

Southdale Rd - 11kV 3 phase reconductor - design report - 2023



LineSmarts Ltd

Approvals

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Approved by			

Version History

Version	Date	Author	Description
1	12/06/2023	CNR	First issue

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2 SCOPE AND GENERAL

2.1 SCOPE

In this project the existing single phase 11kV circuit along Southdale Rd will be reconducted with Fluorine AAAC conductor, in the section of line between structures 78602 and 101212. The support 78602 is currently an intermediate pole but will be converted into a strain pole to allow the rebuild of the line in the next section as part of another project.

In accordance with the networks requirements the line should be designed for a design working life of 50 years, a line security level of II and a maximum operating temperature of 50°C.

3 KEY INFORMATION

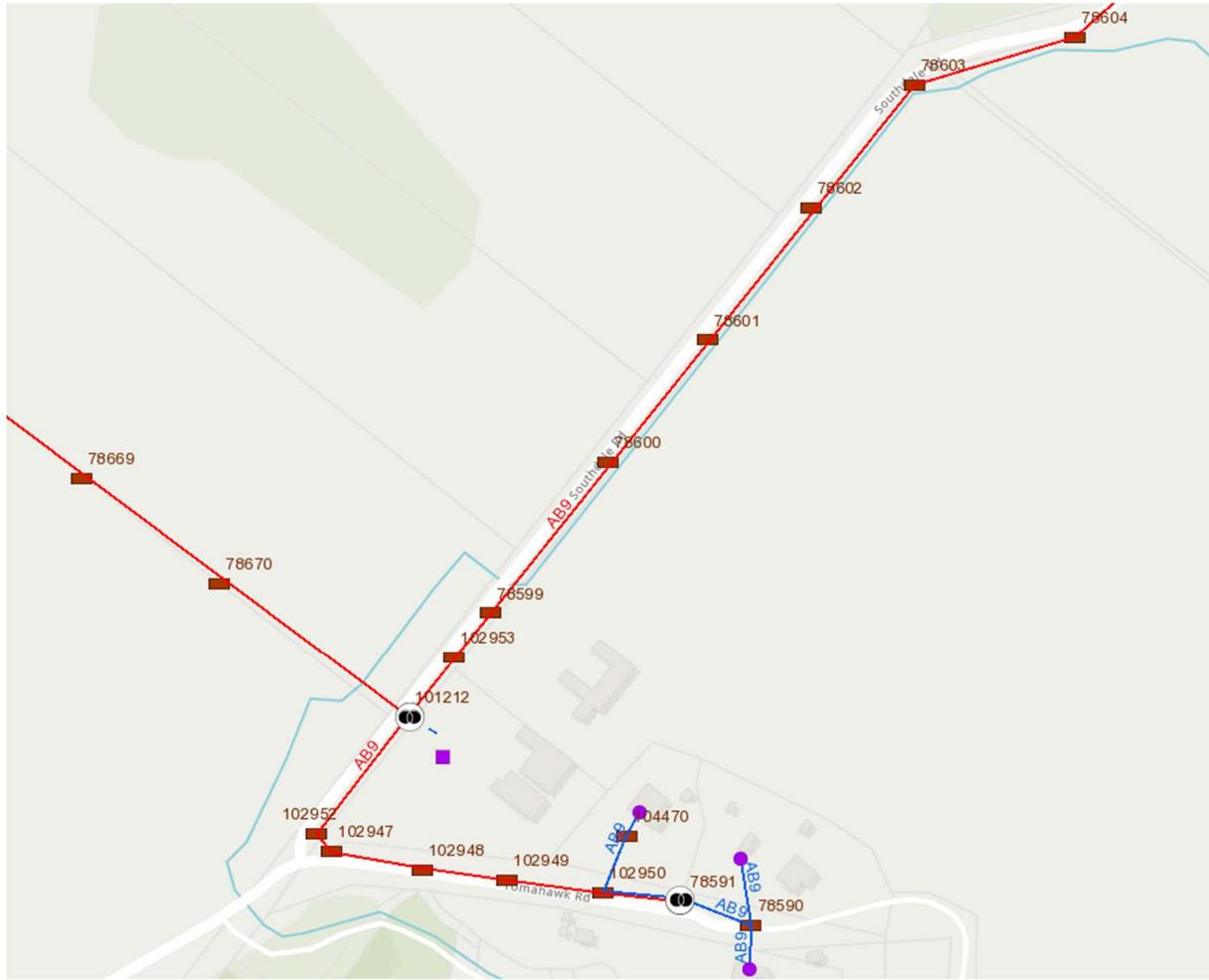
Spans lengths, attachment heights and turnoff angles were measured using Axonic on 30/05/2023.

3.1 SPAN AND SUPPORT PARAMETERS

	Attachment height (m)	Structure type	Turn off angle (°)
78603	7.32	Strain	
78602	7.53	Intermediate	2
78601	7.11	Intermediate	
78600	6.96	Intermediate	
78599	6.99	Intermediate	
102953	9.3	Intermediate	
101212	9.64	Strain	
102952	9.77	Strain	

Structure from	Structure to	Span length (m)
78603	78602	76.8
78602	78601	79.6
78601	78600	74
78600	78599	90.7
78599	102953	25.2
102953	101212	39.9
101212	102952	69.9

3.2 GIS INFORMATION



3.3 KEY DESIGN PARAMETERS

- The line is located 250m-700m from the coast with an elevation of approximately 5m above sea level
- Wind region = NZ2 (Figure 3.1 (B) of AS/NZS1170.2:2021)
- Design working life = 50 years
- Line Security level = II
- Minimum design wind return period = 100 years (Table 6.1 AS/NZS7000:2016)
- Regional wind speed 42m/s (Table 3.1 (B) of AS/NZS1170.2:2021)
- Wind direction multiplier = 1.0 (for NW direction Table 3.2(B) AS/NZS1170.2:2021)
- Terrain category 2 (TC2) in accordance with section 4.2 of AS/NZS1170.2:2021
- Terrain/height multiplier = 1.0 (Conservative for $M_{z,cat}$ Table 4.1 AS/NZS1170.2:2021)
- Snow and ice region = N4 (Figure DD1 AS/NZS7000:2016)
- Snow radial thickness = 30mm (Figure DD4 AS/NZS7000:2016)
- Ice radial thickness = 15mm (Figure DD4 AS/NZS7000:2016)

$$V_z = V_{RP} \times M_d \times M_{z,cat} \times M_s \times M_t \times M_c \text{ (Eqn B1 AS/NZS7000:2016)}$$

$$V_z = 42 \times 1.0 \times 1.0 \times 1.0 \times 1.0 \times 1.0$$

$$V_z = 42\text{m/s}$$

The design wind pressure:

$$q_z = 0.6 \times 42^2 = 1,058\text{Pa (Eqn B4 AS/NZS7000:2016)}$$

The wind will be dominated by Downdraft winds so the span reduction factor will be 1.0 for the span lengths in this project.

The snow and ice distributed loads are calculated using the 'Snow and ice loading on wires calculation tool v7' downloadable from the Module C of the Principles micro-credential as shown below:

Snow load calculation

Gravitational acceleration constant	g	9.806	m/s ²	
Weight span	L _v	70	m	
Altitude		5	m	
Line security level	LSL	II		Section 6.2.2
Design working life	N	50 years		Section 6.2.7
Snow and ice region		N4		Figure DD1
Conductor type		Flourine		Data stored in Tables tab
Conductor diameter	d _c	9	mm	
Conductor unit mass including covering or insulation	m	0.14	kg/m	
Snow radial thickness	r _s	30	mm	Table DD4
Ice thickness	r _i	15	mm	Table DD4
Snow density	ρ _s	400	kg/m ³	Table DD4
Ice density	ρ _i	700	kg/m ³	Table DD4
Reliability multiplier for snow and ice loads	M _{rel}	1		Table DD3
Snow and Ice conductor self-weight load factor	γ _c	1.25		Table 7.1
Snow area	A _s	3,676	mm ²	(Note that equation R6 is incorrect in the standard)
Ice area	A _i	1,131	mm ²	(Note that equation R6 is incorrect in the standard)
Snow distributed load	S _v	14.4	N/m	A _s is divided by 1000000 to convert from mm ² to m ²
Ice distributed load	I _v	7.8	N/m	A _i is divided by 1000000 to convert from mm ² to m ²
Conductor unit weight	G _c	1.4	N/m	
Combined snow and conductor distributed load	W _{vs}	16.1	N/m	
Combined ice and conductor distributed load	W _{vi}	9.5	N/m	
Combined snow and conductor support vertical load	V _s	1.1	kN	(per conductor)
Combined ice and conductor support vertical load	V _i	0.7	kN	(per conductor)

4 CONDUCTOR DESIGN

4.1.1 Vibration design

Calculating the maximum recommended conductor tension for AAAC Fluorine conductor in accordance with Appendix Y of AS/NZS7000:2016.

- Base horizontal tension = 15%
- Static stress - Clamp category = Type B (Post with armour rods) = 1.5%
- Dynamic stress - No damper Terrain category = 2 = 2%

Recommended maximum tension = 15 + 1.5 + 2 = 18.5%

If dampers were used the Dynamic stress factor could be 6.5%, therefore the maximum recommended tension would be as follows:

Recommended maximum tension = 15 + 1.5 + 6.5 = 23%

The design will process on the assumption that dampers will not be used.

4.1.2 Ground clearances

The ground is flat and along Southdale road. Therefore in accordance with NZECP34 Table 4, for 11kV, a vertical ground clearance of 6.5m must be maintained.

Under the extreme circumstances during which the design snow load can be expected to accumulate the vertical ground clearance for non-traversable ground, 4.5m may be considered.

A spreadsheet calculation using 'Line design tool 2023-06-13' indicates that even tensioned at 18.5% of CBL three spans are below the required 1.5m of clearance as shown below.

Line loading schedule																
		Tip load point below top		0.1	m											
		Conductor material strength multiplier		0.9	Tbl 4.1AS/NZS7000:2016											
		Conductor separa		0.4	Equation 3.1AS/NZS7000:2016											
Circuit	Structure ID	Ahead span	Support height difference	Turnoff Angle	Function	Number of phases	Attachment height	Pole height above ground	Ground clearance						Infringement	
									Max temp	Maintenance	Min temp	Max temp	Max wind	Ice		Snow
		L	h													
		m	m				m	m								
	78602	79.6	0	0	Strain	3	7.53	7.63	6.04	6.77	6.92	7.04	5.86	5.40		-0.46
	78601	74	0	0	Intermediate	3	7.11	7.21	5.93	6.56	6.69	6.80	5.77	5.37		-0.57
	78600	90.7	0	0	Intermediate	3	6.96	7.06	5.31	6.26	6.46	6.62	5.08	4.48		-1.19
	78599	25.2	0	0	Intermediate	3	6.99	7.09	8.02	8.09	8.10	8.12	8.00	7.95		1.52
	102953	39.9	0	0	Intermediate	3	9.3	9.4	9.15	9.33	9.37	9.40	9.10	8.99		2.65
	101212		0	0	Strain	3	9.64	9.74								
Circuit	Section	Conductor type	Creep temperature adjustment	Design temperature	Design tension (final)	Voltage	Ruling span	Calculated breaking load								
			t _c	t _d	H _d	Voltage	L _R	CBL								
			°C	°C	%CBL	kV	m	kN								
1		FLOURINE	10	10	18.5%	11.0	75	11.8								

Even using an ACSR at a higher tension will not resolve the clearance issue as shown below:

Line loading schedule																
		Tip load point below top		0.1	m											
		Conductor material strength multiplier		0.9	Tbl 4.1AS/NZS7000:2016											
		Conductor separa		0.4	Equation 3.1AS/NZS7000:2016											
Circuit	Structure ID	Ahead span	Support height difference	Turnoff Angle	Function	Number of phases	Attachment height	Pole height above ground	Ground clearance						Infringement	
									Max temp	Maintenance	Min temp	Max temp	Max wind	Ice		Snow
		L	h													
		m	m				m	m								
	78602	79.6	0	0	Strain	3	7.53	7.63	6.32	6.86	6.97	7.01	6.27	5.91		-0.16
	78601	74	0	0	Intermediate	3	7.11	7.21	6.17	6.63	6.73	6.77	6.12	5.81		-0.33
	78600	90.7	0	0	Intermediate	3	6.96	7.06	5.68	6.37	6.52	6.57	5.61	5.14		-0.82
	78599	25.2	0	0	Intermediate	3	6.99	7.09	8.05	8.10	8.11	8.11	8.04	8.00		1.55
	102953	39.9	0	0	Intermediate	3	9.3	9.4	9.22	9.35	9.38	9.39	9.21	9.12		2.72
	101212		0	0	Strain	3	9.64	9.74								
Circuit	Section	Conductor type	Creep temperature adjustment	Design temperature	Design tension (final)	Voltage	Ruling span	Calculated breaking load								
			t _c	t _d	H _d	Voltage	L _R	CBL								
			°C	°C	%CBL	kV	m	kN								
1		MINK	10	10	24.0%	11.0	75	21.4								

Therefore to make this design work at least two poles will need to be replaced with taller poles. It is proposed to replace pole 78601 with an 11m Busck and pole 78599 with a 12.5m Busck as shown below.

Line loading schedule										Top hole height above GL (m)	Attachment height above GL (m)	
Tip load point below top		0.1	m							11.0m Busck	9.124	9.366
Conductor material strength multiplier		0.9		Tbl 4.1 AS/NZS 7000:2016						12.5m Busck	10.298	10.54
Conductor separation		0.4		Equation 3.1 AS/NZS 7000:2016								

Circuit	Structure ID	Ahead span	Support height difference	Turnoff Angle	Function	Number of phases	Attachment height	Pole height above ground	Ground clearance						Infringement		
									Max temp	Maintenance	Min temp	Max wind	Ice	Snow		Max temp	
		L	h						Max temp								
		m	m				m										
	78602	73.6	0	0	Strain	3	7.53	7.63	6.87	7.67	7.89	8.14	6.82	6.38	0.37		
	78601	74	0	0	Intermediate	3	3.366	3.466	6.80	7.43	7.68	7.90	6.75	6.37	0.30		
	78600	90.7	0	0	Intermediate	3	6.96	7.06	6.70	7.74	8.02	8.35	6.63	6.06	0.20		
	78599	25.2	0	0	Intermediate	3	10.54	10.64	9.76	3.84	3.86	3.89	3.76	3.71	3.26		
	102953	39.9	0	0	Intermediate	3	9.3	9.4	9.07	3.27	3.33	3.39	3.06	8.95	2.57		
	101212		0	0	Strain	3	9.64	9.74									

Circuit	Section	Conductor type	Creep temperature adjustment	Design temperature	Design tension (final)	Voltage	Ruling span	Calculated breaking load
			t _c	t _d	H _L	Voltage	L _p	CBL
			°C	°C	%CBL	kV	m	kN
1		FLOURINE	10	10	12.0%	11.0	75	11.8

By using these taller poles a lower tension of 12% UTS can be used in the Flourine conductor.

4.1.3 Internal clearances

A check of the internal clearances was also made in the 'Line design tool 2023-06-13' spreadsheet showing that the phase spacing is adequate.

Line loading schedule										Section 3.7.3		
Tip load point below top		0.1	m									
Conductor material strength multiplier		0.9		Tbl 4.1 AS/NZS 7000:2016								
Conductor separation		0.4		Equation 3.1 AS/NZS 7000:2016								

Circuit	Structure ID	Ahead span	Support height difference	Turnoff Angle	Function	Number of phases	Attachment height	Pole height above ground	Vertical spacing	Horizontal spacing	Phase spacing utilisation
		L	h								
		m	m				m	m	m	m	%
	78602	73.6	0	0	Strain	3	7.53	7.63	1	0	38%
	78601	74	0	0	Intermediate	3	7.11	7.21	1	0	38%
	78600	90.7	0	0	Intermediate	3	6.96	7.06	1	0	38%
	78599	25.2	0	0	Intermediate	3	6.99	7.09	1	0	38%
	102953	39.9	0	0	Intermediate	3	9.3	9.4	1	0	38%
	101212		0	0	Strain	3	9.64	9.74	1	0	

4.1.4 Tension utilisation

A check of conductor tension utilisation was also made in the 'Line design tool 2023-06-13' spreadsheet showing the utilisations to be low under all load cases.

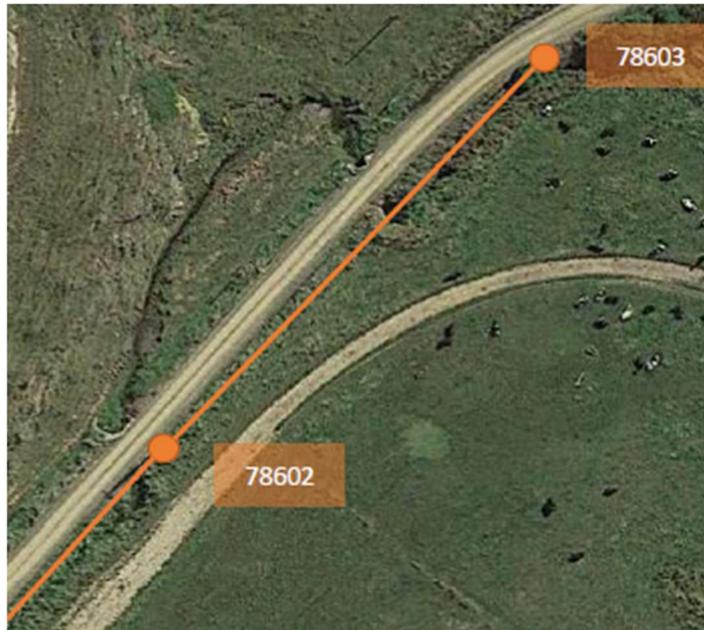
Line loading schedule															
		Tip load point below top	0.1	m											
		Conductor material strength multiplier	0.3	Tbl 4.1 AS/NZS 7000:2016											
		Conductor separation	0.4	Equation 3.1 AS/NZS 7000:2016											
Circuit	Structure ID	Ahead span	Support height difference	Turnoff Angle	Function	Number of phases	Attachment height	Pole height above ground	Sag						
									Max temp	Maintenance	Min temp	Max wind	Ice	Snow	
		L	h						m						
		m	m				m	m							
	78602	79.6	0	0	Strain	3	7.53	7.63	1.00	0.46	0.35	0.31	1.05	1.41	
	78601	74	0	0	Intermediate	3	7.11	7.21	0.86	0.40	0.30	0.27	0.91	1.22	
	78600	90.7	0	0	Intermediate	3	6.36	7.06	1.29	0.60	0.46	0.41	1.37	1.83	
	78599	25.2	0	0	Intermediate	3	6.39	7.09	0.10	0.05	0.04	0.03	0.11	0.14	
	102953	39.9	0	0	Intermediate	3	9.3	9.4	0.25	0.12	0.09	0.08	0.26	0.35	
	101212		0	0	Strain	3	9.64	9.74							
Circuit	Section	Conductor type	Creep temperature adjustment	Design temperature	Design tension (final)	Voltage	Ruling span	Calculated breaking load	Utilisation						
									Max temp	Maintenance	Min temp	Max wind	Ice	Snow	
			t _a	t _d	H _d	Voltage	L _R	CBL							
			°C	°C	%CBL	kV	m	kN							
1		MINK	10	10	24.0%	11.0	75	214	10.4%	33.7%	32.6%	41.7%	40.1%	47.4%	

5 CONSTRUCTION AND MAINTENANCE

It is envisaged that the conductor drum can be positioned just south of pole 101212 where there is a relatively flat grassy area behind the pole as shown in the image below:



The other end of the section of line beside structure 78602 is narrower and provides less room to manoeuvre for vehicles and for positioning equipment.



6 DESIGN REFERENCES

Design component	Design reference document/s
Span and span support details	<ul style="list-style-type: none"> • Southdale Rd - Survey 2023-06-15.xls • Axonic measurements
Snow loading calc	<ul style="list-style-type: none"> • Snow and ice loading on wires calculation tool v7.xls
Ground clearances	<ul style="list-style-type: none"> • Line design tool 2023-06-13.xls
Internal clearances	<ul style="list-style-type: none"> • Line design tool 2023-06-13.xls
Tension utilisation	<ul style="list-style-type: none"> • Line design tool 2023-06-13.xls
Stringing table	<ul style="list-style-type: none"> • Southdale Rd - Stringing table 20220727.xls
Plans	<ul style="list-style-type: none"> • Southdale Rd - Deliverables 2023-06-15.xls
Conductor material	<ul style="list-style-type: none"> • Southdale Rd - Deliverables 2023-06-15.xls
Pole material	<ul style="list-style-type: none"> • Southdale Rd - Deliverables 2023-06-15.xls

7 SANITY CHECKS

In this section checks have been completed using Neara software to validate the design.

Line security level	II	AS/NZS7000:2010 6.2.2
Design working life	50 years	AS/NZS7000:2010 Table 6.1
Wind region	A7	AS/NZS 1170.2:2002 Figure 3.1
Snow region	N4	AS/NZS7000:2010 Figure EE1, AS/NZS1170.3:2003 Figure 2.1
Altitude	5	(m)
Proximity to coast	5km-200km	AS/NZS7000:2010 EE3.3
Terrain category	2	AS/NZS 1170.2:2002 Section 4.2
Shielding multiplier (Ms)	1	AS/NZS 1170.2:2002 Section 4.3
Topographic multiplier (Mt)	1	AS/NZS 1170.2:2002 Section 4.4
Conductor drag coefficient	1	HB331:2012 Table 3.1
Pole drag coefficient	1	HB331:2012 Table 3.1
Equipment drag coefficient	1.5	HB331:2012 Table 3.1
Average temperature for coldest month	5	HB331:2012 Table 7.2
Average ambient temperature for year	10	HB331:2012 Table 7.2

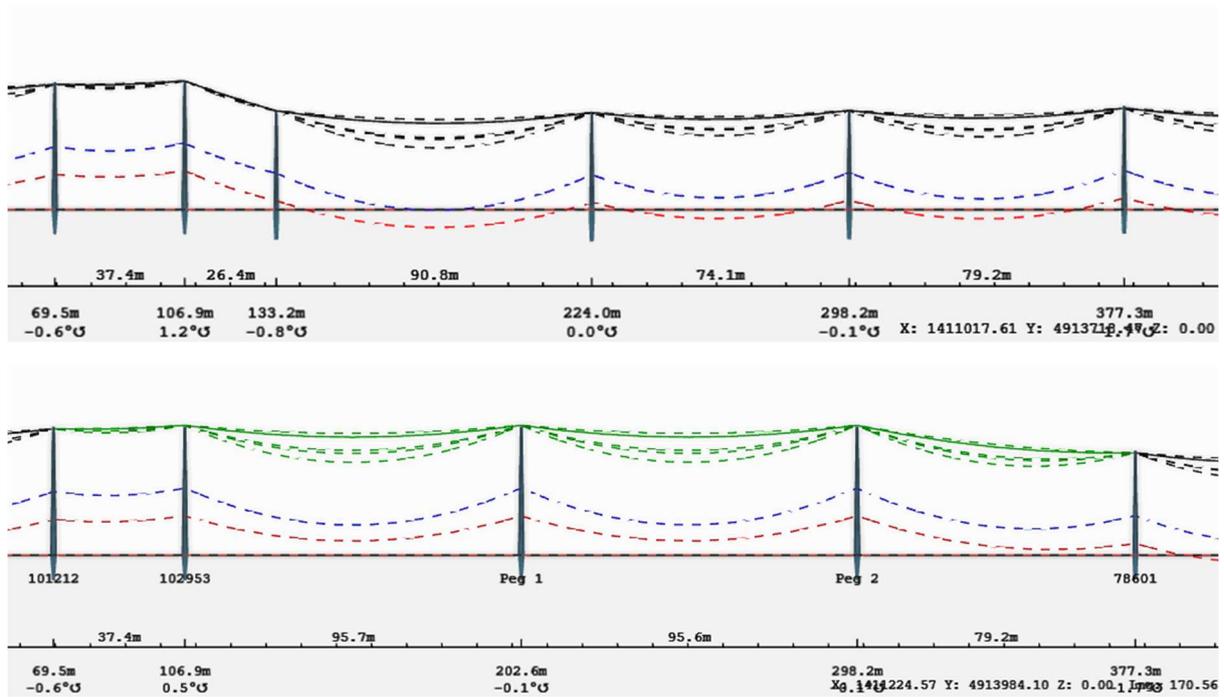
Cancel Apply

General		Conditions				Load Factors				Behavior				Enabled			
Name	Description	Temp (°C)	Wind		Ice/Snow		Cables		Structure		Strength	Creep	Account For				
			Pressure (Pa)	Gust Factor	Radial Thickness (mm)	Density (kg/m ³)	Ft Longitudinal	Fc Transverse	Gc Vertical	Wn Weir	Gs Self-Load			Pole	Plant	Construction	
everyday	Everyday	C > 10	0	0	None	0	0	1.1	1	1.25	1	1.1	service	M+W	M+W	M+W	
max-wind-s	Maximum Wind and maximum weight	C > 10	1037	1037	None	0	0	1.25	1	1.25	1	1.1	strength	M+W	M+W	M+W	☑
max-wind-r	Maximum Wind and minimum weight	C > 10	1037	1037	None	0	0	1.25	1	0	1	0.9	strength	M+W	M+W	M+W	☑
max-wind-snow	Maximum Wind and uplift	C > 10	1037	1037	None	0	0	1.25	1	1.25	1	0.9	strength	M+W	M+W	M+W	☑
snow	Snow	C > 0	0	0	None	30	400	1.1	1	1.25	1	1.1	strength	M+W	M+W	M+W	☑
ice	Ice	C > -5.0	0	0	None	15	700	1.1	1	1.25	1	1.1	strength	M+W	M+W	M+W	☑
wind-ice	Combined Wind and Ice	C > -5.0	0	0	None	0	700	1.1	1	1.25	1	1.1	strength	M+W	M+W	M+W	☑
fail-contain	Failure containment	C > 10	259.3	259.3	None	0	0	1.25	1	1.25	1	1.1	strength	M+W	M+W	M+W	☑
serv-deflex	Servicability deflection limit	C > 10	0	0	None	0	0	1	1	1.1	1	1.1	service	M+W	M+W	M+W	☑
serv-dama	Servicability damage limit	C > 10	0	0	None	0	0	1	1	1.1	1	1.1	service	M+W	M+W	M+W	☑
maintenan	Construction and Maintenance 1	C > 5	100	100	None	0	0	1.25	1	1.5	1	1.1	strength	M+W	M+W	M+W	☑
maintenan	Construction and Maintenance 2	C > 5	100	100	None	0	0	1.25	1	1.5	1	1.1	strength	M+W	M+W	M+W	☑
earthquak	Earthquake	C > 10	0	0	None	0	0	1.25	1	1.3	1	1	strength	M+W	M+W	M+W	☑
max temp	Maximum temperature	C > 50	0	0	None	0	916.7	1.1	1	1.25	1	1.1	service	M+W	M+W	M+W	☑

Add Environment AS/NZS 7000 Export to CSV Import from CSV Replace from CSV Paste to/from Excel

The design loads are similar to those calculated from Neara, although Neara's tool has not been updated to reflect As/NZS1170.2:2021.

The clearances in Neara also match the calculated values.



The sag tension report in Neara yields the same tension results as the manual calc.

Temperature (°C)	0	5	10	15	20	25	30	35	40	45	50	55
Sag (m)	0.1	0.11	0.13	0.15	0.16	0.18	0.2	0.22	0.24	0.26	0.27	0.29
Horizontal Tension (k)	2.27	2.02	1.79	1.59	1.42	1.27	1.15	1.05	0.97	0.9	0.84	0.79
Time (s)	1.72	1.82	1.94	2.06	2.18	2.3	2.41	2.53	2.63	2.73	2.82	2.91