

Information documents are not authoritative. Information documents are for information purposes only and are intended to provide guidance. If there is any discrepancy between an information document and any authoritative document¹ in effect, the authoritative document governs.

1 Purpose

This information document relates to the following authoritative document:

- VAR-001-AB-4, *Voltage and Reactive Control* (“VAR-001-AB-4”).

The purpose of this information document is to provide market participants with clarity regarding the AESO’s voltage control operating practices. This information document is likely of interest to market participants, the operator of transmission facility, and the operator of a generating unit or aggregated generating facility.

2 Background

The AESO is responsible for the overall reliability of the interconnected electric system, including ensuring that transmission system voltages are maintained within acceptable levels in alignment with requirements R2 and R3 of VAR-001-AB-4.

3 AESO Transmission System Voltage Ranges and Control Operating Practices

Pursuant to requirement R1 of VAR-001-AB-4, the system voltage ranges with associated tolerance bands of key substations are provided in *Table 1: Voltage Limits and Operating Ranges* (“Table 1”) of Appendix 1. The AESO operates to the voltage limits indicated in Table 1 through the AESO’s energy management system.

The AESO uses the following voltage control operating practices to maintain transmission system voltage levels within acceptable limits:

- (a) The AESO monitors the real time voltage stability analysis tool in the AESO’s energy management system. If the real time voltage stability analysis tool establishes a more conservative voltage limit for an area than the limit indicated in Table 1, the AESO informs the operators of transmission of the more conservative voltage stability analysis limit and operates to the more conservative limit for the area of concern.
- (b) The AESO operates to the limits indicated in Table 1 if the voltage stability analysis tool is not functioning. If required, the AESO may perform an assessment to determine whether a temporary minimum voltage limit should be established.
- (c) The AESO operates the interconnected electric system with sufficient reactive resources within its boundaries to support the voltage for the next contingency (N-1). The AESO takes corrective action when reactive resources are insufficient to maintain voltage within the minimum limits.
- (d) The AESO coordinates voltage adjustment levels and maintains voltages at the upper end of the normal range during heavy load periods as indicated in Table 1 to reduce the risk of system instability and to be prepared for contingencies.
- (e) The AESO coordinates the use of capacitive and inductive reactive resources to maintain system and interconnection voltages within established limits.

¹ “Authoritative document” is the general name given by the AESO to categories of documents made by the AESO under the authority of the *Electric Utilities Act* and regulations, and that contain binding legal requirements for either market participants or the AESO, or both. Authoritative documents include: the ISO rules, the reliability standards, and the ISO tariff.

- (f) The AESO references either a voltage level at the point of connection to the transmission system or the reactive power to be achieved when issuing instructions to the operator of a generating unit or an aggregated generating facility for reactive support.
- (g) The AESO issues instructions for reactive resources to maintain voltage within the voltage limits identified in Table 1.
- (h) The AESO follows the procedures in section 3.1 and section 3.2 of this information document to maintain voltage within the established limits.

3.1 Voltages Fall Below the Normal Low Limit

The AESO implements one or more of the following operating practices if voltages fall below the normal low limit in Table 1:

- (a) switch capacitor banks “ON” and reactors “OFF” in the area;
- (b) adjust taps on transformer on load tap-changers;
- (c) raise bus voltage or adjust reactive output at generating stations including wind aggregated generating facilities;
- (d) raise static Var Compensator and sync-condenser set points;
- (e) consider reconfiguring the transmission system to avoid possible voltage collapse;
- (f) cancel outages that would contribute to the low voltages;
- (g) perform a real time assessment to determine if a lower voltage limit is acceptable;
- (h) consider effective transmission must-run generation that would support area voltage; and
- (i) take other actions the AESO deems effective, including shedding firm load.

3.2 Voltages Rise Above the Normal High Limit

The AESO implements one or more of the following operating practices if voltages rise above the normal high limit in Table 1:

- (a) switch capacitor banks “OFF” and reactors “ON” in the area;
- (b) lower set points on transformer tap-changers;
- (c) lower bus voltage or adjust reactive output at generating stations including wind aggregated generating facilities;
- (d) lower static Var Compensator or sync-condenser set points;
- (e) consider switching out lightly loaded lines after confirming by a study that there are no next contingency concerns; and
- (f) take other actions the AESO deems necessary to reduce voltage.

4 Operator Requests

The system voltage ranges with associated tolerance bands are provided in Table 1. An operator of a transmission facility may initiate a request to the AESO for a voltage adjustment, including exemptions under requirement R4 of VAR-001-AB-4, on its transmission facility or an adjacent transmission facility. The AESO assesses such requests considering the overall system voltage and immediate or upcoming events of which the AESO is aware. If the AESO does not agree with the need for the adjustment, the AESO provides an explanation to the operator.

Similarly, an operator of a generating unit or aggregated generating facility may initiate a request to the AESO for a voltage adjustment on the generating unit or aggregated generating facility. The AESO assesses such requests considering the overall system voltage and immediate or upcoming events of

which the AESO is aware. If the AESO does not agree with the need for the adjustment, the AESO provides an explanation to the operator.

As part of its assessment, the AESO considers whether the generating unit or aggregated generating facility is able to supply dynamic reactive power reserves. Of particular concern to the AESO is whether a generating unit or aggregated generating facility is operating at a limit, as communicated by the operator of the generating unit or aggregated generating facility as part of its request.

5 Concurrent Voltage (Reactive Power) Directives and Real Power Dispatches

There may be instances where the AESO issues a directive, pursuant to Section 301.2 of the ISO rules, *ISO Directives*, for voltage or reactive power adjustments to the operator of a generating unit or an aggregated generating facility where it is only possible to comply with this directive by lowering the real power output of the generating unit or aggregated generating facility pursuant to Section 203.4 of the ISO rules, *Delivery Requirements for Energy*.

6 Requested Information

The AESO provides the information indicated in requirement R1.1 of VAR-001-AB-4 upon request. Information requests are submitted by email to: ARSsubmittals@aeso.ca.

The owner of a transmission facility is responsible for providing to the AESO, as needed or upon being updated, the normal high and emergency high voltage limits for the substations listed in Table 1. The owner of a transmission facility submits this voltage limit information to the AESO by email to ARSsubmittals@aeso.ca.

Appendices

Appendix 1 – Voltage Limits and Operating Ranges

Appendix 2 – Voltage and Reactive Control Exceptions List (R4 VAR-001-AB-4)

Revision History

Posting Date	Description of Changes
2023-10-02	Updated Voltage Control Table 1.
2022-02-03	Addition of Appendix 2 containing an updated exceptions list that excludes decommissioned Cowley Ridge (CRWD) and includes Cowley North (CRE3).
2021-10-01	Updated Voltage Control Table 1.
2021-06-08	Updated section 6 to provide the frequency of data submission and the AESO email address for submission of the data. Updated Appendix 1 to improve clarity. Updated throughout to align with current AESO drafting principles.
2020-12-14	Updated Voltage Control Table 1.
2020-09-01	Updated Voltage Control Table 1.
2020-07-07	Administrative amendments. Revisions to align with the posted Voltage Control Table 1.

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Posting Date	Description of Changes
2018-10-15	Updated to include references to requirements R1.5 and R1.6 in subsection 7.1; and to add AESO contact information for submission of requests to schedule an outage.
2016-09-28	Administrative amendments.
2016-04-01	Amendments to Sections 1, 3, 4, 5 and 6. Removal of “Related Authoritative Documents” section and renumbering. Removal of Appendix 1. Revisions to reflect change in version number of VAR-001 and VAR-002.
2014-12-04	Amendments to Sections 1, 4, 4.1, 4.2, 4.3 and 5.
2014-10-07	Amendments to Sections 1, 4, 4.1, 4.2 and 4.3. Removing Appendix 1. Re-naming Appendix 2 to Appendix 1.
2014-09-19	Changes to minimum operating limits and desired ranges in Table 1: Voltage Limits and Operating Changes and Limits. Change to Section 1 to remove reference to contact information.
2013-10-01	Initial release.

Appendix 1 – Voltage Limits and Operating Ranges

Table 1 below provides the normal, emergency, and warning limits of key substations.

The AESO has defined voltage operating limits based on the real time operations horizon. The methodology requires the AESO to define pre- and post-contingency voltage limits. The pre- and post-contingency voltage limits are referred to in Table 1 below as “Normal” and “Emergency”, respectively.

The AESO maintains normal limits of the key substations, provided in Table 1, based on real time analysis. Should the voltage rise above or fall below the normal operating limits, the AESO system controller takes corrective action to return within normal operating limits.

The AESO maintains emergency limits of the key substations, provided in Table 1, based on real-time contingency analysis. In real time, the AESO system controller takes corrective action to ensure emergency limits are not exceeded post contingency.

The warning limits of the key substations, shown in Table 1, have been provided for market participant reference purposes. Warning limits are an early indication that action may need to be taken to correct transmission system voltages either by the AESO or by the operator of the transmission facility.

The AESO studies post-contingency load shed mitigation plans to verify that the plan mitigates any low emergency voltage violation if the contingency should occur.

Table 1: Key Substation Voltage Limits and Operating Ranges (Listed by Operator)

Substation Number and Name	Nominal (kV)	Emergency low (kV)	Normal low (kV)	Warning low (kV)	Warning High (kV)	Normal high (kV)	Emergency high (kV)
ALTALINK MANAGEMENT LTD.							
5S East Calgary	240	225	240	242	254	255	255
	138	130	136	138	142	142	142
13S Deerland	240	234	245	245	259	260	260
	138	131	140	140	144	145	145
17S Benalto	240	232	240	246	256	260	260
	138	127	134	138	144	145	145
19S Wabamun	138	127	136	140	144	145	145
28S West Brooks	240	236	242	245	260	264	264
	138	125	137	138	144	145	145
37S North Calder	240	225	238	244	255	260	260
	138	128	135	138	144	145	145
38S East Edmonton	240	222	239	240	253	255	255

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Substation Number and Name	Nominal (kV)	Emergency low (kV)	Normal low (kV)	Warning low (kV)	Warning High (kV)	Normal high (kV)	Emergency high (kV)
	138	127	137	139	144	145	145
39S Bickerdike	240	242	253	258	263	264	264
	138	130	137	140	144	145	145
42S Sarcee	240	226	240	247	253	253	253
	138	129	137	138	142	142	142
58S Edson	138	129	136	138	144	145	145
59S Peigan (Owned by TransAlta)	240	227	246	247	258	264	264
	138	127	136	138	144	145	145
62S Brazeau	240	237	241	242	256	257	257
	138	134	138	140	144	145	145
63S Red Deer	240	230	238	245	256	257	257
	138	130	136	138	144	145	145
64S East Crossfield	240	230	240	242	254	255	255
	138	130	135	138	144	145	145
68S Willesden Green	240	242	244	245	256	264	264
69S North Barrhead	240	239	250	250	268	272	272
	138	134	140	140	144	145	145
71S Lamoureux	240	220	240	240	254	255	255
	138	131	140	140	145	145	145
72S Leismer	240	234	248	262	271	280	280
	144	136	138	140	146	150	150
74S Janet	240	229	240	248	254	264	264

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Substation Number and Name	Nominal (kV)	Emergency low (kV)	Normal low (kV)	Warning low (kV)	Warning High (kV)	Normal high (kV)	Emergency high (kV)
	138	131	137	138	142	142	142
77S Sagitawah	240	234	250	250	263	264	264
	138	131	140	140	144	145	145
83S Taber	138	128	136	138	144	145	145
86S Bigstone	240	223	238	243	253	260	260
	138	127	137	141	145	145	145
87S Gaetz	240	227	235	240	256	260	260
	138	126	139	140	144	145	145
89S Ellerslie	500	478	513	520	540	550	550
	240	221	237	246	254	255	255
102S Langdon	240	228	240	251	255	258	258
118s Canmore	138	131	135	139	144	145	145
132S Ware Junction	240	236	244	254	262	264	264
157S Lac La Biche	138	131	138	138	144	145	145
163S Amoco Empress	240	219	246	247	260	264	264
	138	133	138	140	144	145	145
244S Bowmanton	240	223	245	247	263	264	264
	138	125	136	138	144	145	150
250P Bighorn	138	134	141	142	148	150	150
267S Killarney Lake	138	128	138	139	144	145	145
268S Whitecourt	138	131	138	138	144	145	145
275S Jenner	240	219	247	247	257	260	264

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Substation Number and Name	Nominal (kV)	Emergency low (kV)	Normal low (kV)	Warning low (kV)	Warning High (kV)	Normal high (kV)	Emergency high (kV)
305S Acheson	138	129	136	138	144	145	145
310P Sundance	240	235	249	255	262	264	264
	138	130	136	138	144	145	145
320P Keephills	500	481	506	520	540	550	550
	240	230	239	250	258	260	260
	138	128	133	138	144	145	145
321S Al Rothbauer	138	126	136	138	144	150	150
370S North Lethbridge	240	224	245	247	260	264	264
	138	126	136	138	144	145	145
377S Hardisty	138	126	138	140	144	145	145
391S Balzac	138	132	137	138	144	145	145
394S Empress	138	133	138	139	144	145	145
396S Pincher Creek	138	127	136	140	144	145	145
520S Bennett	500	484	510	512	535	540	540
523S Bullshead	138	126	136	138	144	145	145
535S Joffre	138	125	136	138	142	144	144
602S Cold Creek	138	131	135	138	144	145	145
648S Metiskow	240	233	246	250	260	260	260
	138	129	136	140	145	145	145
ATCO ELECTRIC LTD.							
700S Bonnyville	144	133	138	146	153	153	155
715S Leming Lake	144	133	138	145	150	152	155
716S Lloydminster	144	131	142	143	150	151	155

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Substation Number and Name	Nominal (kV)	Emergency low (kV)	Normal low (kV)	Warning low (kV)	Warning High (kV)	Normal high (kV)	Emergency high (kV)
722S Crystal Lake	144	135	143	144	152	154	155
730S Rycroft	144	133	142	143	153	154	155
732S Mitsue	240	243	254	258	267	270	275
	144	138	145	146	153	154	155
740S H.R. Milner	144	133	144	145	151	152	155
743S Sarah Lake	144	135	142	144	151	152	155
749S Flyingshot Lake	144	136	143	145	151	152	155
751S Hill	144	131	142	143	150	151	155
755S Cordel	240	237	247	249	259	260	270
757S Battle River	144	131	137	138	150	152	152
766S Nevis	240	232	244	248	260	265	265
	144	132	147	148	152	155	155
767S Oyen	144	131	137	141	148	152	155
780S Lubicon	144	137	144	145	153	154	155
786S High Level	144	137	143	144	153	154	155
788S Hotchkiss	144	143	148	149	154	154	155
789S Keg River	144	136	145	146	153	154	158
790S Poplar Hill	144	138	143	145	153	154	155
791S Rainbow Lake	144	137	145	146	153	154	155
793S West Peace River	144	142	147	148	153	154	155
800S Friedenstal	144	136	144	145	153	154	155

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Substation Number and Name	Nominal (kV)	Emergency low (kV)	Normal low (kV)	Warning low (kV)	Warning High (kV)	Normal high (kV)	Emergency high (kV)
801S Anderson	240	240	252	257	262	275	275
	144	131	139	148	151	155	155
809S Louise Creek	240	252	258	260	268	270	275
	144	136	143	144	151	152	155
811S Clairmont Lake	144	134	143	144	153	154	155
813S Little Smoky	240	243	259	261	269	270	275
	144	135	145	146	153	154	155
815S Goodfare	144	136	142	144	153	154	155
825S Whitefish Lake	240	245	257	260	270	275	275
826S Marguerite Lake	240	238	248	249	264	265	275
	144	134	139	141	153	154	155
827S Cranberry Lake	144	136	144	145	151	152	155
834S Wesley Creek	240	248	258	259	273	274	275
	144	139	146	147	153	154	155
840S McNeill	230	219	219	231	248	248	248
	138	133	138	139	143	144	144
845S Big Mountain	144	136	144	145	152	153	155
848S Ruth Lake	240	252	257	260	270	275	275
	144	132	140	143	153	155	155
885S McMillian	240	236	252	260	274	275	275
	144	133	139	148	154	155	155
888S Dover	240	252	257	260	271	275	275

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Substation Number and Name	Nominal (kV)	Emergency low (kV)	Normal low (kV)	Warning low (kV)	Warning High (kV)	Normal high (kV)	Emergency high (kV)
898S Heart Lake	240	241	258	260	270	275	275
	144	133	140	142	150	152	152
939s Livock	500	503	510	522	543	550	550
	240	246	254	258	276	285	285
951s Thickwood	500	500	516	522	544	550	550
	240	252	259	260	270	275	275
977S Salt Creek	240	247	254	262	270	275	275
	144	132	143	145	153	155	155
ENMAX							
SS9	138	130	135	138	142	145	151
SS13	138	130	135	138	142	145	151
SS21	138	130	135	138	142	145	151
SS31	138	131	136	138	142	145	151
SS41	138	131	136	138	142	145	151
SS162 Beddington	240	227	240	242	255	256	264
	138	132	137	142	144	145	151
EPCOR DISTRIBUTION & TRANSMISSION INC.							
52S East Industrial	240	224	238	245	254	255	264
557S Castle Downs	240	225	238	245	254	255	264
665S Dome	240	225	239	245	254	255	264
803S Lambton	240	224	237	245	254	255	264
805S Jasper Terminal	240	225	238	245	254	255	264

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Substation Number and Name	Nominal (kV)	Emergency low (kV)	Normal low (kV)	Warning low (kV)	Warning High (kV)	Normal high (kV)	Emergency high (kV)
816S Petrolia	240	225	238	245	254	255	264
987S Clover Bar	240	224	238	245	254	255	264
Genesee 330P	500	482	506	525	540	550	550
	138	132	138	138	144	152	155

Appendix 2 – Voltage and Reactive Control Exceptions List (R4 VAR-001-AB-4)

In accordance with requirement R4 and the criteria in Appendix 1 of VAR-001-AB-4, the AESO has determined that the following wind aggregated generating facilities, as represented by their pool asset descriptions, are not required to comply with a directive issued in accordance with requirements R5 and R8 of that reliability standard:

- (a) Castle River (CR1);
- (b) Cowley North (CRE3); and
- (c) McBride Lake (AKE1).