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Primary Voltage Services

Revision Sheet

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Table of Contents

Page

1	Introduction	4
2	Reference	4
3	Scope	5
4	Definitions	5
5	Primary Service General Information.....	6
6	Application for Primary Service with Hydro Ottawa.....	8
7	Generic Primary Service Requirements.....	9
8	Outdoor Type Primary Service Requirements.....	11
9	Indoor Type Primary Service Requirements.....	12
9.1	Electrical Equipment Vault Location, Size & Access Requirements.....	13
	<i>9.1.1 Electrical Equipment Vault locations shall allow for convenient installation of incoming primary cables and equipment.....</i>	<i>13</i>
	<i>9.1.2 Electrical Equipment Vault Size Requirements.....</i>	<i>14</i>
	<i>9.1.3 Personal Access Requirements.....</i>	<i>15</i>
	<i>9.1.4 Equipment Access Requirements</i>	<i>15</i>
9.2	Electrical Equipment Vault Construction Requirements.....	16
	<i>9.2.1 Service Duct Banks</i>	<i>16</i>
	<i>9.2.2 Cable trenches</i>	<i>17</i>
	<i>9.2.3 Cable pulling eyes</i>	<i>17</i>
	<i>9.2.4 Personal and Equipment Doors</i>	<i>17</i>
	<i>9.2.5 Sump.....</i>	<i>18</i>
	<i>9.2.6 Fence</i>	<i>19</i>
9.3	Electrical Equipment Vault Support System Requirements.....	19
	<i>9.3.1 Ventilation for Electrical Equipment Vaults Containing Transformers.....</i>	<i>19</i>
	<i>9.3.2 Natural Ventilation</i>	<i>20</i>
	<i>9.3.3 Forced Ventilation</i>	<i>20</i>
	<i>9.3.4 Signs and Safety Measures</i>	<i>21</i>
	<i>9.3.5 Vault Lighting</i>	<i>21</i>
	<i>9.3.6 Emergency Vault Lighting</i>	<i>21</i>
	<i>9.3.7 Vault Fire Protection and Fire Detection.....</i>	<i>21</i>
	<i>9.3.8 120V Receptacles.....</i>	<i>21</i>
	<i>9.3.9 Cable support.....</i>	<i>22</i>
9.4	Electrical Equipment Vault Grounding	22
	<i>9.4.1 Connections to Ground Bus Loop.....</i>	<i>22</i>
	<i>9.4.2 Transformer Tank Bonding.....</i>	<i>23</i>
	<i>9.4.3 Star Point Ground.....</i>	<i>23</i>
10	Overhead Service Requirements.....	23

1 Introduction

This specification is intended to provide the minimum technical requirements for the design and installation of a Primary Service (i.e. electrical Services with nominal voltages greater than 750 volts but less than 50,000 volts) within the Hydro Ottawa Service territory. Customers or their agents shall initiate inquiries concerning Primary Services with Hydro Ottawa and shall be responsible to ensure that they have their most updated specification.

Hydro Ottawa assumes no responsibility in any event when this specification is not followed within HOL, Service territory. The latest approved revision of this document is available on the Hydro Ottawa Website.

2 Reference

- ECG0005 - Commercial Primary Service Electrical Ownership Demarcation Customer Owned Transformer.
- ECG0008 - Distribution System Voltage and Power Quality.
- ECG0009 - Commercial Primary Service Electrical Ownership Demarcation Hydro Owned Transformer.
- ECS0003 - Switching Arrangement 13.2kV Loop System (300-7000kVA) - Single Line.
- ECS0004 - Switching Arrangement for Indoor Metalclad 13.2kV Loop System (above 7000kVA) - Single Line.
- ECS0005 - Typical Transformer Vault \leq 3000kVA with Full Switchgear - Construction Detail.
- ECS0012 - Hydro Ottawa Limited - Conditions of Service.
- ECS0013 - 13.2 kV Customer Owned Switchgear General Guideline.
- ECS0016 - Typical Transformer Vault \leq 1500kVA with Compact Switchgear - Construction Detail
- ECS0031 - Digital Base Mapping Requirements for Electrical Servicing.
- EGS0001 - Grounding Stud - Construction Detail.
- GCS0005 - Installation of Civil Works for Underground Distribution.
- GCS0008 - Revenue Metering Specification.
- GCS0032 - Primary Metering Specification.
- GQS0002 - Civil Contractor Qualifications To Work On or Around Hydro Ottawa Electrical Underground Distribution System.
- UCS0001 - Transformer Base & Pad 3 Phase 150kVA-2500kVA - Construction Detail.
- UCS0004 - Transformer or Switchgear Base & Pad - Construction Detail.
- UCS0025 - Manhole Precast 2 Way Switching 612 - Construction Detail.
- UCS0026 - Switchgear Pad & Base - Construction Detail.
- UCS0028 - Manhole Precast Pulling Chamber Pad - Construction Detail.
- UDS0001 - Duct Concrete Cross Sections - Construction Detail.
- UDS0009 - Building Vault Supply Cable Pulling Chamber - Construction Detail.
- UDS0023 - Duct Pole Lateral for Wood Pole - Construction Detail.
- UFS0001 - Bollards Protective - Construction Detail.
- UGS0002 - Grounding Transformer or Switchgear Base - Grounding Detail

- UGS0004 - Grounding Transformer & Switchgear Bases Side By Side - Grounding Detail
- UGS0005 - Grounding Precast 2 Way Switching Manhole 612 - Grounding Detail.
- UGS0007 - Grounding Transformer Base & Switchgear Manhole Combination Side by Side - Grounding Detail.
- UGS0008 - Grounding Transformer Base & Switchgear Manhole Combination End to End - Grounding Detail.
- UTS0038 - Transformer Clearances Transformer & Switchgear Pad - Clearance Detail.
- Ontario Electrical Safety Code.
- Ontario Building Code.

3 Scope

This specification applies to new Primary Services and/or changes to existing Primary Services to be supplied and installed by Hydro Ottawa and/or the connection of a Customer owned installation to the Hydro Ottawa main distribution system. Note that this document does not cover the design of a Customer owned Primary Service beyond the Ownership Demarcation Point.

This specification should be reviewed in concert with Hydro Ottawa's Conditions of Service (ECS0012) to obtain a broader understanding of site servicing. If there are any discrepancies with this document and the most current revision of HOL's Conditions of Service, the Conditions of Service shall take precedence, unless the Conditions of Service creates a hazard or conflicts with provincial or federal regulations.

Deviation from this specification shall be submitted to Hydro Ottawa for review and approval prior to construction. Hydro Ottawa reserves the right to refuse to energize any installation that does not meet these installation requirements.

Nothing contained in this specification shall prejudice or reduce any regulation or requirement of the Ontario Electrical Safety Code (OESC) or of the Ontario Building Code (OBC). If there is a conflict between this specification and either the Ontario Electrical Safety Code or Ontario Building Code; the more stringent requirement applies.

4 Definitions

“Customer” has the meaning ascribed to it as per Hydro Ottawa Conditions of Service.

“Electrical Equipment Vault” an isolated enclosure, either above or below ground, with fire-resisting walls, ceilings and floors for the purpose of housing transformers and other electrical equipment.

“Expansion” has the meaning ascribed to it as per Hydro Ottawa Conditions of Service.

“Hydro Ottawa Limited (HOL)” local distribution company.

“Integrity” has the meaning ascribed to it as per Hydro Ottawa Conditions of Service.

“**Offer to Connect**” has the meaning ascribed to it as per Hydro Ottawa Conditions of Service.

“**Ownership Demarcation Point**” has the meaning ascribed to it as per Hydro Ottawa Conditions of Service.

“**Primary Service**” means any electrical Service which is supplied with a nominal voltage greater than 750 volts but less than 50,000 volts.

“**Primary Voltage**” means any voltage between 750 volts and 50,000 volts.

“**Service**” has the meaning ascribed to it as per Hydro Ottawa Conditions of Service.

“**Shared Electrical Equipment Vault**” an indoor installation of Hydro Ottawa owned equipment (normally in a Customer owned building) used to supply local small Services. The transformation used can be either from shared transformers used to Service the Customer building or additional transformers installed in the vault dedicated to Hydro Ottawa needs. The available transformation depends on the type of agreement made with the Customer.

“**Supply Point**” has the meaning ascribed to it as per Hydro Ottawa Conditions of Service.

5 Primary Service General Information

Please refer to the following sections in Hydro Ottawa’s Conditions of Service:

Section 2.3.4 Standard Voltage Offerings.

Section 3.2.2 Service Requirements for the maximum supply capacity available from the Hydro Ottawa secondary distribution system. When the maximum demand of an undivided property exceeds these levels, the Customer shall make provisions for a site Primary Service installation.

Section 3.3 for general information on Primary Voltage Supply.

Appendix A: Load Summary Form

Appendix F: Tables A and B - Primary Service Connection - for maximum power supply that can be supplied from Hydro Ottawa’s primary distribution system.

- The Primary Service voltage will be based on the estimated site electrical demand and/or the capacity of the Hydro distribution system in the vicinity of the proposed development.
- The Primary Service option(s) and Service voltage shall be confirmed by Hydro Ottawa when processing the application for Service.

Depending on the site location, the proposed building layout and the site electrical demand, Hydro Ottawa may provide different types of Primary Service installation:

- Outdoor type using pad-mounted type equipment,
- Indoor type using electrical vault type equipment, or
- Mixed type using both indoor and outdoor type equipment.
- Overhead type - if we really must

At the Customer's request, Hydro Ottawa can provide Primary Service option(s) and/or budgetary estimate(s), to Service a site from the Hydro Ottawa main power distribution system. However, Hydro Ottawa cannot formally guarantee that it will maintain its initial options and/or estimates, until a formal application and funding for Service has been received and processed by Hydro Ottawa, and unencumbered land access is certain.

The electrical equipment associated with a Primary Service may be supplied and owned by Hydro Ottawa, provided that the voltage levels required, are in accordance with Hydro Ottawa standards, and that the Customer accepts the Offer to Connect prepared by Hydro Ottawa.

If Hydro Ottawa's standard Offer is rejected, as set out in Hydro Ottawa's Condition of Service (ECS0012) Alternate Bid Process, the Customer can opt for a Customer owned Primary Service installation. In such cases, Hydro Ottawa approval is still required and the Customer shall assume full responsibility for the operation, maintenance and replacement of Customer owned Primary Service components.

The roles and responsibilities for the supply and installation of the Primary Service equipment shall be as defined in the final approved revision of the Offer to Connect. In all cases the revenue metering shall be supplied and installed by Hydro Ottawa.

There are two Ownership Demarcation Points - civil and electrical. The civil Demarcation Point is normally the property line unless there are land rights in place. The electrical Demarcation Point is normally the secondary spades of the transformer. Other electrical Demarcation variations occur depending on primary equipment and ownership involved. Refer to ECG0005 and ECG0009 for electrical Demarcation Point examples. Hydro Ottawa will own all the civil and electrical equipment associated with a Primary Service from the Supply Point to the individual Ownership Demarcation Points. Beyond the Ownership Demarcation Points, all equipment shall be owned by the Customer with the exception of the metering equipment and other equipment as identified in Hydro Ottawa's Conditions of Service section 3.1.1. The Customer owned equipment shall be specified and built according to the latest edition of the CSA standards or equivalent ULC Standards. Related Hydro Ottawa Technical Specifications and forms are available on Hydro Ottawa's website - www.hydroottawa.com. Hydro Ottawa recommends against the use of medium voltage dry type transformers for a Primary Service because the internal losses are so much higher than liquid filled transformers.

All medium voltage Customer owned Service equipment shall comply to Hydro Ottawa's specification ECS0036 - Customer Owned Switchgear for minimum equipment rating and other applicable equipment requirements.

To reduce the risk of financial and schedule losses to the Customer, it is recommended that no acquisition or manufacturing of materials and/or site work associated with the Primary Service installation, be started until the proposed design has been reviewed and accepted by Hydro Ottawa. Equipment nameplate information, shop drawings and transformer and other equipment line

loss information must be submitted to Hydro Ottawa for review and approval before manufacturing the vault equipment.

The Customer shall install, own, and maintain all the civil structures, protective bollards, grounding system, and auxiliary equipment (fences, ventilation, 120V systems such as lighting and receptacles) on their property unless there is a specific Hydro Ottawa agreement indicating otherwise.

The Supply Point, along with the route and number of primary ducts, the proposed location for the Primary Service equipment and references to applicable Hydro Ottawa engineering standards, shall be indicated on the Service drawing provided by Hydro Ottawa after the Offer to Connect has been agreed by all parties.

Hydro Ottawa's Conditions of Service provides minimum energy account requirements. With large complex Services the Customer may be required to enter into an Operating and Maintenance Agreement.

No Primary Service will be energized until the following conditions are satisfied:

- All the civil work has been completed by the Customer as specified by Hydro Ottawa.
- The Service equipment location and application is acceptable by Hydro Ottawa.
- All the electrical work has been completed by the Customer as specified by Hydro Ottawa.
- The work by Hydro Ottawa has been reviewed and approved for no undue hazard and under O. Reg. 22/04.
- A connection authorization has been received at Hydro Ottawa from the Electrical Safety Authority.
- An Electrical Operating and Maintenance Agreement is signed where applicable.
- The security performance deposits have been received at Hydro Ottawa where applicable.
- The land rights have been provided where applicable.
- Any other conditions as outlined in the Offer to Connect document.

Where there is Hydro Ottawa overhead powerlines, refer to Hydro Ottawa's minimum safety clearance requirements (OLS0002) for building placement.

Buildings are to be kept clear from Hydro Ottawa land rights, eg. easements.

6 Application for Primary Service with Hydro Ottawa

A Customer planning a Primary Service for a newer development and/or an owner planning changes and/or the addition of electrical loads to an existing Service, shall contact Hydro Ottawa at least 10 months (24 months or more if a major system Expansion of HOL's distribution system is required) in advance of desired connection date, to determine the availability of electric Service facilities including voltage, underground or overhead supply and metering.

Prior to Hydro Ottawa preparing an Offer to Connect or starting on the design of a site power distribution system (for a multi-building development and/or the design of a Primary Service for

a newer single building development), the site information as outlined in Conditions of Service section 3.3.3 is to be provided by the Customer to Hydro Ottawa.

Prior to Hydro Ottawa starting work on a Service upgrade, the site information as outlined in Conditions of Service section 3.3.3 is to be provided by the Customer to Hydro Ottawa. If the existing transformer(s) need to be replaced and/or upgraded, the completed load summary (Conditions of Service Appendix A) shall be submitted to Hydro Ottawa at least 8 months prior to the date when the transformer(s) are required on the project site.

7 Generic Primary Service Requirements

A typical underground Primary Service installation includes underground duct bank (including spare conduits), high voltage cable(s), high voltage switchgear and/or transformers to suit. All this equipment shall be installed on the Customer's property in a location approved by Hydro Ottawa.

A typical overhead Primary Service installation includes poles, anchors, high voltage cutouts, fuses, lightning arrestors, conductor(s), switchgear and/or transformers to suit. All this equipment shall be installed on the Customer's property in a location approved by Hydro Ottawa.

Hydro Ottawa will endeavor to work with the Customer and/or its agent, to determine a mutually satisfactory location for the Primary Service equipment, to be supplied and installed by Hydro Ottawa; however, the final location of the equipment shall be at the determination of Hydro Ottawa.

Bushes, trees, walls, fences or other obstructions shall not be permitted within the equipment safe clearance area for pad-mounted equipment as per UTS0038. For specific information about tree locations, refer to Hydro Ottawa's Tree Planting Advice brochure, available online at www.hydroottawa.com.

All aspects of a Customer owned Primary Service installation, shall be subject to inspection by the Electrical Safety Authority. In addition, all civil work and electrical installation between the Supply Point and the Ownership Demarcation Point, shall be done in accordance with Hydro Ottawa approved Service drawing and applicable Hydro Ottawa engineering standards.

Existing Primary Services requiring an upgrade must be brought up to the current version of this standard.

The concrete encased duct bank for Hydro Ottawa Primary Service cable(s) (valid for both inside and outside type installation), must be inspected by Hydro Ottawa before concrete is poured. The civil contractor shall meet the minimum requirements of GQS0002 to install underground electrical structures.

Number of spare conduits required for a Primary Service is dependent on the type of Service.

- Simple radial Primary Service – one(1) spare conduit
- Simple looped Primary Service – one(1) spare conduit
- Looped Primary Service from two locations – two(2) spare conduits (one from each location).

- Complex campus Primary Service – one(1) spare conduit for each circuit feeding campus.
- Shared vault – eight(8) spare conduits for future secondary and primary feeders.

It is the Customer's responsibility to ensure that all safety standards are met while constructing a Primary Service.

Hydro Ottawa will assume no responsibility for the costs incurred by the Customer, in providing or making changes to plans and/or structures, to meet the minimum requirements for primary power Services set by Hydro Ottawa. Hydro Ottawa assumes no responsibility for any charges incurred by the Customer, to maintain and/or to improve the Primary Service after it is energized. The Customer is encouraged to contact Hydro Ottawa as soon as practical with any proposed changes so that Hydro Ottawa may determine if there is any impact with its proposed Service Offering.

Hydro Ottawa supplied transformation will depend on availability of distribution voltage levels. Please see Hydro Ottawa's Conditions of Service ECS0012 Appendix F for Hydro Ottawa best case maximum transformation. The standard secondary nominal voltages supplied from Hydro Ottawa owned transformers are as in Conditions of Service Section 2.3.4 - Standard Voltage Offerings. The Customer should design their electrical system to meet the Distribution System Voltage and Power Quality (ECG0008) requirements.

In locations where primary transformation is supplied by Hydro Ottawa, secondary metering is mandatory. For more details on revenue metering, please refer to Hydro Ottawa's Metering Specifications (GCS0008).

Hydro Ottawa encourages the Customer to design their Primary Service for ease of future maintenance so that they may enjoy a safe and reliable Service.

Equipment ownership will be consistent with Hydro Ottawa Conditions of Service and existing agreements.

Primary and Secondary Cables in manholes and Electrical Equipment Vaults must be placed neatly on wall racks around the outside walls. Refer to GCS0004 Sections 10 and 11 and GCG0001 Installation & Testing of Underground Primary and Secondary Power Cables.

Prior to energizing, Hydro Ottawa will conduct an on-site inspection. Our inspection is to verify conformance to the applicable specifications and/or practices and includes visual inspection only. It is not intended to ensure the ongoing safe and reliable operation of the equipment.

The rating of the Customer owned equipment will be verified to agree with ECS0036 and the manufactured shop drawing submitted for review.

The site and/or building power distribution will be verified to agree to the single-line diagram submitted for review.

The nomenclature of the Customer owned equipment will be verified to match Hydro Ottawa operating records.

The access to the Customer owned equipment will be verified to agree with Hydro Ottawa operating practices and equipment accessibility.

8 Outdoor Type Primary Service Requirements

An outdoor type Primary Service is Hydro Ottawa's preferred Service option, if the proposed development allows for pad-mounted equipment and the equipment is provided with proper access for operation and maintenance.

An outdoor type Primary Service may require the installation of pad-mounted transformer(s) along with a pad-mounted switchgear unit, depending on the type of Primary Service (radial, twin radial or loop Service). The type of Primary Service shall be specified by Hydro Ottawa to suit the proposed Supply Point.

Pad-mounted Primary Service equipment shall be situated outside the buildings or structures and shall be completely free of overhead structures, planting or encumbrances of any sort.

Refer to Hydro Ottawa specification UTS0038 for clearance requirements around Hydro Ottawa pad-mounted equipment. All installations shall meet or exceed minimum clearance to buildings or structures as specified in Ontario Electrical Safety Code & Ontario Building Code. The area around pad-mounted equipment must be flat and equipment shall not be located in low areas or on buildings or garage structures.

Pad-mounted equipment shall not be located inside the 15m site line triangle, (per City of Ottawa) or within three meters of entrances to the property in urban areas. This is to ensure proper visibility for drivers entering and exiting the property. Refer to the City of Ottawa's Guidelines for Utility Pedestals within the Road Right-Of-Way.

Pad-mounted equipment shall always remain accessible to utility vehicles equipped for installation, removal, maintenance and operation of the equipment. Access-ways to equipment sites in grass areas require a solid, well drained base under the grass. The area should be capable of supporting vehicles and equipment, having a maximum bearing weight of 31,735kg/ m² [6500lb/ ft²], without creating a depression of more than 50mm [2in]. In order to meet the above criteria, the Customer may be required to use an appropriate fill material and/or install a soil stabilization system such as Geoweb cellular confinement system.

All Hydro Owned pad-mounted service equipment shall sit on precast or poured concrete base or underground cable chamber as specified by Hydro Ottawa; refer to UCS0001, UCS0003, UCS0025 or UCS0026 for Hydro Ottawa equipment base requirements.

Pad-mounted equipment must be installed on 612 manholes in the following situations:

- Pad-mounted switchgear connected to Hydro Ottawa dual radial or looped circuit.
- Pad-mounted transformers feeding more than one Service.
- Pad-mounted transformers of 750kVA or greater if loop circuit capable.
- Pad-mounted transformers of 1000kVA or greater

Hydro Ottawa outdoor type Primary Services are not permitted where construction is planned from lot line to lot line in the “downtown”, where in-sufficient space is available, or in areas where total underground conversion may be planned. These installations may require the installation of an Electrical Equipment Vault normally situated within the building; refer to Section 9.0.

The installation and location of pad-mount transformers shall be in accordance with the Ontario Electrical Safety Code’s latest edition, particularly in regard to building openings and combustible materials. All newer pad-mounted transformers supplied and installed by Hydro Ottawa, are protected by internal current limiting fuses and equipped with a pressure relief device.

Protective bollards as shown in drawings UFS0001 may be required at pad-mounted Primary Service equipment as instructed by Hydro Ottawa.

Pad-mounted equipment shall have a ground grid installed as specified by Hydro Ottawa; refer to UGS0002, UGS0004, UGS0005, UGS0007 or UGS0008 for Hydro Ottawa grounding requirements at Pad-mounted equipment. Hydro Ottawa must check the ground resistance after the electrodes are installed and before backfill. Please call Hydro Ottawa to have the ground resistance measured. The total equivalent resistance shall be 25 ohms or less.

Non-current carrying metal equipment and structures, within 2400mm of electrical pad-mounted equipment, shall be located within the equipment ground grid and bonded to the equipment ground grid, to prevent the built-up of potential differences between the equipment or structures and the nearby earth as per the Ontario Electrical Safety Code.

A horizontal clearance of 3000mm [10ft] from the edge of the pad-mounted equipment shall be maintained to all above grade facilities such as fire hydrants, cell towers, or other foreign structures.

A horizontal clearance of 7600mm [25ft] from the edge of the pad-mounted equipment shall be maintained to the closest point of all above grade gas piping, fuel lines and fuel storage tanks. Where this clearance cannot be achieved; an additional safeguard, such as fire resistant barrier, shall be necessary and be approved in writing by the Fire Department inspector.

9 Indoor Type Primary Service Requirements

Indoor type Primary Service equipment (such as primary cables, switchgear, and oil filled vault type transformers) supplied and installed by Hydro Ottawa, shall be housed in an Electrical Equipment Vault, in accordance to Hydro Ottawa requirements and other applicable codes and standards.

In addition to the information required in Section 6.0, the Customer shall provide the following drawings:

- A mechanical system drawing to show the Electrical Equipment Vault ventilation details, complete with ventilation controls.
- A mechanical system drawing to show transformer oil containment details.

- An equipment layout drawing complete with elevation profile, to show all the electrical equipment as specified by Hydro and all the vault support systems as per Section 9.3.

Customer owned equipment (primary switchgear, secondary switchboard, meter base, Customer owned transformers etc.) or other building Service equipment, shall not be contained within the Hydro Ottawa Electrical Equipment Vault without prior approval by Hydro Ottawa.

The structural details of the Electrical Equipment Vault and mechanical support systems shall be inspected by the local building inspector. The vault electrical support systems (such as lighting, receptacles, ventilation, fire detection, grounding etc.), shall be inspected by the Electrical Safety Authority (ESA).

The electrical vault and the Primary Service equipment up to the Ownership Demarcation Point shall be under the exclusive control of Hydro Ottawa.

The Electrical Equipment Vault shall be accessible to Hydro Ottawa operation personnel at all times (24-7) and shall be locked with Hydro Ottawa standard padlock. Failure to gain access could result in undue power outage to one or more Services/Customers.

9.1 Electrical Equipment Vault Location, Size & Access Requirements

9.1.1 Electrical Equipment Vault locations shall allow for convenient installation of incoming primary cables and equipment.

The Electrical Equipment Vault shall be located in such a way as to avoid ducts running through the building whenever possible. A location on the ground floor next to an outside wall, close to the point of supply and directly accessible from the outside is desired. To reduce the owner's costs of redesign, it is recommended that the architects discuss the Electrical Equipment Vault location with Hydro Ottawa before the plans are finalized.

The Electrical Equipment Vault may be located no lower than one level below the ground floor provided that precautions are taken against flooding and high humidity and provided that the requirements for personnel and equipment access are met. Any locations below the first basement level and above the ground floor level are deemed unacceptable.

An Electrical Equipment Vault will not be accepted below grade where it does not occupy part of a full basement or is the lowest location of the building. The floor in the vault must be at the same level as, or higher than the surrounding floor.

The Electrical Equipment Vault if located below grade may extend past the building footprint, however, not in an area which is subject to salt or similar treatments like entrances and ramps. The vault construction must include a waterproofing system; refer to Section 9.2 for Electrical Equipment Vault Construction Requirements.

An Electrical Equipment Vault shall not be located under garage ramps whether inside or outside the building footprint.

An Electrical Equipment Vault should not be located adjacent to areas where cold floors and/or walls may be problematic due to low vault temperature in the vault in the winter. The inside of the Electrical Equipment Vault shall not be insulated against cold. *ie, Insulation materials fixed directly to the inside walls are not permitted. Plywood or gyprock walls with studs and insulation are also not permitted.*

An Electrical Equipment Vault shall not be located adjacent to an apartment or suite due to transformer noise. The effect of low frequency vibrations produced by the transformers may be a problem, especially for a building with sleeping accommodations. Transformer noise and vibration can be controlled by installing vibration pads under each transformer, at the Customer's cost. In all cases, the area surrounding the vault shall be insulated. Again, insulating materials are not permitted inside a vault. Hydro Ottawa will assume no responsibility for transformer noise in a building if the transformer noise level meets CSA standards.

9.1.2 Electrical Equipment Vault Size Requirements

When transformers and/or switchgear(s) are to be located in a single vault, the floor area shall not be less than indicated below. The final floor area shall be confirmed during the detail design phase to suit the building structural details and/or other physical constraints of the proposed vault.

Number of Switchgear	Number of Transformer Banks	Minimum Vault Area
1	0	25m ² [270ft ²]
1	1	46m ² [495ft ²]
1	2	80m ² [861ft ²]
Shared Electrical Equipment Vault		Consult HOL

Operating space of 3000mm [10ft] or more, to allow sufficient clearance to work the dead break elbows and or train primary cables, shall be provided at the rear of switchgear unit(s). The switchgear front aisle shall be wide enough to operate the gear and in any case should not be less than 1500mm [5ft].

The floor to ceiling height is dependent on the size and type of transformer. Lowering the vault floor level to achieve this height is unacceptable. Refer to table below.

Required Height of Electrical Equipment Vault	
Low profile hi-voltage switchgear only	2,450mm [8 feet]
Up to and including 333kVA transformers	2,450mm [8 feet]
500kVA –833kVA transformers	2,750mm [9 feet]
1000kVA or larger transformers	3,000mm [10 feet]

9.1.3 Personal Access Requirements

Access to an Electrical Equipment Vault shall be directly from outside the building or through the building via public area.

The Electrical Equipment Vault personnel access door shall lead directly into the operating area and shall be located as close as possible to the transformer protective device operating position.

If access to the vault operating area is from a garage structure, then parking shall not be permitted in front of the vault door and a "No Parking" sign must be installed on the door. Hydro Ottawa reserves the right to tow any vehicle parked in front of the vault door at the Customer's expense.

A safe emergency exit route from the Electrical Equipment Vault operating area and enough space to open the vault door fully must be provided.

9.1.4 Equipment Access Requirements

The equipment access route through a building must be reviewed by Hydro Ottawa and sized to meet or exceed Section 9.2.4 (Personal & Equipment Doors).

The required clear height for the access route must not be compromised by any duct, pipe or devices suspended from the ceiling along the access route. In addition, clear height along ramps must be carefully reviewed, as reduced clearances are often encountered partway down ramps.

Indoor stairways or elevators will not be accepted as part of the equipment access route to an Electrical Equipment Vault. Hydro Ottawa may allow the access route to involve a properly rated freight elevator where the building has a permanent backup generator supplying the freight elevator.

An access well leading directly to the Electrical Equipment Vault from the outside is the preferred way of moving equipment in and out of the vault if the vault is located in the basement. A door opening into the well is required between the vault and the well. This door shall be locked from the inside with two draw bolts. The well shall have a drain and a 100mm [4in] curb. The well shall also be suitably covered and accessible to a line truck or crane.

If access to the vault equipment area is from a garage structure, then parking shall not be permitted in front of the vault door and a "No Parking" sign must be installed on the door. Hydro Ottawa reserves the right to tow any vehicle parked in front of the vault door(s) at the Customer's expense.

A lane shall only be used as part of an access route to an Electrical Equipment Vault if it is a public lane, or if it is a private lane wholly owned by the Customer and subject to no easements or rights-of-way. This lane shall also be maintained in good condition and clear for line truck or crane access year round.

9.2 Electrical Equipment Vault Construction Requirements

In addition to Hydro Ottawa requirements, the design and construction of a building Electrical Equipment Vault shall satisfy all applicable codes and standards to include but not limited to the Ontario Electrical Safety Code and the Ontario Building Code. Three (3) hour fire rated walls and ceiling for vaults containing transformers, Electrical Equipment Vaults containing only switchgear that are supplied by looped circuits or dual radial circuits must also be three (3) hour fire rated. Walls shall be constructed of concrete block or poured concrete to a three (3) hour rating.

HOL equipment is seismically rated. The Customer is responsible for the design and installation of any additional seismic restraint required by the building code and/or building inspector.

In no instance will Hydro Ottawa rely on fire extinguishing systems to lower the fire separation requirements applicable to the design and construction of a building Electrical Equipment Vault.

An Electrical Equipment Vault housing Hydro Ottawa equipment shall not be sprinklered. Refer to Section 9.3.7 for fire detection.

The Electrical Equipment Vault construction must include a water proofing system. The proposed waterproofing system must be reviewed by Hydro Ottawa. As a minimum, the vault ceiling slab and walls shall be waterproofed on the outside 3,000mm [10 ft] beyond the perimeter of the vault. The final grading of the area shall be such that water will flow away from the vault.

Equipment housekeeping pads are not allowed in Electrical Equipment Vaults,

The floor at any location within the Electrical Vault and along access routes must have adequate strength to support Hydro Ottawa's transformers. The maximum mass of Hydro Ottawa's stock vault transformers is 5000kg with an approximate area of one-square meter. Typically 3 or more transformers installed within each Electrical vault. Please contact Hydro Ottawa should further equipment load information be required for the Electrical Vault structural design.

The interior of the Electrical Equipment Vault shall be neatly painted with two coats of concrete water base paint. The ceiling and sidewalls shall be painted white and the floor shall be painted grey. A non-flammable epoxy is recommended on the floor.

The construction of the Electrical Equipment Vault must be completed and accepted by Hydro Ottawa prior to Hydro delivering the vault equipment and/or starting work within the vault.

9.2.1 Service Duct Banks

The Service duct bank shall be painted red where they are exposed inside the building and marked with "Danger High Voltage" every 6,100mm [20ft] or in each individual vault.

A 100mm [4in] nominal diameter mandrel and brush approved by Hydro Ottawa shall be pulled through each duct by the contractor in the presence of a Hydro Ottawa inspector. One 6mm [1/4in] polypropylene rope shall be left in each duct.

The Service duct bank entrance to a building and/or vault shall be built at such an elevation, that the conduit shall slope away from the building and be drained into a manhole. Refer to underground duct specs for entry type and waterproofing.

9.2.2 Cable trenches

Floor cable trenches outside or within the equipment vault may be required by Hydro Ottawa to suit the proposed equipment layout.

Cable trenches which are less than or equal to 610mm [24in] deep shall be 410mm [16in] wide. Trenches up to 1,200mm [48in] deep shall be 760mm [30in] wide. No cable trenches shall be less than 2,450mm [8ft] long. No sharp corners are allowed in cable trenches.

Trench cover plates shall be a minimum thickness of 10mm and a maximum mass of 18kg. Trench cover plates are to be designed to hold the weight of the heaviest piece of equipment and moving devices if the trench is on the path of equipment installation or removal.

9.2.3 Cable pulling eyes

Cable-pulling eyes shall be installed at locations designated by Hydro Ottawa, normally at the end of the cable-pulling trench opposite the duct entry point and/or on a wall or ceiling opposite the Service duct entrance.

Cable pulling eyes must be designed to handle the following pulling tensions:

- 13kV Electrical Equipment Vaults 15,000lbs (6,800kg)
- 28kV Electrical Equipment Vaults 22,000lbs (10,000kg)

9.2.4 Personal and Equipment Doors

All doors and doorways to the Electrical Equipment Vault including the vault equipment access door(s) shall not be less than:

Door Size for Electrical Equipment Vault	
Person access only	910mm x 2,130mm [3ft x 7ft]
Low profile hi-voltage switchgear only	1,220mm x 2,130mm [4ft x 7ft]
Up to and including 333kVA transformers	1,220mm x 2,130mm [4ft x 7ft]
Greater than 333kVA – including 833kVA transformers	1,520mm x 2,440mm [5ft x 8ft]
1000kVA or larger transformers	1,830mm x 2,740mm [6ft x 9ft]

Vault personnel access door(s) shall not be less than 910mm x 2,130mm [3ft x 7ft] in size.

A fire door shall normally be closed and shall also be equipped with a device to hold the door open when personnel are inside the vault.

All doors and gates shall open out from the vault and no doors shall provide access directly into the energized area.

All door locks and operating mechanisms must be heavy-duty type and capable of securing the door to make unauthorized entry as difficult as possible.

All double doors with internal hardware shall have a steel astragal to cover the gap between the doors. An astragal on single door or doors with external hardware shall be installed at the request of Hydro Ottawa.

Doors used for personnel access only or for both personnel and equipment access, must be capable of being locked from outside and being operated from both inside and outside. If a double door is used, the inactive door must be equipped with two 20mm x 254mm [3/4" x 10"] bolts located on the inside at the top and bottom in addition to any internal locking mechanism.

Doors used only for equipment access shall be capable of being locked and opened from inside the vault only. A single door shall be equipped with two 20mm x 254mm [3/4" x 10"] bolts and a double door shall be equipped with four 20mm x 254mm [3/4" x 10"] bolts located on the inside at the top and the bottom of both doors. These bolts are in addition to any internal locking mechanism.

The final location of the equipment and/or personal access doors shall be reviewed and confirmed by Hydro Ottawa to suit the proposed equipment layout.

On door(s) to the outside, the hinges and locking hasps shall be designed to minimize their exposure to the outside weather conditions.

9.2.5 Sump

A sump shall be provided if the Electrical Equipment Vault is provided with vault type [oil filled] transformers. The floor shall slope to a drain located in the fenced area in front of the transformers to suit. The drain shall connect to a floor sump located in the operating area. The sump shall be designed to hold the oil of the largest transformer but cannot be smaller than 610mm x 610mm x 610mm [2ft x 2ft x 2ft] minimum dimensions.

As with trench cover plates; the oil sump steel cover plate shall be a minimum thickness of 10mm and a maximum mass of 18kg. Oil sump cover plates are to be designed to hold the weight of the heaviest piece of equipment if the sump is on the path of equipment installation or removal.

Multiple floor drains may be required if multiple banks of transformers are in the vault and are separated too far from each other.

Another option is to use a steel oil tank located in a separate room below the vault to capture the oil.

Removable curbs are required at all doorways. These curbs shall be installed and sealed with approved caulking material after completing the electrical equipment delivery.

9.2.6 Fence

A fencing structure is required between the operating area and the live front equipment to restrict personnel access and protect against accidental contact. Typically the fence structure will be installed after installation of the electrical equipment complete with the cable support structures and/or raceways.

The fence shall be made of chain link fabric and a minimum height of 2,130mm [7ft] and provided with equipment access gate(s) to match the equipment access door; refer to 9.2.4 (Personal & Equipment Doors). The gate(s) shall be equipped with hinges and latch catch and arm or hasp lockable with a Hydro Ottawa padlock.

The chain link fabric used in the fence and gate shall be an 11 gauge galvanized steel wire with a 51mm [2"] opening. Tension shall be applied to the fabric between posts using "draw or tension" bars and the bars shall be fastened to each post with 4 draw bar bands.

The posts should be made in two sections as follows:

- The main post shall be 2-1/2" [63.5mm] Schedule 40 galvanized pipe, 2,130mm [7ft] long with a 100mm x 76mm x 6.4mm [4" x 3" x 1/4"] plate welded to one end.
- The top post shall be 2" [51mm] Schedule 40 galvanized pipe, minimum 910mm [3ft] long with a 76mm x 76mm x 6.4mm [3" x 3" x 1/4"] plate welded on one end.
- The top post will slide inside the main post. The main post shall be bolted to the floor and the top post shall be bolted to the ceiling.

The fence structure shall have no impact on the operation and maintenance of the electrical equipment and shall allow for equipment replacement without having to remove or disturb the fence.

9.3 Electrical Equipment Vault Support System Requirements

9.3.1 Ventilation for Electrical Equipment Vaults Containing Transformers

All Electrical Equipment Vault ventilation systems shall be built according to the latest edition of the Ontario Electrical Safety Code and the Ontario Building Code.

The ventilation openings shall be located to provide ventilation across the transformer area from the floor, through the transformer cooling fins to the ceiling area. Ventilation openings shall be kept away from the switchgear and exposed high voltage equipment. In no case shall the ventilation openings be placed so that blowing snow or rain enters the vault.

When a ventilation opening is not covered by an external duct or is in an accessible ventilation well, it shall not be located next to unshielded electrical apparatus and shall be equipped with a two-way louver, which will prevent anything from being pushed through.

A 13mm [1/2"] mesh screen must be mounted on the inside of all vault ventilation openings and at the exterior of the building if ducts are used.

Fire dampers are required at the vault ventilation openings as per the Ontario Building Code.

All equipment-controlling thermostats shall be located in the operating area.

A high temperature alarm with its own thermostat is required in all electrical vaults containing transformers. An alarm bell and strobe must be installed outside above or beside the door of the vault a shutoff switch is not to be included.

All mechanically operated devices must be accessible or repairable from outside the vault or in the operating area of the vault.

Thermostats shall be set according to the following schedule:

- Dampers → 18°C [65°F] OPEN ↑
- Fans → 27°C [80°F] ON ↑
- Hi Temp Alarms → 43°C [110°F] ON ↑

9.3.2 Natural Ventilation

When using natural ventilation both intake and exhaust openings must be sized to 3 sq. in / kVA [1900mm² / kVA].

Motorized damper(s) are required, and shall be controlled by their own thermostat. In vaults where more than one motorized damper is used, each damper will require its own thermostat.

9.3.3 Forced Ventilation

Fan(s) shall be located on the exhaust side of the ventilation system.

The exhaust fan(s) shall be sized to provide 1.9 l/sec [4 cfm] of ventilation per transformer kVA, based on the total kVA of transformation installed. The capacity of the exhaust fan(s) shall be stated on the vault drawings.

Each fan and motorized damper(s) must be controlled by their own thermostat located in the operating area.

9.3.4 Signs and Safety Measures

All doors, including those for equipment access, shall have signs supplied and installed by Hydro Ottawa. The signs include the Electrical Equipment Vault nomenclature label, an electrical warning sign, and Hydro contact information.

9.3.5 Vault Lighting

Electrical Equipment Vault must be illuminated to 200-500 lux (20-50 fc). Wherever possible, lights shall be mounted on the vault walls 1,980mm [6.5ft] above the ground level or suspended from the ceiling at a height of 2,440mm [8ft]. All lights must be LED strip fixtures and kept away from exposed high voltage equipment to facilitate re-lamping without power disruption. A minimum of three lights is required in a three-phase vault and two lights for a single-phase vault. In each case, there shall be at least one light in the operating area.

The light switch shall be inside the operating area within 300mm [1ft] of the personnel access doorframe. This lighting circuit shall be on its own breaker fed from the emergency generating system.

9.3.6 Emergency Vault Lighting

Further to the lighting in Section 9.3.5 above, each vault shall be equipped with an automatic emergency light located in the operating area near the door. The DC battery pack shall be located outside the vault for testing purposes if applicable.

9.3.7 Vault Fire Protection and Fire Detection

The Electrical Equipment Vault shall be totally enclosed by a fire separation of solid masonry or concrete construction having a fire-resistance rating of not less than 3 hours.

The Electrical Equipment Vault shall be dedicated to contain electrical equipment only.

The fire detection system shall be designed, so that it can be maintained and tested without the need to de-energize the Electrical Equipment Vault.

9.3.8 120V Receptacles

All Electrical Equipment Vaults shall contain one 120-volt duplex receptacle outlet located in the operating area. This outlet shall be on its own breaker fed from the emergency generating system.

9.3.9 Cable support

The Customer shall furnish and install the primary and secondary cable support in the vault where indicated by Hydro Ottawa. Typically the installation of the cable support will be installed after delivery and installation of the main electrical equipment.

9.4 Electrical Equipment Vault Grounding

Grounding shall be installed according to The Ontario Electrical Safety Code and Hydro Ottawa proposal drawing. Where artificial electrodes are used, Hydro Ottawa must check the vault ground resistance after the electrodes are installed and before the floor is poured. For all vaults, the total equivalent resistance shall be 15 ohms or less. Please call Hydro Ottawa to have the ground resistance measured.

A ground bus loop must be mounted to the interior vault wall with a minimum of 6mm [1/4in] bolts, lock washers and nuts spaced 1,220mm [4ft] apart. This bus shall be positioned at 150mm [6in] above the floor and spaced from the wall to allow the fastening of electrical connectors to the bus. This bus shall encircle the vault to allow all necessary components to be connected to it. To reduce the effect of circulating ground currents there is to be an open point in the ground bus at the door to the operating area. The ground bus loop shall be made of copper and sized according to the following:

- For vaults containing transformers 500 kVA and larger, the ground bus loop shall not be smaller than 6mm x 51mm [1/4in x 2in] or equivalent cross-sectional area.
- For vaults containing transformers smaller than 500 kVA, the ground bus loop shall not be smaller than 6mm x 25.4mm [1/4in x 1in] or equivalent cross-sectional area.

9.4.1 Connections to Ground Bus Loop

All bonding and grounding conductors shall be copper. The connections to the ground bus or to the device being bonded / grounded shall be made using compression connectors. Transformer tank bonding connections at the transformer tank and the ground bus loop shall be visible from the operating area of the vault.

The transformer tank shall not be bonded to the transformer secondary neutral terminal directly so that the tank does not become a path for neutral ground currents. If they are bonded together then the transformer tank shall not have a separate bond to the vault ground bus loop.

Each bank of transformers shall have the tank bonds and the neutral ground (star point) connected to the ground bus loop within a 2,000mm space (aka Transformer Ground Zone). This is to:

- To minimize the length of parallel ground paths.

- To minimize the length of circulating ground currents which cause additional equipment heating and EMFs that affect the occupancy and electrical equipment in adjacent rooms.

9.4.2 Transformer Tank Bonding

Transformer tank bonding shall be sized according to the following schedule unless the Ontario Electrical Safety Code requires larger conductors.

Tanks of transformers up to and including 333 kVA	2/0 AWG
Tanks of transformers 500 kVA	4/0 AWG
Tanks of transformers 667 kVA	250 MCM
Tanks of transformers 833 kVA	350 MCM
Tanks of transformers 1000 kVA	500 MCM
Tanks of transformers 1500 kVA	750 MCM
Circuit Breakers	2/0 AWG
All non-current carrying metal parts	No.4 AWG

9.4.3 Star Point Ground

The transformer secondary neutral bus shall be grounded in one location next to the transformer tank grounds (Transformer Ground Zone) inside the vault according to the following schedule:

Transformer Bank	Secondary Voltage	
	<u>347/600V</u>	<u>120/208V</u>
Up to and Including 3 x 167 kVA	2/0 AWG	250 MCM
3 x 250 kVA	4/0 AWG	350 MCM
3 x 333 kVA	250 MCM	600 MCM
3 x 500 kVA	350 MCM	1,000 MCM
3 x 667 kVA	500 MCM	1,000 MCM
3 x 833 kVA	500 MCM	N/A
3 x 1,000 kVA	600 MCM	N/A
3 x 1,500 kVA	750 MCM	N/A

10 Overhead Service Requirements

All aspects of a Customer owned overhead Primary Service installation, shall be subject to inspection by the Electrical Safety Authority. In addition, all work and electrical installation between the Supply Point and the Ownership Demarcation Point, shall be done in accordance with Hydro Ottawa approved Service drawing and applicable Hydro Ottawa engineering standards.

Overhead Services are typically only allowed in rural areas on very large properties.

(ie, farms or large government / industrial properties). Multi-pole structures (pole stands) for switching and/or transformers are not permitted whether for temporary or permanent use. Refer to HOL Conditions of Service section 3.3.

Hydro Ottawa will supply and install primary conductor from the supply pole to the first pole inside the Customer's property including an in-line fused disconnect at the Customer's pole. The electrical Ownership Demarcation Point for overhead Services is at the in-line fused cutout. Refer to ECG0005 fig 1 and ECG0009 fig 1. The first pole must be located just inside the Customer's property.

A gang operated overhead load-break switch is required on the first Customer pole rather than in-line switches in the following circumstances:

- If the Customer's load is to be greater than 300kVA.
- If there is greater than 10kVA of imbedded generation or energy resource facility (ERF).
- Customer is using a delta wired transformer.
- If there is a possibility of Ferroresonance.

The minimum in-line pole with an overhead transformer shall be 45ft Class 3.

New permanent structures (that are 'normally' occupied such as houses, garages, buildings, buildings with balconies, mobile trailer homes) shall not be located within the safe limits of approach (for <46kV, it is 3 metres from the maximum outward conductor swing) plus an additional 2 metres for building maintenance (such as painting, roofing, window washing, brick pointing); this would mean a minimum of 5 metre radial separation from the closest primary phase conductor. In addition, every attempt shall be made to keep existing buildings at least 2 metres horizontally outside of the closest primary phase conductor with respect to the vertical plane (from the ground to the primary phase conductor). On an individual (case-by-case) basis, portable and temporary (less than 1 year) structures such as garden sheds < 100 ft-sq and construction trailers may be installed directly under primary conductors where there is sufficient height (>3 m vertically from primary plus 2m for a person standing on top of the temporary structure) and the structure is grounded (minimum of <25 ohms with a #4 AWG Copper conductor to a 3 meter ground rod) although a reasonable attempt should be made to avoid such arrangements.

The maximum size of a pole transformer for both single phase and three phase (banked) applications is 100kVA.

Grounding at the time of installation must measure less than 25 ohms. Please call Hydro Ottawa to have the ground resistance measured.

Primary overhead metering is allowed when the Customer owns their own transformer and cannot meet Hydro Ottawa standard transformer losses. Refer to MCS0045 for Primary Metering Pole construction. 44kV overhead Services require primary metering.