

Suspension support 1SIS-L2 explanatory note

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1 Field suspension support

This document includes specifications for designing parameters, manufacturing, installation and load forces for the 110 kV suspension support 1SIS-L2.

Support 1SIS-L2 is normal lattice suspension support with narrow body dimensions.

Support heights from foundation top to the lowest crossarm are 19m, 18m, 17m, 16m, 15m, 14m and 13m.

Support designation is done according to the following rules:

- Voltage: 1-110
- Support type: 1SIS-L- Steel Suspension Lattice “I” type tower
- Tower strength label -L2
- Separator
- 110kV lowest crossarm height

Example: 1SIS-L2_19

1.1 Support 1SIS-L maximum span lengths and line angles

Line angle 0°	1SIS-L2 all heights
Ruling span	350 m
Wind span	350 m
Weight span	450 m

2 Design parameters

2.1 Designing standards

Overhead electrical lines exceeding AC 1 kV - Part 1: General requirements - Common specifications EVS-EN 50341-1:2013

Overhead electrical lines exceeding AC 1 kV - Part 2-20: National Normative Aspects (NNA) for ESTONIA (based on EN 50341-1:2012) EVS-EN 50341-2-20:2015

Elering AS design requirements 701 „Projekteerimine“

Elering AS construction requirements 702 „Ehitamine“

Elering AS materials requirements 703 „Materjalid“

2.2 Technical parameters for designing

Reliability class	2
Terrain type	II
Reference wind speed V_b	21 m/s
Reference ice thickness T_{ice}	10 mm
Ice density ρ_{ice}	900 kg/m ³

2.3 Security loads

Supports all security load / broken conductor loads are calculated according to the Elering AS design requirements (701 „Projekteerimine“).

1SIS support is designed to withstand condition where wires of one phases or earth wire are broken in one span and all other phases and earth wires are intact. Conductor loads are calculated at nominal ice load.

The security loads for suspension supports take into account the relaxation of the load resulting from swing of the insulator sets.

2.4 Temperatures

Reference temperature	+5 °C
Maximum ambient temperature	+35 °C
Maximum conductor temperature	+80 °C
Maximum earth wire temperature	+40 °C
Minimum temperature	-40 °C
Temperature at construction cases	-15 °C
Temperature at all other cases	-5 °C

2.5 Phase conductors and earth wires

Phase conductor types:

- 110 kV 3x2x 242-AL1/39-ST1A "Hawk" EDS up to 65 N/mm²

Earth wire type:

- ASLH-V(2S)bb 96 SMF (AL3/A20SA 138/26) EDS up to 90 N/mm²

3 Material and quality requirements for supports

3.1 General

Manufacturer of the support structures shall have factory production control system (FPC) according to the EVS-EN 1090-1 incorporated into the production.

The manufacturing of the steel structures shall be carried out according to the rules set out in the standard EVS-EN 1090-2 and in the reference standards (EN ISO) listed in EVS-EN 1090-2 related to material procurement, execution of works and inspection.

Required execution class for the structures is EXC2. Corresponding requirements for execution can be found in EVS-EN 1090-2 Annex A.3.

3.2 Steel grades

The steel grades and qualities used in the structures shall comply with the standard EVS-EN 10025 for plates and profiles and the standard EVS-EN 10219-1 for cold formed hollow sections. The normal grade is S355.

The steel qualities are:

- Angle bars: S355J0,
- Tubes: S355K2H,
- Plates: S355J2.

3.3 Surface finishing

The galvanizing shall be made according to standard EVS-EN ISO 1461.

- Details with thickness of 3 to 6 mm – minimum 85 µm, average 95±5 µm,
- Details with thickness more than 6 mm - minimum 100 µm, average 115±5 µm.

3.4 Bolts, nuts and washers

Structural bolting assemblies for non-preloaded joints shall conform to EN 15048-1.

Nuts and bolt heads shall be of hexagonal type. The dimensions of the hexagonal bolts (except U-bolts) shall be in accordance with EVS-EN ISO 4014 or DIN 7990. In shear connections the shear force is transmitted through the unthreaded shank of the bolt.

The bolts shall have the minimum mechanical properties specified for property class 8.8 in EVS-EN ISO 898-1.

The dimensions of the nuts shall be in accordance with EVS-EN ISO 4032. The mechanical properties of the nuts shall meet the minimum requirements specified for property class 8 in EVS-EN ISO 898-2 and shall be also in conformity with the strength of the bolt material.

All bolts, nuts and washers shall be hot dip galvanized in accordance with EVS-EN ISO 10684. The minimum thickness of the zinc layer is $45 \pm 5 \mu\text{m}$ (375 g/m^2).

3.5 Welding

The weldings shown on drawings shall fulfill requirements of welding class C standard EVS-EN ISO 5817 unless marked otherwise.

3.6 Tolerances

Tolerances are not marked on drawings but following principles shall be followed:

- Following tolerances can be used:
 - Nominal distance 0 – 2000 mm $\pm 1,0 \text{ mm}$
 - Nominal distance 2000 – 4000 mm $\pm 1,5 \text{ mm}$
 - Nominal distance >4000 mm $\pm 2,0 \text{ mm}$

4 Installation

4.1 Installation materials

Installation materials are typically normal guy ropes, perfomed guy clamps, wedge type clamps, thimbles, bolts, nuts and washers.

Materials used on the structures shall comply with following specifications:

- Steel guy ropes shall be according standard EVS-EN 50189.
- Hexagonal bolts shall be of grade 8.8, nuts shall comply with this.

5.1 Pre-tightening of bolts

The pre-tightening of bolts of property class 8.8 must be carried out in normal bolted connections using torque M_v .

Table 2. Tightening torques of bolts

Bolt	Torque M_v , Nm	Tolerance, Nm
M12	70	± 10
M16	175	± 20
M20	320	± 30
M24 – M36	520	± 40

In bolts or studs going through hollow sections, the tightening torque of the nuts is 20 Nm with double nuts.

Methods used for locking the bolts:

- The bolted connection must always be locked by either breaking the thread by hitting at the base of the nut or by using an extra nut.
- With bolts in tension the locking must always be carried out by using two standard nuts.

5.2 Support erection

Supports are designed to be erected by crane. Depending on the available equipment the support may be lifted as a whole or in multiple sections.

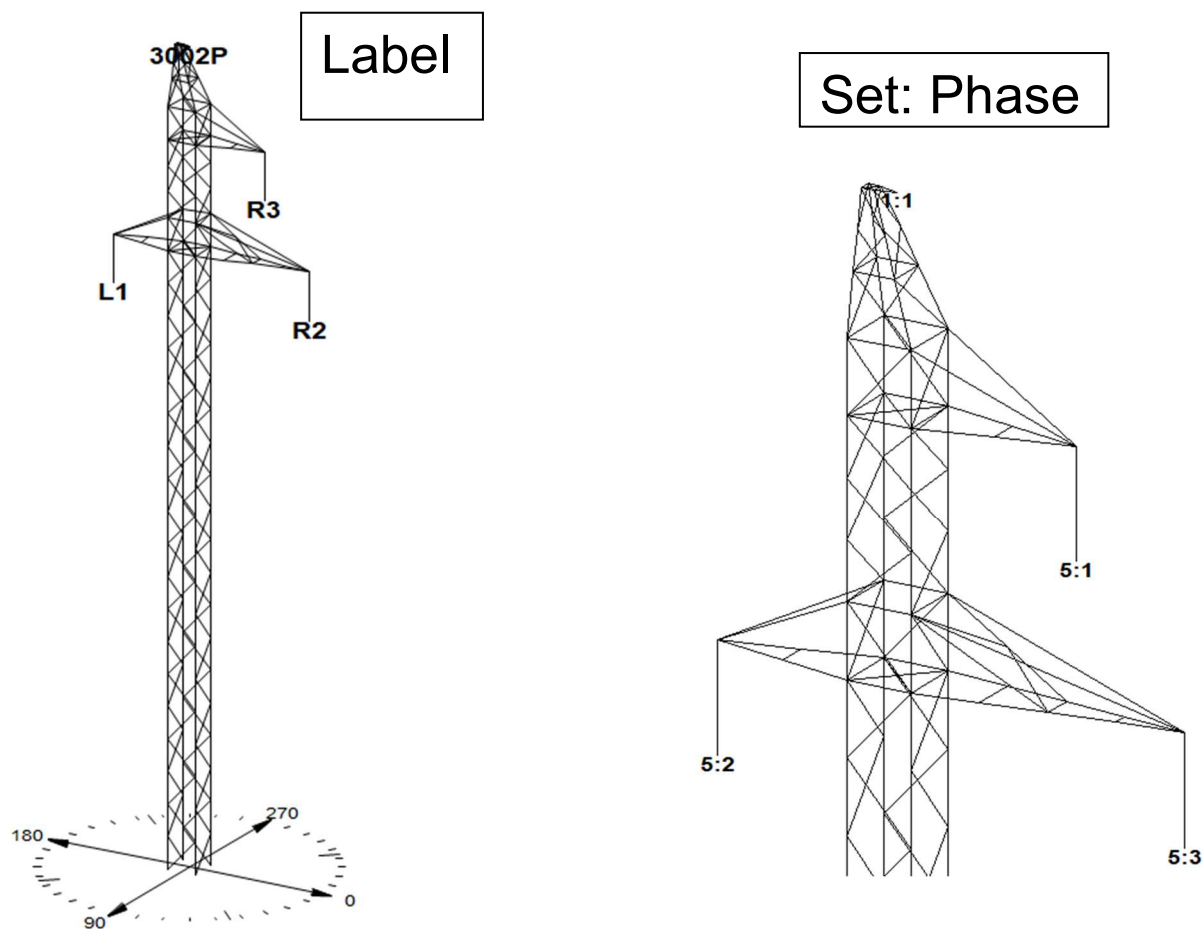
7 Calculation results

7.1 Design software

The conductor tension analyses were made by using the computer program PLSCAD, which was developed in Power Line Systems. The program is designed for the design and analyses of transmission line towers.

Tower modeling and strength analyses were made by using the computer program PLS Tower version 21.01, which was developed in Power Line Systems. The program is designed for the design and analyses of steel towers. Load cases

7.2 Force location points



7.3 Insulator forces and load cases

Row #	Load Case	Insulator Label	Structure Attach Load X (kN)	Structure Attach Load Y (kN)	Structure Attach Load Z (kN)	Structure Attach Load Res. (kN)
1	Tmin,S NA+	EW1	-0.002	-0.009	2.738	2.738
2	Tmin,S NA+	L1	0.321	-0.333	8.887	8.899
3	Tmin,S NA+	R2	0.320	0.138	8.886	8.893
4	Tmin,S NA+	R3	0.318	0.138	8.805	8.812
5	R2 Piirtuulekoormus/Extreme wind load(1a)NA+,S NA+	EW1	0.054	3.804	2.824	4.738
6	R2 Piirtuulekoormus/Extreme wind load(1a)NA+,S NA+	L1	-0.426	8.027	8.996	12.064
7	R2 Piirtuulekoormus/Extreme wind load(1a)NA+,S NA+	R2	-0.380	8.533	8.998	12.406
8	R2 Piirtuulekoormus/Extreme wind load(1a)NA+,S NA+	R3	-0.376	8.532	8.913	12.344
9	R2 Piirjätekoormus+nimituulekoormus/Extreme iceload with nominal wind...,S NA+	EW1	0.024	2.942	6.309	6.961
10	R2 Piirjätekoormus+nimituulekoormus/Extreme iceload with nominal wind...,S NA+	L1	-0.738	5.265	17.249	18.050
11	R2 Piirjätekoormus+nimituulekoormus/Extreme iceload with nominal wind...,S NA+	R2	-0.707	5.915	17.250	18.250
12	R2 Piirjätekoormus+nimituulekoormus/Extreme iceload with nominal wind...,S NA+	R3	-0.705	5.914	17.140	18.146
13	R2 Suur tuulekoormus+nimijätekoormus/H igh wind load with nominal icel...,S NA+	EW1	0.050	3.981	3.814	5.513
14	R2 Suur tuulekoormus+nimijätekoormus/H igh wind load with nominal icel...,S NA+	L1	-0.508	7.701	11.309	13.691
15	R2 Suur tuulekoormus+nimijätekoormus/H igh wind load with nominal icel...,S NA+	R2	-0.464	8.248	11.311	14.007
16	R2 Suur tuulekoormus+nimijätekoormus/H igh wind load with nominal icel...,S NA+	R3	-0.460	8.247	11.219	13.932

17	R2 Piirtuulekoormus/Extreme wind load(1a)NA-,S NA-	EW1	0.056	-3.824	2.824	4.754
18	R2 Piirtuulekoormus/Extreme wind load(1a)NA-,S NA-	L1	-0.362	-8.744	9.000	12.554
19	R2 Piirtuulekoormus/Extreme wind load(1a)NA-,S NA-	R2	-0.410	-8.239	8.998	12.207
20	R2 Piirtuulekoormus/Extreme wind load(1a)NA-,S NA-	R3	-0.407	-8.238	8.913	12.144
21	R2 Piirjätekoormus+nimituulekoormus/Extreme iceload with nominal wind...,S NA-	EW1	0.025	-2.967	6.309	6.972
22	R2 Piirjätekoormus+nimituulekoormus/Extreme iceload with nominal wind...,S NA-	L1	-0.695	-6.186	17.253	18.341
23	R2 Piirjätekoormus+nimituulekoormus/Extreme iceload with nominal wind...,S NA-	R2	-0.728	-5.536	17.250	18.132
24	R2 Piirjätekoormus+nimituulekoormus/Extreme iceload with nominal wind...,S NA-	R3	-0.726	-5.536	17.140	18.027
25	R2 Suur tuulekoormus+nimijätekoormus/H igh wind load with nominal icel...,S NA-	EW1	0.052	-4.003	3.814	5.529
26	R2 Suur tuulekoormus+nimijätekoormus/H igh wind load with nominal icel...,S NA-	L1	-0.447	-8.477	11.314	14.144
27	R2 Suur tuulekoormus+nimijätekoormus/H igh wind load with nominal icel...,S NA-	R2	-0.493	-7.930	11.311	13.823
28	R2 Suur tuulekoormus+nimijätekoormus/H igh wind load with nominal icel...,S NA-	R3	-0.490	-7.929	11.219	13.747
29	R2E Broken Ahead Set 5.1 NA+,S NA+	EW1	0.001	-0.008	3.646	3.646
30	R2E Broken Ahead Set 5.1 NA+,S NA+	L1	-0.087	-0.322	10.977	10.982
31	R2E Broken Ahead Set 5.1 NA+,S NA+	R2	-0.088	0.133	10.976	10.977
32	R2E Broken Ahead Set 5.1 NA+,S NA+	R3	31.802	-0.026	5.343	32.248
33	R2E Broken Ahead Set 5.2 NA+,S NA+	EW1	0.001	-0.008	3.646	3.646
34	R2E Broken Ahead Set 5.2 NA+,S NA+	L1	31.803	0.026	5.343	32.249

35	R2E Broken Ahead Set 5.2 NA+,S NA+	R2	-0.088	0.133	10.976	10.977
36	R2E Broken Ahead Set 5.2 NA+,S NA+	R3	-0.088	0.133	10.898	10.900
37	R2E Broken Ahead Set 5.3 NA+,S NA+	EW1	0.001	-0.008	3.646	3.646
38	R2E Broken Ahead Set 5.3 NA+,S NA+	L1	-0.087	-0.322	10.977	10.982
39	R2E Broken Ahead Set 5.3 NA+,S NA+	R2	31.802	-0.026	5.343	32.248
40	R2E Broken Ahead Set 5.3 NA+,S NA+	R3	-0.088	0.133	10.898	10.900
41	R2E Broken ahead earthwire NA+,S NA+	EW1	19.100	0.000	1.842	19.188
42	R2E Broken ahead earthwire NA+,S NA+	L1	-0.087	-0.322	10.977	10.982
43	R2E Broken ahead earthwire NA+,S NA+	R2	-0.088	0.133	10.976	10.978
44	R2E Broken ahead earthwire NA+,S NA+	R3	-0.088	0.133	10.899	10.900
45	R2E Broken back Set 5.1 NA+,S NA+	EW1	0.001	-0.008	3.646	3.646
46	R2E Broken back Set 5.1 NA+,S NA+	L1	-0.087	-0.322	10.977	10.982
47	R2E Broken back Set 5.1 NA+,S NA+	R2	-0.088	0.133	10.976	10.977
48	R2E Broken back Set 5.1 NA+,S NA+	R3	- 25.470	0.097	5.511	26.059
49	R2E Broken back Set 5.2 NA+,S NA+	EW1	0.001	-0.008	3.646	3.646
50	R2E Broken back Set 5.2 NA+,S NA+	L1	- 25.480	-0.206	5.554	26.079
51	R2E Broken back Set 5.2 NA+,S NA+	R2	-0.088	0.133	10.976	10.977
52	R2E Broken back Set 5.2 NA+,S NA+	R3	-0.088	0.133	10.898	10.900
53	R2E Broken back Set 5.3 NA+,S NA+	EW1	0.001	-0.008	3.646	3.646
54	R2E Broken back Set 5.3 NA+,S NA+	L1	-0.087	-0.322	10.977	10.982
55	R2E Broken back Set 5.3 NA+,S NA+	R2	- 25.479	0.097	5.554	26.078
56	R2E Broken back Set 5.3 NA+,S NA+	R3	-0.088	0.133	10.898	10.900
57	R2E Broken back earthwire NA+,S NA+	EW1	- 19.098	-0.008	1.879	19.190
58	R2E Broken back earthwire NA+,S NA+	L1	-0.087	-0.322	10.977	10.982
59	R2E Broken back earthwire NA+,S NA+	R2	-0.088	0.133	10.976	10.978
60	R2E Broken back earthwire NA+,S NA+	R3	-0.088	0.133	10.899	10.900

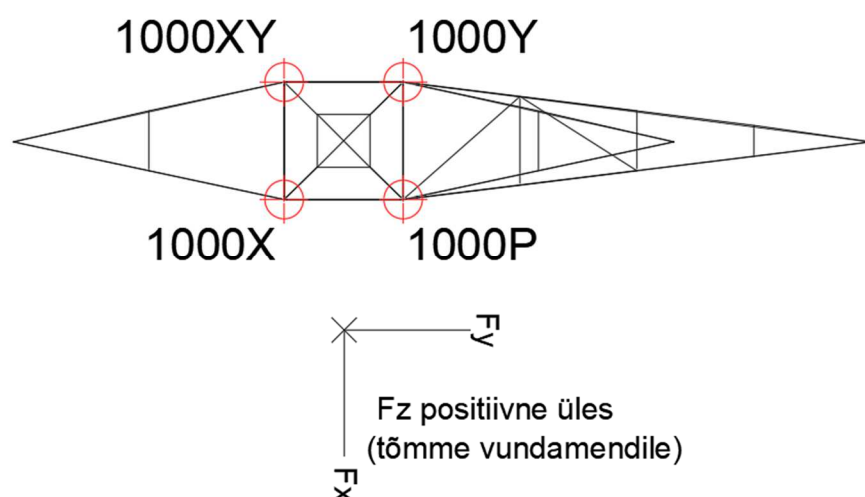
61	R2E Broken Ahead Set 5.1 NA-,S NA-	EW1	0.001	-0.008	3.646	3.646
62	R2E Broken Ahead Set 5.1 NA-,S NA-	L1	-0.087	-0.322	10.977	10.982
63	R2E Broken Ahead Set 5.1 NA-,S NA-	R2	-0.088	0.133	10.976	10.977
64	R2E Broken Ahead Set 5.1 NA-,S NA-	R3	31.802	-0.026	5.343	32.248
65	R2E Broken Ahead Set 5.2 NA-,S NA-	EW1	0.001	-0.008	3.646	3.646
66	R2E Broken Ahead Set 5.2 NA-,S NA-	L1	31.803	0.026	5.343	32.249
67	R2E Broken Ahead Set 5.2 NA-,S NA-	R2	-0.088	0.133	10.976	10.977
68	R2E Broken Ahead Set 5.2 NA-,S NA-	R3	-0.088	0.133	10.898	10.900
69	R2E Broken Ahead Set 5.3 NA-,S NA-	EW1	0.001	-0.008	3.646	3.646
70	R2E Broken Ahead Set 5.3 NA-,S NA-	L1	-0.087	-0.322	10.977	10.982
71	R2E Broken Ahead Set 5.3 NA-,S NA-	R2	31.802	-0.026	5.343	32.248
72	R2E Broken Ahead Set 5.3 NA-,S NA-	R3	-0.088	0.133	10.898	10.900
73	R2E Broken ahead earthwire NA-, S NA-	EW1	19.100	0.000	1.842	19.188
74	R2E Broken ahead earthwire NA-, S NA-	L1	-0.087	-0.322	10.977	10.982
75	R2E Broken ahead earthwire NA-, S NA-	R2	-0.088	0.133	10.976	10.978
76	R2E Broken ahead earthwire NA-, S NA-	R3	-0.088	0.133	10.899	10.900
77	R2E Broken back Set 5.1 NA-,S NA-	EW1	0.001	-0.008	3.646	3.646
78	R2E Broken back Set 5.1 NA-,S NA-	L1	-0.087	-0.322	10.977	10.982
79	R2E Broken back Set 5.1 NA-,S NA-	R2	-0.088	0.133	10.976	10.977
80	R2E Broken back Set 5.1 NA-,S NA-	R3	- 25.470	0.097	5.511	26.059
81	R2E Broken back Set 5.2 NA-,S NA-	EW1	0.001	-0.008	3.646	3.646
82	R2E Broken back Set 5.2 NA-,S NA-	L1	- 25.480	-0.206	5.554	26.079
83	R2E Broken back Set 5.2 NA-,S NA-	R2	-0.088	0.133	10.976	10.977
84	R2E Broken back Set 5.2 NA-,S NA-	R3	-0.088	0.133	10.898	10.900
85	R2E Broken back Set 5.3 NA-,S NA-	EW1	0.001	-0.008	3.646	3.646
86	R2E Broken back Set 5.3 NA-,S NA-	L1	-0.087	-0.322	10.977	10.982

87	R2E Broken back Set 5.3 NA-,S NA-	R2	- 25.479	0.097	5.554	26.078
88	R2E Broken back Set 5.3 NA-,S NA-	R3	-0.088	0.133	10.898	10.900
89	R2E Broken back earthwire NA-,S NA-	EW1	- 19.098	-0.008	1.879	19.190
90	R2E Broken back earthwire NA-,S NA-	L1	-0.087	-0.322	10.977	10.982
91	R2E Broken back earthwire NA-,S NA-	R2	-0.088	0.133	10.976	10.978
92	R2E Broken back earthwire NA-,S NA-	R3	-0.088	0.133	10.899	10.900

7.4 Element group usage

Row #	Group Label	Group Desc.	Angle Type	Angle Size	Max Usage %
1	V01	Chord (Low body)	EA	110x110x10	93.46
2	V02	Chord Chord (Up body)	EA	100x100x8	89.54
3	VB-11	CA1 Chord low (Long crossarm)	EA	70x70x7	93.92
4	VB-21	CA2 Chord up (short crossarm)	EA	60x60x6	86.03
5	BR-11	Bracing (Body/cage)	EA	80x80x8	94.30
6	FCH1	Horizontal (Cage horizontal CA low)	EA	70x70x7	86.75
7	FCH2	Horizontal (Cage horizontal CA up)	EA	60x60x6	73.65
8	FD1	Bracing (Cage horizontal)	EA	70x70x7	93.25
9	FD2	Bracing (Cage horizontal)	EA	50x50x5	60.43
10	VT-11	Crossarm tension CA1 (long)	EA	60x60x6	58.40
11	VT-21	Crossarm tension CA2 (short)	EA	60x60x6	43.95
12	D-21	Crossarm CA1 lower horizontal	EA	50x50x5	1.35
13	FCT-12	Crossarm tension CA1	EA	50x50x5	7.22
14	D-11	Crossarm diagonals CA1	EA	50x50x5	2.64
15	V03	Chord (Cage)	EA	90x90x6	49.65
16	BR-13	Bracing (EW)	EA	50x50x5	97.71
17	V04	Chord (EW)	EA	70x70x7	24.96
18	D-12	Crossarm horizontal CA1	EA	50x50x5	0.03

7.5 Foundation forces



Loads are without strength coordination coefficient

Row #	Load Case	Foundation Description	Axial Force (kN)	Shear Force (kN)
1	Tmin,S NA+	1000P	45.06	1.31
2	Tmin,S NA+	1000X	6.25	0.71
3	Tmin,S NA+	1000XY	-16.26	0.13
4	Tmin,S NA+	1000Y	23.85	0.76
5	R2 Piirtuulekoormus/Extreme wind load(1a)NA+,S NA+	1000P	492.29	2.42
6	R2 Piirtuulekoormus/Extreme wind load(1a)NA+,S NA+	1000X	-483.06	25.87
7	R2 Piirtuulekoormus/Extreme wind load(1a)NA+,S NA+	1000XY	-460.09	3.52
8	R2 Piirtuulekoormus/Extreme wind load(1a)NA+,S NA+	1000Y	510.18	22.62

9	R2 Piirjätekoormus+nimituulekoormus/Extreme iceload with nominal wind...,S NA+	1000P	323.16	1.11
10	R2 Piirjätekoormus+nimituulekoormus/Extreme iceload with nominal wind...,S NA+	1000X	- 324.88	15.94
11	R2 Piirjätekoormus+nimituulekoormus/Extreme iceload with nominal wind...,S NA+	1000XY	- 274.89	2.27
12	R2 Piirjätekoormus+nimituulekoormus/Extreme iceload with nominal wind...,S NA+	1000Y	364.16	11.82
13	R2 Suur tuulekoormus+nimijätekoormus/High wind load with nominal icel...,S NA+	1000P	452.92	2.05
14	R2 Suur tuulekoormus+nimijätekoormus/High wind load with nominal icel...,S NA+	1000X	- 446.01	23.07
15	R2 Suur tuulekoormus+nimijätekoormus/High wind load with nominal icel...,S NA+	1000XY	- 415.98	3.20
16	R2 Suur tuulekoormus+nimijätekoormus/High wind load with nominal icel...,S NA+	1000Y	476.32	19.58
17	R2 Piirtuulekoormus/Extreme wind load(1a)NA-,S NA-	1000P	- 450.07	5.03
18	R2 Piirtuulekoormus/Extreme wind load(1a)NA-,S NA-	1000X	450.22	23.01
19	R2 Piirtuulekoormus/Extreme wind load(1a)NA-,S NA-	1000XY	474.60	2.38
20	R2 Piirtuulekoormus/Extreme wind load(1a)NA-,S NA-	1000Y	- 415.43	25.25
21	R2 Piirjätekoormus+nimituulekoormus/Extreme iceload with nominal wind...,S NA-	1000P	- 251.35	4.51
22	R2 Piirjätekoormus+nimituulekoormus/Extreme iceload with nominal wind...,S NA-	1000X	244.03	12.22
23	R2 Piirjätekoormus+nimituulekoormus/Extreme iceload with nominal wind...,S NA-	1000XY	290.51	1.03
24	R2 Piirjätekoormus+nimituulekoormus/Extreme iceload with nominal wind...,S NA-	1000Y	- 195.65	14.99

25	R2 Suur tuulekoormus+nimijäitekoormus/High wind load with nominal icel...,S NA-	1000P	- 402.04	4.94
26	R2 Suur tuulekoormus+nimijäitekoormus/High wind load with nominal icel...,S NA-	1000X	400.68	20.02
27	R2 Suur tuulekoormus+nimijäitekoormus/High wind load with nominal icel...,S NA-	1000XY	430.33	2.04
28	R2 Suur tuulekoormus+nimijäitekoormus/High wind load with nominal icel...,S NA-	1000Y	- 361.72	22.31
29	R2E Broken Ahead Set 5.1 NA+,S NA+	1000P	423.18	52.46
30	R2E Broken Ahead Set 5.1 NA+,S NA+	1000X	406.85	40.19
31	R2E Broken Ahead Set 5.1 NA+,S NA+	1000XY	- 406.80	21.87
32	R2E Broken Ahead Set 5.1 NA+,S NA+	1000Y	- 362.69	38.55
33	R2E Broken Ahead Set 5.2 NA+,S NA+	1000P	381.84	22.93
34	R2E Broken Ahead Set 5.2 NA+,S NA+	1000X	322.76	38.08
35	R2E Broken Ahead Set 5.2 NA+,S NA+	1000XY	- 363.23	54.61
36	R2E Broken Ahead Set 5.2 NA+,S NA+	1000Y	- 280.91	38.02
37	R2E Broken Ahead Set 5.3 NA+,S NA+	1000P	360.10	79.00
38	R2E Broken Ahead Set 5.3 NA+,S NA+	1000X	346.82	66.83
39	R2E Broken Ahead Set 5.3 NA+,S NA+	1000XY	- 337.27	48.67
40	R2E Broken Ahead Set 5.3 NA+,S NA+	1000Y	- 309.19	65.12
41	R2E Broken ahead earthwire NA+,S NA+	1000P	307.66	9.05
42	R2E Broken ahead earthwire NA+,S NA+	1000X	266.77	0.98
43	R2E Broken ahead earthwire NA+,S NA+	1000XY	- 283.61	9.68

44	R2E Broken ahead earthwire NA+,S NA+	1000Y	- 226.53	0.38
45	R2E Broken back Set 5.1 NA+,S NA+	1000P	- 284.44	42.75
46	R2E Broken back Set 5.1 NA+,S NA+	1000X	- 332.10	32.58
47	R2E Broken back Set 5.1 NA+,S NA+	1000XY	328.67	17.66
48	R2E Broken back Set 5.1 NA+,S NA+	1000Y	348.56	32.11
49	R2E Broken back Set 5.2 NA+,S NA+	1000P	- 220.94	18.18
50	R2E Broken back Set 5.2 NA+,S NA+	1000X	- 295.94	29.07
51	R2E Broken back Set 5.2 NA+,S NA+	1000XY	261.12	42.46
52	R2E Broken back Set 5.2 NA+,S NA+	1000Y	316.42	30.19
53	R2E Broken back Set 5.3 NA+,S NA+	1000P	- 243.73	64.03
54	R2E Broken back Set 5.3 NA+,S NA+	1000X	- 274.95	53.45
55	R2E Broken back Set 5.3 NA+,S NA+	1000XY	281.04	38.73
56	R2E Broken back Set 5.3 NA+,S NA+	1000Y	298.30	53.23
57	R2E Broken back earthwire NA+,S NA+	1000P	- 232.08	9.45
58	R2E Broken back earthwire NA+,S NA+	1000X	- 289.50	1.80
59	R2E Broken back earthwire NA+,S NA+	1000XY	272.94	9.14
60	R2E Broken back earthwire NA+,S NA+	1000Y	312.96	1.03
61	R2E Broken Ahead Set 5.1 NA-,S NA-	1000P	423.18	52.46
62	R2E Broken Ahead Set 5.1 NA-,S NA-	1000X	406.85	40.19
63	R2E Broken Ahead Set 5.1 NA-,S NA-	1000XY	- 406.80	21.87

64	R2E Broken Ahead Set 5.1 NA-,S NA-	1000Y	- 362.69	38.55
65	R2E Broken Ahead Set 5.2 NA-,S NA-	1000P	381.84	22.93
66	R2E Broken Ahead Set 5.2 NA-,S NA-	1000X	322.76	38.08
67	R2E Broken Ahead Set 5.2 NA-,S NA-	1000XY	- 363.23	54.61
68	R2E Broken Ahead Set 5.2 NA-,S NA-	1000Y	- 280.91	38.02
69	R2E Broken Ahead Set 5.3 NA-,S NA-	1000P	360.10	79.00
70	R2E Broken Ahead Set 5.3 NA-,S NA-	1000X	346.82	66.83
71	R2E Broken Ahead Set 5.3 NA-,S NA-	1000XY	- 337.27	48.67
72	R2E Broken Ahead Set 5.3 NA-,S NA-	1000Y	- 309.19	65.12
73	R2E Broken ahead earthwire NA-,S NA-	1000P	307.66	9.05
74	R2E Broken ahead earthwire NA-,S NA-	1000X	266.77	0.98
75	R2E Broken ahead earthwire NA-,S NA-	1000XY	- 283.61	9.68
76	R2E Broken ahead earthwire NA-,S NA-	1000Y	- 226.53	0.38
77	R2E Broken back Set 5.1 NA-,S NA-	1000P	- 284.44	42.75
78	R2E Broken back Set 5.1 NA-,S NA-	1000X	- 332.10	32.58
79	R2E Broken back Set 5.1 NA-,S NA-	1000XY	328.67	17.66
80	R2E Broken back Set 5.1 NA-,S NA-	1000Y	348.56	32.11
81	R2E Broken back Set 5.2 NA-,S NA-	1000P	- 220.94	18.18
82	R2E Broken back Set 5.2 NA-,S NA-	1000X	- 295.94	29.07
83	R2E Broken back Set 5.2 NA-,S NA-	1000XY	261.12	42.46
84	R2E Broken back Set 5.2 NA-,S NA-	1000Y	316.42	30.19

85	R2E Broken back Set 5.3 NA-,S NA-	1000P	- 243.73	64.03
86	R2E Broken back Set 5.3 NA-,S NA-	1000X	- 274.95	53.45
87	R2E Broken back Set 5.3 NA-,S NA-	1000XY	281.04	38.73
88	R2E Broken back Set 5.3 NA-,S NA-	1000Y	298.30	53.23
89	R2E Broken back earthwire NA-,S NA-	1000P	- 232.08	9.45
90	R2E Broken back earthwire NA-,S NA-	1000X	- 289.50	1.80
91	R2E Broken back earthwire NA-,S NA-	1000XY	272.94	9.14
92	R2E Broken back earthwire NA-,S NA-	1000Y	312.96	1.03