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| Version | Date | Description of Revisions |
| 1 | August 30, 2006 | Approved final document. |
| 2 | February 19, 2010 | Modified ‘Related Sections’ |
| 3 | November 12, 2013 | Consolidation of all review comments, spec upgrade project. |
| 4 | July 28, 2014 | Changes to reflect renaming of commissioning specification and final review (AV) |
| **5** | **November 17, 2014** | **Updated, Finalized Specification – Reference eDOCS #5630515 v6 (AV)** |
| 6 | February 2, 2015 | Updated standards (ANSI/IEEE 837-2014) |
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NOTE:

This is a CONTROLLED Document. Any documents appearing in paper form are not controlled and should be checked against the on-line file version prior to use.

**Notice:** This Document hardcopy must be used for reference purpose only.

**The on-line copy is the current version of the document.**

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## Related Sections

### [Under "Related Sections", identify other Sections that are related to, and/or dependent on, the work results or information specified elsewhere. The list should be limited to Sections with specific information that the reader might expect to find in this Section, but is specified elsewhere. For example, if hardware for aluminum entrances is specified in the aluminum entrance Section, a cross-reference would be appropriate in the finish hardware Section. The purpose of this cross-referencing is for information only, to aid in finding those other requirements—not to define the scope of the Section.

### Cross-referencing here may also be used to coordinate assemblies or systems whose components may span multiple Sections and which must meet certain performance requirements as an assembly or system.

### Contractor is responsible for coordination of the Work.

### This Section is to be completed/updated during the design development by the Consultant. If it is not applicable to the section for the specific project it may be deleted.]

### [List Sections specifying installation of products supplied but not installed under this Section and indicate specific items.]

### Section [\_\_\_\_\_\_ – \_\_\_\_\_\_\_\_\_\_\_\_]: Execution requirements for ...[item]... specified under this Section.

### [List Sections specifying products installed but not supplied under this Section and indicate specific items.]

### Section [\_\_\_\_\_\_ – \_\_\_\_\_\_\_\_\_\_\_\_]: Product requirements for ...[item]... for installation under this Section.

### [List Sections specifying related requirements.]

### Section [\_\_\_\_\_\_ – \_\_\_\_\_\_\_\_\_\_\_\_]: [Optional short phrase indicating relationship].

## References

[*Delete .1 if Section 01060 – Regulatory Requirements is included in Contract Documents.*]

### Comply with the latest edition of the following statutes, codes, standards and all amendments thereto:

#### Institute of Electrical and Electronics Engineers, Inc. (IEEE):

##### IEEE 242-2001, IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

##### IEEE 519-2014, IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

##### ANSI/IEEE 399-1997, IEEE Recommended Practice for Industrial and Commercial Power System Analysis (Brown Book)

##### ANSI/IEEE Standard 837-2014 - IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

#### American National Standards Institute (ANSI):

##### C57.12.00-2010, IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

#### CSA Standard C22.2 No. 41-13, Grounding and Bonding Equipment (Tri-national standard, with NMX-J-590-ANCE and UL 467)

#### Ontario Electrical Safety Code, 25th Edition, 2012

## Measurement and Payment

*[Choose one of the following payment language provisions that best suits the individual project.*

*If this Section is not specifically referenced by an item in the Bid Form, please use the following language:*

.1 The work of this Section will not be measured separately for payment. All costs associated with the work of this Section shall be included in the Contract Price.

*OR If this Section is specifically referenced in the Bid Form, use the following language and identify the relevant item in the Bid Form:*

.1 All costs associated with the work of this Section shall be included in the price(s) for Item No(s). \_\_\_ in the Bid Form.

*If the work of this Section is to be measured and paid for by several different methods, please amend the standard wording given above to reflect the different methods of measurement and payment.*]

## Submittals

### As part of the Shop Drawings submission: Provide five copies of each of the studies below in hard cover, three-ring binders, including:

#### Ground Grid Design study and grounding system study, indicating touch and step voltage. [*Consultant to confirm these are two separate studies or amend as required*]

#### Short circuit study.

#### Protective Device Coordination Study: submit prior to submission of transformer and switchgear and MCC drawings. Drawings will not be reviewed prior to co-ordination study.

#### Load flow and power factor correction study.

#### Harmonic Analysis Study for plant appreciation under normal and standby power.

#### Arc Flash Study.

#### [*Consultant to review the detailed requirements for each study that is not fully defined in these specifications and to amend the specs to include study requirements as required*].

## Quality Assurance

### The ground grid design, short circuit study, protective device coordination study, and arc flash study shall be prepared by a professional electrical engineer licensed to practice in the Province of Ontario and approved by the Consultant.

## Sequencing and Scheduling

### The complete ground grid design and short circuit study shall be submitted and reviewed before the Consultant will approve shop drawings for the switchgear, switchboard, motor control centre, and equipment for incoming service.

### The short circuit and protective device coordination and Ground Grid Design and grounding system studies to be updated prior to Substantial Performance of the Work [*Consultant to confirm these are two separate studies or amend as required*] . Utilize characteristics of as-installed equipment and materials.

## General

### Equipment and component titles used in the studies shall be identical to the equipment and component titles shown on the Drawings.

### Perform studies using a personal computer with approved software for the application. The Region shall be provided with a copy of the software if requested.

### Perform complete fault calculations for each proposed and ultimate source combination.

### Coordinate with the Local Distribution Company (LDC, supply authority) [*Insert actual name of the LDC*] to obtain their design fault levels and protective settings.

### Source combination may include present and future power company supply circuits, large motors, or generators.

## Short Circuit Study

### General:

#### Use cable impedances based on actual conductor materials.

#### Use bus impedances based on copper bus bars.

#### Use cables and bus resistances calculated at 25 degrees Celsius.

#### Use 600-volt cable reactances based on use of typical dimensions of RW90, Teck conductors.

### Provide:

#### Calculation methods and assumptions.

#### Selected base per unit quantities

#### Impedance diagrams

#### Zero sequence impedance diagrams

#### Typical calculation

#### Tabulations of calculated quantities

#### Results, conclusions, and recommendations.

### Calculate short circuit interrupting and momentary (when applicable) duties for an assumed three-phase bolted fault at each:

#### LDC’s (electric utility’s) supply termination point.

#### Main switchgear, on normal power and standby power.

#### Medium and low voltage switchgear and switchboards.

#### Motor control centres

#### All 600V branch circuit panelboards

### Provide bolted line-to-ground fault current study for areas as defined for three-phase bolted fault short circuit study.

### Verify:

#### Equipment and protective devices are applied within their ratings.

#### Adequacy of switchgear and motor control centres bus bars to withstand short circuit stresses.

#### Adequacy of transformer windings to withstand short circuit stresses.

#### Cable and busway sizes for ability to withstand short circuit heating, besides normal load currents.

## Ground Grid Design

#### Ensure all step and touch potentials are considered acceptable and conform to the requirements of the Ontario Electrical Safety Code, 25th Edition, 2012.

#### Measure soil conductivity prior to performing the ground grid design. Use soil conductivity results in the preparation of the ground grid design.

## Tabulations

### General Data:

#### Short circuit reactances of rotating machines.

#### Cable and conduit material data

#### Bus data

#### Transformer data

#### Circuit resistance and reactance values.

### Short Circuit Data:

#### Fault impedances

#### X to R ratios

#### Asymmetry factors

#### Motor contributions

#### Short circuit kVA

#### Symmetrical and asymmetrical fault currents

### Recommended Protective Device Settings.

#### Solid State Relays:

##### Adjustable pickup

##### Adjustable time current characteristics

##### Curve slope and type

##### Current tap

##### Time dial

##### Instantaneous pickup

##### Overvoltage and under-voltage alarms

##### Reverse current settings

##### Metering and communications settings

#### Circuit Breakers:

##### Adjustable pickup

##### Adjustable time-current characteristics

##### Adjustable instantaneous pickup

## Study Analyses

### A written summary of all studies listed in subsection 1.4.1 shall include:

#### Scope of studies performed;

#### Explanation of bus and branch numbering system;

#### Prevailing conditions;

#### Selected equipment deficiencies;

#### Results of short circuit and coordination studies; and

#### Comments and suggestions, including suggestions regarding changes and additions to equipment rating and/or characteristics.

### Notify the Consultant in writing of existing circuit protective devices improperly rated for new fault conditions.

## Load Flow and Power Factor Correction Study

### Load flow and power factor correction study

#### At the end of the construction and commissioning, document and demonstrate the distribution of power and voltage levels throughout the system for 25%, 50% and 100% load conditions for operation under normal and standby power conditions.

### Study results shall include:

#### Real kW;

#### Reactive kVAR;

#### Power flow through transformers and cables;

#### Power factor at each bus and system losses;

#### Power factor exceeding minimum 0.95 requirements;

#### Identification of overloaded transformers and cables; and

#### Recommendations for proper transformers, power factor corrective devices and cables.

### Study Procedure

#### Document normal and contingent operating conditions.

#### Utilize state of the art software which utilizes an interactive technique to calculate, real and reactive power flow and bus voltage levels throughout the system.

#### Create a database from the nameplates and by monitoring the existing feeders with a digital power monitor. Monitor each feeder for minimum of two hours, during typical operating period utilize current and voltage, kW kVAR and kVA and power factor as an input to the load flow program.

### Results: The load flow study shall include:

#### Bus voltages, line currents, power factor, transformer loading;

#### Recommended transformers tap settings;

#### Complete set of capacitor recommendations;

#### Recommended equipment upgrades or circuit configurations to optimize the power flow and power factor from the source to the loads; and

#### All documentation and software (as required) related to all tests in an organized manner in a single report document. Provide a copy of the documentation report in electronic format in addition to a hard copy.

## Harmonic Analysis Study

### Carry out the harmonic analysis of the electrical distribution system for the circuit conditions listed below:

#### Existing system configuration.

#### System with new VFDs or other non-linear harmonic creation loads in operation at no load, 50% and 100 load conditions.

### Provide the following data from each study:

#### System harmonic voltages in RMS and % THD;

#### System harmonic current in RMS and % THD;

#### An IEEE 519-2014 analysis at the point of common coupling with incoming utility;

#### Capacitor bank evaluation on the basis voltage, current and kVA;

#### Calculate the harmonic generation of each VFD, take field measurement of VFD current harmonic generation during the process operation;

#### If the calculated magnitude of harmonic voltages and/or currents are excessive, the corrective solution will be suggested to reduce harmonic quantities within acceptable limited; and

#### Recommend a filter and provide complete specifications for the same.

### Results: At the conclusion of the harmonic analysis submit the report including the following data:

#### Description, purpose, basis and scope of the harmonic study and single line diagram of the system;

#### Tables listing the individual harmonic voltages and currents and total harmonic distortions for all major buses within the electrical distribution system, waveforms for all of the calculated harmonic voltages will be displayed;

#### Plot of frequency vs. impedance for all capacitor locations (harmonic resonance scan);

#### Complete recommendations for harmonic filters, shunt capacitors and series reactors, required for harmonic suppression;

#### Complete text report of each measurement location sorted by current and voltage, and listing the harmonic component and total harmonic distortion;

#### Waveform of each measurement sample; and

#### Detailed harmonic spectrums of harmonic generating loads.

# PRODUCTS [NOT USED]

# EXECUTION

## General

### Adjust relay and protective device settings according to values established by the coordination study approved by the Consultant.

### Provide detailed data sheets for all programmable meters, relays and monitors within scope of this study, including all multifunction relays, feeder protection relays, motor protection relays and power monitors.

#### Detailed data sheets shall include all:

##### Protective device settings;

##### Ranges;

##### Output relay functions;

##### Parameters for input devices;

##### Addressing; and

##### Communication settings.

#### Data sheets shall be in electronic format, suitable for downloading to appropriate MS Office applications , and in hardcopy format to review.

#### Make mirror modifications to equipment as required to accomplish conformance with the short circuit and protective device coordination studies.

#### All data shall be provided in an electronic format in addition to hardcopy in a format suitable for upload to the Region’s CMMS (Maximo).

## Field Quality Control

### Test relay setting by secondary current and voltage injection.

### Test ground continuity and resistance prior to energizing electrical systems.

### Test grounding system efficiency for compliance with Electrical Safety Code and LDC (local supply authority) requirements. Verify that ohmic resistance and touch and step voltage values are not exceeded.

## Commissioning

### For all commissioning activities on systems where components of this Section are integral to functionality, refer to Section 01810 – Equipment Testing and Facility Commissioning. All inspection and testing activities shall be completed in accordance with this Section and provided to the Consultant prior to the start of commissioning activities.

**END OF SECTION**