TasNetworks' power quality planning levels

Supplementary Information

Annual Planning Report

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Contents

TasNetworks acknowledges the palawa (Tasmanian Aboriginal community) as the original owners and custodians of lutruwita (Tasmania). TasNetworks, acknowledges the palawa have maintained their spiritual and cultural connection to the land and water. We pay respect to Elders past and present and all Aboriginal and Torres Strait Islander peoples here with us today.

Power quality planning levels

Power quality refers to the technical characteristics of the electricity received by customers that ensure the customer can utilise energy from the network successfully, without interference to or incorrect use of electrical equipment. Power quality encompasses supply voltage:

- Steady-state magnitude;
- Fluctuation;
- Distortion; and
- Unbalance for multi-phase connections.

Steady state magnitude relates to maintaining voltage within acceptable levels over the longer term. Voltage fluctuation relates to short term swells and sags in voltage magnitude. If the fluctuations continue to occur then they are referred to as "flicker". Voltage distortion relates to waveform deviations and includes recurrent harmonics and infrequent transients due to things such as network operational switching and lightning. Other supply issues arise from deviations in system frequency that are a broader power system operational matter and circulating ground currents that can interfere with sensitive electronic equipment.

Generally, the voltage magnitude (over and under voltages) is the most common power quality issue reported in the distribution network as it is directly impacted by network capacity.

Schedules 5.1a, 5.1 and 5.3 of the National Electricity Rules (**the Rules**) describe the planning, design and operating criteria applied to our distribution network for power quality. The quality of supply standards relevant to the distribution network are detailed in AS/NZS 61000 Electromagnetic compatibility (**EMC**), Chapter 5 of the Rules and Chapter 8 of the Tasmanian Electricity Code **(the Code)**. The standards for each element of quality of supply are:

- Voltage
  - SA/SNZ TS IEC 61000.3.5:2013 EMC –Limits – Limitation of voltage fluctuations and flicker in low-voltage power supply systems for equipment with rated current greater than 75 A;
  - TR IEC 61000.3.7:2012 EMC – Limits – Assessment of emission limits for the connection of fluctuating installations to MV, HV and EHV power systems;
  - AS/NZS 61000.3.100-2011 EMC – Limits – Steady state voltage limits in public electricity systems; and
  - Section 8.6.4 of the Code and S5.1a.4 and S5.1a.5 of the Rules.

- Harmonics
  - AS/NZS 61000.2.2:2003 (R2013) EMC – Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems;
  - TR IEC 61000.3.6:2012 EMC – Limits – Assessment of emission limits for the connection of distorting installations to MV, HV and EHV power systems;
  - AS/NZS 61000.2.4:2009 EMC – Environment – Compatibility levels in industrial plants for low-frequency conducted disturbances;
  - AS/NZS 61000.2.12:2003 (R2013) EMC – Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public medium-voltage power supply systems; and
  - S5.1a.6 of the Rules.
- Power factor
  - Section 8.6.3 of the Code and S5.3 of the Rules.
- Unbalance
  - Schedule S5.1a.7 of the Rules.

This appendix provides our planning levels for over and under voltage, voltage unbalance, and harmonic voltage content and voltage fluctuation.

The actual emission level allocated to any particular connection will be less than the planning level given below. We will allocate emission levels for particular connections at the time of assessing a connection application.

1 Planning levels for over and under voltages

The Rules illustrate the allowable temporary over-voltage (TOV) envelope in S5.1a.4 (the Rules Figure S5.1a.1), which is reproduced in Figure 1 below.

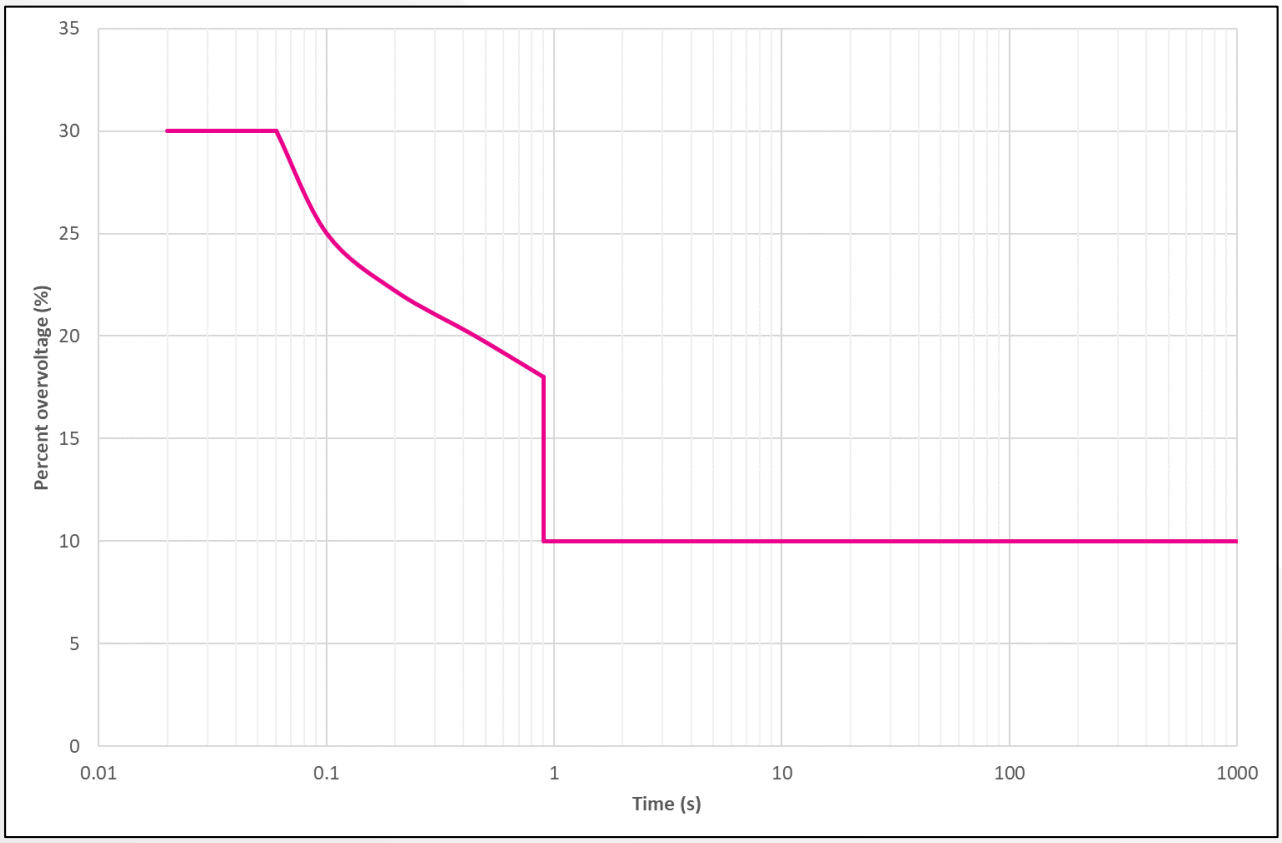

Figure 1: The over-voltage requirements (reproduced from the Rules S5.1a.1)

The Rules do not specify a standard for transient voltage recovery following under voltage events. We have compiled the under-voltage characteristic in Figure 2 largely from performance standards applicable to generating units. This is the magenta (pink) line in Figure 2. The shaded area is the minimum access standard of S5.2.5.4 of the Rules.

We consider the compiled recovery standard to be a reasonable guide to the required voltage recovery characteristics that would enable the power system to adequately recover, following a network event. We will use Figure 2 for general assessment of under voltage performance, but we reserve the right to apply alternate performance metrics as required.

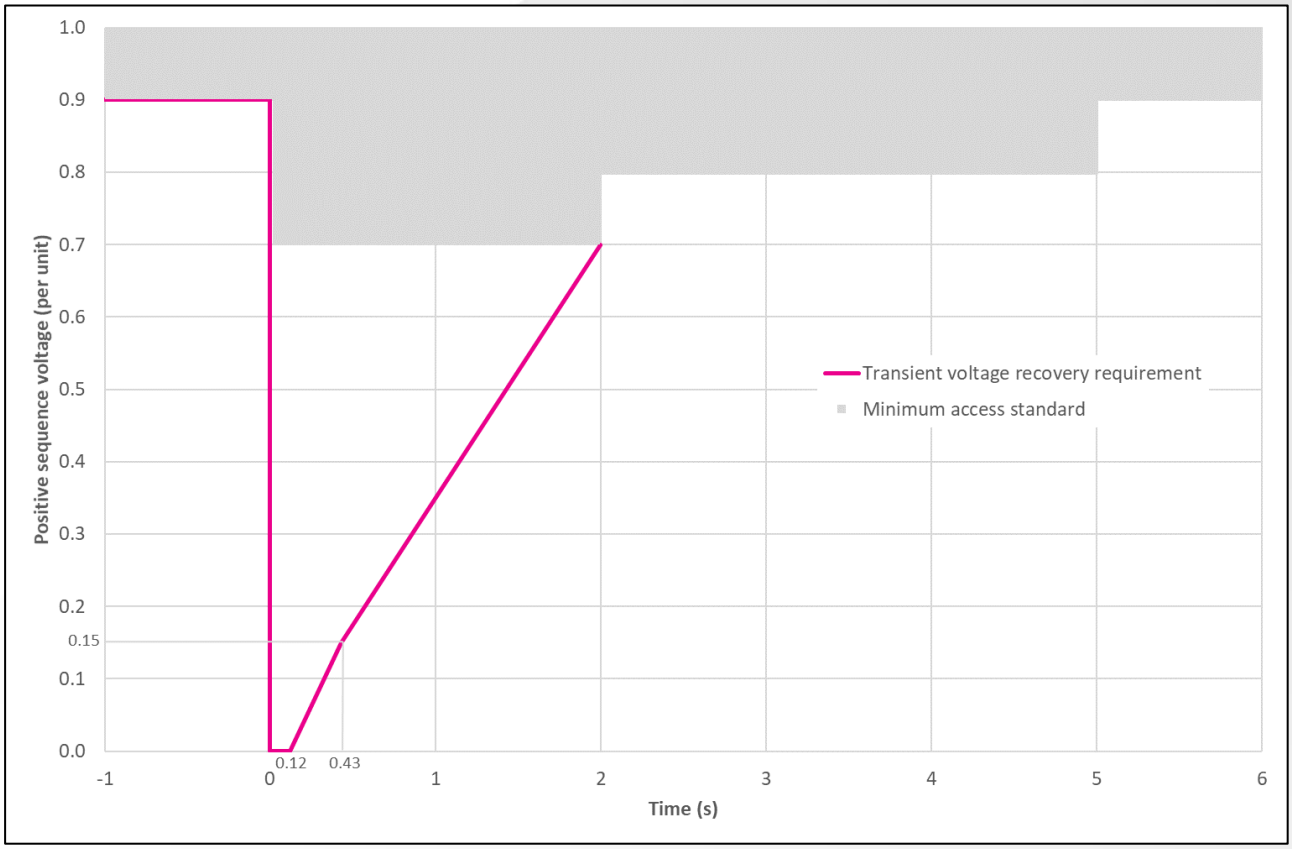

Figure 2: Voltage recovery requirements following network under voltage events

2 Planning levels for voltage fluctuation

Voltage fluctuations are defined as repetitive or random variations in the magnitude of the supply voltage. The magnitudes of these variations do not usually exceed 10 per cent of the nominal supply voltage. However, small magnitude changes occurring at particular frequencies can give rise to an effect called flicker.

There are two important parameters to voltage fluctuations: the frequency of fluctuation and the magnitude of fluctuation. Voltage fluctuations may cause spurious tripping of relays, interference with communications equipment, and may trip out electronic equipment.

With respect to planning levels for voltage fluctuations, Table 1 has been derived and adopted for the Tasmanian transmission network. Note that TR IEC 61000.3.7:2012 should be referenced for further details.[1]

Table 1: Voltage fluctuation planning levels

Flicker level	Bus voltage	
	HV 35 kV<Un≤230 kV	MV 1 kV<Un≤35 kV
P_{ST}	0.8	0.9
P_{LT}	0.6	0.7

P_{ST} Short-term flicker level is a measure of the change in relative voltage magnitude versus the frequency of the voltage changes, calculated on a 10-minute basis. An index level of less than 1.0 in the low voltage network is considered acceptable.

P_{LT} Long-term flicker level is an average of P_{ST} values evaluated over a period of two hours. An index level of less than 0.8 in the low voltage network is considered acceptable.

[1] The Rules S5.1a.5 refers to AS/NZS 61000.3.7:2001. This standard has been superseded by TR IEC 61000.3.7:2012

3 Planning levels for harmonic voltage

With respect to planning levels for harmonic voltages, Table 2 has been derived and adopted for the Tasmanian transmission network. Note that TR IEC 61000.3.6:2012 should be referenced for further details.[2]

Table 2: Harmonic planning levels for the Tasmanian network

Harmonic number	Permissible voltage level (% of the nominal voltage)				
	Transmission or sub-transmission busbars		Load busbars		
	220 kV / 110 kV	44 kV / 33 kV	33 kV / 22 kV / 11 kV	6.6 kV	0.4 kV
2	1.14	1.37	1.84	1.87	1.90
3	2.00	2.75	4.27	4.39	4.50
4	0.60	0.72	0.96	0.98	1.00
5	2.00	3.01	5.12	5.31	5.50
6	0.27	0.32	0.43	0.44	0.50
7	2.00	2.69	4.19	4.34	4.50
8	0.27	0.32	0.43	0.44	0.50
9	0.81	0.95	1.27	1.31	1.35
10	0.29	0.34	0.46	0.47	0.49
11	1.50	1.94	2.97	3.11	3.25
12	0.27	0.31	0.41	0.43	0.44
13	1.50	1.80	2.53	2.64	2.75
14	0.25	0.29	0.38	0.40	0.41
15	0.21	0.24	0.32	0.34	0.35
16	0.23	0.27	0.36	0.38	0.39
17	1.11	1.27	1.69	1.77	1.85
18	0.22	0.25	0.34	0.36	0.37
19	0.98	1.11	1.48	1.56	1.63
20	0.22	0.24	0.33	0.34	0.36
21	0.15	0.17	0.23	0.24	0.25
22	0.21	0.23	0.31	0.33	0.35
23	0.78	0.87	1.17	1.24	1.31

[2] The Rules S5.1a.6 refers to AS/NZS 61000.3.6:2001. This standard has been superseded by TR IEC 61000.3.6:2012

Harmonic number	Permissible voltage level (% of the nominal voltage)				
	Transmission or sub-transmission busbars		Load busbars		
	220 kV / 110 kV	44 kV / 33 kV	33 kV / 22 kV / 11 kV	6.6 kV	0.4 kV
24	0.20	0.23	0.30	0.32	0.34
25	0.71	0.79	1.05	1.12	1.18
26	0.20	0.22	0.29	0.31	0.33
27	0.12	0.13	0.18	0.19	0.20
28	0.19	0.21	0.28	0.30	0.32
29	0.59	0.65	0.86	0.93	0.99
30	0.19	0.21	0.28	0.30	0.32
31	0.55	0.59	0.79	0.85	0.91
32	0.19	0.20	0.27	0.29	0.31
33	0.12	0.13	0.17	0.19	0.20
34	0.19	0.20	0.26	0.29	0.31
35	0.47	0.50	0.66	0.72	0.78
36	0.18	0.19	0.26	0.28	0.30
37	0.43	0.46	0.61	0.67	0.72
38	0.18	0.19	0.25	0.28	0.30
39	0.12	0.13	0.17	0.18	0.20
40	0.18	0.19	0.25	0.27	0.30
41	0.38	0.39	0.53	0.58	0.62
42	0.18	0.18	0.24	0.27	0.29
43	0.35	0.36	0.49	0.54	0.58
44	0.18	0.18	0.24	0.27	0.29
45	0.12	0.12	0.16	0.18	0.20
46	0.17	0.18	0.24	0.26	0.29
47	0.31	0.32	0.42	0.47	0.51
48	0.17	0.17	0.23	0.26	0.29
49	0.29	0.29	0.39	0.44	0.48
50	0.17	0.17	0.23	0.26	0.28
Total harmonic distortion	3.00	4.36	6.61	6.93	7.30

Planning levels at generating unit busbars (terminal connection voltage) are to be taken as half of these values, recognising that there is a cost associated with specifying a higher level of required harmonic immunity for such plant.

4 Planning levels for voltage unbalance

The planning levels for voltage unbalance are summarised in Table S5.1a.1 of the Rules, being part of Schedule 5.1a (System Standards). This table is replicated in Table 3.

Table 3: Planning levels for voltage unbalance (from the Rules Table S5.1a.1)

Nominal supply voltage (kV)	Maximum negative sequence voltage (% of nominal voltage)			
Column 1	Column 2	Column 3	Column 4	Column 5
	No contingency event	Credible contingency event	General	Once per hour
	30 minute average	30 minute average	10 minute average	1 minute average
More than 100	0.5	0.7	1.0	2.0
More than 10 but not more than 100	1.3	1.3	2.0	2.5
10 or less	2.0	2.0	2.5	3.0

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