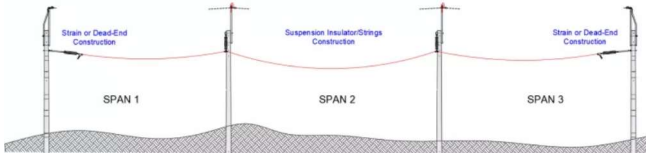


CATENARY SAG-TENSION CALCULATOR (by: Jared Cuchapin, 2018)



References:

1. NS220 Overhead Design Manual
2. RUS Bulletin 1724E-200
3. Overhead Power Line Design – F. Kiessling, P. Nefzger, J.F. Nolasco and U. Kaintzyk
4. Principles of Power System – K. Mehta

1. LINE CHARACTERISTICS

	Variable Symbol	Value	Unit	
Span Length (Ruling Span)	S	200	m	<i>Important: Creep is not considered in the calculation.</i>
Conductor Name		Condor		
Conductor Size		*795		
Stranding		*54/7		
Diameter	dia	0.027760845	m	
Cross-sectional Area	A	0.0004548	m ²	
Final Modulus of Elasticity	E	59000000000	N/m ²	
Coefficient of Linear Thermal Expansion	alpha	0.0000193	/deg C	
Unit Weight	W.1	14.98140393	N/m	
Ultimate Tensile Strength	RTS	127084.0909	N	

2. LOADING CONDITIONS: NESC RULE 250C (EXTREME WIND)

Initial Loading	(These are the conditions when the conductor was first strung.)		
Initial Horizontal Tension	H.1	31,771.02	N
Initial Conductor Temperature	t.1	15	deg C

Final Loading	(These are the conditions where conductor will be subjected to wind, ice or max temperature.)		
1. Thermal Load			
Conductor Temperature @ final loading	t.2	15	deg C
2. Wind Load			
Wind Pressure	P	2189.7	Pa (N/m ²)
Additional Conductor Weight due to wind	W.wind	60.788	N/m
3. Ice Load			
Ice Thickness	t	0	m
Ice Density	density	915	kg/m ³
Additional Conductor Weight due to ice	W.ice	0.000	N/m

TOTAL EFFECT OF ICE AND WIND

$$W_{ice} = \text{Volume} \times \text{density} = \rho_{ice} \pi t (D + t)$$

$$W_{wind} = P_{wind} (D + 2t)$$

$$W_{total} = \sqrt{(W + W_{ice})^2 + (W_{wind})^2}$$

EFFECT OF ICE EFFECT OF WIND

NESC "k" constant	k	0.000	kg/m
Resultant Conductor Weight	W.2	62.607	N/m
Blowout Angle	theta	1.329	radians 76.194 degrees

3. CALCULATION OF FINAL HORIZONTAL TENSION

(Note: Please review the fundamental concepts of the sag-tension to understand the foregoing equations. This is the link to my website.) https://electricalengineerresources.com/engineering_guides/

CONDUCTOR STATE CHANGE EQUATION

$$H_2^3 + H_2^2 \left(\frac{(W_1 S)^2 AE}{24 H_1^2} - H_1 + (t_2 - t_1) \alpha AE \right) - \frac{(W_2 S)^2 AE}{24} = 0$$

ANOTHER FORM OF CSCE:

$$H_2^3 + A H_2^2 - B = 0 \quad \text{where:} \quad B = (W_2 S C_1)^2 \quad C_2 = \alpha EA$$

$$A = C_2 (t_2 - t_1) + \left(\frac{W_1 S C_1}{H_1} \right)^2 - H_1 \quad C_1 = \sqrt{\frac{EA}{24}}$$

Coefficients:

_A	-21826.96003
_B	1.75293E+14
_C1	1057.378835
_C2	517.88076

$H_2^3 + A H_2^2 - B = 0$	0	>>>>>>>>>>
Final Horizontal Tension H.2	64,267.534	Newtons

Note: To solve the cubic equation, you have 2 options
1) MANUALLY: use the "goalseek" command of excel.
 See Manual.

OR
 2) AUTOMATICALLY: Enable macro and click the button on the left. Trust me, there no hidden virus in the file.

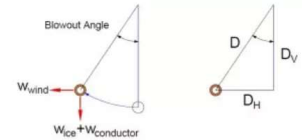
STOP! Do not proceed to "results summary" until "goalseek" have been performed.

RESULTS SUMMARY:

Sags:

Initial Conductor Sag	D.1	2.358	m
Final Conductor Sag	D.2	4.875	m
Horizontal Sag	HD.1	4.733	m
Vertical Sag	VD.2	1.166	m

Difference	(Negative value represents Cold Uplift.)
2.52	meters
8.26	feet



TOTAL EFFECT OF ICE AND WIND

Conductor Lengths:

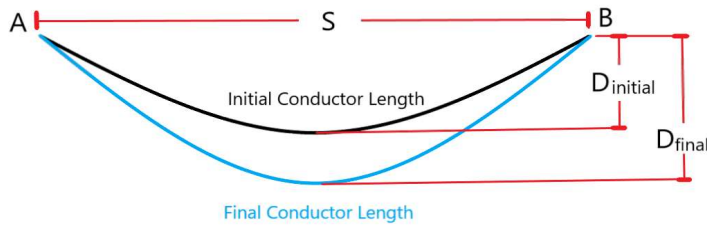
Initial Conductor Length	L.1	200.074	m
Final Conductor Length	L.2	200.316	m

Tensions:

Initial Horizontal Tension	H.1	31,771.02	Newtons
Initial Tension @ supports	T.1	31,806.35	Newtons
Final Horizontal Tension	H.2	64,267.53	Newtons
Final Tension @ supports	T.2	64,572.72	Newtons

25% of Rated Tensile Strength

51% of Rated Tensile Strength



$$\text{Cond. LENGTH: } L = S \left[1 + \frac{S^2 W^2}{24H^2} \right]$$

$$\text{SAG: } D = \frac{H}{W} \left[\cosh \frac{SW}{2H} - 1 \right]$$

$$T_{\text{average at supports (same level)}} = H + WD$$