
Testing and Commissioning of High Voltage Stations and Unit Substations

The intent of this bulletin is to establish a consistent and uniform enforcement approach for the requirements of Rule 36-304(4) of the Canadian Electrical Code, Part I (CEC). This bulletin clarifies that altered, modified, retrofitted, custom-built and field assembled Unit Substation must meet the requirements of CEC Rule 2-024. Also, this bulletin clarifies the annual (operating) permit requirements of the Vancouver Electrical By-law No. 5563.

CEC Rule 36-304(4) requires that after completion of construction, the resistance of the station ground electrode at each station shall be measured and changes shall be made if necessary to verify and ensure that the maximum permissible resistance of Subrule (1) is not exceeded. It is intended by the requirements of Rule 36-304(1), (2) & (4) that a detailed testing and commissioning of all components comprising a High Voltage Station is undertaken to ascertain the acceptable levels of step and touch voltages to be in conformance with Table 52 of the CEC and the potential voltage rise is not more than 5000 Volts at all parts of the station ground grid under the maximum ground fault current conditions.

When an electrical installation includes a High Voltage component, such installation shall not be energized until a testing and commissioning report is provided to the City Electrician by an acceptable independent agency other than the installing electrical contractor. The commissioning report submitted by the independent agency must indicate that the High Voltage Station or a Unit Substation has been successfully tested in accordance with provisions of Section 36 of the CEC, and that the installation is ready to be energized.

The testing and commissioning report must include (but not be limited to) the following:

1. Operation of all required interlocks between fuse compartments, load breaking or isolating means.
2. Operation of all isolating and disconnecting means.
3. Insulation resistance of all isolating and disconnecting means.
4. Contact resistance of all insulating and disconnecting means.
5. Protection coordination study.
6. Step and touch voltages calculations and ground resistance test.
7. Visual inspection of all isolating and disconnecting means.
8. Hi-Pot test of all isolating and disconnecting means and the cells for termination of the incoming BC Hydro cables.
9. Visual inspection of transformer(s).
10. Transformer insulation resistance test (Megger test).
11. Transformer "Turn to turn ratio" (TTR) test on all taps.
12. Transformer winding temperature test (test of WTI trip).
13. Visual inspection of all connections to the Station Ground Electrode.
14. Confirmation that all interconnections between pieces of electrical equipment assembled on the site into a "Unit Substation" follow the supplier's / manufacturer's shop drawings; and meet the requirements of the CEC Part I.

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- 15. Confirmation that the tested High Voltage Station or Unit Substation is ready to be energized.

The following completed checklists and report must be submitted with the testing and commissioning report:

- 16. The HV Unit Substations Checklist (Attachment 1) and the HV Service General Checklists (Attachments 2 & 3) of this bulletin.
- 17. The Special Inspection report of the installed "Unit Substation" evaluated in conformance with CSA Model Code SPE-1000 for CEC Rule 2-024. See Note A below.

Notes:

A. Electrical equipment used in installations must be "approved" in conformance with CEC Rule 2-024. In accordance with Section 0 and Appendix B of the CEC, "approved" electrical equipment installed under provisions of the CEC is required to be certified to the specific CSA product Standards as listed in Appendix A. Where such CSA Standards do not exist, the equipment approval could be accomplished via a field evaluation procedure in conformance with CSA Model Code SPE-1000.

There are a wide variety of Unit Substation designs to meet the project requirements. A Unit Substation is an integrated unit consisting of one or more transformers electrically and mechanically connected to; and coordinated in design with the disconnecting means, overcurrent devices and other associated equipment contained in suitable enclosures designed and constructed to restrict access to live parts. Such integration may invalidate the original certification marks of the components of a Unit Substation. Also, modification to or substitution of original equipment / components may void certification.

There is no CSA standard to which a Unit Substation can be designed and constructed; and there is no CSA product Standard available to certify Unit Substation. To meet the requirements of CEC Rule 2-024, a Unit Substation could be accepted as being "approved" only under provisions of a Special Inspection performed to the CSA Model Code SPE 1000. Any organization that is accredited by the Standards Council of Canada as a Special Inspection body could provide such field evaluation (SI services); and adhere the SI label to the evaluated Unit Substation. Unit Substation with such a label is deemed to be "approved". (Refer to Item 17 above)

Please refer to this website for organizations accredited by the Standards Council of Canada: <https://www.scc.ca/en/accreditation/inspection-bodies/directory-of-accredited-clients>

B. Annual (Operating) Permit - Section 5.14 of the Vancouver Electrical By-law No. 5563 requires that where the service KVA rating exceeds 500, the building owner must apply for and obtain an annual permit. Where an annual permit has been issued to a person pursuant to this By-law, that person shall not be required during the term of such permit to obtain a permit for minor electrical works which do not increase the total service or supply KVA rating specified in the application by more than 5 percent. An annual permit authorizes an owner to maintain all existing operating electrical equipment in safe and proper working order in conformance with CEC Rule 2-300.

(Original signed by)

(Original signed by)

W. White
Deputy City Electrician
Manager, Trades Inspection

P. Ryan, M.Sc., P.Eng.
Chief Building Official
Director, Building Code and Policy

Bulletin 2005-004-EL

ATTACHMENT 1

HV Unit Substations Checklist

Installation Address: _____ Permit Number **EP-**_____

Note 1: To be completed by the Registered Professional of the Testing / Commissioning Agency.

Note 2: For information requirements of a portable unit substation used in the installation for a special event, refer to Bulletin 2000-048-EL.

Item	Description	References: CEC Rules, Bulletins	Conformance to the referenced requirements	
			Yes	No
1	HV Station Ground Resistance Report (See Attachment 2)	36-304		
2	HV Equipment Approval - Note: unit substation approval accomplished via a field evaluation procedure in conformance with CSA Model Code SPE-1000	2-024; Item 17 (Note A) of Bulletin 2005-004-EL		
3	Clearance and spacing of live parts	36-108; 36-110; 36-212; Tables 30, 31, 32, 33, 34 & 35		
4	Operation of HV switches	36-212; 36-214		
5	Interlocks	36-208; 36-214		
6	Switch, fuse, and breaker ratings	36-202; 36-204		
7	Transformer overload and overheating protection:	26-252		
	(a) Relay and tripping device settings			
	(b) Transformer core temperature device			
8	Installation integrity: (a) Insulation	As per shop drawings		
	(b) Torqued as per installation specifications			
	(c) Stand-off supports and bushings			
9	Interconnections between pieces of electrical equipment assembled on the site into a "Unit Substation" follow the supplier's / manufacturer's shop drawings; and meet the requirements of the CEC Part I.	Shop drawings of unit substation; CE Code, Part I		
10	Tested HV Station / Unit Substation is ready to be energized	Item 15 of Bulletin 2005-004-EL		

Additional Comments:

Testing Agency: _____

Name: _____

Address: _____

Telephone: _____

Facsimile: _____

Email: _____

Signature: _____ **Date:** _____

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ATTACHMENT 2

HV Service General Checklist

Installation Address: _____ Permit Number **EP-**_____

Note 1: To be completed by the Registered Professional of the testing agency or by the Registered Professional responsible for the design of the HV installation. (P.Eng. of record)

Note 2: For information requirements of a portable unit substation used in the installation for a special event, refer to Bulletin 2000-048-EL.

Note 3: Completed report - to be provided as part of Attachment 1 (Item 1).

High Voltage Station Ground Resistance Report				
Item	Requirements of Table 52		Conformance with applicable requirements of Table 52	
			Yes	No
1	Type of Ground / Soil	(Please specify):		
2	Measured Resistance of the station Ground Electrode			
3	Calculated Step Voltage at the HV station			
4	Calculated Touch Voltage at the HV station			

Testing Agency: _____

Company Name:
(if other than the testing agency) _____

Name: _____ **P.Eng.**
Affix Professional Seal

Address: _____

Telephone: _____

Facsimile: _____

Email: _____

Signature: _____ **Date:** _____

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ATTACHMENT 3

HV Service General Checklist

Installation Address: _____ Permit Number **EP-**_____

Note 1: To be completed by the Registered Professional responsible for the design of the HV installation. (P.Eng. of record)

Note 2: For information requirements of a portable unit substation used in the installation for a special event, refer to Bulletin 2000-048-EL.

Item	Description	References: CEC Rules, Bulletins	Conformance to the referenced requirements		
			Yes	No	N/A
1	Horizontal clearance of HV conductors from adjacent structures; guarding	36-004; 36-110; Table 33; Bulletin 2015-002-AD/EL			
2	Service raceways, including drainage and pull box facilities	2-322; 6-300; 12-944; 36-100; Bulletin 2000-028-EL Bulletin 2003-002-EL Bulletin 2007-003-EL			
3	Working space; entrance to and exit from; marking to warn persons of potential electric shock and arc flash hazards.	2-306; 2-308; 2-310; Table 56			
4	Space for service and distribution equipment	6-206; 26-352- 36-200 Bulletin 2000-045-EL			
5	Access to nameplates and parts requiring maintenance	2-122			
6	Presence of other than electrical equipment	2-124; Bulletin 2000-045-EL			
7	(a) Dielectric liquid-filled equipment, indoors	26-012; 26-246; 36-206;			
	(b) Dielectric liquid-filled equipment, outdoors	26-014; 26-242; 36-212; Bulletin 2015-002-AD/EL			
8	Illumination of equipment	2-316; 26-356			
9	Warning notices	36-006			
10	Electrical equipment service room/Vault	26-012			
	(a) Location	36-200			
	(b) Construction	ARTICLE 3.6.2.1. / 3.6.2.7 DIVISION B VBBL			
	(c) Door Swing	3.6.2.6.(1) DIV. B VBBL			
	(d) Fire alarm system devices (Smoke detectors if not sprinklered)	Bulletin 2000-045-EL 3.6.2.7.(3)(b) DIV. B VBBL			
	(e) Adjacent Hazardous Areas (Commercial repair garages)	20-102			
	(f) If sprinklered, adequate protection for electrical equipment	26-008; 26-248(5); Article 8.15.11.3 NFPA 13			
11	Ventilation - (a) Proof that the system is adequate and suitable for the purpose	VBBL DIV. B 3.6.2.7(6) 2-320; Appendix B; P. Eng. Ltr			
	(b) Intake location	VBBL DIV. B 6.2.3.12			

Item	Description	References: CEC Rules, Bulletins	Conformance to the referenced requirements		
			Yes	No	N/A
12	Grounding and bonding requirements:	Bulletin 2005-004-EL			
	(a) Station ground electrode	36-300; 36-302			
	(b) Connections to the station ground electrode	36-104(5); 36-308; Appendix B			
	(i) Method of connection (as specified by the design professional)	36-300; 36-308; Appendix B			
	(ii) Conductor sizes (as specified by the design professional)	CEC Table 51			
	(c) If a ground bus (pad) for testing purposes is installed:				
	(i) Accessibility	2-312			
	(ii) Conductors marked for testing purposes	36-308(7); 2-100			
	(d) If a gang-operated switch is installed:				
	(i) Operating shaft grounded	36-310(1)(a) or (b)			
	(ii) 1.2 m X 1.8 m gradient control mat				
	(iii) positioned for vertical or horizontal operation				
	(iv) connection of the mat by two separate conductors (size and method of connection as specified by the design engineer)				
	(e) If a metallic fence is installed:				
	(i) located minimum 1 m inside perimeter of station ground electrode area				
	(ii) connections to the fence				
13	LV breakers and fuses:	Section 14			
	(a) Size / trip setting	Accepted Plans; Specifications			
	(b) Interrupting capacity	14-012; 14-014;			
14	Ground Fault protection or ground fault detection device.	14-102; 10-106(2)&(3)			
15	Seismic restraints	VBBL DIV. B 4.1.8.18			
16	Owner is advised that an annual (operating) permit must be obtained in conformance with the Vancouver Electrical By-law No. 5563	Note B of Bulletin 2005-004-EL			
17	Other - (Please specify)				

Additional Comments: _____

Testing Agency: _____

Name: _____

Address: _____

Telephone: _____

Facsimile: _____

Email: _____

Signature: _____ Date: _____

P.Eng.
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