.2)	20.0 (15.2)	20.0 (15.8)	21.0 (16.3)	22.0 (17.8)	25.0 (20.3)	29.0 (24.3)
(4) Over roofs accessible to truck traffic.	20.0 (15.5)	20.0 (16.0)	20.0 (16.0)	21.0 (16.5)	23.0 (18.5)	23.0 (18.5)	24.0 (19.2)	25.0 (20.2)	25.0 (20.8)	26.0 (21.3)	27.0 (22.8)	30.0 (25.3)	34.0 (29.3)
2. Signs, chimneys, billboards, radio and television antennas, tanks, and other installations not classified as buildings or bridges.													
a. Horizontal	7.0 (3.0)	8.0 (3.5)	8.0 (3.5)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.2)	11.0 (6.8)	12.0 (7.3)	13.0 (8.8)	16.0 (11.3)	20.0 (15.3)
b. Vertical over or under	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (6.0)	12.0 (8.0)	13.0 (8.2)	13.0 (8.7)	14.0 (9.7)	15.0 (10.3)	15.0 (10.8)	17.0 (12.3)	19.0 (14.8)	23.0 (18.8)
3. Other supporting structures, wires, conductors, or cables of one line passing near a lighting support, traffic signal support, or a supporting structure of a second line, without being attached thereto.													
a. Horizontal	8.0 (3.5)	8.0 (3.5)	8.0 (3.5)	8.0 (3.5)	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	10.0 (5.2)	10.0 (6.7)	11.0 (6.2)	12.0 (7.8)	15.0 (10.3)	19.0 (14.2)
b. Vertical	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	10.0 (5.5)	10.0 (5.5)	10.0 (5.5)	11.0 (6.2)	11.0 (6.7)	12.0 (7.2)	13.0 (8.8)	16.0 (11.3)	20.0 (15.2)

Table 7 – PacifiCorp Standard Practice (NESC Table 234–1)
Clearances of Wires, Conductors, and Cables, and Unguarded Rigid Live Parts Adjacent but Not Attached to Buildings and Other Installations Except Bridges

Clearances are with 6 lb/sf WIND. See NESC Rules 233C1 and 233C2a.

Elevation range for table: 6300 9300
Construction tolerance: 4 feet

Clearances of	Insulated communication conductors and cables messengers; surge protection wires; grounded guys; natural conductors meeting Rule 230E1; supply cables meeting Rule 230C1 (feet)	Supply cables cables of 0 to750 V meeting Rules 230C2 or 230C3 (feet)	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors								
					over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 27 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
1. Buildings													
a. Horizontal													
(1). To walls, projection, and guarded windows.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	8.0 (3.5)	10.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.4)	11.0 (6.3)	12.0 (7.5)	14.0 (9.1)	16.0 (11.9)	21.0 (16.1)
(2) To unguarded windows.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.4)	11.0 (7.7)	12.0 (8.3)	14.0 (10.0)	16.0 (12.7)	21.0 (16.1)
(3) To balconies and areas readily accessible to pedestrians.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.4)	11.0 (6.9)	12.0 (7.5)	14.0 (9.1)	16.0 (11.9)	21.0 (16.1)
b. Vertical													
(1) Over or under roofs or projections not readily accessible to pedestrians.	7.0 (3.0)	8.0 (3.5)	14.0 (10.0)	15.0 (10.5)	17.0 (12.5)	17.0 (12.7)	18.0 (13.2)	19.0 (14.4)	19.0 (14.9)	20.0 (15.5)	22.0 (17.1)	24.0 (19.9)	29.0 (24.1)
(2) Over or under balconies and roofs readily accessible to pedestrians.	15.0 (10.5)	15.0 (11.0)	15.0 (11.0)	16.0 (11.5)	18.0 (13.5)	18.0 (13.7)	19.0 (14.2)	20.0 (15.4)	20.0 (15.9)	21.0 (16.5)	23.0 (18.1)	25.0 (20.9)	30.0 (25.1)
(3) Over roofs accessible to vehicles but not subject to truck traffic.	15.0 (10.5)	15.0 (11.0)	15.0 (11.0)	16.0 (11.5)	18.0 (13.5)	18.0 (13.7)	19.0 (14.2)	20.0 (15.4)	20.0 (15.9)	21.0 (16.5)	23.0 (18.1)	25.0 (20.9)	30.0 (25.1)
(4) Over roofs accessible to truck traffic.	20.0 (15.5)	20.0 (16.0)	20.0 (16.0)	21.0 (16.5)	23.0 (18.5)	23.0 (18.5)	24.0 (19.2)	25.0 (20.4)	25.0 (20.9)	26.0 (21.5)	28.0 (23.1)	30.0 (25.9)	35.0 (30.1)
2. Signs, chimneys, billboards, radio and television antennas, tanks, and other installations not classified as buildings or bridges.													
a. Horizontal	7.0 (3.0)	8.0 (3.5)	8.0 (3.5)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.4)	11.0 (6.9)	12.0 (7.5)	14.0 (9.1)	16.0 (11.9)	21.0 (16.1)
b. Vertical over or under	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (6.0)	12.0 (8.0)	13.0 (8.2)	13.0 (8.7)	14.0 (9.9)	15.0 (10.4)	15.0 (11.0)	17.0 (12.6)	20.0 (15.4)	24.0 (19.6)
3. Other supporting structures, wires, conductors, or cables of one line passing near a lighting support, traffic signal support, or a supporting structure of a second line, without being attached thereto.													
a. Horizontal	8.0 (3.5)	8.0 (3.5)	8.0 (3.5)	8.0 (3.5)	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	10.0 (5.3)	10.0 (5.8)	11.0 (6.4)	13.0 (8.0)	15.0 (10.8)	20.0 (15.0)
b. Vertical	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	10.0 (5.5)	10.0 (5.5)	10.0 (5.5)	11.0 (6.3)	11.0 (6.8)	12.0 (7.4)	14.0 (9.0)	16.0 (11.8)	21.0 (16.0)

Table 8 – PacifiCorp Standard Practice (NESC Table 234–1)
Clearances of Wires, Conductors, and Cables, and Unguarded Rigid Live Parts Adjacent but Not Attached to Buildings and Other Installations Except Bridges

Clearances are with 6 lb/sf WIND. See NESC Rules 233C1 and 233C2a.

Elevation range for table: 9300 12300
Construction tolerance: 4 feet

Clearances of	Insulated communication conductors and cables messengers; surge protection wires; grounded guys; natural conductors meeting Rule 230E1; supply cables meeting Rule 230C1 (feet)	Supply cables cables of 0 to750 V meeting Rules 230C2 or 230C3 (feet)	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors: over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 27 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
1. Buildings													
a. Horizontal													
(1). To walls, projection, and guarded windows.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	8.0 (3.5)	10.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.5)	12.0 (6.3)	12.0 (7.7)	14.0 (9.5)	17.0 (12.5)	22.0 (17.0)
(2) To unguarded windows.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.5)	12.0 (8.3)	12.0 (8.9)	14.0 (10.7)	17.0 (13.7)	22.0 (17.0)
(3) To balconies and areas readily accessible to pedestrians.	9.0 (4.5)	9.0 (5.0)	9.0 (5.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.5)	12.0 (7.1)	12.0 (7.7)	14.0 (9.5)	17.0 (12.5)	22.0 (17.0)
b. Vertical													
(1) Over or under roofs or projections not readily accessible to pedestrians.	7.0 (3.0)	8.0 (3.5)	14.0 (10.0)	15.0 (10.5)	17.0 (12.5)	17.0 (12.7)	18.0 (13.2)	19.0 (14.5)	20.0 (15.1)	20.0 (15.7)	22.0 (17.5)	25.0 (20.5)	30.0 (25.0)
(2) Over or under balconies and roofs readily accessible to pedestrians.	15.0 (10.5)	15.0 (11.0)	15.0 (11.0)	16.0 (11.5)	18.0 (13.5)	18.0 (13.7)	19.0 (14.2)	20.0 (15.5)	21.0 (16.1)	21.0 (16.7)	23.0 (18.5)	26.0 (21.5)	31.0 (26.0)
(3) Over roofs accessible to vehicles but not subject to truck traffic.	15.0 (10.5)	15.0 (11.0)	15.0 (11.0)	16.0 (11.5)	18.0 (13.5)	18.0 (13.7)	19.0 (14.2)	20.0 (15.5)	21.0 (16.1)	21.0 (16.7)	23.0 (18.5)	26.0 (21.5)	31.0 (26.0)
(4) Over roofs accessible to truck traffic.	20.0 (15.5)	20.0 (16.0)	20.0 (16.0)	21.0 (16.5)	23.0 (18.5)	23.0 (18.5)	24.0 (19.2)	25.0 (20.5)	26.0 (21.1)	26.0 (21.7)	28.0 (23.5)	31.0 (26.5)	36.0 (31.0)
2. Signs, chimneys, billboards, radio and television antennas, tanks, and other installations not classified as buildings or bridges.													
a. Horizontal	7.0 (3.0)	8.0 (3.5)	8.0 (3.5)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.5)	12.0 (7.1)	12.0 (7.7)	14.0 (9.5)	17.0 (12.5)	22.0 (17.0)
b. Vertical over or under	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (6.0)	12.0 (8.0)	13.0 (8.2)	13.0 (8.7)	15.0 (10.0)	15.0 (10.6)	16.0 (11.2)	17.0 (13.0)	20.0 (16.0)	25.0 (20.5)
3. Other supporting structures, wires, conductors, or cables of one line passing near a lighting support, traffic signal support, or a supporting structure of a second line, without being attached thereto.													
a. Horizontal	8.0 (3.5)	8.0 (3.5)	8.0 (3.5)	8.0 (3.5)	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	10.0 (5.3)	10.0 (5.9)	11.0 (6.5)	13.0 (8.3)	16.0 (11.3)	20.0 (15.8)
b. Vertical	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	9.0 (4.5)	10.0 (5.5)	10.0 (5.5)	10.0 (5.5)	11.0 (6.3)	11.0 (6.9)	12.0 (7.5)	14.0 (9.3)	17.0 (12.3)	21.0 (16.8)

Table 9 – PacifiCorp Standard Practice (NESC Table 234–2)
Clearances of Wires, Conductors, and Cables From Bridges

Clearances with NO WIND. See NESC Rules 234D1a and 234H4.

Elevation range for table: Sea Level to 3300
Construction tolerance: 4 feet

	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors; supply cables of 0 to 750 V meeting Rules 230C2 or 230C3 (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors								
			over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 28 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
1. Clearance over bridges.											
a Attached	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (5.7)	11.0 (6.2)	12.0 (7.1)	12.0 (7.6)	13.0 (8.0)	14.0 (9.4)	16.0 (11.8)	20.0 (15.4)
b. Not attached	14.0 (10.0)	15.0 (10.5)	17.0 (12.5)	17.0 (12.7)	18.0 (13.2)	19.0 (14.1)	19.0 (14.6)	20.0 (15.0)	21.0 (16.4)	23.0 (18.8)	27.0 (22.4)
2. Clearance beside, under or within bridge structure.											
a. Readily accessible portions of any bridge, including wing, walls, and bridge attachments.											
(1) Attached	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (5.7)	11.0 (6.2)	12.0 (7.1)	12.0 (7.6)	13.0 (8.0)	14.0 (9.4)	16.0 (11.8)	20.0 (15.4)
(2) Not Attached	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.1)	14.0 (9.6)	15.0 (10.0)	16.0 (11.4)	18.0 (13.8)	22.0 (17.4)
b. Ordinarily inaccessible portions of bridges (other than brick, concrete, or masonry) and from abutments.											
(1) Attached	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (5.7)	11.0 (6.2)	12.0 (7.1)	12.0 (7.6)	13.0 (8.0)	14.0 (9.4)	16.0 (11.8)	20.0 (15.4)
(2) Not Attached	8.0 (4.0)	9.0 (4.5)	11.0 (6.5)	11.0 (6.7)	12.0 (7.2)	13.0 (8.1)	13.0 (8.6)	14.0 (9.0)	15.0 (10.4)	17.0 (12.8)	21.0 (16.4)

Table 10 – PacifiCorp Standard Practice (NESC Table 234–2)
Clearances of Wires, Conductors, and Cables From Bridges

Clearances with NO WIND. See NESC Rules 234D1a and 234H4.

Elevation range for table: 3300 6300
Construction tolerance: 4 feet

	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors; supply cables of 0 to 750 V meeting Rules 230C2 or 230C3 (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors: over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 28 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
1. Clearance over bridges.											
a Attached	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (5.7)	11.0 (6.2)	12.0 (7.2)	12.0 (7.8)	13.0 (8.3)	14.0 (9.8)	17.0 (12.3)	21.0 (16.3)
b. Not attached	14.0 (10.0)	15.0 (10.5)	17.0 (12.5)	17.0 (12.7)	18.0 (13.2)	19.0 (14.2)	19.0 (14.8)	20.0 (15.3)	21.0 (16.8)	24.0 (19.3)	28.0 (23.3)
2. Clearance beside, under or within bridge structure.											
a. Readily accessible portions of any bridge, including wing, walls, and bridge attachments.											
(1) Attached	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (5.7)	11.0 (6.2)	12.0 (7.2)	12.0 (7.8)	13.0 (8.3)	14.0 (9.8)	17.0 (12.3)	21.0 (16.3)
(2) Not Attached	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.2)	14.0 (9.8)	15.0 (10.3)	16.0 (11.8)	19.0 (14.3)	23.0 (18.3)
b. Ordinarily inaccessible portions of bridges (other than brick, concrete, or masonry) and from abutments.											
(1) Attached	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (5.7)	11.0 (6.2)	12.0 (7.2)	12.0 (7.8)	13.0 (8.3)	14.0 (9.8)	17.0 (12.3)	21.0 (16.3)
(2) Not Attached	8.0 (4.0)	9.0 (4.5)	11.0 (6.5)	11.0 (6.7)	12.0 (7.2)	13.0 (8.2)	13.0 (8.8)	14.0 (9.3)	15.0 (10.8)	18.0 (13.3)	22.0 (17.3)

Table 11 – PacifiCorp Standard Practice (NESC Table 234–2)
Clearances of Wires, Conductors, and Cables From Bridges

Clearances with NO WIND. See NESC Rules 234D1a and 234H4.

Elevation range for table: 6300 9300
Construction tolerance: 4 feet

	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors; supply cables of 0 to 750 V meeting Rules 230C2 or 230C3 (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors								
			over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 28 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
1. Clearance over bridges.											
a Attached	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (5.7)	11.0 (6.2)	12.0 (7.4)	12.0 (7.9)	13.0 (8.5)	15.0 (10.1)	17.0 (12.9)	22.0 (17.1)
b. Not attached	14.0 (10.0)	15.0 (10.5)	17.0 (12.5)	17.0 (12.7)	18.0 (13.2)	19.0 (14.4)	19.0 (14.9)	20.0 (15.5)	22.0 (17.1)	24.0 (19.9)	29.0 (24.1)
2. Clearance beside, under or within bridge structure.											
a. Readily accessible portions of any bridge, including wing, walls, and bridge attachments.											
(1) Attached	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (5.7)	11.0 (6.2)	12.0 (7.4)	12.0 (7.9)	13.0 (8.5)	15.0 (10.1)	17.0 (12.9)	22.0 (17.1)
(2) Not Attached	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.4)	14.0 (9.9)	15.0 (10.5)	17.0 (12.1)	19.0 (14.9)	24.0 (19.1)
b. Ordinarily inaccessible portions of bridges (other than brick, concrete, or masonry) and from abutments.											
(1) Attached	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (5.7)	11.0 (6.2)	12.0 (7.4)	12.0 (7.9)	13.0 (8.5)	15.0 (10.1)	17.0 (12.9)	22.0 (17.1)
(2) Not Attached	8.0 (4.0)	9.0 (4.5)	11.0 (6.5)	11.0 (6.7)	12.0 (7.2)	13.0 (8.4)	13.0 (8.9)	14.0 (9.5)	16.0 (11.1)	18.0 (13.9)	23.0 (18.1)

Table 12 – PacifiCorp Standard Practice (NESC Table 234–2)
Clearances of Wires, Conductors, and Cables From Bridges

Clearances with NO WIND. See NESC Rules 234D1a and 234H4.

Elevation range for table: 9300 12300
Construction tolerance: 4 feet

	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors; supply cables of 0 to 750 V meeting Rules 230C2 or 230C3 (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors								
			over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 28 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
1. Clearance over bridges.											
a Attached	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (5.7)	11.0 (6.2)	12.0 (7.5)	13.0 (8.1)	13.0 (8.7)	15.0 (10.5)	18.0 (13.5)	23.0 (18.0)
b. Not attached	14.0 (10.0)	15.0 (10.5)	17.0 (12.5)	17.0 (12.7)	18.0 (13.2)	19.0 (14.5)	20.0 (15.1)	20.0 (15.7)	22.0 (17.5)	25.0 (20.5)	30.0 (25.0)
2. Clearance beside, under or within bridge structure.											
a. Readily accessible portions of any bridge, including wing, walls, and bridge attachments.											
(1) Attached	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (5.7)	11.0 (6.2)	12.0 (7.5)	13.0 (8.1)	13.0 (8.7)	15.0 (10.5)	18.0 (13.5)	23.0 (18.0)
(2) Not Attached	9.0 (5.0)	10.0 (5.5)	12.0 (7.5)	12.0 (7.7)	13.0 (8.2)	14.0 (9.5)	15.0 (10.1)	15.0 (10.7)	17.0 (12.5)	20.0 (15.5)	25.0 (20.0)
b. Ordinarily inaccessible portions of bridges (other than brick, concrete, or masonry) and from abutments.											
(1) Attached	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (5.7)	11.0 (6.2)	12.0 (7.5)	13.0 (8.1)	13.0 (8.7)	15.0 (10.5)	18.0 (13.5)	23.0 (18.0)
(2) Not Attached	8.0 (4.0)	9.0 (4.5)	11.0 (6.5)	11.0 (6.7)	12.0 (7.2)	13.0 (8.5)	14.0 (9.1)	14.0 (9.7)	16.0 (11.5)	19.0 (14.5)	24.0 (19.0)

Table 13 – PacifiCorp Standard Practice (NESC Table 234–2)
Clearances of Wires, Conductors, and Cables From Bridges

Clearances with 6 lbs/sf WIND. See NESC Rules 234D1a and 234H4.

Elevation range for table: Sea Level to 3300
Construction tolerance: 4 feet

	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors; supply cables of 0 to 750 V meeting Rules 230C2 or 230C3 (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors								
			over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 28 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
1. Clearance over bridges.											
a Attached	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (5.7)	11.0 (6.2)	12.0 (7.1)	12.0 (7.6)	13.0 (8.0)	14.0 (9.4)	16.0 (11.8)	20.0 (15.4)
b. Not attached	14.0 (10.0)	15.0 (10.5)	17.0 (12.5)	17.0 (12.7)	18.0 (13.2)	19.0 (14.1)	19.0 (14.6)	20.0 (15.0)	21.0 (16.4)	23.0 (18.8)	27.0 (22.4)
2. Clearance beside, under or within bridge structure.											
a. Readily accessible portions of any bridge, including wing, walls, and bridge attachments.											
(1) Attached	7.0 (3.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.1)	11.0 (6.6)	12.0 (7.0)	13.0 (8.4)	15.0 (10.8)	19.0 (14.4)
(2) Not Attached	9.0 (5.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.1)	11.0 (6.6)	12.0 (7.0)	13.0 (8.4)	15.0 (10.8)	19.0 (14.4)
b. Ordinarily inaccessible portions of bridges (other than brick, concrete, or masonry) and from abutments.											
(1) Attached	7.0 (3.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.1)	11.0 (6.6)	12.0 (7.0)	13.0 (8.4)	15.0 (10.8)	19.0 (14.4)
(2) Not Attached	8.0 (4.0)	9.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.1)	11.0 (6.6)	12.0 (7.0)	13.0 (8.4)	15.0 (10.8)	19.0 (14.4)

Table 14 – PacifiCorp Standard Practice (NESC Table 234–2)
Clearances of Wires, Conductors, and Cables From Bridges

Clearances with 6 lbs/sf WIND. See NESC Rules 234D1a and 234H4.

Elevation range for table: 3300 6300
Construction tolerance: 4 feet

	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors; supply cables of 0 to 750 V meeting Rules 230C2 or 230C3 (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors								
			over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 28 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
1. Clearance over bridges.											
a Attached	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (5.7)	11.0 (6.2)	12.0 (7.2)	12.0 (7.8)	13.0 (8.3)	14.0 (9.8)	17.0 (12.3)	21.0 (16.3)
b. Not attached	14.0 (10.0)	15.0 (10.5)	17.0 (12.5)	17.0 (12.7)	18.0 (13.2)	19.0 (14.2)	19.0 (14.8)	20.0 (15.3)	21.0 (16.8)	24.0 (19.3)	28.0 (23.3)
2. Clearance beside, under or within bridge structure.											
a. Readily accessible portions of any bridge, including wing, walls, and bridge attachments.											
(1) Attached	7.0 (3.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.2)	11.0 (6.8)	12.0 (7.3)	13.0 (8.8)	16.0 (11.3)	20.0 (15.3)
(2) Not Attached	9.0 (5.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.2)	11.0 (6.8)	12.0 (7.3)	13.0 (8.8)	16.0 (11.3)	20.0 (15.3)
b. Ordinarily inaccessible portions of bridges (other than brick, concrete, or masonry) and from abutments.											
(1) Attached	7.0 (3.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.2)	11.0 (6.8)	12.0 (7.3)	13.0 (8.8)	16.0 (11.3)	20.0 (15.3)
(2) Not Attached	8.0 (4.0)	9.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.2)	11.0 (6.8)	12.0 (7.3)	13.0 (8.8)	16.0 (11.3)	20.0 (15.3)

Table 15 – PacifiCorp Standard Practice (NESC Table 234–2) Clearances of Wires, Conductors, and Cables From Bridges

Clearances with 6 lbs/sf WIND. See NESC Rules 234D1a and 234H4.

Elevation range for table: 6300 9300
Construction tolerance: 4 feet

	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors; supply cables of 0 to 750 V meeting Rules 230C2 or 230C3 (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors								
			over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 28 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
1. Clearance over bridges.											
a Attached	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (5.7)	11.0 (6.2)	12.0 (7.4)	12.0 (7.9)	13.0 (8.5)	15.0 (10.1)	17.0 (12.9)	22.0 (17.1)
b. Not attached	14.0 (10.0)	15.0 (10.5)	17.0 (12.5)	17.0 (12.7)	18.0 (13.2)	19.0 (14.4)	19.0 (14.9)	20.0 (15.5)	22.0 (17.1)	24.0 (19.9)	29.0 (24.1)
2. Clearance beside, under or within bridge structure.											
a. Readily accessible portions of any bridge, including wing, walls, and bridge attachments.											
(1) Attached	7.0 (3.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.4)	11.0 (6.9)	12.0 (7.5)	14.0 (9.1)	16.0 (11.9)	21.0 (16.1)
(2) Not Attached	9.0 (5.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.4)	11.0 (6.9)	12.0 (7.5)	14.0 (9.1)	16.0 (11.9)	21.0 (16.1)
b. Ordinarily inaccessible portions of bridges (other than brick, concrete, or masonry) and from abutments.											
(1) Attached	7.0 (3.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.4)	11.0 (6.9)	12.0 (7.5)	14.0 (9.1)	16.0 (11.9)	21.0 (16.1)
(2) Not Attached	8.0 (4.0)	9.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.4)	11.0 (6.9)	12.0 (7.5)	14.0 (9.1)	16.0 (11.9)	21.0 (16.1)

Table 16 – PacifiCorp Standard Practice (NESC Table 234–2)
Clearances of Wires, Conductors, and Cables From Bridges

Clearances with 6 lbs/sf WIND. See NESC Rules 234D1a and 234H4.

Elevation range for table: 9300 12300
Construction tolerance: 4 feet

	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors; supply cables of 0 to 750 V meeting Rules 230C2 or 230C3 (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors								
			over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 28 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
1. Clearance over bridges.											
a Attached	7.0 (3.0)	8.0 (3.5)	10.0 (5.5)	10.0 (5.7)	11.0 (6.2)	12.0 (7.5)	13.0 (8.1)	13.0 (8.7)	15.0 (10.5)	18.0 (13.5)	23.0 (18.0)
b. Not attached	14.0 (10.0)	15.0 (10.5)	17.0 (12.5)	17.0 (12.7)	18.0 (13.2)	19.0 (14.5)	20.0 (15.1)	20.0 (15.7)	22.0 (17.5)	25.0 (20.5)	30.0 (25.0)
2. Clearance beside, under or within bridge structure.											
a. Readily accessible portions of any bridge, including wing, walls, and bridge attachments.											
(1) Attached	7.0 (3.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.5)	12.0 (7.1)	12.0 (7.7)	14.0 (9.5)	17.0 (12.5)	22.0 (17.0)
(2) Not Attached	9.0 (5.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.5)	12.0 (7.1)	12.0 (7.7)	14.0 (9.5)	17.0 (12.5)	22.0 (17.0)
b. Ordinarily inaccessible portions of bridges (other than brick, concrete, or masonry) and from abutments.											
(1) Attached	7.0 (3.0)	8.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.5)	12.0 (7.1)	12.0 (7.7)	14.0 (9.5)	17.0 (12.5)	22.0 (17.0)
(2) Not Attached	8.0 (4.0)	9.0 (3.5)	9.0 (4.5)	9.0 (4.7)	10.0 (5.2)	11.0 (6.5)	12.0 (7.1)	12.0 (7.7)	14.0 (9.5)	17.0 (12.5)	22.0 (17.0)

Table 17 – PacifiCorp Standard Practice (NESC Table 234–3)
Clearances of Wires, Conductors, and Cables Passing Over or Near Swimming Pools

Clearances with NO WIND. See NESC Rules 234E1, 234E2. and 234H4.

Elevation range for table: Sea Level to 3300
Construction tolerance: 4 feet

	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors; supply cables of 0 to 750 V meeting Rules 230C2 or 230C3 (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors								
			over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 28 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
A. Clearance in any direction from the water level, edge of pool, base of diving platform, or anchor raft.	27.0 (22.5)	27.0 (23.0)	29.0 (25.0)	30.0 (25.2)	30.0 (25.7)	31.0 (26.6)	32.0 (27.1)	32.0 (27.5)	33.0 (28.9)	36.0 (31.3)	39.0 (34.9)
B Clearance in any direction to the diving platform or tower.	19.0 (14.5)	19.0 (15.0)	21.0 (17.0)	22.0 (17.2)	22.0 (17.7)	23.0 (18.6)	24.0 (19.1)	24.0 (19.5)	25.0 (20.9)	28.0 (23.3)	31.0 (26.9)
C Vertical clearance over adjacent land.	Clearance shall be as required by Rule 232.										

Table 18 – PacifiCorp Standard Practice (NESC Table 234–3)
Clearances of Wires, Conductors, and Cables Passing Over or Near Swimming Pools

Clearances with NO WIND. See NESC Rules 234E1, 234E2. and 234H4.

Elevation range for table: 3300 6300
Construction tolerance: 4 feet

	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors; supply cables of 0 to 750 V meeting Rules 230C2 or 230C3 (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors								
			over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 28 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
A. Clearance in any direction from the water level, edge of pool, base of diving platform, or anchor raft.	27.0 (22.5)	27.0 (23.0)	29.0 (25.0)	30.0 (25.2)	30.0 (25.7)	31.0 (26.7)	32.0 (27.3)	32.0 (27.8)	34.0 (29.3)	36.0 (31.8)	40.0 (35.8)
B Clearance in any direction to the diving platform or tower.	19.0 (14.5)	19.0 (15.0)	21.0 (17.0)	22.0 (17.2)	22.0 (17.7)	23.0 (18.7)	24.0 (19.3)	24.0 (19.8)	26.0 (21.3)	28.0 (23.8)	32.0 (27.8)
C Vertical clearance over adjacent land.	Clearance shall be as required by Rule 232.										

Table 19 – PacifiCorp Standard Practice (NESC Table 234–3)
Clearances of Wires, Conductors, and Cables Passing Over or Near Swimming Pools

Clearances with NO WIND. See NESC Rules 234E1, 234E2. and 234H4.

Elevation range for table: 6300 9300
Construction tolerance: 4 feet

	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors; supply cables of 0 to 750 V meeting Rules 230C2 or 230C3 (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors								
			over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 28 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
A. Clearance in any direction from the water level, edge of pool, base of diving platform, or anchor raft.	27.0 (22.5)	27.0 (23.0)	29.0 (25.0)	30.0 (25.2)	30.0 (25.7)	31.0 (26.9)	32.0 (27.4)	32.0 (28.0)	34.0 (29.6)	37.0 (32.4)	41.0 (36.6)
B Clearance in any direction to the diving platform or tower.	19.0 (14.5)	19.0 (15.0)	21.0 (17.0)	22.0 (17.2)	22.0 (17.7)	23.0 (18.9)	24.0 (19.4)	24.0 (20.0)	26.0 (21.6)	29.0 (24.4)	33.0 (28.6)
C Vertical clearance over adjacent land.	Clearance shall be as required by Rule 232.										

Table 20 – PacifiCorp Standard Practice (NESC Table 234–3)
Clearances of Wires, Conductors, and Cables Passing Over or Near Swimming Pools

Clearances with NO WIND. See NESC Rules 234E1, 234E2. and 234H4.

Elevation range for table: 9300 12300
Construction tolerance: 4 feet

	Unguarded rigid live parts, 0 to 750 V; noninsulated communication conductors; supply cables of 0 to 750 V meeting Rules 230C2 or 230C3 (feet)	Supply cables over 750 V meeting Rules 230C2 or 230C3; open supply conductors 0 to 750 V (feet)	Open Supply Conductors								
			over 750 V to 22 kV to ground (34.5 kV to phase) (feet)	over 22 kV to 27 kV to ground (46 kV to phase) (feet)	over 28 kV to 42 kV to ground (69 kV to phase) (feet)	over 42 kV to 70 kV to ground (115 kV to phase) (feet)	over 70 kV to 84 kV to ground (138 kV to phase) (feet)	over 84 kV to 98 kV to ground (161 kV to phase) (feet)	over 98 kV to 140 kV to ground (230 kV to phase) (feet)	over 140 kV to 210 kV to ground (345 kV to phase) (feet)	over 210 kV to 318 kV to ground (500 kV to phase) (feet)
A. Clearance in any direction from the water level, edge of pool, base of diving platform, or anchor raft.	27.0 (22.5)	27.0 (23.0)	29.0 (25.0)	30.0 (25.2)	30.0 (25.7)	32.0 (27.0)	32.0 (27.6)	33.0 (28.2)	34.0 (30.0)	37.0 (33.0)	42.0 (37.5)
B Clearance in any direction to the diving platform or tower.	19.0 (14.5)	19.0 (15.0)	21.0 (17.0)	22.0 (17.2)	22.0 (17.7)	24.0 (19.0)	24.0 (19.6)	25.0 (20.2)	26.0 (22.0)	29.0 (25.0)	34.0 (29.5)
C Vertical clearance over adjacent land.	Clearance shall be as required by Rule 232.										

1. Scope

This standard describes the vegetation clearing along rights-of-way (ROW) of the NU operating companies in Connecticut and Massachusetts where overhead transmission lines are to be constructed. The practices described here apply to the construction requirements for all 115kV and 345kV [1] electric transmission lines, and are consistent with the North American Electric Reliability Council (NERC) Vegetation Management Standard FAC-003-1 dated 2/16/2006, The New England Independent System Operator's (ISO-NE) vegetation clearing standard OP-3 dated 2/1/2005, and the National Electrical Safety Code (NESC) Rule 218 as adopted by the Connecticut Department of Public Utility Control (Regulation Sec. 16-11-134).

This standard applies to new construction clearing requirements and practices and not to on-going future vegetation maintenance of the ROW's. The initial clearance requirements outlined in this standard are intended to provide adequate clearances for a period of four (4) years at which time scheduled maintenance will be performed to reestablish or preserve the initial clearances. The maintenance of the vegetation following construction is addressed under the Northeast Utilities Specification for Rights-of-Way Vegetation Management. Low-maturing trees, which are allowed to remain after completion of vegetation clearing, are still subject to future trimming and removals, depending upon their growth and health, as well as the future needs of NU to operate, maintain, and add or replace electric facilities on the ROW.

NU operating companies typically obtain permanent easement rights for the placement of overhead transmission lines, including the right to clear vegetation within the fully defined limits of a ROW. In most locations the right to remove any tree or portion of tree outside the easemented limits of the ROW ("danger tree") that by falling could endanger the transmission line facilities is also obtained. These rights are necessary to provide for the safe and reliable operation and maintenance of any overhead transmission line that is built on a ROW.

Notwithstanding these rights, the standard practice of the NU operation companies is to minimize tree and other vegetation removal that is required for new transmission line construction by:

A. Designing new lines to keep the positions of new conductors as much as possible within any existing cleared ROW corridor, thus minimizing additional clearing

B. Remove non-compatible vegetation (trees and tall growing shrub species) within the conductor clearance zone (area directly under the conductors extending 15 feet horizontally outward from the outermost line conductors)

[1] Except for possible modifications to existing 69kV lines, it is unlikely that NU will construct any new 69kV lines. Therefore, this standard covers 115 and 345kV lines only, and 115kV line clearances would apply to any new 69kV lines.

C. Allowing low-maturing tree species such as dogwoods to remain within the side zones (area outside of the conductor clearance zone extending to the edge of the ROW clearing limits) where these low-maturing species exist

D. Re-establishing pre-existing access roads for construction vehicles to minimize the clearing of low growth within the existing corridor for access

E. Locating new line structures close to old structures and overlapping the work areas of old structures to reduce to the amount of clearing for the new structure work areas

F. Where feasible, using existing conductors to pull in new conductors, thus reducing damage to low growth vegetation along the cleared corridor

G. Engaging an arborist to determine individual "danger trees" for removal considering
   1) Species
   2) Soil conditions
      a) including wetland vs. upland
      b) susceptibility to flooding
      c) depth to rock (and adaptability of the species to those conditions)
   3) Health of the tree
   4) Inclination of trunk
   5) shape of crown

Refer to figures V-1 through V-6 for diagrams of the conductor clearance zone and side zones associated with various line structure types.

2. Clearance between Conductors and Woody Vegetation

Transmission lines within the Northeast Utilities System present a variety of woody vegetation control situations. Regulatory authorities may require "buffers" or "screening" at visually sensitive highway and local road crossings or other locations, and such locations require special attention to achieve and maintain the necessary clearances. At all other locations, standard ROW vegetation clearing practices for new line construction are as follows:

A. Within the ROW limits, as depicted on Figures A, B, and C, cut all tall-maturing tree species of any height while retaining existing compatible woody shrub species (see Appendix 1).

B. Clear-cut construction areas at structure locations and access roads as depicted on Figure C.

C. At road crossings, within side zones and other sensitive areas, as specified by ROW development and management plans, retain existing low-maturing tree species such as Flowering Dogwood (see Appendix 2) to the extent that these trees will not conflict with operation of the transmission line prior to the next scheduled vegetation maintenance.

D. At ravines, river crossings, and similar locations: retain tree species on the ROW where the conductors will be significantly higher than normal and where the vegetation at full mature height would not violate Figure A clearances and will not cause construction or access problems.

The minimum clearances established in Figures A, B, and C between conductors and woody vegetation includes allowances for re-growth over the periodic maintenance cycle of four (4) years for vegetation within the cleared limits of the ROW, and ten (10) years for vegetation beyond the cleared limits of the ROW. The defined clearances cover all vegetation including natural growth, screens or buffers, orchards, ornamental plantings, nursery stock, and danger trees.

The minimum clearances applicable to woody vegetation are shown in the included figures.

1) Figure A; Minimum Conductor Clearances
2) Figure B; Danger Tree Clearance
3) Figure C; Conductor Clearance Zone, Side Zones and Structure Clearing Areas for New Construction

Where Orchards, ornamental plantings, or nursery stock is permitted by easement or license to exist, the maximum tree heights allowed within the conductor and side zones are shown in Figure A. Agreements with individual property owners may define site-specific maximum allowable tree heights and should be checked prior to scheduled maintenance activities.

Where rights exist beyond the edge of the ROW, any tree designated as a "danger tree," i.e. a tree that can fall within the dimensions noted in Figure B that is determined to be an imminent hazard will be removed at the discretion of the arborist. In sensitive areas adjacent to or within the ROW or where rights or other permission to remove danger trees cannot be obtained, arborists will direct the removal of those portions of the tree canopy projecting into the ROW, and those portions of a tree which, if they become detached, may fall within the minimum clearance distances as shown on Figure B. On side-hill ROW's, danger trees can be found significantly further from the conductors on the uphill side of the ROW.

3. <u>Clearing for New Construction</u>

This clearing consists of clear cutting four distinct areas of the ROW as defined by Figure C. These clearing areas are:

A. Basic clearing of the ROW width, which consists of a conductor clearance zone and side zones. Low-maturing woody shrub species are typically not removed from the side zones, and low maturing tree species such as Flowering Dogwood will be preserved where they do not conflict with construction needs.

B. Clearing at each structure location as required for construction equipment

C. Clearing the full length of all access road and spurs to structure sites for a cleared width of fifteen (15) feet

D. Removal of danger trees that pose an imminent risk to the new line along the new or existing clearing edge

For new line construction, in addition to the cleared area around each structure, a lay-down and assembly area may be required that is considerably larger. The size of this area depends upon topography, the type of structure to be assembled, and the type of foundation required at the site. Also at selected locations spaced several miles apart, setup sites for conductor-pulling equipment are required within the conductor zone and may require some removal of shrub growth.

The process to accomplish the clearing for new construction involves:

A. Field survey and stake the edge of the clearing limits and conductor zone
B. The NU "Owner's Representative" further reviews the survey staking before clearing begins
C. Where specified in an existing agreement with individual landowners, the Owner's Representative or his designee marks acceptable low growing trees they will attempt to retain within a side zone
D. The Owner's Representative contacts landowners before the clearing begins if they wish to discuss the clearing as marked out, and to ask if the property owner wishes to take ownership of the cut wood
E. Where the landowner will take the cut wood, an agreement will specify the contractor's placement of cut wood outside the ROW, or the landowner's schedule for removal if at a location within the ROW
F. Carry out the clearing operation
G. Cut using chain saws within wetland areas, and minimize the use of mechanized equipment for removal (note: mechanized equipment may be used to remove the logs and tree tops from a wetland by positioning equipment outside wetlands to drag out logs and tops using cables)
H. During or shortly after the initial clearing operation, an arborist will evaluate trees beyond the edge of the clearing limits to identify and mark danger trees that pose an imminent risk to the new line
I. The landowner will then be given an opportunity to discuss the danger trees marked for removal with the Owner's Representative who will then give instructions to the contractor

Contracts for clearing will be structured to effectively implement the above process and this standard. Despite efforts to minimize tree and other vegetation removal, there may still be locations where the transmission facility requirements and/or the existing vegetation conditions are such that no substantial vegetation may remain within the ROW limits.

4. <u>Clearing for Structure Maintenance or the Replacement of an Existing Line</u>

Clearing for structure maintenance or replacement of an existing line is similar to that for new line construction with the following exceptions:

A. Clearing needs depend on the relative location of the rebuilt line with respect to the existing maintained area of the ROW and the proposed construction method for installation of conductors and shield wires. These factors may reduce the needed clearing.

B. Structure site and access road clearing will still be required but may also be significantly reduced.

C. When structures from the old line are removed, the cleared area at these sites and the access spurs to them will be allowed to naturally re-vegetate with native plant species, which may include native grasses, forbs or shrubs.

5. Decision Responsibility for Retention of Non-standard Woody Vegetation

The transmission line Construction Manager and Contractor Arborist will be responsible for obtaining approval from the Transmission Supervisor, Vegetation Management before allowing vegetation to remain which conflicts with the clearances shown in Figures A, B, and C.

6. Approving Managers and SME

Dorian Hill
Manager Transmission Line and Civil Engineering
Northeast Utilities

Peter Avery
Manager Transmission Line Construction and MTCE
Northeast Utilities

SME

Anthony Johnson III
Supervisor Transmission Vegetation Management
Northeast Utilities

7. Deviations

This standard sets forth the current NU 'best practices' for most applications of this subject matter. Therefore, deviation from this standard is generally not permitted. However, in unique instances a user may submit a written deviation request including justification to the listed Subject Matter Expert (SME). The SME must approve or deny the request in writing prior to the user commencing any non-standard activities. The SME may consult with his/her supervisor, co-SME if any and co-SME supervisor, and subsequently must copy any approval to them.

Revision History
Rev.0 – original issue
Rev. 1 – Clarified conductor zone and side zone definitions, and clearing practices to address NERC reliability requirements through strict conformance to the ISO-NE OP-3.

APPENDIX 1

SHRUB SPECIES ALLOWED TO REMAIN: (PARTIAL LIST)

COMMON NAME	GENUS/SPECIES
Arrowwood Viburnum	*Viburnum dentatum*
Bayberry	*Myrica pennsylvanica*
Blueberry - Highbush	*Vaccinium corymbosum*
Blueberry - Lowbush	*Vaccinium angustifolium & V. vacillans*
Brambles	*Rubus spp.*
Buttonbush	*Cephalanthus occidentalis*
Dogwood - Gray	*Cornus racemosa*
Dogwood - Redosier	*Cornus stolonifera*
Dogwood - Silky	*Cornus amomum*
Elderberry	*Sambucus spp.*
Hazelnut	*Corylus americana & C. cornuta*
Honeysuckle - Bush	*Diervilla lonicera*
Honeysuckle - Fly	*Lonicera canadensis*
Honeysuckle - Tartarian	*Lonicera tatarica*
Huckleberry	*Gaylussacia spp.*
Maple-leaf Viburnum	*Viburnum acerifolium*
Meadowsweet - Broad-leaved	*Spirea latifolia*
Meadowsweet - Narrow-leaved	*Spirea alba*
Mountain Laurel	*Kalmia spp.*
Oblong Fruited Juneberry	*Amelanchier bartramiana*
Oldfield Common Juniper	*Juniperus depressa*
Pasture Juniper	*Juniperis communis*
Running Shadbush	*Amelanchier stolonifera*
Sheeplaurel	*Kalamia augustifolia*
Spicebush	*Lindera benzoin*
Steeplebush	*Spirea tomentosa*
Sumac - Smooth	*Rhus glabra*
Sweetfern	*Comptonia peregrina*
Sweetpepperbush	*Clethra alnifolia*
Winterberry	*Ilex verticillata*
Witch Hobble	*Vburnum alnifolium*
Witherod	*Viburnum cassinoides*

APPENDIX 2

LOW-MATURING TREE AND SHRUB SPECIES ALLOWED TO REMAIN ALONG THE SIDE ZONES: (PARTIAL LIST)

All species listed above including:

Alder	*Almus spp.*
Dogwood - Alternate-leaved	*Cornus alternifolia*
Dogwood - Flowering	*Cornus florida*
Sumac - Shining	*Rhus copillina*
Sumac - Staghorn	*Rhus typhina*
Willows (except tree species)	*Salix spp.*
Witch-Hazel	*Hamamelis virginiana*

Figure A

Minimum Conductor Clearances

* All Other Woody Species		
Line Voltage	A (ft.)	B (ft.)
69 & 115 kV	12	11
230 & 345 kV	16	15

500kV

* Orchards		
Line Voltage	A (ft.)	B (ft.)
69 & 115 kV	14	11
230 & 345 kV	18	15

500kV

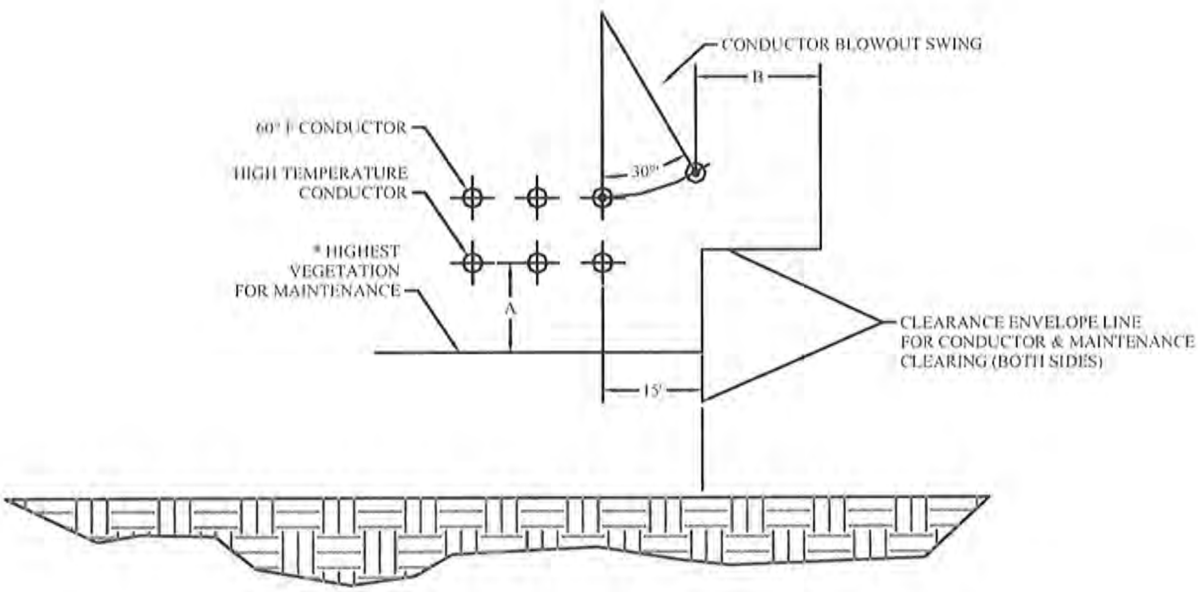


Figure B

Danger Tree Clearances

Line Voltage	A (ft.)
69 & 115 kV	6
230 & 345 kV	10

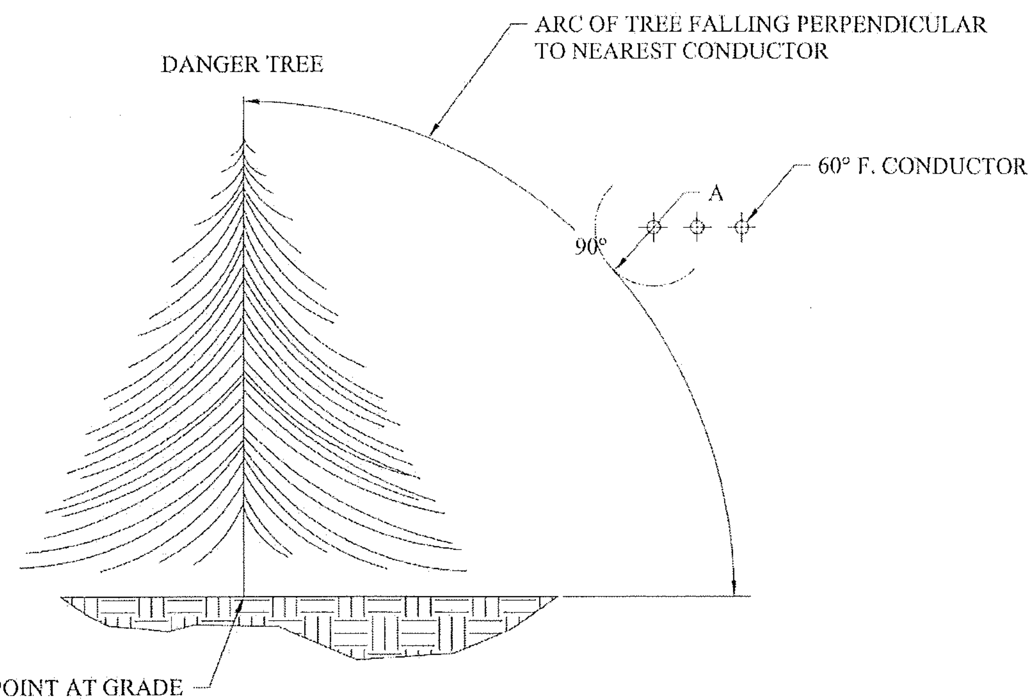
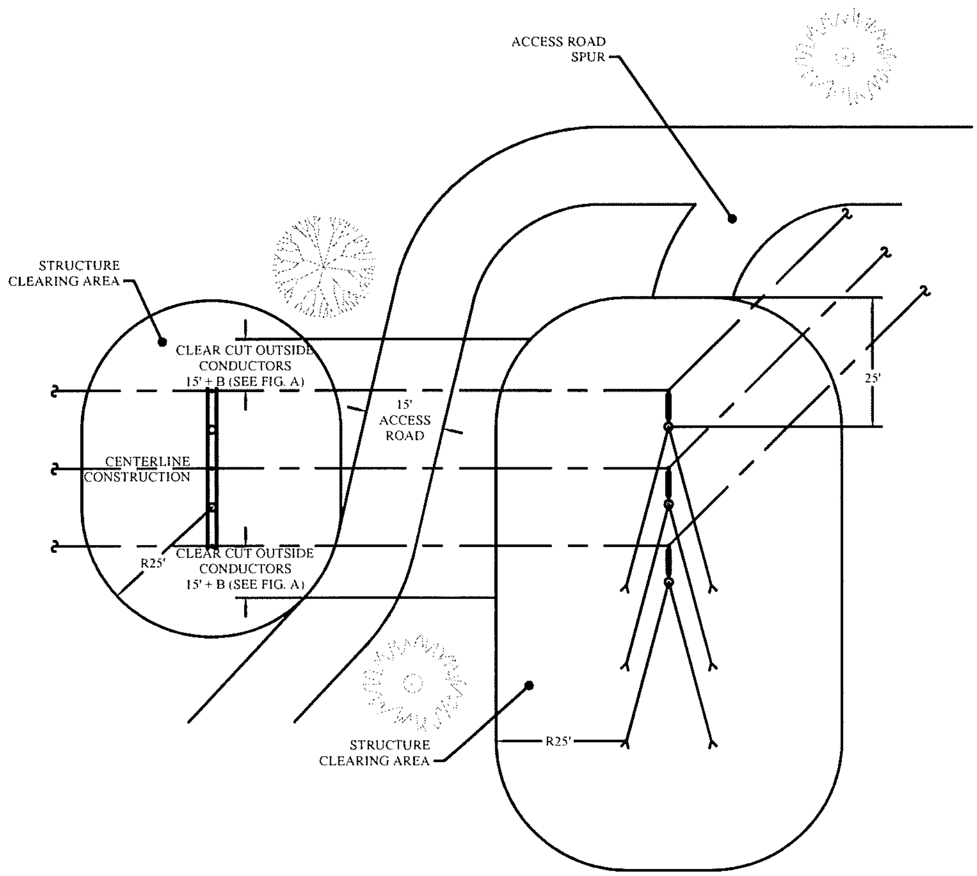
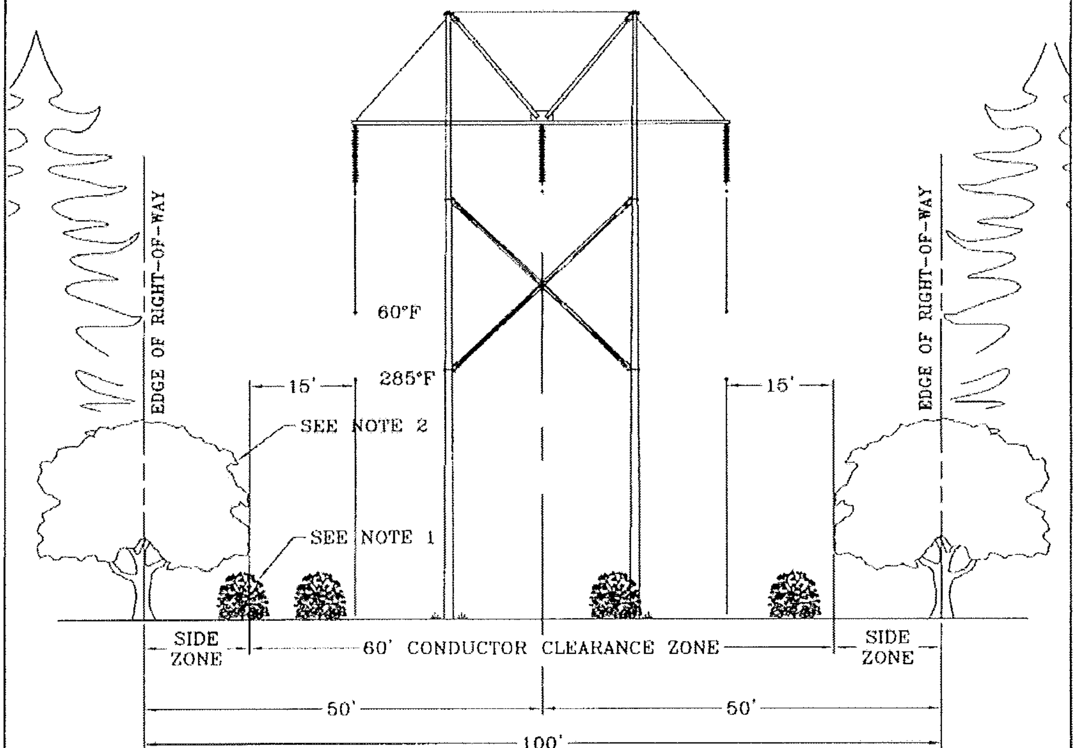


Figure C

Conductor Clearance Zone, Side Zones
and Structure Clearing Areas for New Construction





NOTES:

1) WOODY SHRUB SPECIES
2) LOW MATURING TREE SPECIES SUCH AS DOGWOODS ALLOWED OUTSIDE CONDUCTOR CLEARANCE ZONES.
3) ACTUAL DIMENSION TO R.O.W. EDGE VARIES. ADD UP TO 25' TO SIDE ZONE WHERE EXTRA RIGHT-OF-WAY EXISTS.

NORTHEAST UTILITIES SERVICE CO.

TITLE
TYPICAL VEGETATION CLEARING FOR A 115-kV H-FRAME STRUCTURE LINE

BY RDG	REV A	APP DEH	APP
DATE 04/13/04	DATE 05/13/08	DATE 12/23/04	DATE
SCALE NONE	MICROFILM DATE	DWG. NO. FIGURE V-1	
P.A. #			

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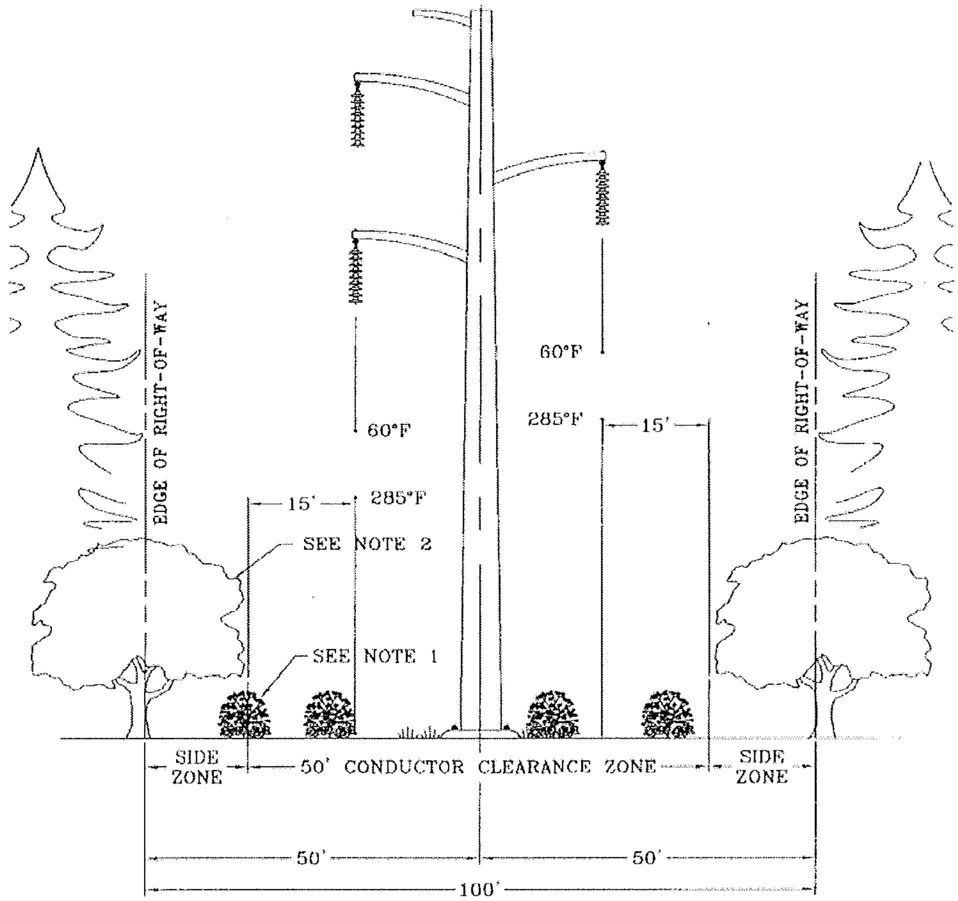

NOTES:

1) WOODY SHRUB SPECIES
2) LOW MATURING TREE SPECIES SUCH AS DOGWOODS ALLOWED OUTSIDE CONDUCTOR CLEARANCE ZONES.
3) ACTUAL DIMENSION TO R.O.W. EDGE VARIES. ADD UP TO 25' TO SIDE ZONE WHERE EXTRA RIGHT-OF-WAY EXISTS.

NORTHEAST UTILITIES SERVICE CO.

TITLE
TYPICAL VEGETATION CLEARANCE
FOR A 115-kV DELTA POLE STRUCTURE LINE

BY RDG	REV RDG	APP DEH	APP
DATE 04/13/04	DATE 05/13/08	DATE 12/23/04	DATE
SCALE none	MICROFILM DATE	DWG. NO. FIGURE V-2	
P.A. #			

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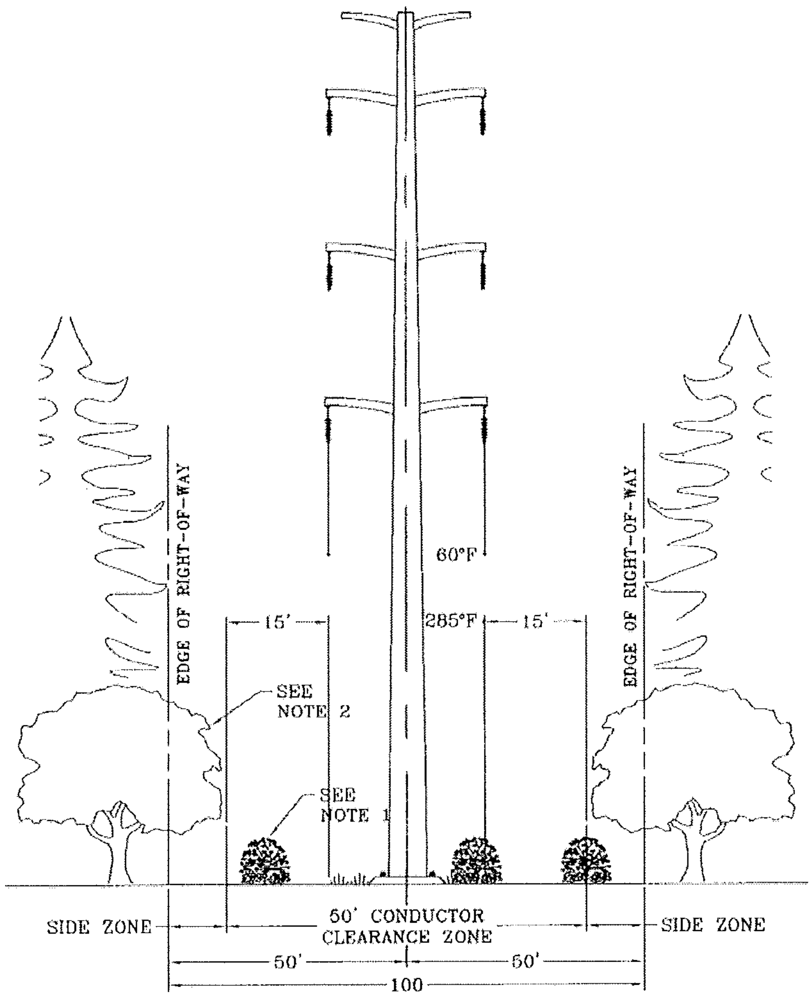

NOTES:
1) WOODY SHRUB SPECIES
2) LOW MATURING TREE SPECIES SUCH AS DOGWOODS ALLOWED OUTSIDE CONDUCTOR CLEARANCE ZONES.
3) ACTUAL DIMENSION TO R.O.W. EDGE VARIES. ADD UP TO 25' TO SIDE ZONE WHERE EXTRA RIGHT-OF-WAY EXISTS.

NORTHEAST UTILITIES SERVICE CO.

TITLE
TYPICAL VEGETATION CLEARING FOR A 115-kV VERTICAL POLE STRUCTURE LINE

BY RDG	REV A	APP DEH	APP
DATE 04/13/04	DATE 05/13/08	DATE 12/23/04	DATE
SCALE none	MICROFILM DATE	DWG. NO. FIGURE V-3	
P.A. #			

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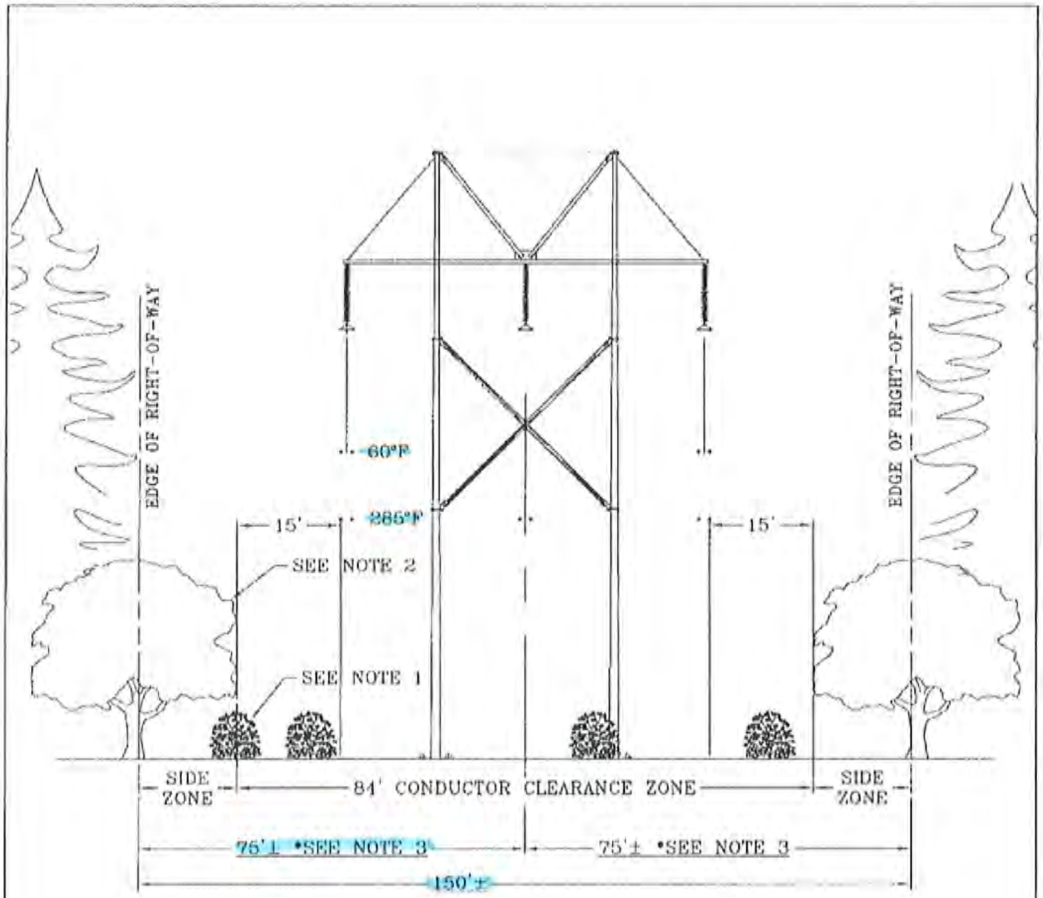


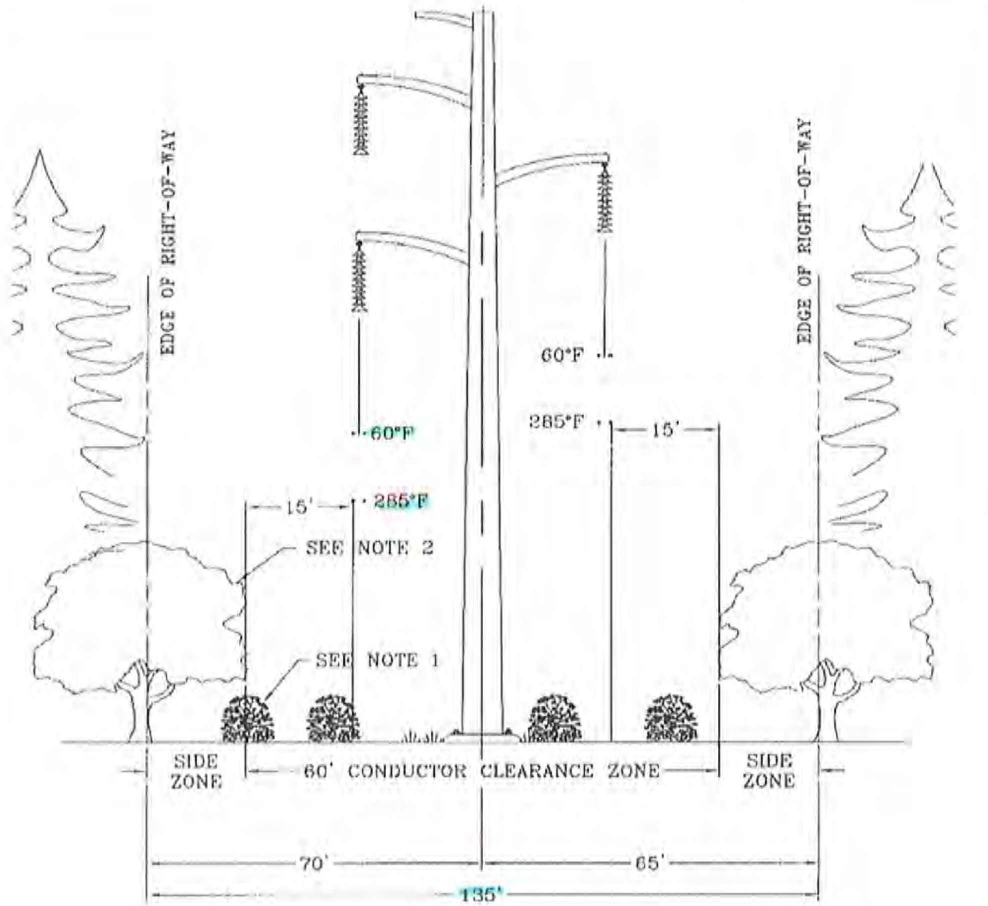
NOTES:
1) WOODY SHRUB SPECIES
2) LOW MATURING TREE SPECIES SUCH AS DOGWOODS ALLOWED OUTSIDE CONDUCTOR CLEARANCE ZONES.
3) ACTUAL DIMENSION TO R.O.W. EDGE VARIES. ADD UP TO 25' TO SIDE ZONE WHERE EXTRA RIGHT-OF-WAY EXISTS.

NORTHEAST UTILITIES SERVICE CO.

TITLE
TYPICAL VEGETATION CLEARING FOR A 345-kV H-FRAME STRUCTURE LINE

BY RDG	REV A	APP DEH	APP
DATE 04/13/04	DATE 05/13/08	DATE 12/23/04	DATE
SCALE NONE	MICROFILM DATE	DWG. NO. FIGURE V-4	
P.A. #			

Figure V-4 **Right-of-Way Vegetation Initial Clearance Standard** **for 115- and 345-kV Transmission Lines**			
Northeast Utilities Approved by: DEH, PJA	**Design and Application**	**OTRM** **030.0014**	**Rev. 1** **05/16/2008**



NOTES:
1) WOODY SHRUB SPECIES
2) LOW MATURING TREE SPECIES SUCH AS DOGWOODS ALLOWED OUTSIDE CONDUCTOR CLEARANCE ZONES.
3) ACTUAL DIMENSION TO R.O.W. EDGE VARIES. ADD UP TO 25' TO SIDE ZONE WHERE EXTRA RIGHT-OF-WAY EXISTS.

NORTHEAST UTILITIES SERVICE CO.			
TITLE TYPICAL VEGETATION CLEARING FOR A 345-kV DELTA POLE STRUCTURE LINE			
BY RDG	REV RDG	APP DEH	APP
DATE 04/13/04	DATE 05/13/08	DATE 12/23/04	DATE
SCALE none	MICROFILM DATE	DWG. NO. FIGURE V-5	
P.A. #			

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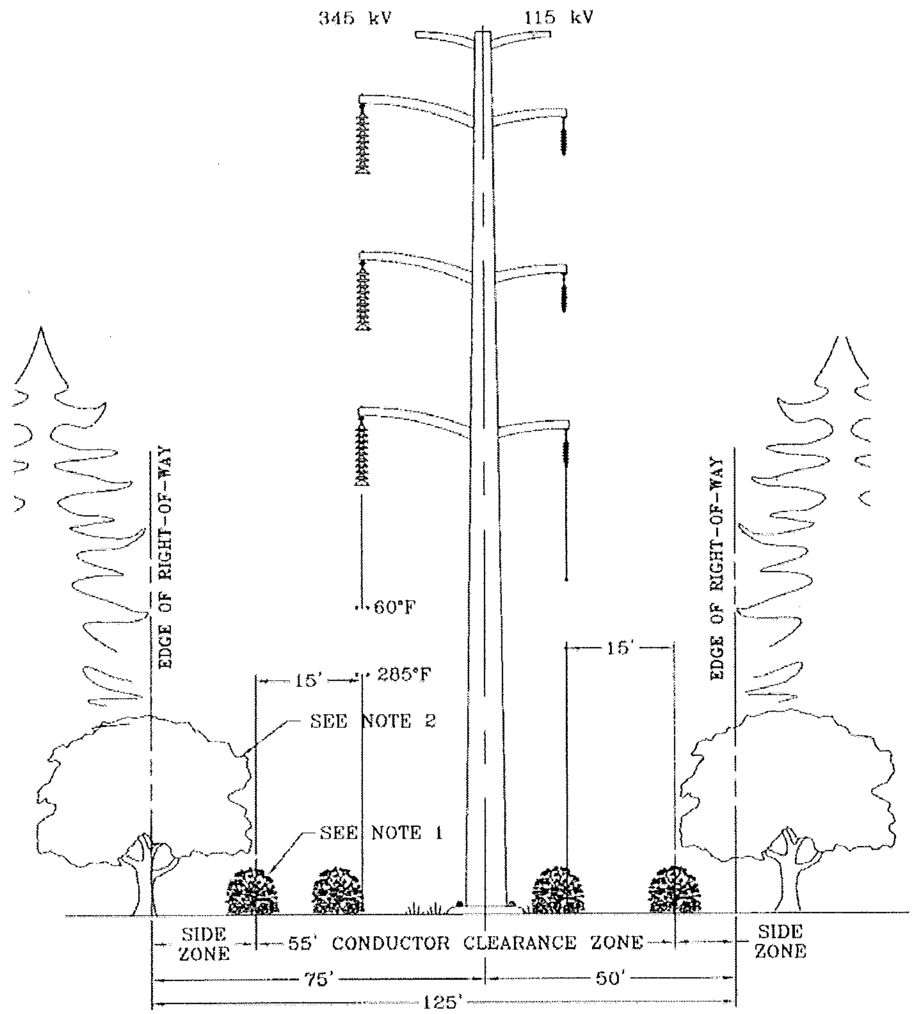
Figure V-5
Right-of-Way Vegetation Initial Clearance Standard for 115- and 345-kV Transmission Lines



NOTES:

1) WOODY SHRUB SPECIES
2) LOW MATURING TREE SPECIES SUCH AS DOGWOODS ALLOWED OUTSIDE CONDUCTOR CLEARANCE ZONES.
3) ACTUAL DIMENSION TO R.O.W. EDGE VARIES. ADD UP TO 25' TO SIDE ZONE WHERE EXTRA RIGHT-OF-WAY EXISTS.

NORTHEAST UTILITIES SERVICE CO.

TITLE
TYPICAL VEGETATION CLEARING FOR A 345/115-kV VERTICAL POLE STRUCTURE LINE

BY RDG	CHKD A	APP DEH	APP
DATE 04/13/04	DATE 05/13/08	DATE 12/23/04	DATE
SCALE none	MICROFILM DATE	DWG. NO. FIGURE V-6	
P.A. #			

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CONCLUSIONS

- While performing several iterations of these Right-of-Way (ROW) width calculations, it became evident that placing twice the number of structures required under normal transmission line design is the only way the applicant could get the proposed 100-foot ROW to meet the National Electric Safety Code (NESC). The proposed 100-foot ROW width would be acceptable with spans under 850 feet. Under any other transmission line scenario the engineer would use a ruling span length in access of 1500 feet, which would greatly reduce the number of structures.

- I made reference to other utilities' general ROW design practices in order to illustrate the minimum widths. Please note that not only do these utilities consider blowout, but they add a buffer and use the National Electric Safety Code to have an adder of 50" for surges or lightning strokes.

- Should you have any questions, concerns or comments regarding the contents of this reference calculation please do not hesitate to contact me at MXWI@deainc.com, or 503.499.1350.

TELEPHONE REPORT

DATE OF CALL:	August 9, 2010	ROUTING: (Name & Location)	
TIME OF CALL:	1330	1.	
CALL PLACED BY:	Patrick Lynch	2.	
CALL PLACED TO:	Steve Herling	3.	
TOPIC OF PHONE CALL:	PJM Interconnect plan to deal with PSEG not going on-line until 2015	4.	
FILE DESIGNATION:		5.	

DISCUSSION:

Today, I called Steve Herling of the PJM interconnect to gather his reaction to the statement of PSEG that because of the permits they need to have in hand, they will not be able to complete construction until 2015.

Mr Herling responded that PJM has two primary concerns in dealing with this issue. One, is the "delivery of energy" and two, "the distribution of that energy." To be able to meet those concerns, PJM, in concert with the power companies is developing a plan that will enable the companies to deliver and distribute energy from the period, 2012 to 2015. As of this date, that plan will "probably" include the stabilization and upgrade of several existing generators in the Roseland, NJ vicinity to meet the PJM needs. This plan must then be submitted to NERC for review and approval. If the plan is deemed "viable" by NERC, the companies should not be penalized.

I thanked Mr Herling for the info and he said "feel free to call my anytime on this project. The total time of the conversation was 5 minutes.

FOLLOW-UP ACTION REQUIRED?	YES ____ NO _____
FOLLOW UP ACTION TO BE TAKEN BY:	
FOLLOW-UP ACTION:	
DATE FOLLOW-UP ACTION COMPLETED:	
FURTHER COMMENTS OR PENDING REQUIREMENTS:	

Gregory J. Smith
Manager-Transmission Expansion

PPL Electric Utilities
Two North Ninth Street, GENN5
Allentown, PA 18101-1179

August 26, 2010

Mr. John J. Donahue
Superintendent
National Park Service
Delaware Water Gap National Recreation Area
Bushkill, PA 18324

Ms. Pamela Underhill
Superintendent
Appalachian National Scenic Trail
PO Box 50
252 McDowell Street
Harper's Ferry, WV 25425

Re: Construction of 500kV Transmission Line Within
<u>PPL Electric Utility Corporation's Existing 100-Foot Right-of-Way</u>

Dear Mr. Donahue and Ms. Underhill:

As you know, PPL Electric Utility Corporation ("PPL Electric") has submitted an application for both a right-of-way permit and a construction permit for the construction and operation of the proposed 500 kV Susquehanna to Roseland Project. As you are also aware, PPL Electric has existing easements rights in Pennsylvania that traverse the Delaware River Water Gap National Recreation Area ("DEWA"). Those easements grant PPL Electric the rights, among other things, to reconstruct its facilities.

There are some areas in the park where PPL Electric has rights that are of a width greater than 100-feet. However, there is an approximate .8 mile stretch where the National Park Service has taken the position that PPL Electric's easement rights are limited to a width of 100 feet.[1] This .8 mile stretch is the area where PPL Electric has requested a right-of-way permit for an additional 25 feet on each side of the existing right of way.

As part of the project, PPL Electric analyzed whether it could safely and reliably construct and operate a 500 kV transmission line pursuant to its existing

[1] PPL Electric maintains that it is not limited to 100 feet for reconstruction for all but one of the easements. However, it has chosen not to challenge the NPS determination on that issue. Therefore, for purposes of this letter it is assuming that the easements in question do limit its construction to within a 100-foot right-of-way.

easement rights, because doing so would eliminate the need for a right-of-way permit. PPL Electric has concluded that it can safely and reliably construct and operate a transmission line pursuant to its existing easement rights (for purposes of this letter, the "100-foot ROW alternative"). That 100-foot ROW alternative would have two more structures than the current proposal, primarily because of issues relating to the 100-foot width in the .8 mile area reference. The structure heights would be approximately the same height as currently proposed.

PPL Electric provided the details of the 100-foot alternative to your consultant, Dave Evans Associates ("DEA"). In initial discussions, DEA questioned whether the 100-foot ROW alternative could meet National Electric Safety Code ("NESC") standards. However, after further discussions, and after PPL Electric provided additional documentation and analysis on that issue, it is our understanding that DEA is in agreement with PPL Electric's position that the 100-foot ROW alternative would meet all NESC standards.

Subsequently, DEA raised additional issues relating to the construction and operation of the 100-foot ROW alternative, which are as follows:

1. Allowable conductor tension.
2. Effect of wind on conductor temperature.
3. PJM criteria.
4. Electric fields.

PPL Electric notes that except for number 3, the above issues are not related to the width of the right-of-way. With regard to number 3, guidelines are provided by PJM in the document, PJM DESIGN AND APPLICATION OF OVERHEAD TRANSMSISSION LINES 69KV AND ABOVE, dated 5/20/2002 and found on the PJM website. This document lists target right-of-way widths of 300 feet for double circuit 500 kV and 150 feet for single or double circuit 230 kV. Clarification is provided by PJM on the TRANSMISSION OWNERS GUIDELINES webpage with the statement

> Transmission Owner Technical Guidelines & Recommendations below, formerly were referred to as the "PJM TSDS Technical Requirements", as published by the PJM Transmission & Substation Design Committee (TSDS).
> The documents included here are still subject to PJM's review and may thus potentially change before being formally published pursuant to Section 1.2c of the PJM Open Access Transmission Tariff (PDF).
> These documents were originally developed for PJM by TSDS member companies when PJM's footprint matched the NERC MAAC Region (contributing companies included AE, BGC, DPL, JCPL, MetEd, PECO, PENELEC, PEPCO, PPL and PSEG.) Many of these companies often reference these documents for their Technical Requirements and Standards as defined in the PJM OATT. PJM now extends into multiple NERC regions. New members typically reference their own documents and therefore these documents no longer represent all of PJM. However, all PJM members are welcome to reference these documents.

And, additional clarification is provided by PJM on the TRANSMISSION OWNERS ENGINEERING AND CONSTRUCTION STANDARDS webpage with the statement

> Applicable engineering and construction standards are specified by each PJM Transmission Owner.

Thus, although PJM has guidelines for transmission line design, it is the Transmission Owners who have the final say, and responsibility for safe and reliable design of transmission lines. It is worth nothing that the currently proposed Susquehanna-Roseland 500 kV Transmission Line will be constructed within rights-of-way that vary from 150 feet to over 300 feet.

PPL Electric has concluded that none of the above items present any issues with respect to the 100-foot ROW alternative. In that regard, enclosed with this letter is a detailed analysis, including calculations, of each of the above items performed by Sargent & Lundy, LLC, the design engineer retained by PPL Electric as part of this project. In summary, that analysis concludes that the design proposed by PPL Electric relating to the 100-foot ROW alternative complies with any concerns raised by DEA.

In conclusion, PPL Electric maintains the design that has been provided for the 100-foot ROW alternative complies with all applicable regulations, including NESC and PJM criteria. Accordingly, the safe and reliable construction and operation of a 500kV transmission line within PPL Electric's existing easements, as demonstrated by the 100-foot ROW alternative, is feasible.

PPL Electric further notes that it, as the utility company providing electric transmission service in the area, has the obligation and responsibility to determine whether a transmission facility can be constructed and maintained in a safe and reliable manner. While PPL Electric appreciates comments and suggestions from DEA, ultimately it is PPL Electric that must determine whether such a facility can be constructed. As indicated above, in this case PPL Electric has determined that the 100-foot ROW alternative can be built safely and reliably.

Accordingly, PPL Electric maintains that the 100-foot ROW alternative should be included as one of the alternatives studied in the Environmental Impact Statement. Quite simply, failure to do so ignores a viable option that can be constructed without the acquisition of any right-of-way permit from the National Park Service.

Thank you for your time and attention.

Sincerely,

Gregory J. Smith

Gregory J. Smith
Manager-Transmission Expansion

Enclosure

United States Department of the Interior

NATIONAL PARK SERVICE
Delaware Water Gap National Recreation Area
Bushkill, Pennsylvania 18324

IN REPLY REFER TO:

D5015

SEP 10 2010

Mr. Keith O' Neal, Director
Division of Electric Reliability Standards
Office of Electric Reliability
Federal Energy Regulatory Commission
88 First Street NE
Washington DC 20426

Dear Mr. O' Neal:

The National Park Service (NPS) has been asked by two regional electric utility companies (PPL in Pennsylvania and PSE&G in New Jersey) to provide permits for access across NPS lands and for construction of an additional 500kV line within their existing Right-of-Way (ROW). The structures would be built to hold a double circuit 500kV line where in some areas the existing width of the ROW is only 100 feet. The ROW of concern runs for 4.2 miles through the Appalachian National Scenic Trail (APPA), Delaware Water Gap National Recreation Area (DEWA), and the Middle Delaware National Scenic and Recreational River (MDSR), all units of the NPS. To evaluate the permit request we are preparing an Environmental Impact Statement (EIS).

The regional electrical energy interconnect group, PJM, has issued a set of Technical Requirements (section V.A of PJM TSDS Technical Requirements dated May 20, 2002) that address the design and application of overhead transmission lines 69kV and above. On Table 1 (page 12) of this document, PJM lists the *requirements* and the *recommendations* for transmission line design parameters. Our question is, are these requirements and recommendations the standard within which the utility companies are mandated to work when siting and planning new transmission lines? Is compliance with these standards optional?

We look forward to your timely reply as we are trying to maintain a tight EIS schedule and this information is vital to our analysis.

Please feel free to contact us or Patrick Lynch of our staff at (570) 426-2428.

Sincerely,

John J. Donahue
Superintendent
Delaware Water Gap National Recreation Area &
Middle Delaware National Scenic and
Recreational River
(570) 426-2418

Pamela Underhill
Superintendent
Appalachian National Scenic Trail
(304) 535-6278

Enclosure

Cc:
Andrew Tittler, DOI Office of the Solicitor
Patrick Lynch, National Park Service, DEWA
Kara Deutsch, National Park Service, DEWA
Sarah Bransom, National Park Service, APPA
Amanda Stein, National Park Service, DEWA
Patrick Malone, National Park Service, DSC
Jennifer McConaghie, National Park Service, NER

Clint Riley, U.S. Fish and Wildlife Service
Pamela Shellenberger, U.S. Fish and Wildlife Service

Mr. Gregory Smith
Manager, Transmission Expansion
PPL Electric Utilities
Two North Street, GENN5
Allentown, Pennsylvania 18101-1179

Denver Service Center - TIC
Attn: SRLINE EIS
12795 W. Alameda Parkway
Denver, CO 80225-0287

V.A
PJM Design and Application of Overhead Transmission Lines 69kV and Above

These design criteria have been established to assure acceptable reliability of the bulk transmission system facilities. These set forth the design and service conditions, and establish insulation levels for transmission lines. Some of these parameters were based on requirements for the Keystone, Conemaugh, Susquehanna Eastern, or LDV EHV projects, and others were developed by consensus of the PJM transmission line owners. Specific component requirements are listed in their own sections (in addition to NESC the proposed IEC 61936 could be a good reference). The criteria listed are requirements for lines rated 230 kV and above, and are guidelines for lines below 230 kV.

PJM DESIGN OF
OVERHEAD TRANSMISSION LINES 69 kV AND ABOVE

1.0 SCOPE AND GENERAL REQUIREMENTS

1.1. This document sets forth the requirements and recommendations for the design of overhead electric transmission facilities.

1.1.1. Transmission lines, for the purpose of this document, are those with an operating voltage of 69kV or greater.

1.1.2. The term "TO" in this document refers to the Transmission Owner, the party that will own and be responsible for the maintenance of the subject transmission facility.

1.2. The design and operation of all transmission lines shall meet the requirements of the National Electrical Safety Code (ANSI/IEEE C-2) [NESC]. The edition of the NESC in effect at the time of the design shall govern.

1.3. The electrical and strength requirements of this document shall apply to all new transmission lines; and extensions, taps, or additions to existing transmission lines where the circuit length of the new construction is 1000ft or more.

1.4. The design of modifications to existing transmission lines; or extensions, taps, or additions to existing transmission lines where the circuit length of the new construction is less than 1000ft; shall meet the requirements used for the design of the existing line and shall meet the requirements of the latest edition of the NESC.

1.5. The designs of existing transmission lines may not in all cases meet these criteria. The existing lines themselves are excluded from the scope of this document. However, taps from or extensions to these existing lines are covered under the scope of this document.

1.6. Switch structures are not within the scope of this document. If a switch is to be mounted on a transmission structure, the structure design shall have adequate strength and rigidity to ensure the reliable operation of the line and switch.

1.7. Transmission structures supporting non-electric transmission facilities (telecommunications antennas, fiber-optic cables, etc.) shall be capable of resisting the structural loads resulting from these facilities within the strength requirements of this document. The locating of such non-electric facilities on transmission structures shall not jeopardize the operation, maintenance, and reliability of the transmission lines.

1.8. While this document provides detailed criteria for the design of transmission lines on the PJM system, these do not represent the only issues to consider in the design of such lines. Other issues must also be considered such as: maintenance, inspection, and repair on both the structures and the wires of these lines. This will ensure the reliability of the line at a minimal cost well into the future.

1.9. In some instances, the requirements or recommendations specified in this document may come into conflict with other issues such as permitting or local issues. These specifications may be adjusted and negotiated with the specific and written approval of the TO. The agreed negotiation of a relaxation of any specification for an individual project or circumstance does not automatically result in a subsequent revision in this guide. Subsequent instances must be addressed individually on a case-by-case basis.

1.10. The use of structure guys, and wood structures shall be approved by the TO.

2.0 CONDUCTORS

Conductors must be selected with sufficient thermal capability to meet continuous and emergency current ratings. Ratings of conductors applied to the PJM system should be determined using the PJM TSDS "Bare Overhead Transmission Conductor Ratings, November 2000".

The overhead line conductor and static wire should be chosen from those used by the TO. This provides the ability to quickly repair a section of line with utility stock material should an emergency arise. Standard transmission conductor types are ACSR, ACSR/AW, ACSS, and ACAR. Other conductor types will be reviewed by the TO.

The ambient temperature range listed in Table 1 covers the PJM system and is used for the electrical ratings of the conductors as well as the structural loads upon the towers or poles.

3.0 CONDUCTOR SAG & TENSION CRITERIA

3.1 Alcoa – Sag & Tension Common Point

The maximum tension case shall be allowed to default as the common point between the initial and final sag tables. No other common point shall be allowed. An example would be a common point based upon NESC Heavy conditions when calculated tensions for the 1-1/2" Heavy Ice case exceed those for the NESC case.

4.0 STRENGTH REQUIREMENTS

4.1. **Structure Types** – the following descriptions of structure types shall apply to the provisions for strength requirements

4.1.1. *Suspension Structure* – A structure where the phase conductors and static wires are attached through the use of suspension insulators and hardware or, in the case of the static wire, with a clamp not capable of resisting the full design tension of the wire.

4.1.2. *Strain Structure* – A structure where the phase conductors and static wires are attached to the structure by use of dead-end insulators and hardware but where the ability of the structure to resist a condition where all wires are broken on one side under full loading is not required or desired. Typically, strain structures would be used where the line deflection angle is 45 degrees or less. Structures subject to strain structure requirement shall be as identified by the Utility.

4.1.3. *Dead-end Structure* - A structure where the phase conductors and static wires are attached to the structure by use of dead-end insulators and hardware and where the ability of the structure to resist a condition where all wires are broken on one side under full loading is required or desired. Typically, dead-end structures would be used where the line deflection angle is greater than 45 degrees. Structures subject to dead-end structure requirement shall be as identified by the Utility.

4.1.4. *Line Termination Structure* – A structure where the phase conductors and static wires are to be installed on one side only for the purpose of terminating the line, usually at a substation or switchyard. This permanent dead-end condition is assumed in the application of all applicable loading conditions.

4.2. **Loading Definitions**

4.2.1. *Wind Pressure* – The pressure resulting from the exposure of a surface to wind. The pressure values provided are for wind acting upon objects with circular cross section. Pressure adjustments for other shapes shall be as set forth by the ASCE Guidelines for Electrical Transmission Line Structural Loading (ASCE Publication 74) [ASCE 74].

4.2.2. *Radial Ice* – Radial ice is an equal thickness of ice applied about the circumference of the conductors and static wires. Ice density is assumed to be 57 lbs per cubic foot. For the purpose of transmission line design, ice is not applied to the surface of the structure, insulators, or line hardware.

4.2.3. *Temperature* – Used for calculating conductor and static wire sag and tension.

4.2.4. *Transverse load* – Forces or pressures acting perpendicular to the direction of the line. For angle structures, the transverse direction is parallel to the bisector of the angle of the transmission centerline.

4.2.5. *Longitudinal load* – Forces or pressures acting parallel to the direction of the line. For angle structures, the longitudinal direction is perpendicular to the bisector of the angle of the transmission centerline.

4.2.6. *All wires intact* – A condition where all intended spans of conductors and static wires are assumed to be in place. In the case of a Line Termination Structure, conductor and static wire spans are only on one side of the structure. .

4.2.7. *Broken Conductor or Static Wire* – A condition where one or more conductors or static wires are specified as broken. It is assumed that the broken conductor or static wire is in place on one side of the tower, and is removed from the other side. The span length for determination of loads from the conductor or static wire weight, wind pressure, and radial ice shall be not less than 60% of the design span length for the intact condition.

4.2.8. *Load Factor* – A value by which calculated loads are multiplied in order of provide increased structural reliability. For the purpose of structural design, Overload Capacity Factors as specified by NESC shall be considered Load Factors.

4.3. Design Loading Conditions

4.3.1. *NESC* – The provisions of the NESC Heavy Loading District, Class B Construction shall apply to all structure types. All wires intact. The latest NESC edition in effect at the time of line design shall apply. For informational purposes, the 1997 edition of NESC specifies the following requirements. Wind pressure – 4psf. Radial Ice – 0.5in. Temperature - 0°F. For the purpose of calculating conductor or static wire tensions, a load constant of 0.3lbs shall be added to the resultant of the per linear foot weight, wind, and ice loads on the conductor or static wire. For steel structures, the load factor for wind load is 2.50; the load factor for vertical loads (dead weight and ice) is 1.50; and the load factor for conductor and static wire tension is 1.65. The associated factors for wooden transmission line structures shall be obtained from the TO.

4.3.2. *Extreme Wind Loading Condition* – Applies to all structure types. All wires intact.

4.3.2.1. *Line voltage 230kV and greater.* Wind pressure applied to the wires shall be 25psf. The ambient temperature is to be 60°F. The wind pressure applied to the structure shall be 31.25psf. Load factor is 1.00.

4.3.2.2. *Line voltage less than 230kV.* The provisions of the NESC Extreme Wind loading shall be applied, subject to a minimum wind pressure of 17psf. The load factor is 1.00. The provision in NESC permitting exclusion of structures less than 60ft in height from extreme wind criteria shall not apply.

4.3.3. *Heavy Ice Loading Condition* – Applies to all structure types. All wires intact.

4.3.3.1. *Line voltage 230kV and greater.* Radial ice thickness on the wires only is to be 1.50in. No wind pressure. Temperature is 32°F. Load factor is 1.00.

4.3.3.2. *Line voltage less than 230kV.* Heavy ice loading (if any) shall be as specified by the TO. Ice loading will not be more severe than that required for voltages 230kV or greater.

4.3.4. _Longitudinal Loading Conditions for Suspension Structures_ (line voltage 230kV or greater) – The TO will specify one or more of the following loading conditions for design of Suspension Structures.

4.3.4.1. *One broken conductor or static wire*. Any one phase conductor or static wire is assumed broken. For construction using bundled phase conductors, one subconductor of any one phase bundle shall be assumed broken, the other subconductor(s) of that phase shall be assumed intact. All other conductors and static wires are intact. Loading condition is NESC Heavy. The longitudinal load shall be the tension of the broken static wire or broken conductor or subconductor. Tensions shall not be reduced by assumed insulator swing. For the intact phases and static wires, the wind on the structure, and the structure dead weight, the NESC load factors shall apply. For the broken static wire or the phase with the broken conductor or broken subconductor, the load factor shall be 1.10.

4.3.4.2. *Differential Ice Loading*. All wires intact. No Wind. Temperature 32°F. All conductors and static wires on one side of the structure shall be assumed to have 1.0in radial ice. All conductors and static wires on the other side of the tower shall be assumed to have no ice. The determination of differential tension may include calculated swing of suspension insulator or static wire assemblies. Load factor 1.10.

4.3.4.3. *Bound stringing block* – All wires intact. 2psf wind. No ice. 30°F. Any one static wire or phase conductor (or all subconductors of any one phase) are assumed to bind in a running block during installation. The block is assumed to swing 45° in-line. This swing will result in a longitudinal load equal to the calculated vertical load of the static wire or phase conductor(s) under this loading condition. Load factor is 2.00.

4.3.5. _Longitudinal Loading Conditions for Strain Structures_ – The TO will specify one or more of the following loading conditions for design of Strain Structures.

4.3.5.1. *One broken conductor or static wire*. Any one phase conductor or static wire is assumed broken. For construction using bundled phase conductors, one subconductor of any one phase bundle shall be assumed broken, the other subconductor(s) of that phase shall be assumed intact. All other conductors and static wires are intact. Loading condition is NESC Heavy. The longitudinal load shall be the tension of the broken static wire or broken conductor or subconductor. For the intact phases and static wires, the wind on the structure, and the structure dead weight, the NESC load factors shall apply. For the broken static wire or the phase with the broken conductor or broken subconductor, the load factor shall be 1.10.

OR

4.3.5.2. *All conductors and static wires broken*. Loading condition is NESC Heavy. Load factor is 1.00.

4.3.6. _Longitudinal Loading Condition for Dead End Structures_ – All conductors and static wires are to be intact on one side of the structure only. Loading condition is NESC Heavy. Load factors are those specified by NESC.

4.3.7. *Longitudinal Loading Condition for Line Termination Structures* – Conductors and static wires are to be intact on one side of the structure only. All loading conditions and load factors set forth by Section 4.3.1, 4.3.2, and 4.3.3 shall apply.

4.3.8. *Foundation Loading* – The ultimate strength of overturning moment and uplift foundations shall be not less than 1.25 times the design factored load reactions of the structure. The ultimate strength of foundations subjected to primarily to compression load shall be not less than 1.10 times the design factored load reactions of the structure. Overturning moment foundations designed by rotation or pier deflection performance criteria shall use unfactored structure reactions for determination of the foundation performance, but shall use factored reactions for the 1.25 time ultimate strength check.

4.3.9. *Personnel Support Loading* – Structures shall be designed to support a point load of 350 lb at any point where a construction or maintenance person could stand or otherwise be supported.

5.0 ELECTRICAL DESIGN PARAMETERS

5.1 Right-Of-Way Width

The transmission line is to be designed with adequate right-of-way width to provide access for line maintenance, repair, and vegetation management as shown in Table 1. These widths are based upon the listed number of circuits on the right-of-way. For additional circuits, a wider right-of-way should be utilized.

Vehicle or other means of access to each structure site is required for both construction and maintenance activities.

5.2 Wire to Ground Clearance

The minimum allowed clearance between the lowest transmission line conductor(s) shall meet the required NESC minimum plus a safety envelope of 3 feet. (The safety envelope is required to allow for sag and clearance uncertainties due to: actual conductor operating temperature, conductor sagging error, ground topography accuracy, plotting accuracy and other sources of error. The inclusion of a safety envelope is considered to be prudent). The NESC minimum shall be calculated with the conductor at maximum operating voltage and the maximum operating temperature or maximum conductor loading. The minimum clearances should take into account the limitation of a 5 mA shock current as given in NESC Rule 232D3c. All areas beneath the line shall be assumed to allow vehicle access beneath the line. For agricultural areas that may utilize farming equipment, additional clearance will be provided to assure public safety and line reliability during the periods of farming and harvesting activities.

5.3 Wire to Signs, Structures, etc Under the Wires

The minimum allowed clearance between the lowest transmission line conductor(s) shall meet the required NESC minimum plus a safety envelope of 3 feet. The NESC minimum shall be calculated with the conductor at maximum operating voltage and the maximum operating temperature.

5.4 Wire to Structure Clearances

The minimum clearances between the phase conductors and the supporting tower or pole shall not be less than shown in Table 1. These clearances are to apply for all anticipated conductor positions from an every day condition to a displaced condition due to a 9-psf wind or ice loading. These clearances do not have any adders provided for birds or other animals, but are based upon the switching surge values listed in Table #1.

5.5 **Wire-to-Wire Clearances**

Clearance between the bottom transmission conductor and any lower wire shall meet the required clearance of NESC Rule 233 and 235as a minimum. When the lower wire is a non transmission wire, then the clearance should be at least 10 feet for voltages less than or equal to 230 kV, and 20 feet for voltages above 230 kV. This will allow safe personnel access to the non-transmission conductors. These clearances should be calculated with the transmission conductor at maximum operating temperatures or heavy ice, whichever provides greater conductor sag, and the non-transmission conductor at 0°F.

Clearances between transmission conductors should be either the larger of clearances based upon switching surges, or clearances based on the NESC. The per unit switching surges to use for the calculation are shown in Table #1.

Using switching surge values, the method used to determine the actual required clearance is given in section 5 of the EPRI Transmission Line Reference Book 115 kV - 138 kV Compact Line Design.

For transmission conductors of different circuits, the clearances should be increased so that any wind induced dynamic conductor movement does not result in any breaker operations and subsequent reduction in transmission circuit reliability.

5.6 **Conductor Operating Temperature and Conductor Sag**

The conductor will be assumed to operate at or above the minimum temperature shown below, and at temperatures less than the maximum shown below. While the line conductor may be designed to operate at a lower temperature, the line must be sagged assuming the conductor temperature is at or above the minimum shown. For designed operating temperatures above the minimum shown, and still below the maximum, the line sag and clearances will be calculated for that operating temperature after rounding up to the nearest 10°C. In no case will a conductor operating temperature be allowed above the maximum shown in the table. Refer to the PJM "Bare Overhead Transmission Conductor Ratings" for the ampacity and temperatures of conductors.

Conductor Type	Minimum Conductor Operating Temperature for Sagging and Clearance Purposes	Maximum Operating Temperature
ACAR	100°C	140°C
ACSR, ACSS	125°C	180°C

Consult with the local transmission utility for the maximum operating temperature since some companies use slightly different values. Higher values for ACSS conductors may only be used with specific approval from the TO. Studies of the long-term high temperature operation of all conductor-connected hardware must be investigated prior to the request for approval from the local transmission utility.

5.7 **Insulation Requirements**

The insulation system for the transmission line shall have values in excess of the leakage distance, 60 Hz wet, and Critical Impulse flashover specified in Table 1. These values shown are minimum conditions and may need to be increased in specific locations such as coastal environments, industrial smokestack sites, or high altitudes. (BIL values are not included here as they are associated with substation insulation and not transmission line insulation,) 5.8 **Lightning Performance and Grounding**

All transmission structures will be individually grounded through a dedicated earth driven grounding system composed of ground rods and / or buried counterpoise. This system is to be measured on each individual structure prior to the installation of any overhead conductors or wires. The maximum acceptable resistance measurement of this grounding system for voltages up to and including 230 kV is 25 Ohms, and 15 ohms for voltages 345 kV and greater. The grounding system may include radial counterpoise wires, equipotential rings, or both. The TO must approve all grounding methods, and connections to the grounding system that are below grade. These resistance requirements are to assure acceptable lightning performance on the line as well as provide for the safe grounding of the line by construction and maintenance forces.

Individual tower grounding measurements will be allowed to exceed the 25 or 15 Ohms required only if the average value for the 5 adjacent structures along the line is less than the 25 or 15-Ohm restriction.

To assure acceptable lightning performance, a shield wire is required above each transmission line. The number of shield wires and the maximum shielding angles between the shield wire and phase conductor are shown in Table 1. Each new structure design is to be analyzed using the EPRI MULTIFLASH or equivalent software to determine that the line design and actual grounding design provides the required lightning performance shown in Table 1.

In instances where it is very difficult to provide the required lightning performance, the TO may grant permission to utilize a limited application of transmission lines arresters. In no case will chemical ground treatments be allowed to improve structure grounding.

5.9 **EMF, RFI, TVI, and Audible Noise**

The transmission line system is to be designed so that radio and TV interference is just perceptible at the edge of the right-of-way. This is typically the case with radio signal to noise ratios above 20 db, and TV signal to noise ratios above 40 db. The achievement of this level of performance is more of a problem for lines above 230 kV, so a radio frequency survey and investigation should be performed to measure actual radio and TV signal strength and calculate the signal to noise ratio.

Audible noise at the edge of the right-of-way should be calculated for the designed transmission line using wet conductor as the design condition. The resultant noise level must not exceed the level limited by the state and local authorities. Typically the limitation is 55 dbA during the daylight hours, and 50 dbA at night.

Electric and Magnetic Field (EMF) levels are to be calculated using the EPRI ENVIRO or equivalent software and compared to any state or local limits. Modifications are to be made through phasing, structure height, ground clearance, etc. to assure these limitations are met. If no specific limitations exist, the line should be designed to the level of EMF on and adjacent to the right-of-way. A typical example of such an effort is the appropriate choice of phasing on the right-of-way.

5.10 **Inductive Interference**

A study should be done to determine the inductive impact upon other utilities due to the power flow in the new transmission line. The power flow may induce unusual currents and voltages in magnetic and electrical conductors that run parallel to the transmission line.

When it is determined that the currents or voltages are being induced in nearby utilities or other facilities, the engineer for the new or modified line being constructed must take the appropriate corrective actions to eliminate or lower the currents or voltages to an acceptable level.

5.11 **Line Transpositions**

The transmission line designer may be required to transpose the geometry of a new transmission line if the voltage imbalance exceeds the tolerance of the TO at the substations the line connect s to. If transpositions structures are required, they shall be designed to provide for easy routine maintenance of the structure.

5.12 **Line Crossings**

Line crossings should be avoided if possible, but when line crossings are unavoidable they should be configured such that the most important circuits to the transmission network are on top. Additionally, crossings must be configured such that a single component failure will not outage more than one other circuit (beyond the circuit with the failed component). This is in accordance with MAAC Criteria.

6.0 OTHER DESIGN PARAMETERS

6.1 Line Cascade Mitigation

Transmission line failures that cascade beyond the original structural failure must be avoided. To accomplish this, the design of a new or modified line shall incorporate dead-end strain structures routinely employed along the line. An alternative is to utilize suspension structures that are longitudinally guyed to resist full line tension if all wires on one side were broken. For wood construction, the strain structures shall also have in-line storm guys utilized to provide the structural strength. The line tensions assumed for this condition are the NESC Heavy loadings on one side of the structure as defined above, and no tension on the other. The structures shall be placed routinely along the line to resist a line cascade, but in no case shall these structures be placed farther than 5 miles apart.

6.2 Corrosion Protection

Corrosion protection will be evaluated for all buried structural steel on transmission structures. This covers buried grillage, driven caissons, etc. The line designer will submit a recommendation to the TO for the corrosion mitigation method to be used for buried structural steel. The proposed method must show at least a 50 year durability before any degradation of structural strength is allowed. It is acceptable to include systems that require some routine maintenance such as cathodic protection using buried sacrificial anodes.

Above grade steel will be protected from corrosion using a coating acceptable to the TO. Typical alternatives that have been used include weathering steel, galvanized steel, or painted steel.

6.3 Climbing Devices

6.3.1 Steel pole structures shall utilize climbing ladders. The TO shall specify the requirements and placement of the climbing ladders.

6.3.2 All steel towers shall be designed with step bolts as the provision for climbing. The TO shall specify the requirements and placement of the step bolts.

7.0 MAINTENANCE

For maintenance see section V.L.2.A

TABLE 1
Transmission Line Design Parameters

Parameter	Requirements 500 kV	Requirements 345 kV	Requirements 230 kV	Recommendations 138 kV	Recommendations 115 kV	Recommendations 69 kV
Ambient Temperature Range	-30°C to +40°C (from –40°C N & W of Blue Mountain)			-30°C to +40°C (from –40°C N & W of Blue Mountain)		
Minimum Extreme Wind Loading	25 PSF		**New Line** NESC Figure 250-2 or a minimum wind pressure of 17 psf. **Existing Line** **Larger of**: NESC Figure 250-2 **OR** the original line design parameters	New Line: NESC Figure 250-2 Existing Line: **Larger of**: NESC Figure 250-2 **OR** the original line design parameters		
Heavy Ice Load (No Wind)	1½"			Consult the TO for applicable heavy ice loading requirements		
Code Requirements	NESC Grade "B" Heavy			NESC Grade "B" Heavy		
Flood Plain	The line shall meet the applicable Local, State and Federal regulations.			The line shall meet the applicable Local, State and Federal regulations.		
Sag and tension Calculation Method	Alcoa Sag & Tension Software or equivalent			Alcoa Sag & Tension Software or equivalent		
Damper Requirements	<18% RBS (No dampers Required) 18% -20% RBS (Dampers Required)			<18% RBS (No dampers Required) 18% -20% RBS (Dampers Required)		
Galloping Mitigation	Provide adequate clearance so that 12" of clearance exists between wire galloping ellipses to minimize conductor or structure damage. The TO may revise this requirement for areas with significant galloping history.			Provide adequate clearance so that 12" of clearance exists between wire galloping ellipses to minimize conductor or structure damage. The TO may revise this requirement for areas with significant galloping history.		
Spacers	18" spacing - NO Preformed wire spacers allowed.			18" spacing - NO Preformed wire spacers allowed.		
Provisions for Live Line Maintenance	As required by the TO.			As required by the TO.		
Access Requirements	Construction and maintenance access is required to each structure.			Construction and maintenance access is required to each structure.		
Approved conductor sizes for NEW Construction	Match approved conductor sizes and bundle configuration with local utility company			Match approved conductor sizes and bundle configuration with local utility company		

TABLE 1
Transmission Line Design Parameters

	Requirements			Recommendations		
Parameter	**500 kV**	**345 kV**	**230 kV**	**138 kV**	**115 kV**	**69 kV**
Approved static and OPGW wire sizes for NEW Construction	Match approved conductor sizes with the TO.			Match approved conductor sizes with the TO.		
Right-of-way width (Target values)	200 Ft. – 1 ckt. 300 Ft.(min.) – 2 ckts	170 Ft – 1 ckt	150 Ft 1 & 2 ckts	100 Ft 1 & 2 ckts	100 Ft 1& 2 ckts	60 - 100 Ft
Max. Number of circuits per structure	1 unless specifically approved by TO		2 unless specifically approved by TO	2 unless specifically approved by TO		
Min. design ground clearance at Max. Sag	NESC minimum requirements PLUS an additional 3 feet			NESC minimum requirements PLUS an additional 3 feet		
Conductor to structure steel clearance (min.)	125 in.	91 in.	69 in.	52 in.	42 in.	28 in.
Insulation Requirements						
Leakage distance	360 in.	250 in.	167in.	100 in.	83 in.	50 in.
60 Hz WET	950 kV	635 kV	490 kV	375 kV	295 kV	170 kV
Switching Surge	2.2 per unit.	2.4 per unit	2.5 per unit	3.0 per unit	3.0 per unit	3.5 per unit
Critical Impulse Flashover	2145 kV	1440 kV	1105 kV	860 kV	670 kV	440 kV
Maximum Structure Ground Resistance	15 Ohms	15 Ohms	25 Ohms	25 Ohms		
Step & Touch Potential Issues	Provide a structure grounding system that meets the step and touch requirements of the TO.			Provide a structure grounding system that meets the step and touch requirements of the TO.		
Minimum Number of Static Wires Required	Minimum of 1 per <u>circuit</u>			Minimum of 1 per <u>structure</u>		
Isokeraunic Level	40			40		
Maximum Shielding Angle	15°	20°	25°	30°	30°	30°
Target Lightning Outage Performance	1.0 per 100 ckt mi. / yr	1.0 per 100 ckt mi. / yr	2.0 per 100 ckt mi. / yr	3.0 per 100 ckt mi. / yr	3.0 per 100 ckt mi. / yr	4.0 per 100 ckt mi. / yr
EMF Limits	As Required by TO and State Regulatory Agencies			As Required by TO and State Regulatory Agencies		
Radio Interference at edge of right-of-way	300 μV @ 1 MHz (350 kV to gnd)	300 μV @ 1 MHz (230 kV to gnd)	No limits specified	No limits specified		
Audible Noise	Per applicable state laws for noise at edge of right-of-way			Per applicable state laws for noise at edge of right-of-way		

United States Department of the Interior

NATIONAL PARK SERVICE
Delaware Water Gap National Recreation Area
Bushkill, Pennsylvania 18324

IN REPLY REFER TO:

D5015

SEP 13 2010

Mr. Steve Herling, Vice President
PJM Interconnection L.L.C.
955 Jefferson Avenue
Valley Forge Corporate Center
Norristown, Pennsylvania 19403-2497

Dear Mr. Herling:

The National Park Service (NPS) has been asked by two regional electric utility companies (PPL in Pennsylvania and PSE&G in New Jersey) to provide permits for access across NPS lands and for construction of an additional 500kV line within their existing Right of Way (ROW). The structures would be built to hold a double circuit 500kV line where in some areas the existing width of the ROW is only 100 feet. The ROW of concern runs for 4.2 miles through the Appalachian National Scenic Trail (APPA), Delaware Water Gap National Recreation Area (DEWA), and the Middle Delaware National Scenic and Recreational River (MDSR), all units of the NPS. To evaluate the permit request we are preparing an Environmental Impact Statement (EIS).

We have a question regarding PJM's Technical Requirements that address the design and application of overhead transmission lines 69kV and above (section V.A of PJM TSDS Technical Requirements dated May 20, 2002). On Table 1 (page 12) of this document, PJM lists the *requirements* and the *recommendations* for transmission line design parameters. Our question is, are these requirements and recommendations the standard within which the utility companies are mandated to work when siting and planning new transmission lines?

We look forward to your timely reply as we are trying to maintain an efficient EIS schedule and this information is vital to our analysis.

Please feel free to contact us or Patrick Lynch of our staff at (570) 426-2428.

Sincerely,

John J. Donahue
Superintendent
Delaware Water Gap National Recreation Area &
Middle Delaware National Scenic and
Recreational River
(570) 426-2418

Pamela Underhill
Superintendent
Appalachian National Scenic Trail
(304) 535-6278

Enclosure

Cc:
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V.A
PJM Design and Application of Overhead Transmission Lines 69kV and Above

These design criteria have been established to assure acceptable reliability of the bulk transmission system facilities. These set forth the design and service conditions, and establish insulation levels for transmission lines. Some of these parameters were based on requirements for the Keystone, Conemaugh, Susquehanna Eastern, or LDV EHV projects, and others were developed by consensus of the PJM transmission line owners. Specific component requirements are listed in their own sections (in addition to NESC the proposed IEC 61936 could be a good reference). The criteria listed are requirements for lines rated 230 kV and above, and are guidelines for lines below 230 kV.

PJM DESIGN OF
OVERHEAD TRANSMISSION LINES 69 kV AND ABOVE

1.0 SCOPE AND GENERAL REQUIREMENTS

1.1. This document sets forth the requirements and recommendations for the design of overhead electric transmission facilities.

1.1.1. Transmission lines, for the purpose of this document, are those with an operating voltage of 69kV or greater.

1.1.2. The term "TO" in this document refers to the Transmission Owner, the party that will own and be responsible for the maintenance of the subject transmission facility.

1.2. The design and operation of all transmission lines shall meet the requirements of the National Electrical Safety Code (ANSI/IEEE C-2) [NESC]. The edition of the NESC in effect at the time of the design shall govern.

1.3. The electrical and strength requirements of this document shall apply to all new transmission lines; and extensions, taps, or additions to existing transmission lines where the circuit length of the new construction is 1000ft or more.

1.4. The design of modifications to existing transmission lines; or extensions, taps, or additions to existing transmission lines where the circuit length of the new construction is less than 1000ft; shall meet the requirements used for the design of the existing line and shall meet the requirements of the latest edition of the NESC.

1.5. The designs of existing transmission lines may not in all cases meet these criteria. The existing lines themselves are excluded from the scope of this document. However, taps from or extensions to these existing lines are covered under the scope of this document.

1.6. Switch structures are not within the scope of this document. If a switch is to be mounted on a transmission structure, the structure design shall have adequate strength and rigidity to ensure the reliable operation of the line and switch.

1.7. Transmission structures supporting non-electric transmission facilities (telecommunications antennas, fiber-optic cables, etc.) shall be capable of resisting the structural loads resulting from these facilities within the strength requirements of this document. The locating of such non-electric facilities on transmission structures shall not jeopardize the operation, maintenance, and reliability of the transmission lines.

1.8. While this document provides detailed criteria for the design of transmission lines on the PJM system, these do not represent the only issues to consider in the design of such lines. Other issues must also be considered such as: maintenance, inspection, and repair on both the structures and the wires of these lines. This will ensure the reliability of the line at a minimal cost well into the future.

1.9. In some instances, the requirements or recommendations specified in this document may come into conflict with other issues such as permitting or local issues. These specifications may be adjusted and negotiated with the specific and written approval of the TO. The agreed negotiation of a relaxation of any specification for an individual project or circumstance does not automatically result in a subsequent revision in this guide. Subsequent instances must be addressed individually on a case-by-case basis.

1.10. The use of structure guys, and wood structures shall be approved by the TO.

2.0 CONDUCTORS

Conductors must be selected with sufficient thermal capability to meet continuous and emergency current ratings. Ratings of conductors applied to the PJM system should be determined using the PJM TSDS "Bare Overhead Transmission Conductor Ratings, November 2000".

The overhead line conductor and static wire should be chosen from those used by the TO. This provides the ability to quickly repair a section of line with utility stock material should an emergency arise. Standard transmission conductor types are ACSR, ACSR/AW, ACSS, and ACAR. Other conductor types will be reviewed by the TO.

The ambient temperature range listed in Table 1 covers the PJM system and is used for the electrical ratings of the conductors as well as the structural loads upon the towers or poles.

3.0 CONDUCTOR SAG & TENSION CRITERIA

3.1 Alcoa – Sag & Tension Common Point

The maximum tension case shall be allowed to default as the common point between the initial and final sag tables. No other common point shall be allowed. An example would be a common point based upon NESC Heavy conditions when calculated tensions for the 1-1/2" Heavy Ice case exceed those for the NESC case.

4.0 STRENGTH REQUIREMENTS

4.1. **Structure Types** – the following descriptions of structure types shall apply to the provisions for strength requirements

4.1.1. *Suspension Structure* – A structure where the phase conductors and static wires are attached through the use of suspension insulators and hardware or, in the case of the static wire, with a clamp not capable of resisting the full design tension of the wire.

4.1.2. *Strain Structure* – A structure where the phase conductors and static wires are attached to the structure by use of dead-end insulators and hardware but where the ability of the structure to resist a condition where all wires are broken on one side under full loading is not required or desired. Typically, strain structures would be used where the line deflection angle is 45 degrees or less. Structures subject to strain structure requirement shall be as identified by the Utility.

4.1.3. *Dead-end Structure* - A structure where the phase conductors and static wires are attached to the structure by use of dead-end insulators and hardware and where the ability of the structure to resist a condition where all wires are broken on one side under full loading is required or desired. Typically, dead-end structures would be used where the line deflection angle is greater than 45 degrees. Structures subject to dead-end structure requirement shall be as identified by the Utility.

4.1.4. *Line Termination Structure* – A structure where the phase conductors and static wires are to be installed on one side only for the purpose of terminating the line, usually at a substation or switchyard. This permanent dead-end condition is assumed in the application of all applicable loading conditions.

4.2. **Loading Definitions**

4.2.1. *Wind Pressure* – The pressure resulting from the exposure of a surface to wind. The pressure values provided are for wind acting upon objects with circular cross section. Pressure adjustments for other shapes shall be as set forth by the ASCE Guidelines for Electrical Transmission Line Structural Loading (ASCE Publication 74) [ASCE 74].

4.2.2. _Radial Ice_ – Radial ice is an equal thickness of ice applied about the circumference of the conductors and static wires. Ice density is assumed to be 57 lbs per cubic foot. For the purpose of transmission line design, ice is not applied to the surface of the structure, insulators, or line hardware.

4.2.3. _Temperature_ – Used for calculating conductor and static wire sag and tension.

4.2.4. _Transverse load_ – Forces or pressures acting perpendicular to the direction of the line. For angle structures, the transverse direction is parallel to the bisector of the angle of the transmission centerline.

4.2.5. _Longitudinal load_ – Forces or pressures acting parallel to the direction of the line. For angle structures, the longitudinal direction is perpendicular to the bisector of the angle of the transmission centerline.

4.2.6. _All wires intact_ – A condition where all intended spans of conductors and static wires are assumed to be in place. In the case of a Line Termination Structure, conductor and static wire spans are only on one side of the structure.

4.2.7. _Broken Conductor or Static Wire_ – A condition where one or more conductors or static wires are specified as broken. It is assumed that the broken conductor or static wire is in place on one side of the tower, and is removed from the other side. The span length for determination of loads from the conductor or static wire weight, wind pressure, and radial ice shall be not less than 60% of the design span length for the intact condition.

4.2.8. _Load Factor_ – A value by which calculated loads are multiplied in order of provide increased structural reliability. For the purpose of structural design, Overload Capacity Factors as specified by NESC shall be considered Load Factors.

4.3. Design Loading Conditions

4.3.1. _NESC_ – The provisions of the NESC Heavy Loading District, Class B Construction shall apply to all structure types. All wires intact. The latest NESC edition in effect at the time of line design shall apply. For informational purposes, the 1997 edition of NESC specifies the following requirements. Wind pressure – 4psf. Radial Ice – 0.5in. Temperature - 0°F. For the purpose of calculating conductor or static wire tensions, a load constant of 0.3lbs shall be added to the resultant of the per linear foot weight, wind, and ice loads on the conductor or static wire. For steel structures, the load factor for wind load is 2.50; the load factor for vertical loads (dead weight and ice) is 1.50; and the load factor for conductor and static wire tension is 1.65. The associated factors for wooden transmission line structures shall be obtained from the TO.

4.3.2. _Extreme Wind Loading Condition_ – Applies to all structure types. All wires intact.

4.3.2.1. _Line voltage 230kV and greater._ Wind pressure applied to the wires shall be 25psf. The ambient temperature is to be 60°F. The wind pressure applied to the structure shall be 31.25psf. Load factor is 1.00.

4.3.2.2. _Line voltage less than 230kV._ The provisions of the NESC Extreme Wind loading shall be applied, subject to a minimum wind pressure of 17psf. The load factor is 1.00. The provision in NESC permitting exclusion of structures less than 60ft in height from extreme wind criteria shall not apply.

4.3.3. _Heavy Ice Loading Condition_ – Applies to all structure types. All wires intact.

4.3.3.1. _Line voltage 230kV and greater._ Radial ice thickness on the wires only is to be 1.50in. No wind pressure. Temperature is 32°F. Load factor is 1.00.

4.3.3.2. _Line voltage less than 230kV._ Heavy ice loading (if any) shall be as specified by the TO. Ice loading will not be more severe than that required for voltages 230kV or greater.

4.3.4. *Longitudinal Loading Conditions for Suspension Structures* (line voltage 230kV or greater) – The TO will specify one or more of the following loading conditions for design of Suspension Structures.

4.3.4.1. *One broken conductor or static wire*. Any one phase conductor or static wire is assumed broken. For construction using bundled phase conductors, one subconductor of any one phase bundle shall be assumed broken, the other subconductor(s) of that phase shall be assumed intact. All other conductors and static wires are intact. Loading condition is NESC Heavy. The longitudinal load shall be the tension of the broken static wire or broken conductor or subconductor. Tensions shall not be reduced by assumed insulator swing. For the intact phases and static wires, the wind on the structure, and the structure dead weight, the NESC load factors shall apply. For the broken static wire or the phase with the broken conductor or broken subconductor, the load factor shall be 1.10.

4.3.4.2. *Differential Ice Loading.* All wires intact. No Wind. Temperature 32°F. All conductors and static wires on one side of the structure shall be assumed to have 1.0in radial ice. All conductors and static wires on the other side of the tower shall be assumed to have no ice. The determination of differential tension may include calculated swing of suspension insulator or static wire assemblies. Load factor 1.10.

4.3.4.3. *Bound stringing block* – All wires intact. 2psf wind. No ice. 30°F. Any one static wire or phase conductor (or all subconductors of any one phase) are assumed to bind in a running block during installation. The block is assumed to swing 45° in-line. This swing will result in a longitudinal load equal to the calculated vertical load of the static wire or phase conductor(s) under this loading condition. Load factor is 2.00.

4.3.5. *Longitudinal Loading Conditions for Strain Structures* – The TO will specify one or more of the following loading conditions for design of Strain Structures.

4.3.5.1. *One broken conductor or static wire*. Any one phase conductor or static wire is assumed broken. For construction using bundled phase conductors, one subconductor of any one phase bundle shall be assumed broken, the other subconductor(s) of that phase shall be assumed intact. All other conductors and static wires are intact. Loading condition is NESC Heavy. The longitudinal load shall be the tension of the broken static wire or broken conductor or subconductor. For the intact phases and static wires, the wind on the structure, and the structure dead weight, the NESC load factors shall apply. For the broken static wire or the phase with the broken conductor or broken subconductor, the load factor shall be 1.10.

OR

4.3.5.2. *All conductors and static wires broken*. Loading condition is NESC Heavy. Load factor is 1.00.

4.3.6. *Longitudinal Loading Condition for Dead End Structures* – All conductors and static wires are to be intact on one side of the structure only. Loading condition is NESC Heavy. Load factors are those specified by NESC.

4.3.7. *Longitudinal Loading Condition for Line Termination Structures* – Conductors and static wires are to be intact on one side of the structure only. All loading conditions and load factors set forth by Section 4.3.1, 4.3.2, and 4.3.3 shall apply.

4.3.8. *Foundation Loading* – The ultimate strength of overturning moment and uplift foundations shall be not less than 1.25 times the design factored load reactions of the structure. The ultimate strength of foundations subjected to primarily to compression load shall be not less than 1.10 times the design factored load reactions of the structure. Overturning moment foundations designed by rotation or pier deflection performance criteria shall use unfactored structure reactions for determination of the foundation performance, but shall use factored reactions for the 1.25 time ultimate strength check.

4.3.9. *Personnel Support Loading* – Structures shall be designed to support a point load of 350 lb at any point where a construction or maintenance person could stand or otherwise be supported.

5.0 ELECTRICAL DESIGN PARAMETERS

5.1 Right-Of-Way Width

The transmission line is to be designed with adequate right-of-way width to provide access for line maintenance, repair, and vegetation management as shown in Table 1. These widths are based upon the listed number of circuits on the right-of-way. For additional circuits, a wider right-of-way should be utilized.

Vehicle or other means of access to each structure site is required for both construction and maintenance activities.

5.2 Wire to Ground Clearance

The minimum allowed clearance between the lowest transmission line conductor(s) shall meet the required NESC minimum plus a safety envelope of 3 feet. (The safety envelope is required to allow for sag and clearance uncertainties due to: actual conductor operating temperature, conductor sagging error, ground topography accuracy, plotting accuracy and other sources of error. The inclusion of a safety envelope is considered to be prudent). The NESC minimum shall be calculated with the conductor at maximum operating voltage and the maximum operating temperature or maximum conductor loading. The minimum clearances should take into account the limitation of a 5 mA shock current as given in NESC Rule 232D3c. All areas beneath the line shall be assumed to allow vehicle access beneath the line. For agricultural areas that may utilize farming equipment, additional clearance will be provided to assure public safety and line reliability during the periods of farming and harvesting activities.

5.3 Wire to Signs, Structures, etc Under the Wires

The minimum allowed clearance between the lowest transmission line conductor(s) shall meet the required NESC minimum plus a safety envelope of 3 feet. The NESC minimum shall be calculated with the conductor at maximum operating voltage and the maximum operating temperature.

5.4 Wire to Structure Clearances

The minimum clearances between the phase conductors and the supporting tower or pole shall not be less than shown in Table 1. These clearances are to apply for all anticipated conductor positions from an every day condition to a displaced condition due to a 9-psf wind or ice loading. These clearances do not have any adders provided for birds or other animals, but are based upon the switching surge values listed in Table #1.

5.5 Wire-to-Wire Clearances

Clearance between the bottom transmission conductor and any lower wire shall meet the required clearance of NESC Rule 233 and 235as a minimum. When the lower wire is a non transmission wire, then the clearance should be at least 10 feet for voltages less than or equal to 230 kV, and 20 feet for voltages above 230 kV. This will allow safe personnel access to the non-transmission conductors. These clearances should be calculated with the transmission conductor at maximum operating temperatures or heavy ice, whichever provides greater conductor sag, and the non-transmission conductor at 0°F.

Clearances between transmission conductors should be either the larger of clearances based upon switching surges, or clearances based on the NESC. The per unit switching surges to use for the calculation are shown in Table #1.

Using switching surge values, the method used to determine the actual required clearance is given in section 5 of the EPRI Transmission Line Reference Book 115 kV - 138 kV Compact Line Design.

For transmission conductors of different circuits, the clearances should be increased so that any wind induced dynamic conductor movement does not result in any breaker operations and subsequent reduction in transmission circuit reliability.

5.6 Conductor Operating Temperature and Conductor Sag

The conductor will be assumed to operate at or above the minimum temperature shown below, and at temperatures less than the maximum shown below. While the line conductor may be designed to operate at a lower temperature, the line must be sagged assuming the conductor temperature is at or above the minimum shown. For designed operating temperatures above the minimum shown, and still below the maximum, the line sag and clearances will be calculated for that operating temperature after rounding up to the nearest 10°C. In no case will a conductor operating temperature be allowed above the maximum shown in the table. Refer to the PJM "Bare Overhead Transmission Conductor Ratings" for the ampacity and temperatures of conductors.

Conductor Type	Minimum Conductor Operating Temperature for Sagging and Clearance Purposes	Maximum Operating Temperature
ACAR	100°C	140°C
ACSR, ACSS	125°C	180°C

Consult with the local transmission utility for the maximum operating temperature since some companies use slightly different values. Higher values for ACSS conductors may only be used with specific approval from the TO. Studies of the long-term high temperature operation of all conductor-connected hardware must be investigated prior to the request for approval from the local transmission utility.

5.7 Insulation Requirements

The insulation system for the transmission line shall have values in excess of the leakage distance, 60 Hz wet, and Critical Impulse flashover specified in Table 1. These values shown are minimum conditions and may need to be increased in specific locations such as coastal environments, industrial smokestack sites, or high altitudes. (BIL values are not included here as they are associated with substation insulation and not transmission line insulation,) 5.8 **Lightning Performance and Grounding**

All transmission structures will be individually grounded through a dedicated earth driven grounding system composed of ground rods and / or buried counterpoise. This system is to be measured on each individual structure prior to the installation of any overhead conductors or wires. The maximum acceptable resistance measurement of this grounding system for voltages up to and including 230 kV is 25 Ohms, and 15 ohms for voltages 345 kV and greater. The grounding system may include radial counterpoise wires, equipotential rings, or both. The TO must approve all grounding methods, and connections to the grounding system that are below grade. These resistance requirements are to assure acceptable lightning performance on the line as well as provide for the safe grounding of the line by construction and maintenance forces.

Individual tower grounding measurements will be allowed to exceed the 25 or 15 Ohms required only if the average value for the 5 adjacent structures along the line is less than the 25 or 15-Ohm restriction.

To assure acceptable lightning performance, a shield wire is required above each transmission line. The number of shield wires and the maximum shielding angles between the shield wire and phase conductor are shown in Table 1. Each new structure design is to be analyzed using the EPRI MULTIFLASH or equivalent software to determine that the line design and actual grounding design provides the required lightning performance shown in Table 1.

In instances where it is very difficult to provide the required lightning performance, the TO may grant permission to utilize a limited application of transmission lines arresters. In no case will chemical ground treatments be allowed to improve structure grounding.

5.9 **EMF, RFI, TVI, and Audible Noise**

The transmission line system is to be designed so that radio and TV interference is just perceptible at the edge of the right-of-way. This is typically the case with radio signal to noise ratios above 20 db, and TV signal to noise ratios above 40 db. The achievement of this level of performance is more of a problem for lines above 230 kV, so a radio frequency survey and investigation should be performed to measure actual radio and TV signal strength and calculate the signal to noise ratio.

Audible noise at the edge of the right-of-way should be calculated for the designed transmission line using wet conductor as the design condition. The resultant noise level must not exceed the level limited by the state and local authorities. Typically the limitation is 55 dbA during the daylight hours, and 50 dbA at night.

Electric and Magnetic Field (EMF) levels are to be calculated using the EPRI ENVIRO or equivalent software and compared to any state or local limits. Modifications are to be made through phasing, structure height, ground clearance, etc. to assure these limitations are met. If no specific limitations exist, the line should be designed to the level of EMF on and adjacent to the right-of-way. A typical example of such an effort is the appropriate choice of phasing on the right-of-way.

5.10 **Inductive Interference**

A study should be done to determine the inductive impact upon other utilities due to the power flow in the new transmission line. The power flow may induce unusual currents and voltages in magnetic and electrical conductors that run parallel to the transmission line.

When it is determined that the currents or voltages are being induced in nearby utilities or other facilities, the engineer for the new or modified line being constructed must take the appropriate corrective actions to eliminate or lower the currents or voltages to an acceptable level.

5.11 **Line Transpositions**

The transmission line designer may be required to transpose the geometry of a new transmission line if the voltage imbalance exceeds the tolerance of the TO at the substations the line connect s to. If transpositions structures are required, they shall be designed to provide for easy routine maintenance of the structure.

5.12 **Line Crossings**

Line crossings should be avoided if possible, but when line crossings are unavoidable they should be configured such that the most important circuits to the transmission network are on top. Additionally, crossings must be configured such that a single component failure will not outage more than one other circuit (beyond the circuit with the failed component). This is in accordance with MAAC Criteria.

6.0 OTHER DESIGN PARAMETERS

6.1 Line Cascade Mitigation

Transmission line failures that cascade beyond the original structural failure must be avoided. To accomplish this, the design of a new or modified line shall incorporate dead-end strain structures routinely employed along the line. An alternative is to utilize suspension structures that are longitudinally guyed to resist full line tension if all wires on one side were broken. For wood construction, the strain structures shall also have in-line storm guys utilized to provide the structural strength. The line tensions assumed for this condition are the NESC Heavy loadings on one side of the structure as defined above, and no tension on the other. The structures shall be placed routinely along the line to resist a line cascade, but in no case shall these structures be placed farther than 5 miles apart.

6.2 Corrosion Protection

Corrosion protection will be evaluated for all buried structural steel on transmission structures. This covers buried grillage, driven caissons, etc. The line designer will submit a recommendation to the TO for the corrosion mitigation method to be used for buried structural steel. The proposed method must show at least a 50 year durability before any degradation of structural strength is allowed. It is acceptable to include systems that require some routine maintenance such as cathodic protection using buried sacrificial anodes.

Above grade steel will be protected from corrosion using a coating acceptable to the TO. Typical alternatives that have been used include weathering steel, galvanized steel, or painted steel.

6.3 Climbing Devices

6.3.1 Steel pole structures shall utilize climbing ladders. The TO shall specify the requirements and placement of the climbing ladders.

6.3.2 All steel towers shall be designed with step bolts as the provision for climbing. The TO shall specify the requirements and placement of the step bolts.

7.0 MAINTENANCE

For maintenance see section V.L.2.A

TABLE 1
Transmission Line Design Parameters

Parameter	Requirements			Recommendations		
	500 kV	345 kV	230 kV	138 kV	115 kV	69 kV
Ambient Temperature Range	-30°C to +40°C (from –40°C N & W of Blue Mountain)			-30°C to +40°C (from –40°C N & W of Blue Mountain)		
Minimum Extreme Wind Loading	25 PSF		**New Line** NESC Figure 250-2 or a minimum wind pressure of 17 psf. **Existing Line** **Larger of**: NESC Figure 250-2 **OR** the original line design parameters	New Line: NESC Figure 250-2 Existing Line: **Larger of**: NESC Figure 250-2 **OR** the original line design parameters		
Heavy Ice Load (No Wind)	1½"			Consult the TO for applicable heavy ice loading requirements		
Code Requirements	NESC Grade "B" Heavy			NESC Grade "B" Heavy		
Flood Plain	The line shall meet the applicable Local, State and Federal regulations.			The line shall meet the applicable Local, State and Federal regulations.		
Sag and tension Calculation Method	Alcoa Sag & Tension Software or equivalent			Alcoa Sag & Tension Software or equivalent		
Damper Requirements	<18% RBS (No dampers Required) 18% -20% RBS (Dampers Required)			<18% RBS (No dampers Required) 18% -20% RBS (Dampers Required)		
Galloping Mitigation	Provide adequate clearance so that 12" of clearance exists between wire galloping ellipses to minimize conductor or structure damage. The TO may revise this requirement for areas with significant galloping history.			Provide adequate clearance so that 12" of clearance exists between wire galloping ellipses to minimize conductor or structure damage. The TO may revise this requirement for areas with significant galloping history.		
Spacers	18" spacing - NO Preformed wire spacers allowed.			18" spacing - NO Preformed wire spacers allowed.		
Provisions for Live Line Maintenance	As required by the TO.			As required by the TO.		
Access Requirements	Construction and maintenance access is required to each structure.			Construction and maintenance access is required to each structure.		
Approved conductor sizes for NEW Construction	Match approved conductor sizes and bundle configuration with local utility company			Match approved conductor sizes and bundle configuration with local utility company		

TABLE 1
Transmission Line Design Parameters

	Requirements			Recommendations		
Parameter	**500 kV**	**345 kV**	**230 kV**	**138 kV**	**115 kV**	**69 kV**
Approved static and OPGW wire sizes for NEW Construction	Match approved conductor sizes with the TO.			Match approved conductor sizes with the TO.		
Right-of-way width (Target values)	200 Ft. – 1 ckt. 300 Ft.(min.) – 2 ckts	170 Ft – 1 ckt	150 Ft 1 & 2 ckts	100 Ft 1 & 2 ckts	100 Ft 1& 2 ckts	60 - 100 Ft
Max. Number of circuits per structure	1 unless specifically approved by TO		2 unless specifically approved by TO	2 unless specifically approved by TO		
Min. design ground clearance at Max. Sag	NESC minimum requirements PLUS an additional 3 feet			NESC minimum requirements PLUS an additional 3 feet		
Conductor to structure steel clearance (min.)	125 in.	91 in.	69 in.	52 in.	42 in.	28 in.
Insulation Requirements						
Leakage distance	360 in.	250 in.	167in.	100 in.	83 in.	50 in.
60 Hz WET	950 kV	635 kV	490 kV	375 kV	295 kV	170 kV
Switching Surge	2.2 per unit.	2.4 per unit	2.5 per unit	3.0 per unit	3.0 per unit	3.5 per unit
Critical Impulse Flashover	2145 kV	1440 kV	1105 kV	860 kV	670 kV	440 kV
Maximum Structure Ground Resistance	15 Ohms	15 Ohms	25 Ohms	25 Ohms		
Step & Touch Potential Issues	Provide a structure grounding system that meets the step and touch requirements of the TO.			Provide a structure grounding system that meets the step and touch requirements of the TO.		
Minimum Number of Static Wires Required	Minimum of 1 per <u>circuit</u>			Minimum of 1 per <u>structure</u>		
Isokeraunic Level	40			40		
Maximum Shielding Angle	15°	20°	25°	30°	30°	30°
Target Lightning Outage Performance	1.0 per 100 ckt mi. / yr	1.0 per 100 ckt mi. / yr	2.0 per 100 ckt mi. / yr	3.0 per 100 ckt mi. / yr	3.0 per 100 ckt mi. / yr	4.0 per 100 ckt mi. / yr
EMF Limits	As Required by TO and State Regulatory Agencies			As Required by TO and State Regulatory Agencies		
Radio Interference at edge of right-of-way	300 µV @ 1 MHz (350 kV to gnd)	300 µV @ 1 MHz (230 kV to gnd)	No limits specified	No limits specified		
Audible Noise	Per applicable state laws for noise at edge of right-of-way			Per applicable state laws for noise at edge of right-of-way		

955 Jefferson Ave.
Valley Forge Corporate Center
Norristown, PA 19403-2497

September 20, 2010

RECEIVED
SEP 21 2010
BY:

Ms. Pamela Underhill
Superintendant
Appalachian National Scenic Trail
PO Box 50 252 McDowell Street
Harper's Ferry, WV 25425

Mr. John J Donahue
Superintendant
National Park Service
Delaware Water Gap National Recreation Area Bushkill, PA 18324

RE: PJM TSDS TECHNICAL REQUIREMENTS

Dear Ms Underhill and Mr. Donahue:

I have reviewed the PJM TSDS Technical Requirements document, the subject of your September 13, 2010 letter, with our technical staff and with our Legal Department. That document was under development in the 2001 – 2002 timeframe among the transmission owners in the Mid-Atlantic portion of PJM, then the entirety of the PJM footprint. With the integration of a number of Western and Southern transmission owner systems into PJM the document was never finalized and approved for use. At this time, it serves only as a set of guidelines and the controlling document is the ANSI/IEEE National Electrical Safety Code.

If you have any further questions, please call me at 610-666-8834.

Sincerely,

Steven R. Herling
Vice President – Planning

SRH/nbm: 611587

United States Department of the Interior

NATIONAL PARK SERVICE
Delaware Water Gap National Recreation Area
Bushkill, Pennsylvania 18324

IN REPLY REFER TO:

D5015

NOV 18 2010

Mr. Gregory Smith
Manager - Transmission Expansion
PPL Electric Utilities
Two North Ninth Street, GENPL3
Allentown, PA 18101-1179

Dear Mr. Smith:

As we review the draft alternatives and associated comments, we need to clarify a point regarding the contention that the proposal can be constructed within the existing one hundred (100) foot right of way. All other discussions of safety and regulatory requirements aside, our understanding from previous discussion with you and your team is that you believe you can construct the proposed project within the existing ROW with one caveat. That caveat is that you also have the right to clear what you deem to be "danger trees" found outside of your deeded ROW and located on National Park Service Lands. Please verify or correct our understanding of your assertion in this matter at the earliest possible date. Thank you for your kind attention to this matter.

Sincerely,

John Donahue
Superintendent
Delaware Water Gap National Recreation Area &
Middle Delaware National Scenic and
Recreational River
(570) 426-2418

Pam Underhill
Superintendent
Appalachian National Scenic Trail
(304) 535-6279

Cc: Andrew Tittler, DOI Office of the Solicitor
Patrick Lynch, National Park Service, DEWA
Kara Deutsch, National Park Service, DEWA
Sarah Bransom, National Park Service, APPA
Amanda Stein, National Park Service, DEWA
Patrick Malone, National Park Service, DSC
Jennifer McConaghie, National Park Service, NER

Clint Riley, U.S. Fish and Wildlife Service
Pamela Shellenberger, U.S. Fish and Wildlife Service

Denver Service Center - TIC
Attn: SRLINE EIS
12795 W. Alameda Parkway
Denver, CO 80225-0287

Gregory J. Smith
Manager-Transmission Expansion

PPL Electric Utilities
Two North Ninth Street, GENN5
Allentown, PA 18101-1179

December 7, 2010

Mr. John J. Donahue
Superintendent
National Park Service
Delaware Water Gap National Recreation Area
Bushkill, PA 18324

Ms. Pamela Underhill
Superintendent
Appalachian National Scenic Trail
National Park Service
P.O. Box 50
Harpers Ferry, WV 25425

Re: PPL Electric Utilities Corporation/Vegetation Management
<u>In the Delaware Water Gap National Recreation Area ("DEWA")</u>

Dear Mr. Donahue and Ms. Underhill:

Thank you for the opportunity to respond to your letter of November 18, 2010, regarding the need and right of PPL Electric Utilities Corporation ("PPL Electric") to clear what PPL Electric identifies as "danger trees." The answer to your question is that PPL Electric does need to remove danger trees with respect to the 100-foot alternative and, in fact, has the right to remove danger trees under its existing easements.

The relevant easement agreements include the following language:

> And, further, in consideration of said payments, we do hereby release and quit claim the said Pennsylvania Power & Light Company, its successors, assigns and lessees, of, and from any and all damages, loss or injury that maybe at any time caused by or result from the construction, reconstruction, operation and maintenance of the said lines, or the trimming or cutting down of any and all trees which, in the judgment of the said Company, its successors, assigns and lessees, may interfere with the construction, reconstruction, maintenance or operation of the said lines or menace the same.

Based on the above language, PPL Electric has the right to cut and remove danger trees. Further, as you are aware, PPL Electric has been removing danger trees as part of its vegetation management program for many years.

PPL Electric also has the right to remove danger trees consistent with the Stipulation and Order of Settlement that was entered into between PPL Electric and the National Park Service that was approved by the District Court for the Middle District of Pennsylvania on August 19, 2010. In that stipulation it was agreed that PPL Electric has the right to perform vegetation management consistent with its easement rights and its Transmission Vegetation Management Program ("TVMP"). That Stipulation also indicated that the work this past year would be done consistent with the Scope of Work provided to NPS on May 19, 2010. Both the TVMP and the Scope of Work includes the removal of danger trees and, consistent with its easement rights and historical practice, PPL Electric removed 11 danger trees when the work was performed this past year.

Finally, PPL Electric notes that it is required by federal regulation to protect all of its transmission lines from trees and other vegetation that could come in contact with or otherwise impair the reliability or safety of the lines. Failure to protect the lines would subject PPL to fines under federal regulation.

Again, thank you for the opportunity to respond to your question. If you are in disagreement with PPL Electric's position, please advise at your earliest convenience.

Very truly yours,

Gregory J. Smith

Gregory J. Smith

cc: Ronald J. Reybitz, Esq.
John Lain, Esq.

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12/07/10 4:04 PM

Patrick J. McMackin
Project Director – Susquehanna Roseland

PPL Electric Utilities
Two North Ninth Street, Plaza 3
Allentown, PA 18101-1179

ppl™

February 14, 2011

In regards to: SRLINE EIS 25147

Delaware Water Gap National Recreation Area
c/o Amanda Stein
HQ River Road, Off Route 209
Bushkill, PA 18324

Dear Ms. Stein:

Thank you again for taking the time to conference call with us on 18 January 2011. Hopefully, NPS and EA found this time well spent. As a follow-up to the discussion during that call and in an effort to further help the NPS and EA with the EIS process, we reviewed the information that was provided on File-Works over the last several years. We thought it might be helpful to consolidate all associated files in a new, single folder titled "Existing 100 foot ROW Alternative."

In regards to your specific information requests, we also reviewed each of the documents and identified the exact location of the information and provided a summary below. Lastly, we have updated some of the documents to remove outdated information.

The following summary should help provide some clarity and assist with locating the specific information requested on the existing 100' ROW alternative. Attachment 1 contains detailed references to the documents and pages that contain the information we believe will help in your analysis.

<u>Access Routes/Roads:</u>

All associated access routes/roads for the existing 100' ROW alternative are the same in location and size as those that would be utilized for the Applicants' original proposed route. Although there are additional transmission structures needed for this alternative, the same access routes/roads needed to access and remove existing structures will be utilized for access to these additional transmission structures. Reference Attachment 1 for additional information, including references to existing documents posted in File Works.

<u>Transmission Structure Locations, Heights and Spans</u>

The associated transmission structures B17-4, B17-5 and B17-6 for the existing 100' ROW alternative are the same as those that would be utilized for the Applicants' original proposed route. There are two additional transmission structures needed on NPS property for this alternative: B17-3A and B17-5A. Reference Attachment 1 for additional information, including references to existing documents posted in File Works.

Transmission Structure Crane Pads:

The associated transmission structure crane pads for B17-3, B17-4, B17-5 and B17-6 for the existing 100' ROW alternative are the same in location and size as those that would be utilized for the Applicants' original proposed route. However, there are two additional transmission structures (B17-3A and B17-5A) that will require crane pads that will be entirely on NPS property. Additionally, an additional transmission structure (B17-2A) located outside NPS property will require an extra crane pad that will be approximately one-half on NPS property. Lastly, no new crane pads will be required for the removal of the existing structure on NPS property. Reference Attachment 1 for additional information, including references to existing documents posted in File Works.

100' Right-of-Way Boundaries

These are the same ROW boundaries currently granted PPL for the operations of the existing 230 kV transmission line.

The document titled "DEWA_existing_ROW_Alternative_12142009.pdf" identifies the boundaries for the current PPL ROW for the existing 100' ROW alternative. The ROW boundaries are identified on both page 1 and 2 by solid black lines, as noted in the Legend.

Vegetation Management - Access Road Construction

All construction vegetation clearing associated with the construction of the access routes/roads for the existing 100' ROW alternative are the same in location and size as those that would be utilized for the Applicants' original proposed route. Although there are additional transmission structures needed for this alternative, the same access routes/roads needed to access and remove existing structures will be utilized for access to these additional transmission structures.

The document titled "DEWA_existing_ROW_Alternative_12142009.pdf" identifies the proposed access roads for the existing 100' ROW alternative. This document provides an aerial view of the portion of the line that would be modified to accommodate construction of the new transmission line within the existing ROW. Reference the "Access Routes/Roads" section in Attachment 1 for more details.

Vegetation Management - Transmission Structure Construction and Removal

It is expected that additional clearing for the construction vegetation clearing associated with the construction and removal of transmission structures for the existing 100' ROW alternative will be very minimal, depending on the time passed since the last wire zone/border zone routine vegetation management associated with the existing 230 kV transmission line ROW currently operating on NPS property. The primary difference between the existing 100' ROW alternative and the Applicants' original proposed route is that the width of the ROW and associated clearing will be reduced by twenty-five (25) feet on each side. Additionally, more clearing including grubbing, would be required in the additional crane pad areas (B17-2A, B17-3A and B17-5A). There will be no additional clearing beyond what is presently required from the last structure in Pennsylvania, B17-6, to the Delaware River and the New Jersey border.

The document titled "DEWA_existing_ROW_Alternative_12142009.pdf" identifies the proposed transmission structures and crane pads for the existing 100' ROW alternative. Reference the "Transmission Structure Locations" and "Transmission Structure Crane Pads" sections in Attachment 1 for more details.

Vegetation Management - Transmission Line Operations

It is expected that additional vegetation management for the operations of the existing 100' ROW alternative will be very minimal compared to the ongoing wire zone/border zone routine vegetation management associated with the existing 230 kV transmission line ROW currently operating on NPS property. The primary difference between operations of the existing 100' ROW alternative and the Applicants' original proposed route is that the width of the ROW and associated clearing will be reduced by twenty-five (25) feet on each side. Additionally, as a result of the reduced ROW and clearing, vegetation management activities will be more routine (likely annually), there will be a lower tolerance for danger trees outside the ROW, the option for aerial clearing and maintenance will be eliminated, and access roads will need to be maintained in a more functional state. There will be no additional clearing from the last structure in Pennsylvania, B17-6, to the Delaware River than would be required for the existing 230 kV transmission line ROW currently operating on NPS property.

Additionally, the document titled "100' ROW Information.PDF" contains more information on the minimum vegetation management cycle. Assuming an annual two (2) foot growth rate, the minimum cycle for all spans is currently expected to be every three years. However, for the span between B173-A and B17-4 it is expected to be every year. This is based on the remaining buffer from tree line. This span is primarily over the existing Arnott Fen which currently does not promote the growth of tall vegetation.

Transmission Structure Maintenance

The steel mono-pole structures proposed for use do not require routine painting. Therefore, the associated routine maintenance that has historically been performed on the existing transmission structures, specifically the lattice towers, will no longer be required. Painting will also not be required for the structures in the Applicants' original proposal.

Traffic and Visitor Impacts

Due to the additional structures required for the 100' ROW alternative, construction duration is currently estimated to be an additional 2 weeks. Impacts to traffic and visitors should be relatively minor as work is anticipated to be scheduled during the winter months. Also reference the Follow-up to Data Request: #108, included in the data request response package dated September 15, 2010 and posted in File Works. To access this document (Followup Data Request 09152010 Responses.pdf) in File Works, open the "DEWA" folder, then the "Data Gap Responses" folder and lastly, the "Followup 9-15-10 Responses" folder.

Updated Documents

The document titled "DEWA_existing_ROW_Alternative_12142009.pdf," which provides an aerial view and identifies the proposed access roads for the existing 100' ROW alternative, has been updated. A new document titled "B17_PA_DEWA_Access_01272011.pdf" has been prepared. Obsolete project information has been removed and additional data labels added. We hope this further helps support the NPS and EA in their efforts.

Lastly, the latest version of the PPL EU "Specification for Initial Clearing and Control Maintenance of Vegetation On or Adjacent To Electric Line Right-of-Way through Use Of Herbicides, Mechanical, and Hand-clearing Technique - LA-79827-8" has been uploaded to File-Works in the folder titled "Vegetation". Changes associated with this latest revision are noted on page 2 of the document.

The Applicants stand ready to continue to provide any additional support needed to ensure a timely, accurate and complete EIS process. Should NPS or EA require any additional information or wish to discuss this or any other information provided, please feel free to contact Jeff Luzenski, 610-774-4184, or myself.

These documents are also available electronically on the enclosed CD, and have been uploaded today to the project's File-Works site.

In addition, two hard copies and one CD have been sent to the Appalachian National Scenic Trail c/o Sarah Bransom, and a hard copy to the Denver Service Center for inclusion in the administrative record. Additionally, one CD has been sent to Andrew Tittler at the Office of the Solicitor and one CD to EA Engineering Science and Technology, Inc.

Please let me know if additional copies are needed.

Sincerely,

Patrick J. McMackin

Patrick J. McMackin, P.E.

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Attachment 1

100 Foot ROW Alternative Details

The following provides additional information from documents referenced above.

Access Routes/Roads:

The document titled "DEWA_existing_ROW_Alternative_12142009.pdf" identifies the proposed access roads for the existing 100' ROW alternative. This document provides an aerial view of the portion of the line that would be modified to accommodate construction of the new transmission line within the existing ROW. The document identifies the Delaware Water Gap NRA boundaries, the boundaries of the ROW (including the proposed 100' ROW sections), existing transmission structures, proposed transmission structures, the proposed transmission line, surveyed wetlands, proposed crane pad locations and sizes, the proposed access routes/roads and associated, approximate clearing area needed for the access routes/roads.

Page 1 identifies the "Existing Alternate Route" as a dotted yellow line, as noted in the Legend. Specifically identified are the access routes/roads off of:

> River Road to proposed new transmission structure B17-2. (Note: This proposed new transmission structure and its associated access route/road are not on NPS property. The access route/road and new transmission structure B17-2 are identical to those for the proposed route originally submitted by the applicants. The associated access route/road to this structure already exists and is utilized for routine maintenance of the existing transmission line.)
>
> River Road to existing structure 37-2 and to proposed new transmission structure B17-2A (Note: This transmission structure, B17-2A, and a majority of its associated access route/road are not on NPS property). Only approximately 250' of the access route/road will be on NPS property and on the existing PPL ROW. Approximately only one-half of the crane pad for the new transmission structure B17-2A will be on the NPS property and within the existing PPL ROW. The associated access route/road to this structure already exists and is utilized for routine maintenance of the existing transmission line.)
>
> River Road to existing structure 37-3 and to proposed new transmission structure B17-3 (Note: This proposed new transmission structure and its associated access route/road are not on NPS property. The access route/road, its crane pad and new transmission structure B17-3 are identical to those for the proposed route originally submitted by the applicants. The associated access route/road to this structure already exists and is utilized for routine maintenance of the existing transmission line. However, approximately only one-half of the crane pad for the new transmission structure B17-3 will be on the NPS property and within the existing PPL ROW.)
>
> Community Drive to existing structure 38-1 and to proposed new transmission structure B17-3A. (Note: This new transmission structure, B17-3A, its crane pad and its associated access route/road are all on NPS property. The crane pad for the new transmission structure B17-3A

will be on the NPS property and within the existing PPL ROW. The associated access route/road to these structures already exists and is utilized for routine maintenance of the existing transmission line.)

Page 1 also identifies the "New Preferred Route" as a dashed yellow line, as noted in the Legend. Specifically identified is the access route/road off of:

> Community Drive to existing structure 38-1 and to proposed new transmission structure B17-4. (Note: Page 1 only shows the initial portion of a USFWS preferred access route/road that the applicants are currently planning to utilize. This new access route/road is on NPS property. The applicants are currently planning to utilize this access route/road as a result of an onsite investigation and consultation with the PA FBC and USFWS that occurred subsequent to the applicants' original submittal. This new preferred route will help further minimize any potential bog turtle issues as identified by the PA FBC and USFWS. Additionally, the removal of a stream crossing grate on the existing proposed access route/road by NPS personnel subsequent to the applicants' original submittal, further supports the use of this new preferred access route/road.)

Page 2 identifies an "Existing Alternate Route" as a dotted yellow line, as noted in the Legend (The same as page 1.). Specifically identified are the access routes/roads from:

> Proposed new transmission structure B17-4 to proposed new transmission structure B17-5. (Note: This proposed new transmission structures and its associated access route/road are all on NPS property. The access route/road, new transmission structures B17-4 and B17-5, and associated crane pads are identical to those for the proposed route submitted by the applicants. The associated access route/road between these structures already exists and is utilized for routine maintenance of the existing transmission line.)
>
> Proposed new transmission structure B17-5 to existing transmission structure 38-3. (Note: This proposed new transmission structure and its associated access route/road are all on NPS property. The associated access route/road between these structures already exists and is utilized for routine maintenance of the existing transmission line.)
>
> Existing transmission structure 38-3 to proposed new transmission structure B17-5A. (Note: This proposed new transmission structure and its associated access route/road are all on NPS property. The access route/road between the existing structure and the proposed new transmission structure B17-5A is identical to the proposed route submitted by the applicants. The associated access route/road between these structures already exists and is utilized for routine maintenance of the existing transmission line.)
>
> Proposed new transmission structure B17-5A to proposed new transmission structure B17-6 and existing transmission structure 38-4. (Note: This proposed new transmission structures and its associated access route/road are all on NPS property. The access route/road, the new transmission structure B17-6 and its associated crane pad are identical to those for the proposed route submitted by the applicants. The associated access route/road between these structures already exists and is utilized for routine maintenance of the existing transmission line.)

Page 2 also identifies a "New Preferred Route" as a dashed yellow line, as noted in the Legend. Specifically identified is the remaining section of the access route/road off of:

> Community Drive to existing structure 38-2 and to proposed new transmission structure B17-4. (Note: Page 2 only shows the final portion of a USFWS preferred access route/road that the applicants are currently planning to utilize. As stated above, this new access route/road is on NPS property. The applicants are currently planning to utilize this access route/road as a result of an onsite investigation and consultation with the USFWS that occurred subsequent to the applicants' original submittal. This new preferred route will help further minimize any potential Bog Turtle issues as identified by USFWS. Additionally, the removal of a stream crossing grate on the existing proposed access route/road by NPS personnel subsequent to the applicants' original submittal, further supports the use of this new preferred access route/road.)

Transmission Structure Locations

The document titled "DEWA_existing_ROW_Alternative_12142009.pdf" identifies the proposed transmission structures for the existing 100' ROW alternative.

Page 1 identifies the approximate location of each "Existing Transmission Structure" as an orange box, as noted in the Legend. Specifically identified are two existing transmission structures currently on NPS property.

Page 1 also identifies the approximate location of each "Proposed Transmission Structure" as red box, as noted in the Legend. Specifically identified on page 1 are:

- B17-3A (Note: This is an additional structure on NPS property that would be needed to support the existing 100' ROW design and operations. All other proposed transmission structures on page 1 are not on NPS property.)

Page 2 identifies the approximate location of each "Existing Transmission Structure" as an orange box, as noted in the Legend (same as page 1). Specifically identified are three existing transmission structures currently on NPS property.

Page 2 also identifies the approximate location of each "Proposed Transmission Structure" as red box, as noted in the Legend (same as page 1). Specifically identified on page 2 are:

- B17-4 (Note: This proposed transmission structures on NPS property and its location are identical to the same transmission structure for the proposed route submitted by the applicants.)

- B17-5 (Note: This proposed transmission structures on NPS property and its location are identical to the same transmission structure for the proposed route submitted by the applicants.)

- B17-5A (Note: This is an additional structure on NPS property that would be needed to support the existing 100' ROW design and operations. All other proposed transmission structures on page 1 are not on NPS property.)

- B17-6 (Note: This proposed transmission structures on NPS property and its location are identical to the same transmission structure for the proposed route submitted by the applicants.)

Transmission Structure Heights

The document titled "Blowout Rev2.pdf" is the Finite Element Sag Tension Report. Page 11 of this report has a plan and profile of the existing 100' ROW alternative. The respective height and elevation of each structure is noted on this page.

Summary of information in document "Blowout Rev2.pdf" follows:

- B17-3A: "ht =184.01 ele = 528.00"
- B17-4: "ht =184.01 ele = 533.00"
- B17-5: "ht =184.01 ele = 509.00"
- B17-5A: "ht =184.01 ele = 695.00"
- B17-6: "ht =184.01 ele = 532.00"

Transmission Line Spans:

The document titled "Blowout Rev2.pdf" is the Finite Element Sag Tension Report. Page 11 of this report has a plan and profile of the existing 100' ROW alternative. The respective span between each structure is noted on this page.

Summary of information in document "Blowout Rev2.pdf" follows:

- B17-2 to B17-2A: "417.58"
- B17-3 to B17-3A: "573.51""
- B17-3A to B17-4: "1058.11"
- B17-4 to B17-5: "587.82" (Note: Same as Applicants' proposed route.)
- B17-5 to B17-5A: "528.21"
- B17-5A to B17-6: "749.86"

Transmission Structure Crane Pads:

The document titled "DEWA_existing_ROW_Alternative_12142009.pdf" identifies the proposed transmission structure crane pads for the existing 100' ROW alternative.

Summary of information in document "DEWA_existing_ROW_Alternative_12142009.pdf" follows:

Page 1 identifies the approximate location of each "Crane Pad" as a gray rectangle, as noted in the Legend. Specifically identified on page 1 are:

- B17-2A crane pad (Note: This additional crane pad, a portion (approximately one-half) of which is on NPS property and entirely located within PPL's existing ROW, would be needed to support the existing 100' ROW design and construction.)

- B17-3 crane pad (Note: This is crane pad, a portion (approximately one-half) of which is on NPS property and entirely located within PPL's existing ROW would the same as the same one that would be utilized for the Applicants' original proposed route.)

- B17-3A (Note: This additional crane pad, located entirely on NPS property and PPL's existing ROW, would be needed to support the existing 100' ROW design and construction.)

Page 2 identifies the approximate location of each "Crane Pad" as gray rectangle, as noted in the Legend (same as page 1). Specifically identified on page 2 are:

- B17-4 crane pad (Note: This crane pad, located entirely on NPS property and within the existing PPL ROW, would be the same as the one that would be utilized for the Applicants' original proposed route.)

- B17-5 crane pad (Note: This crane pad, located entirely on NPS property and within the existing PPL ROW, would be the same as the one that would be utilized for the Applicants' original proposed route.)

- B17-5A crane pad (Note: This additional crane pad, located entirely on NPS property and within the existing PPL ROW, would be needed to support the existing 100' ROW design and construction.)

- B17-6 crane pad (Note: This is crane pad, located entirely on NPS property and within the existing PPL ROW, would be the same as the one that would be utilized for the Applicants' original proposed route.)