This addendum varies the Contract Documents and will form part of the Contract Documents and is to be read, interpreted and coordinated with all other parts, including General and Supplementary General Conditions of the Contract and all Sections in Division 1. The cost of all work contained herein is to be included in the Contract Sum. The following revisions supersede the information contained in the original drawings and specifications issued for the above named project to the extent referenced and shall become a part thereof.

1 GENERAL

.1 This addendum is issued prior to receipt of Bids to provide for certain revisions to and clarification to the Contract Documents.

.2 The work required by this Addendum shall be executed in accordance with the requirements of the Contract and Contract Documents.

.3 Include in the Stipulated Price, the cost of all work described in this Addendum.

2 SITE WALKTHROUGH QUERIES

.1 A question was raised regarding a hazardous materials report for the PARC facility. There are no known hazardous materials, but should the contractor encounter anything that is suspected to be hazardous a change order will be issued to do an assessment and if positive a further change order for abatement.

3 SPECIFICATIONS

.1 A commissioning authority has been engaged for the project. Replace specification Section 018100 in its entirety with the attached section. References to commissioning authority have been added.

4 ARCHITECTURAL ADDENDUM

.1 Refer to architectural addendum, prepared by DGBK Architects, appended to this Addendum, (4 pages).

5 ELECTRICAL ADDENDUM

.1 Refer to electrical addendum E01, prepared by Stantec Consulting Ltd., dated December 10, 2013, appended to this Addendum, (55 pages).

End of Addendum

PART 1 – GENERAL

1.1 Definitions

.1 ‘‘Commissioning’’ is a designed process of ensuring that systems are designed, installed, functionally tested and capable of being operated and maintained to perform in conformity with the design intent.

.2 Commissioning begins with planning and includes design, construction, start-up, acceptance and training and can be applied throughout the life of the building.

.3 This contract includes construction, start-up, acceptance, training and limited post-occupancy commissioning activities.

.4 ‘‘Sections 018000’’ means all Sections included in commissioning. Sections 018100, 230800, 230801, 230802 and 230900.

1.2 Precedence

.1 Refer to General Conditions clauses.

1.3 Summary

.1 Purpose
  - .1 The purpose of the commissioning process is to provide the Departmental Representative assurance that the systems have been installed in the prescribed manner and will operate in conformity with the design intent.
  - .2 Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems to beneficial use by the occupants.
  - .3 The Contractor verifies installation, provides scheduling and coordination and commissioning activities, performs training, starts up equipment, conducts functional performance testing, corrects deficiencies, performs retests and provides documentation of the process.
  - .4 The Commissioning authority, hired directly by the Departmental Representative, provides an unbiased, objective view of the systems: installation, documentation, operation and performance.
  - .5 Commissioning procedures and results will be observed by the Departmental

Representative (the commissioning Authority and/or the Departmental Representative).

.6 The contractor is expected to verify the functional readiness of systems to be tested prior to performing the tests in the presence of the Departmental Representative.

.7 Test failure will indicate that the contractor has not adequately verified the readiness of the systems.

.2 General

.1 Furnish labour and material to accomplish building commissioning as specified in Sections 018000.

.2 Requirements of Sections 018000 shall be accomplished by a qualified Test Contractor, as specified herein.

.3 The requirement for and responsibilities of the Test Contractor are indicated herein.

.4 The Commissioning Authority is an independent contractor and will work under a separate contract directly with the Departmental Representative. The responsibilities of the Commissioning Authority are indicated below, for information only.

.5 Unless otherwise noted, verification tests and functional performance tests (FPTs) specified elsewhere in Sections 018000 apply to all equipment and systems identified under Systems/Equipment To Be Tested.

.3 Provide the services of a qualified Test Contractor with commissioning expertise as described in this section.

.4 Commissioning activities are described in detail in other sections of the work.

.5 Acceptance of the Work requires successful completion of various acceptance procedures including but not limited to verification procedures and functional performance tests.

.1 Verification procedures include a full range of checks and tests to determine that all components, equipment, systems and interfaces between systems operate in accordance with contract documents. This includes all operating modes, all interlocks, all control responses and all specified responses to abnormal or emergency conditions.

.2 Functional performance testing verifies that systems, as installed, are capable of producing the required effect in accordance with the design intent. Functional performance testing shall progress from tests of individual components of the central equipment and systems, including but not limited to: the new and existing lab exhaust systems, the relocated penthouse exhaust fan, and power switching, to tests of the systems that distribute the services throughout the building. During functional performance testing, failures in performance may be revealed. Performance deficiencies will be evaluated to determine the cause and whether they are part of the contractual obligations.

.6 As each acceptance procedure is accomplished physical responses of the system shall be observed and compared to the specified requirements in order to verify the test results. The actual physical responses of system components must be observed. Reliance on control signals or other indirect indicators is not adequate. The input and output signals for each control component also need to be observed to confirm that they are correct for each physical condition.

1.4 Related Sections

.1 Section 014500 - Quality Control.

.2 Section 230900- EMCS: Commissioning.

.3 Section 230800- Commissioning Testing Requirements.

.4 Section 230801- Commissioning Component Testing.

.5 Section 230802- Commissioning System Testing

.6 Section 233400- Fans

.7 Section 230593- Testing, Adjusting and Balancing

1.5 Test Contractor

.1 Responsibilities: The Test Contractor shall execute Sections 018000. Responsibilities of the

Test Contractor are specified in Sections 018000 and include, but are not limited to:

.1 Coordinate and manage the Contractor's commissioning activities.

.2 Coordinate directly with each subcontractor with respect to their responsibilities and contractual obligations for commissioning.

.3 Obtain, assemble and submit commissioning documentation.

.4 Attend periodic on-site commissioning meetings.

.5 Develop the commissioning plan and schedule. Integrate commissioning schedule into the master construction activity schedule. Update schedule at specified intervals.

.6 Develop detailed commissioning test procedures and forms.

.7 Conduct installation verification inspections.

.8 Review controls documentation and interface with other systems.

.9 Obtain, review and assemble operation and maintenance information and as-built drawings provided by the various subcontractors and vendors.

.10 Note any inconsistencies or deficiencies in system operations. Enforce system compliance or recommend to the Departmental Representative modifications to system design that will correct or enhance system performance.

.11 Coordinate Departmental Representative test witnessing, after verifying that pre-tests have been satisfactorily conducted and final tests are ready to be performed.

.12 Be present during training sessions to direct video recording, present training and direct the presentations of others.

.13 Be present during start-up activities to direct and witness execution of start-up.

.14 Monitor performance of testing, adjusting and balancing (TAB) activities to ensure acceptable results, and use of approved methods and instrumentation.

.15 Ensure that necessary test instrumentation is available during verification and functional performance testing, and that instruments meet quality and calibration requirements and are in good working order.

.16 Be present during verification and functional performance testing and retesting to direct and witness execution of tests.

.17 In the event that a commissioning test fails, determine the cause of failure. Direct timely correction of deficiency and then retest. If more than two commissioning tests of the same systems are required, reimburse the Departmental Representative for billed costs for the extraordinary participation of the Departmental Representative, consultant, and Commissioning Authority.

.18 Prepare and submit commissioning reports.

.19 Track commissioning deficiencies until correction and retesting is successfully completed.

.20 Assemble and submit Verification Report and Commissioning Report to the Departmental Representative for approval by Commissioning Authority.

.2 Qualifications: The Test Contractor shall meet the following minimum qualifications:

.1 Extensive experience in startup and troubleshooting Laboratory ventilation and exhaust, fume hood exhaust, HVAC, hot water heating, chilled water, steam, plumbing, fire suppression, electrical, emergency power, fire alarm, life safety, energy monitoring and control system (EMCS) and telecommunications systems of similar complexity to those contained in these documents.

.2 Excellent working knowledge of complex environmental, fire alarm, and electric power control and facility management systems; be capable of understanding control vendor's operating system and control code; be capable of troubleshooting control code and recommending necessary modifications.

.3 Competency in system design and intent.

.4 Knowledge of the test and balance of air and hydronic systems.

.5 Excellent communication and writing skills, organizational skills and ability to work well with management and trades contractors.

.6 A bachelors degree in mechanical engineering and P.Eng certification, with extensive practical field experience is preferred; however, other technical training such as AScT and experience with extensive practical field experience will be considered.

.6 Staff performing work shall have specific experience with the mechanical systems at the PARC Summerland site.

.3 Qualifications Submittal: Submit the Test Contractor resume and statement of qualifications to the Departmental Representative for approval. Document preceding qualifications and include the following:

.1 Present employment, including company name and address; present title and job description; and history of employment (include dates and positions held).

.2 Relevant work experience (job name, position held and work history).

.3 Education and technical training.

.4 Interview: The Departmental Representative reserves the right to personally interview the Test Contractor candidate prior to accepting placement in the position. Final approval of the Test Contractor will be by the Departmental Representative.

.5 Conflict of interest: The Test contractor shall not be financially associated with any of the Division 1 through Division 26 contractors or vendors prior to engaging in this contract, to avoid potential conflicts of interest.

.6 Authority: Provide a letter of authority to the Test Contractor signed by a principal of the General Contractor’s firm. Submit copy of letter to Departmental Representative. Letter shall authorize the Test Contractor to:

.1 Make inspections required for commissioning.

.2 Coordinate, schedule and manage commissioning activities of the Contractor, subcontractors and suppliers.

.3 Obtain documentation required for commissioning from the Contractor, subcontractors and vendors.

.4 Report directly to the principal regarding deficiencies, delayed resolution of deficiencies, schedule conflicts, and lack of cooperation or expertise on the part of subcontractors or suppliers.

1.6 Commissioning Authority

.1 This subsection is provided for the Contractor's information only. The Contractor is not responsible for the hiring of the Commissioning

Authority.

.2 The Departmental Representative has hired a Commissioning Authority

.3 The duties of the Commissioning Authority include, but are not limited to, the following:

.1 Review the Contractor's commissioning plans and schedules.

.2 Review the Contractor's commissioning procedures.

.3 Witness, verify arid approve satisfactory completion of verification and functional performance tests.

.4 Review and approve specified documentation.

.5 Coordinate participation of Departmental Representative personnel involved in functional performance testing and participation in required training.

.6 When commissioning has been successfully completed, recommend final acceptance to the Departmental Representative.

.4 The Commissioning Authority is expected to communicate as follows:

.1 The Commissioning Authority will formally communicate with the Contractor via approved project channels. It is expected, however, that informal communication and coordination will be conducted directly with the Test Contractor. As the Departmental Representative’s commissioning representative, it is expected that the Commissioning Authority will communicate directly with Engineers, as may be appropriate.

.2 The Commissioning Authority will keep the Departmental Representative advised regarding commissioning activities, progress, problems that may develop, solutions to problems, systems performance and schedules.

1.7 Coordination

.1 Coordination and management: Provide overall coordination and management of the commissioning program as specified herein. The commissioning process will require cooperation of the Contractor, subcontractors, vendors, Departmental Representative, and Commissioning Authority. The commissioning team shall include the following:

.1 Contractor: Project manager and Test Contractor.

.2 Subcontractors: As required by the prime contractor.

.3 Manufacturers' factory engineers: As specified elsewhere.

.4 Commissioning authority: Project manager and project Departmental Representatives.

.5 Engineer: Mechanical Engineer and electrical Engineer.

1.8 Submittals

.1 General: Submit the following in accordance with general and supplemental conditions of the contract and Division I specification sections.

.2 Commissioning plan: Submit commissioning plan to the Departmental Representative for review and approval by the Engineer and Commissioning Authority within 30 calendar days of notice to proceed.

.3 Commissioning schedule: Submit commissioning schedule to the Departmental Representative for review and approval by the Engineer and Commissioning Authority within 30 calendar days of notice to proceed.

.4 Design intent documentation: Submit edited and updated design intent narratives to the Departmental Representative for review and approval by the Engineer and Commissioning Authority.

.5 Critical flow chart diagrams: Submit edited and updated critical flow chart diagrams to the Departmental Representative for review and approval by the Engineer and Commissioning Authority.

.6 Start-up plan: For each piece of equipment or system for which formal start-up is specified elsewhere in Sections 018000, submit the following to the Departmental Representative for review and approval by the Engineer and Commissioning Authority
Obtain approval of the start-up plan prior to beginning start-up activities.

.1 Start-up schedule.

.2 Names of firms/individuals required to participate.

.3 Detailed start-up procedures.

.4 Start-up data forms.

.7 Test equipment identification list: For each instrument, sorted according to intended use, submit to the Departmental Representative for review and approval by the Engineer and Commissioning Authority: Manufacturer; model number; serial number; calibration certification; range; accuracy; resolution; and intended use.

.8 Operations manuals and maintenance manuals: Submit to the Departmental Representative prior to the start of training.

.9 Start-up procedures: Submit start-up procedures for equipment for which formal start-up is specified in Sections 018000 to the Departmental Representative for review and approval by the Engineer and Commissioning Authority. These procedures will be reviewed for technical depth, clarity of documentation, and completeness.

.10 Start-up data forms: Submit start-up data forms for equipment for which formal start-up is specified elsewhere to the Departmental Representative for review and approval by the Engineer and Commissioning Authority.

.11 Testing, adjusting and balancing (TAB) report: Submit written TAB report to the Departmental Representative for review and approval by the Engineer and Commissioning Authority. Refer to section 230593 for details.

.12 Verification test and functional performance test procedures: Submit test procedures for verification tests and functional performance tests specified elsewhere to the Departmental

Representative for review and approval by the Engineer and Commissioning Authority.

.1 Each procedure shall have a unique alphanumerical designator.

.2 The same procedure may be applied to multiple identical pieces of equipment or systems.

.3 Procedures shall reference the applicable specification section upon which the procedure is based.

.4 These procedures will be reviewed for technical depth, clarity of documentation, compliance with acceptance criteria specified elsewhere and completeness.

.5 Identify the value for all set points and inputs, positions of adjustable devices, valves, dampers and switches.

.6 Identify the range of acceptable results for each condition tested.

.7 Procedures shall be detailed, stand-alone test instructions, written with sufficient step-by-step information to allow a test to be repeated under identical conditions with repeatable results. Other documents referenced by a procedure must be included, at minimum those portions applicable to the procedure.

.13 Test data forms: Submit verification test and functional performance test data forms or equipment for which tests are specified in Sections 018000, to the Departmental representative for review and approval by the Engineer and commissioning authority.

.1 Identify each functional performance test data form by a unique designator consisting of the applicable functional performance test procedure designator followed by a dash digit suffix to distinguish multiple uses of the same procedure.

.2 Include space to record: Description of the procedure; whether the form is for a retest of a failed procedure; identification and location of the equipment being tested identification of instrumentation used by serial number; observed conditions at each step of the procedure; acceptable results as specified elsewhere; date of the test; names of technicians performing the procedure; name and signature of the Test Contractor; name and signature of the Commissioning Authority or Departmental Representative-designated witness (signature of witness shall only indicate concurrence with reported results and observations; acceptance of the results will be reported separately by the Commissioning Authority after review of the data forms).

.14 Test deficiency report forms: Submit verification test and functional performance test deficiency report forms to the Departmental representative for review and approval by the Engineer and Commissioning Authority. Include space to record:
  .1 Associated test data form number;
  .2 Date of test;
  .3 Name of person reporting the deficiency;
  .4 Description of the observations associated with the failure of the test;
  .5 Cause of the failure, if apparent at the time of the test;
  .6 Date and description of corrective action taken;
  .7 Name and signature of person taking corrective action; and
  .8 Schedule for retest.

<u>1.9 Commissioning Plan</u>

.1 Develop a commissioning plan to identify how commissioning activities will be integrated into general construction and trade activities. The plan is the key means for the Test Contractor to inform all parties as to how each system functions, independently and with respect to other systems. The plan shall be updated regularly and redistributed to the commissioning team for review and comment. The intent of this plan is to evoke questions, expose issues and resolve them with input from the entire commissioning team early in construction. The commissioning plan shall identify how commissioning responsibilities are distributed.

.2 Include an organizational chart showing lines of communication and authority of the Test Contractor relative to key general contractor positions and to key subcontractors.

.3 Identify who will be responsible for producing the various procedures, reports, Departmental Representative notifications and forms required in this division.

.4 Include the commissioning schedule integrated with the construction schedule.

.5 Describe the test/acceptance procedure.

.6 Identify which subcontractors will participate in each of the tests.

.7 Identify instrumentation required for each test.

.8 Identify who will provide instrumentation for each test.

.9 Operational description: This shall include, for example, the design criteria, design intent, code requirements, specifics of the equipment to be provided, sequences of operation, operating priorities, protocols, etc.

1.10 Schedule

.1 Commissioning schedule: Integrate functional performance testing and commissioning requirements into the Critical Path Method (CPM) master construction schedule. Commissioning scheduling is the responsibility of the contractor.

.1 Prior to the beginning of start-up or verification testing activities, update the schedule of commissioning activities monthly.

.2 Two weeks prior to the beginning of start-up or verification testing activities, provide a detailed two-week look-ahead schedule. Thereafter, update the two week look-ahead schedule weekly for the duration of commissioning. The two-week look-ahead schedule shall identify the date, time, beginning location, contractor personnel required, and anticipated duration for each start-up or test activity.

1.11 Commissioning Staging

.1 The exhaust systems shall be commissioned in several stages. Refer to the phasing of the project. Each phase shall be fully functional, commissioned and reviewed by the Departmental Representative before proceeding to the next stage.

.2 The general exhaust system and the lab exhaust system shall be re-balanced and made operational to facilitate operation of the facility at completion of each phase.

.3 After all final phase is commissioned, a final integrated commissioning of labs shall be performed.

.4 Test contractor shall review the commissioning staging and schedule with the Departmental Representative at the beginning of the construction, and modify as required to suit the site condition, laboratory operation and project requirements.

.5 Test existing fume hoods to provide face velocities as stipulated by Engineer after the replacement of associated exhaust fans and ductwork with new control devices and ductwork.

1.12 Coordination with Departmental Representative

.1 The Departmental Representative will witness all start-up and test activities specified in this division. The Departmental Representative will designate witnesses and alternates for each activity.

.2 Notify the Departmental Representative in writing of the date, time, location and anticipated duration of start-up and test activities as required in schedule above.

.3 Provide written timely notice to Departmental Representative of any changes in date, time, location or anticipated duration of start-up and test activities. For the purpose of this paragraph, written notice shall be received by Departmental Representative a minimum of 72 hours in advance is to be considered timely notice.

.4 Contractor shall reimburse Departmental Representative for actual costs incurred by the Departmental Representative as the result of failure to provide timely notice per preceding paragraph of changes in date, time, location or anticipated duration of start-up and test activities.

.5 Obtain the signature of designated witness on all data forms. If the witness is unavailable at the scheduled time and location of the activity, so note, and proceed per schedule without the witness.

1.13 Commissioning Meetings

.1 Attend periodic commissioning meetings.

.1 Prior to the beginning of start-up or functional performance testing activities, the Departmental Representative will hold commissioning meetings at least monthly.

.2 Beginning two weeks prior to the commencement of start-up or verification testing activities, whichever is earlier, the Departmental Representative will hold commissioning meetings at least weekly. Thereafter, and for the duration of commissioning, commissioning meetings will continue to be held at least weekly.

.3 The Departmental Representative may require additional meetings if the commissioning process appears to be behind schedule or if there are coordination problems. The Test Contractor may also request in writing additional meetings.

.4 Commissioning meetings shall carry through all phases of the work.

PART 2 – PRODUCTS

2.1 Test Equipment

.1 Provide industry standard test equipment required for performing the tests specified herein.

.2 Instrumentation shall meet the following standards:

.1 Be of sufficient quality and accuracy to test and measure system performance within the tolerances required to determine adequate performance.

.2 Be calibrated on the manufacturers' recommended intervals with calibration tags permanently affixed to the instrument being used.

.3 Be maintained in good repair and operating condition throughout the duration of use on this project.

.4 Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

.3 Immersion temperature measuring instruments, liquids:

.1 Range, -40°F to 120°F; type, glass partial stem immersion; minimum accuracy, within 1/2 of scale division; resolution, 1°C

.2 Range, 0°F to 220°F; type, glass partial stem immersion; minimum accuracy, within 1/2 of scale division; resolution, 1°C

.4 Air temperature measuring instruments:

.1 Range, -40°F to 120°F; type, glass partial stem immersion; minimum accuracy, within 1/2 of scale division; resolution, 1°C

.2 Range, 0°F to 220°F; type, glass partial stem immersion; minimum accuracy, within 1/2 of scale division; resolution, 1°C

.5 Hydronic pressure measuring instruments:

.1 Range, indicated pressure shall be in the middle half of the instrument range; type, minimum Grade A gauge with stainless steel, alloy steel, monel or bronze Bourdon tube; minimum accuracy, within +-0.25% of full scale; resolution, 0.5 PSI subdivisions on a 4.5 inch dial with a mirrored scale and knife-edge pointer.

.6 Hydronic differential pressure measuring instruments:

.1 Range, indicated pressure shall be in the middle half of the instrument range; type, dual inlet, minimum Grade A gauge with dual stainless steel, alloy steel, monel or bronze Bourdon tubes and a single pointer; minimum accuracy, within +-0.25% of full scale; resolution, 0.5 PSI subdivisions on a 4.5 inch dial with a mirrored scale and knife-edge pointer.

.7 Air pressure measuring instruments:
  .1 Range, indicated pressure shall be in the inclined portion of the scale; type, inclined/vertical manometer; resolution: if air velocity less than 1,000 fpm, then 0.005 inch graduations; if air velocity between 1,000 and 4,000 fpm, then 0.01 inch graduations; if air velocity greater than 4,000 fpm, then 0.1 inch graduations.

2.2 Reports

.1 Testing, adjusting and balancing (TAB) progress reports: After TAB activities have begun, submit weekly TAB progress reports to the Departmental Representative.
Identify:
  .1 Systems or subsystems for which preliminary balancing is complete.
  .2 Systems or subsystems for which final balancing is complete.
  .3 Status of deficiencies and balancing problems encountered, including corrective actions taken.
  .4 Updated schedule of remaining TAB activities.

.2 Installation verification audit: Prior to start-up, submit a report of installation verification audit activities to the Departmental Representative for review and approval by the Engineer and Commissioning Authority. Identify equipment and components verified, deficiencies noted, corrective action taken and the dates and initials of the persons making the entries.

.3 Start-up deficiency report: Within five days following start-up of each system or equipment, submit start-up deficiency report forms to the Departmental Representative.
Identify systems and/or equipment started-up, deficiencies noted, corrective action taken and the dates and initials of the persons making the entries.

.4 Test deficiency reports: At the end of each day in which verification tests or functional performance tests are conducted, submit test deficiency report forms to the Departmental Representative for tests for which acceptable results were not achieved during the day.

  .1 Identify tests for which acceptable results were not obtained by test number and description, equipment identification and location. Briefly describe observations about the performance that were associated with failure to achieve acceptable results. Identify the cause of failure if such is apparent.

.2 When corrections have been completed, update the functional performance test deficiency report forms. Identify corrective action taken and the dates and initials of the persons making the entries.

.3 Identify the schedule for retesting.

.5 Commissioning test data report: At the conclusion of acceptance phase commissioning activities, submit a report of all test data forms.

.1 Submit signed start-up, balancing, verification test, and functional performance test data forms and deficiency report forms. Include forms for failed tests and for acceptable tests.

.2 Bind data forms in three ring binders. Imprint covers with project name, date, and the words, "Commissioning Test Data."

.3 Separate data with index tab dividers.

.4 Provide a table of contents.

.5 Group all data forms for a single test together. Place the data form with final, acceptable results in front of data forms with failed results. Locate deficiency report forms behind the test data form on which the deficiency was originally noted.

PART 3 – EXECUTION

3.1 Design Intent Documentation

.1 Edit and update design intent narratives provided by the Departmental Representative. Incorporate the effect of approved substitution requests, change orders and responses to requests for clarifications that change the information in the Engineer's design intent narratives.

3.2 One-Line Diagrams

.1 Edit and update one-line diagrams provided by the Departmental Representative. Incorporate the effect of approved substitution requests, change orders and responses to requests for clarifications that change the information in the Engineer's one-line diagrams.

.2 Provide one-line diagrams for the systems identified in 3.2.3.

.3 One-line diagrams are intended to support narrative system descriptions and the overall commissioning process. Depending on the system in question, the following procedures for developing the one-line diagrams are to be employed:

  .1 Update the existing AutoCAD-based one-line diagrams provided by the Departmental Representative for the following systems: laboratory fume hood exhaust, electrical power; emergency power; supply air systems; return air systems; and exhaust air systems.

  .2 Update and revise vendor supplied AutoCAD-based shop drawings; revise as required to match the format for commissioning documents. This method shall be employed for the following systems:
    .1 energy management control;
    .2 fire alarm/smoke evacuation/life safety graphics.

3.3 Commissioning Procedures

.1 Sequence of testing: Commissioning shall proceed from lower to higher levels of complexity. For each discrete subsystem or system, testing at the lower level shall be completed prior to starting the next higher level of tests.
Verification tests shall precede functional performance tests.
In general, the order of testing from lowest to highest is:
  .1 Static tests (such as pipe and duct leakage tests).
  .2 Flushing and cleaning.
  .3 Start-up.
  .4 Component verification tests (motors, actuators, sensors, etc.).
  .5 Balancing.
  .6 Subsystem verification tests.

.7 System verification tests.
.8 Central equipment functional performance tests.
.9 System functional performance tests.
.10 Intersystem functional performance tests.

.2 Retesting: Repeat, at no additional cost to the Departmental Representative, the complete verification test procedure for each test for which acceptable results are not achieved. Repeat tests until acceptable results are achieved. Compensate the Departmental Representative for direct costs incurred as the result of tests repeated to achieve acceptable results. Fill out a new test data form for each retest.

.3 Correction of deficiencies:

.1 Correct functional performance test deficiencies promptly and schedule retest.

.2 Corrections during verification or functional performance tests are generally prohibited to avoid consuming the time of personnel waiting for the test, but not involved in making the correction. Exceptions will be allowed if the cause of the failure is obvious and corrective action can be completed in less than five minutes. If corrections are made under this exception, the failure shall be noted on the test data form. A new test data form, marked retest, shall be initiated after the correction has been made. The entire test procedure shall be repeated.

.4 Witnesses: Witnesses will be designated by the Departmental Representative to observe the commissioning process under the direction of the Commissioning Authority. Departmental Representative shall provide no labour or materials in the commissioning process. The only function of the Departmental Representative shall be to observe and comment on the progress and results of commissioning.

.1 Provide access to permit the Departmental Representative to directly observe the performance of the equipment being tested.

.2 Provide ladders, scaffolding, and staging as required to permit the Departmental Representative to directly observe the performance of the equipment being tested.

.3 Notify the Departmental Representative of commissioning schedule changes at least 48 hours in advance if a Departmental Representative will be involved.

3.4 Operations Manuals and Maintenance Manuals

.1 Review operations manuals and maintenance manuals prepared by other divisions of the work related to commissioning for compliance with the requirements of Division I.

.2 Incorporate the standard technical literature into a systems-specific document: concise; to the point; and above all, tailored specifically to this facility.

.3 Obtain the equipment manufacturer's standard technical literature relevant to the operation and maintenance of the provided equipment. The literature shall be specifically oriented to the equipment provided, indicating all operation and maintenance procedures, parts lists, assembly/disassembly diagrams, and related information. Wiring diagrams must be complete and specific to the equipment provided.

.4 Submit the draft document for review by the Departmental Representative, Engineer and commissioning Authority to ensure completeness, proper written communications, and compliance with each reviewer's knowledge of the significant requirements.

.5 Refer to the required submissions for format, number of copies, etc.

3.5 Installation Verification

.1 During construction, periodically observe the work of the prime contractor and subcontractors to ensure that all installations are being made in accordance with the intent of the contract documents, insofar as the installation impacts the goals of commissioning.

.2 Before system start-up begins, conduct an installation verification audit. The audit shall include, but not be limited to, a check of:

.1 Piping specialties including balance, control and isolation valves.

.2 Ductwork specialty items including turning devices; balance, fire, smoke and control dampers; and access doors.
.3 Control sensor types and locations.
.4 Identification of piping, valves, starters, gauges, thermometers, etc.
.5 Documentation of prestart-up tests performed, including manufacturers' factory tests.
.6 Accessibility to equipment in 1-3 above.

.3 If any work is found to be incomplete, inaccessible for safe operation and maintenance, incorrect or non-functional, record deficiencies and correct the deficiencies before system start-up work proceeds.

3.6 System Start-up

.1 Develop a start-up plan. Commence with system start-up after approval has been given to the start-up plan and the prestart-up inspection has been completed by the Test Contractor. The Test Contractor shall witness system start-up and list all system and equipment deficiencies noted during start-up.
The Contractor shall take corrective action on all system deficiencies noted and demonstrate suitable system operation to the Test Contractor. Notify Engineer of start-up activities schedule at least five working days in advance. Departmental Representative and Commissioning Authority will witness start-up procedures. Test Contractor shall obtain signature of the Departmental Representative and Commissioning Authority indicating successful start-up.

3.7 Start-up Deficiency Lists

.1 Prepare start-up deficiency list forms to report deficiencies discovered in conjunction with system start-up. Start-up deficiency forms shall indicate the system being started-up; the location and identification of the deficient equipment/material; date of observation; initials of the observer; observed deficiency; date of correction; initials of person making the correction; and corrective action taken.

.2 Issue start-up deficiency report forms to the Contractor for corrective action, and to the Departmental Representative for tracking. The Contractor shall advise the Test Contractor and Departmental Representative when all start-up deficiency list items have been corrected.

3.8 Testing Adjusting

.1 Coordinate demonstration of the accuracy of the and Balancing (TAB)

air and hydronic TAB report as required in Section 230593. Advise the TAB firm when systems are complete and ready for balancing. TAB shall not commence until after systems start-ups and component verification tests, and shall be essentially complete prior to system verification tests.

.2 Verify the accuracy of the TAB work prior to commencing any verification test activities that may be adversely affected by improper balancing.

3.9 Test Procedures

.1 Develop start-up procedures, verification test procedures and functional performance test procedures documentation. Personnel experienced in the technical aspects of each system to be commissioned shall be engaged if necessary to augment the expertise of the Test Contractor. Include test procedures and test data sheets for each system based upon actual system configuration. Emphasis shall be placed on testing procedures that will conclusively determine actual system performance and compliance with the Contract and design intent.

.2 Test procedures shall fully describe system configuration and steps required for each test; appropriately documented so that another party can repeat the tests with virtually identical results.

.3 The majority of mechanical equipment requires integral safety devices to stop/prevent equipment operation unless minimum safety standards or conditions are met. This could include adequate oil pressure, proof-of-flow, non-freezing conditions, maximum head pressure, etc. Functional performance test procedures shall demonstrate the actual performance of safety shutoffs in real or closely simulated conditions of failure.

.4 Systems may include safety devices and components that control a variety of equipment operating as a system. Interlocks may be hard-wired or installed via software. Test procedures shall demonstrate these interlocks.

.5 Inform appropriate subcontractors and vendors before commissioning is started as to what the tests and expected results will be. Whereas some test results and interpretations may not become evident until the actual tests are performed, all participants should have a reasonable understanding of the requirements.

3.10 Review Software Documentation

.1 Review vendor/contractor-provided detailed EMCS/BAS software documentation. This includes obtaining EMCS/BAS program documentation, a review of the programming approach, interface with other systems (such as lighting, fire alarm, security, clock, emergency generator monitoring, and utility metering), and a review of the specific software routines as applied to this project. Discrepancies in programming approaches shall be resolved to provide the Departmental Representative with the most appropriate, simple and straightforward approach to software routines.

.2 Provide copies of all of the preceding material, including electronic copies of all control system software, to the Departmental Representative so that the Departmental Representative can simulate system operation and troubleshoot the software.

3.11 Training

.1 Prepare and submit a training plan for approval. The training plan shall include for each training session:
   .1 Dates, start and finish times, and locations.
   .2 Outline of the information to be presented.
   .3 Names and qualifications of presenters.
   .4 List of texts and other materials required to support training.

.2 Obtain assistance from appropriate subcontractors and vendors to provide training for the Departmental Representative as specified in Divisions 23 and 26.

.3 Provide videotape documentation of training of the Departmental Representative for each system. Training will be in a classroom setting on site with the appropriate schematics, handouts and audio/visual training aids.

.4 Catalogue training videotapes and deliver to the Departmental Representative with the OPERATIONS MANUALS AND MAINTENANCE manuals in accordance with Divisions 23, 26 and Sections 018000.

.5 Host each training session:
   .1 Provide program overview and curriculum guidance.
   .2 Obtain signatures of attendees on a sign-in

list.

.6 Equipment vendors provide training on the specifics of each system and philosophy, troubleshooting, and repair techniques as specified in the relevant sections of this specification.

.7 Installation subcontractors provide training on peculiarities specific to this project and job specific experience in the relevant sections of this specification.

3.12 Record Drawings

.1 Review record drawings to verify accuracy.

3.13 Exclusions

.1 The Departmental Representative and Commissioning Authority are not responsible for construction means, methods, job safety or any management function related to commissioning on the job site.

.2 The contractor shall provide all technical services requiring tools or the use of tools to test, adjust or otherwise bring equipment into a full operational state.

PROJECT:

Summerland – Lab Exhaust System Alteration
Pacific Agri-Food Research Centre
4200 Highway 97
Summerland, B.C.

DGBK Project No. 06-131 Phase 3

CONSULTANT: DGBK Architects

This Addendum is to be read in conjunction with and considered as an integral part of the Contract Documents. Revisions supersede the information contained in previously issued Drawings, Specifications and Addenda.
Bid Price submitted is to include all items of this Addendum.
Consideration will not be allowed for any extras due to any Bidder not being familiar with the contents of this Addendum.

DRAWINGS: Full Size Drawings: A100, A100.1, A102

Item 1
ADDED: Drawing A100.1

.1) Roof Plan for New Work split into two sheets.
- "Partial Roof Plan (West) - New Work" on A100
- "Partial Roof Plan (East) – New Work" on A100.1

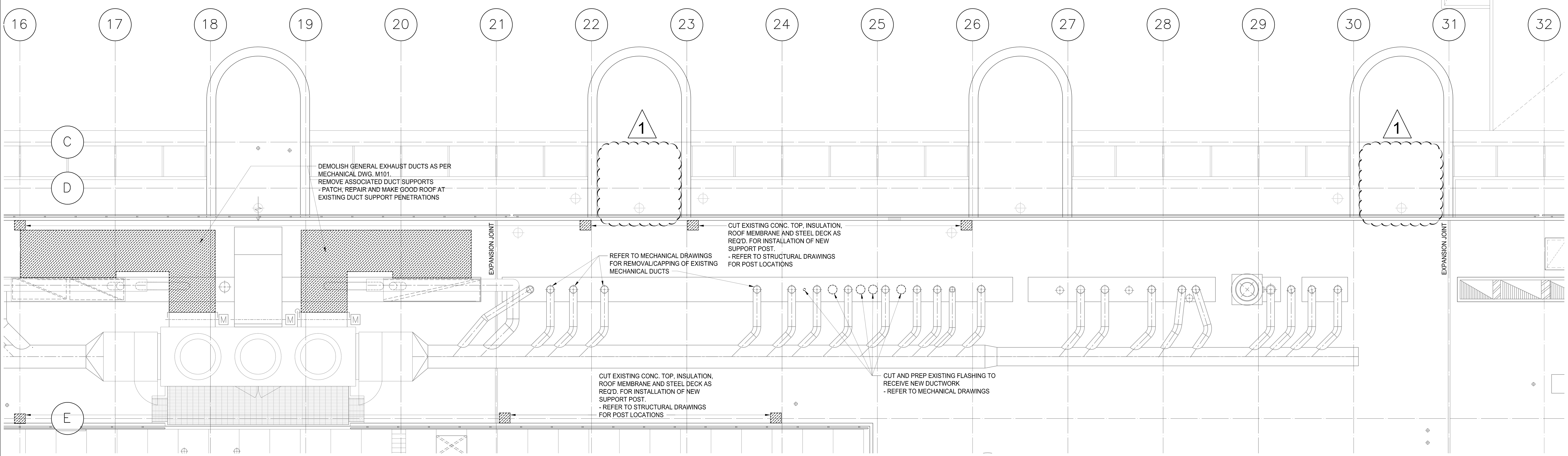
.2) Detail reference numbers revised on A102

Item 2
DELETE: New 38mm diameter guardrail at North parapet from scope of work (along North parapet between gridlines 21 to 32)

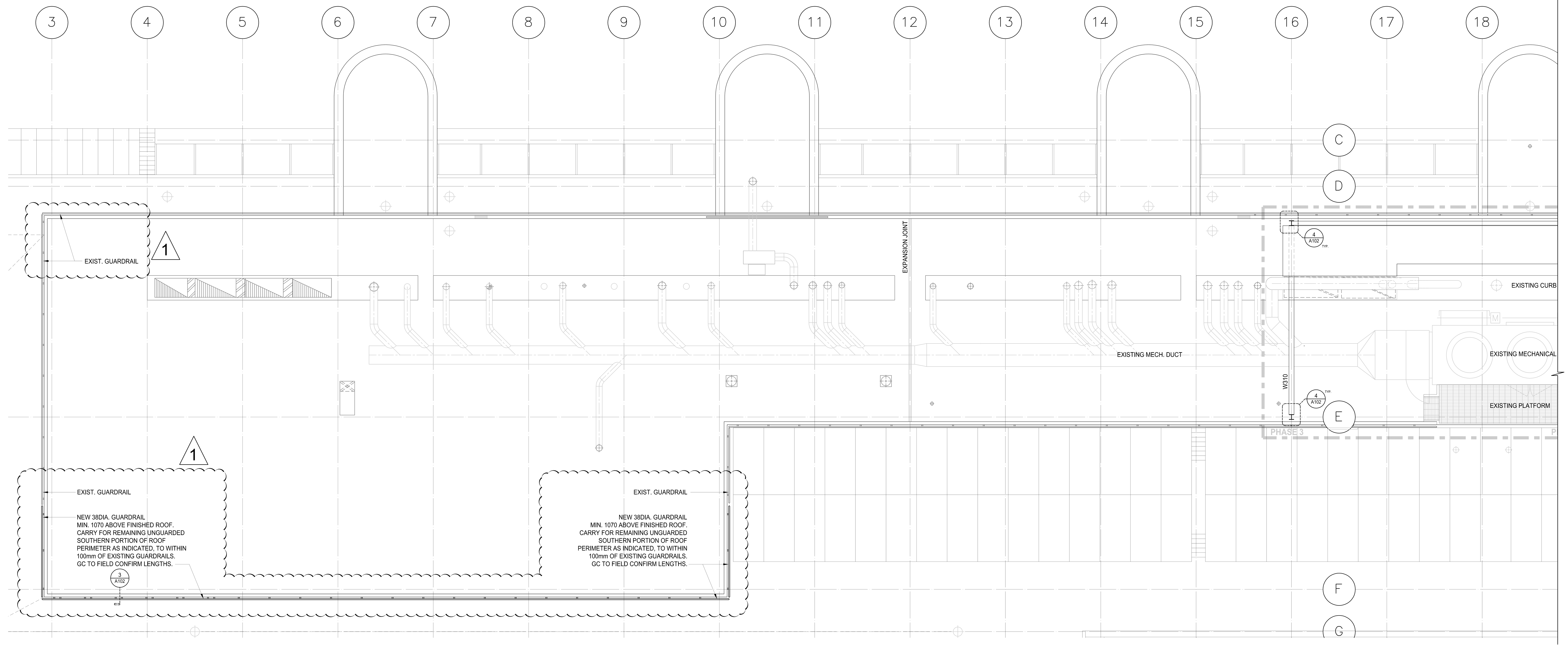
.1) Drawing 1-A100 – Note to relocate Antennae on Stair Towers 5 and 7 removed
.2) Drawing 1-A100.1 – "New" guardrail at North parapet, between gridlines 21 to 32 revised to "Existing"
.3) Drawing 5/6-A102 – References to "New Guardrail" revised to "Existing Guardrail"

Item 3
ADD: New 38mm diameter guardrail to enclose unguarded South portion of roof as indicated on A100 and A100.1. GC to field confirm lengths of new guardrail to within 100mm of existing guardrails.

End of Addendum No. 1



1 PARTIAL ROOF PLAN - DEMOLITION
SCALE 1 = 50



2 PARTIAL ROOF PLAN (WEST) - NEW WORK
SCALE 1 = 50

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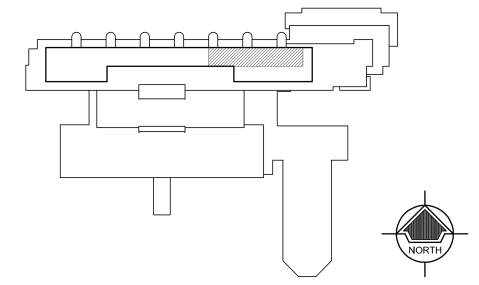
Pacific Region
SERVICES IMMOBILIERS
Région de Pacifique



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GENERAL NOTES:

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10. FIRESTOP ALL NEW DUCT PENETRATIONS IN WALLS/CEILINGS. REFER TO MECHANICAL DRAWINGS.

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6	Issued for Addendum #1	2013.12.09
5	Issued for Tender	2013/08/16
4	Issued for 66% Progress Review (Fume Hoods)	2013/02/27
3	Issued for 100%	2012/11/02
2	Issued for 99% Progress Review	2012/07/17
1	Issued for 99% Coordination	2012/06/22
0	Issued for 50% Progress Review	2012/03/16

Client/client

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

**641 - 800 BURRARD STREET
VANCOUVER, BC**

Project title/Titre du projet

**SUMMERLAND , BRITISH COLUMBIA
4200 HIGHWAY 97
PACIFIC AGRI-FOOD RESEARCH CENTRE**

SUMMERLAND- LAB EXHAUST SYSTEM ALTERATION

Consultant Approval Box Only
-

Designed by/Concept par
-

Drawn by/Dessine par
L. Mac

PWGSC Project Manager/Administrateur de Projets TPSGC
T. DUNPHY

PWGSC, Regional Manager, Architectural and Engineering Services/Gestionnaire régionale, Services d'architectural et de génie, TPSGC
Philip Fung

Drawing title/Titre du dessin
ROOF PLAN
DEMOLITION AND NEW WORK

Project No./No. du projet	Sheet/Feuille	Revision no./La Révision no.
R.018297.001	A-100	6

PWGSC – A0 – 1000x841

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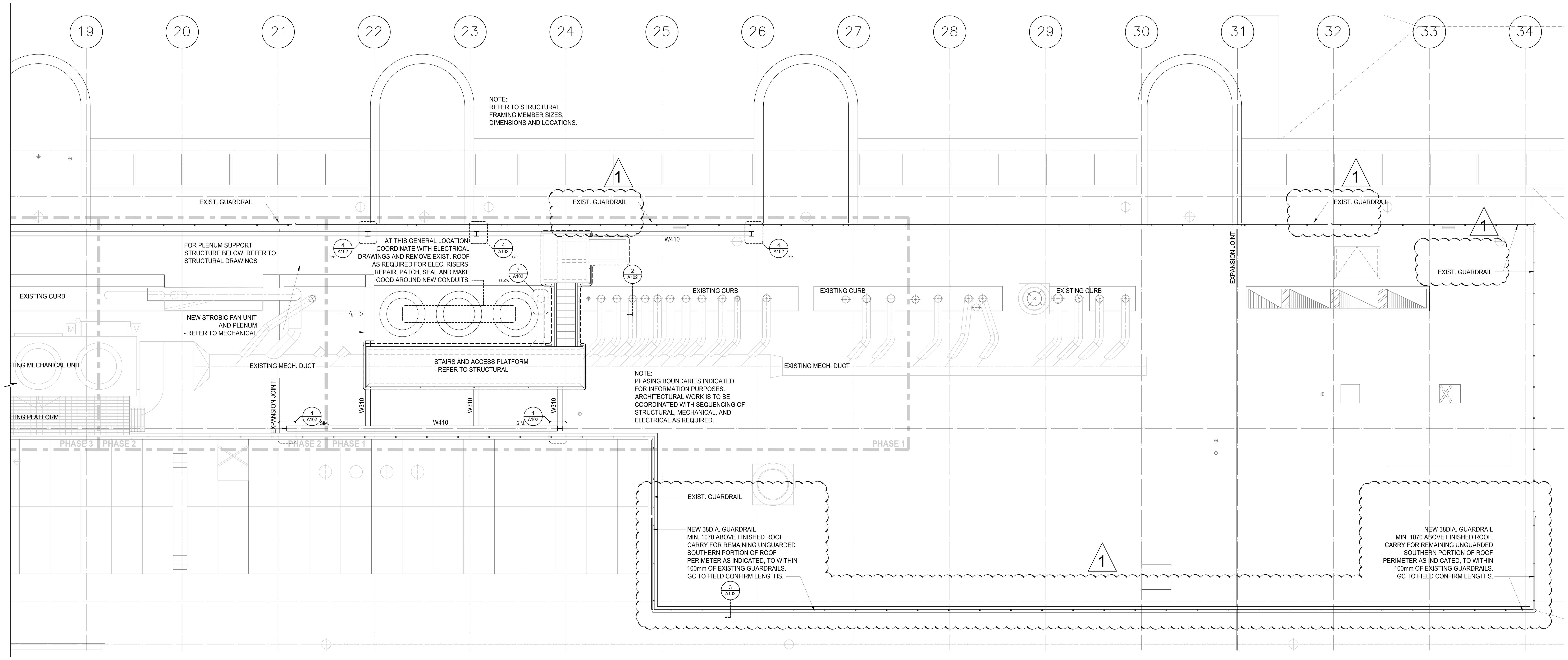

1 PARTIAL ROOF PLAN (EAST) - NEW WORK
SCALE 1 = 50

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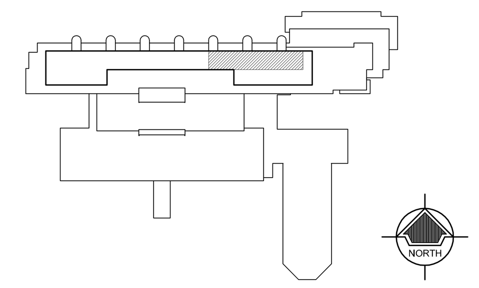

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SUMMERLAND- LAB EXHAUST SYSTEM ALTERATION

Consultant Approval Box Only
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Designed by/Concept par
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T. DUNPHY

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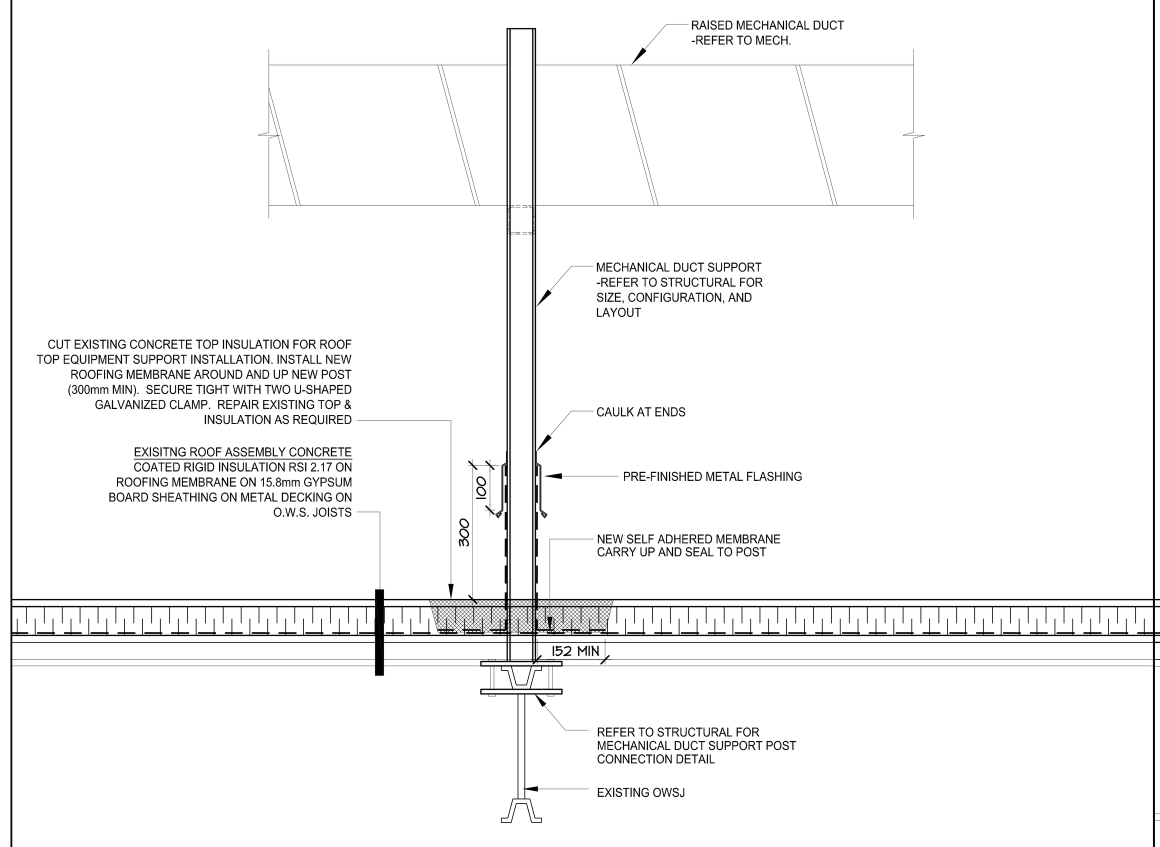
Philip Fung

Drawing title/Titre du dessin
ROOF PLAN
NEW WORK

Project No./No. du projet	Sheet/Feuille	Revision no./La Révision no.
R.018297.001	A-100.1	6



1 / **-** **SECTION DETAIL - ROOF PENETRATION AT MECH. DUCT H-SUPPORTS**
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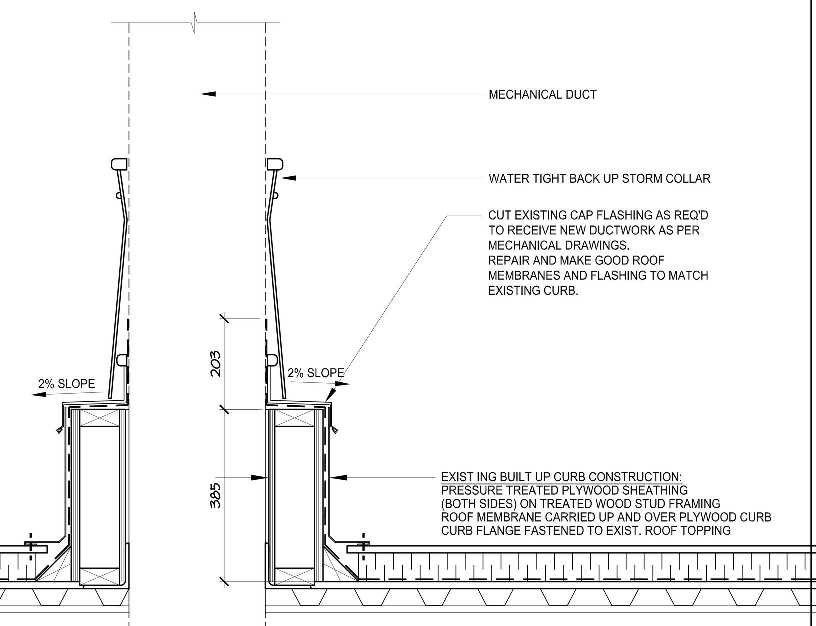

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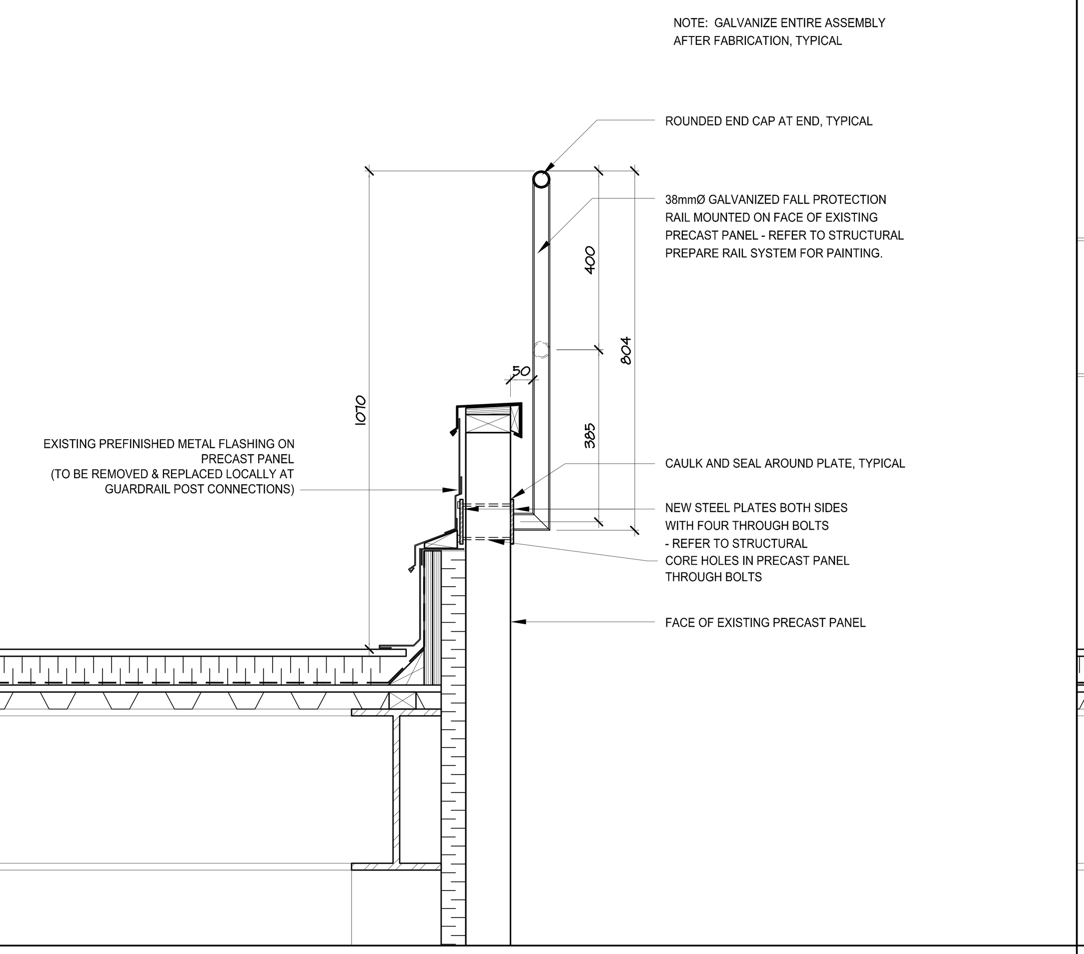

3 / **A100** **SECTION DETAIL - NEW GUARDRAIL AT ROOF PARAPET**
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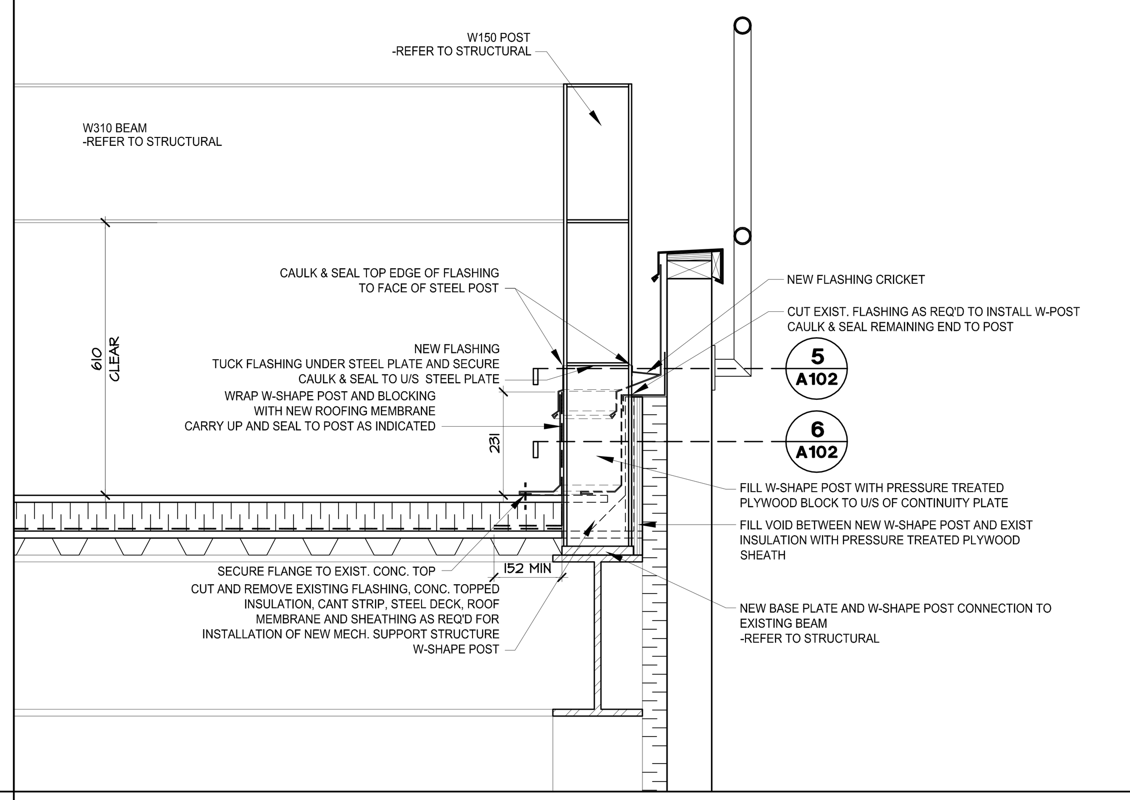
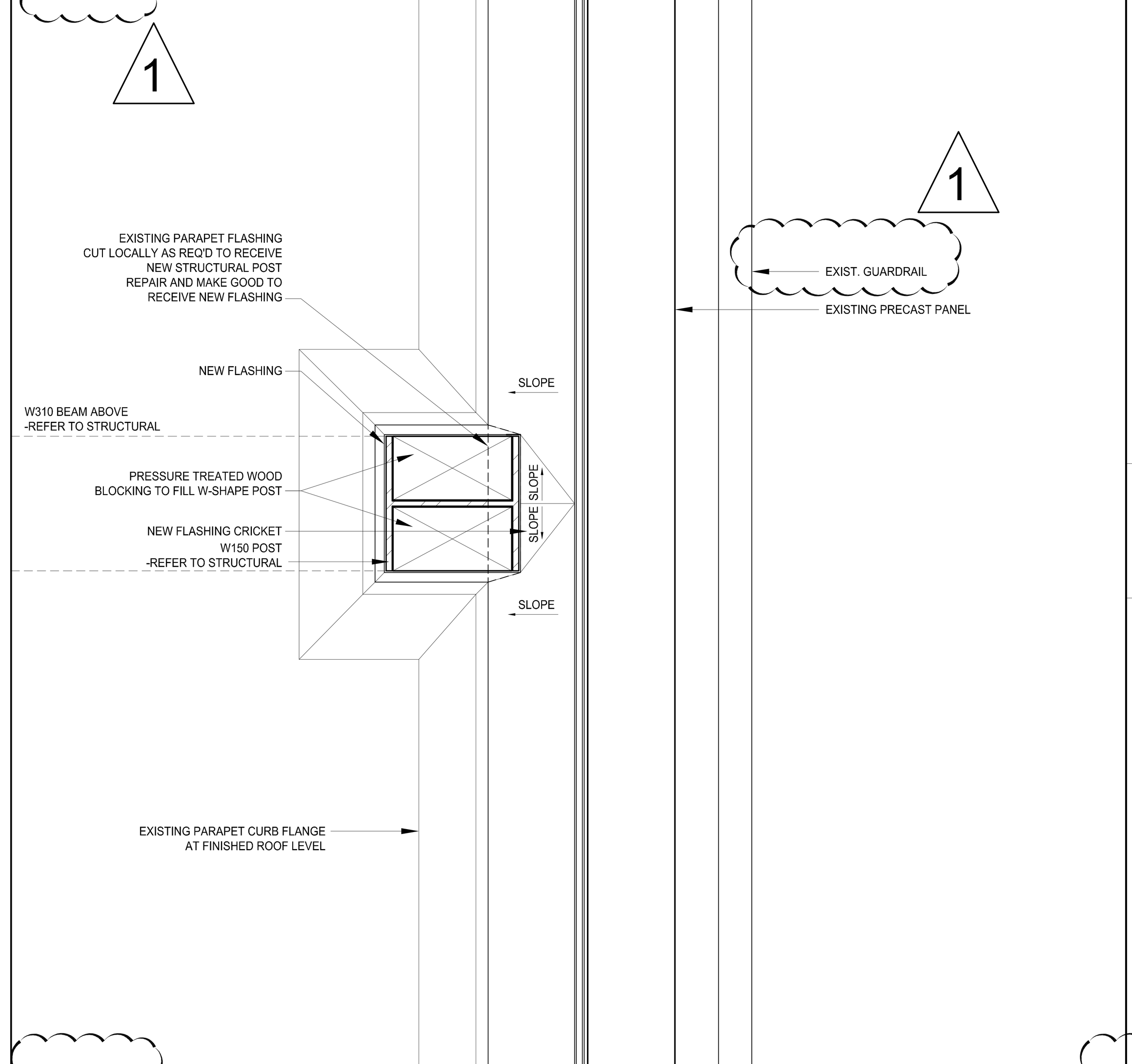
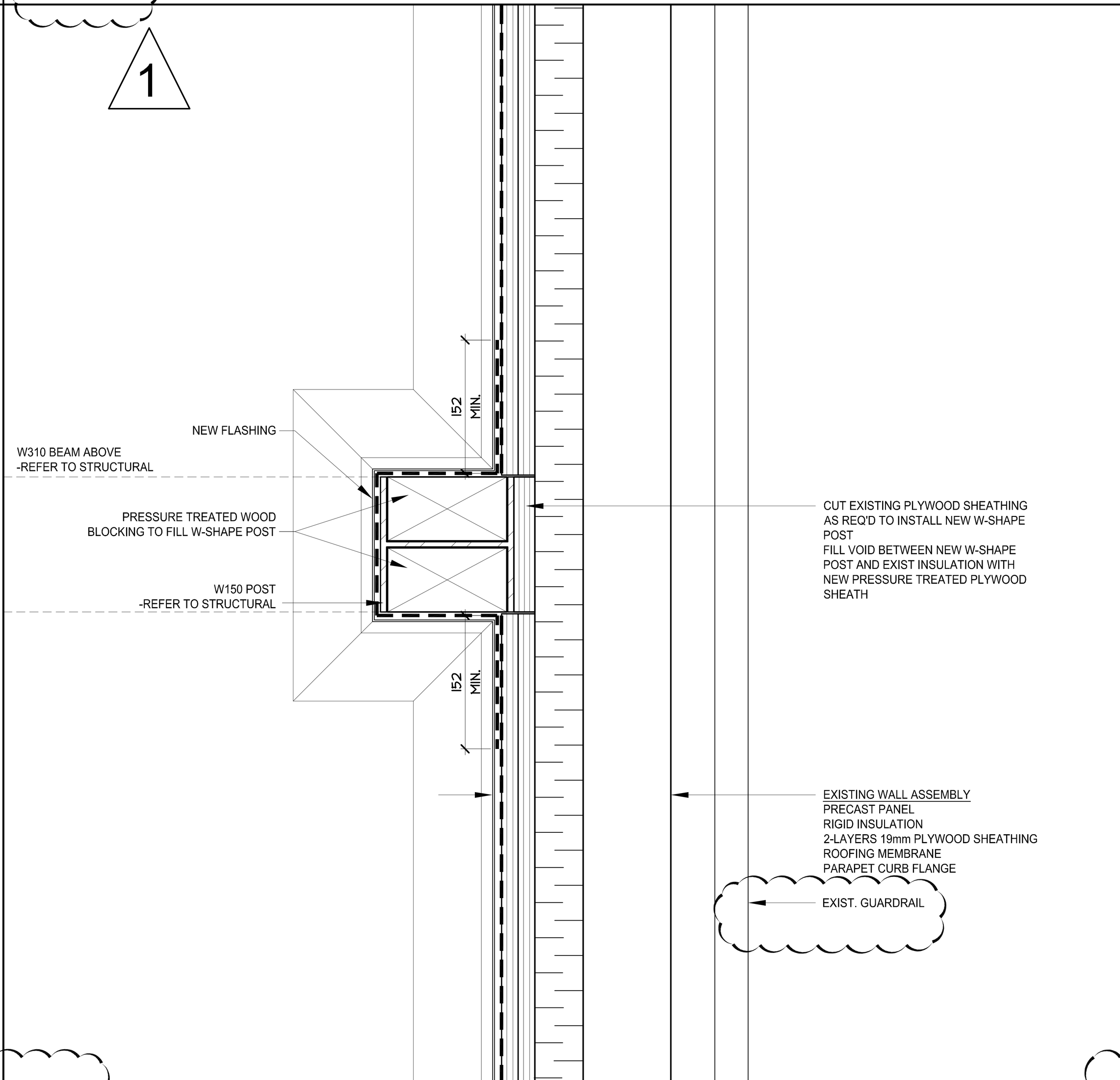


4 / **A100** **SECTION DETAIL - ROOF PENETRATION AT W-SHAPE POST**
SCALE 1:10



5 / **A102** **PLAN DETAIL - FLASHING CRICKET AT W-SHAPE POST**
SCALE 1:5



6 / **A102** **PLAN DETAIL - ROOF PENETRATION AT W-SHAPE POST**
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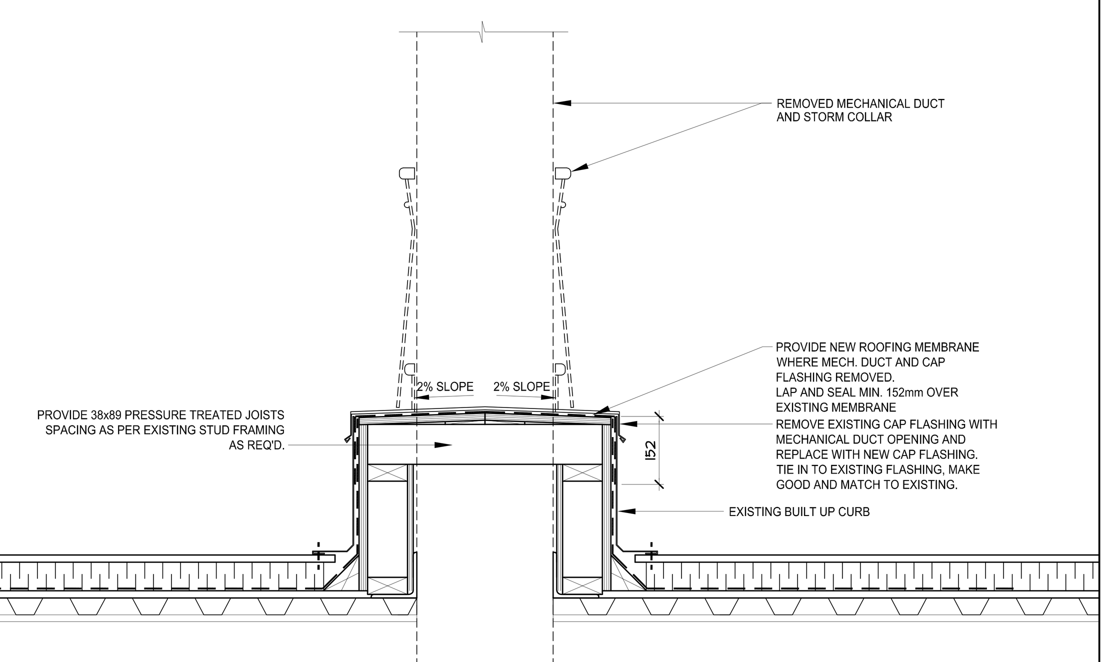

7 / **A100.1** **SECTION DETAIL - CAP FLASHING REPLACEMENT AT REMOVED MECH. DUCTS**
SCALE 1:10

8 / **A-** **DETAIL**
SCALE X:X

1

1

1

9 / **A-** **DETAIL**
SCALE X:X

10 / **A-** **DETAIL**
SCALE X:X

11 / **A-** **DETAIL**
SCALE X:X

12 / **A-** **DETAIL**
SCALE X:X

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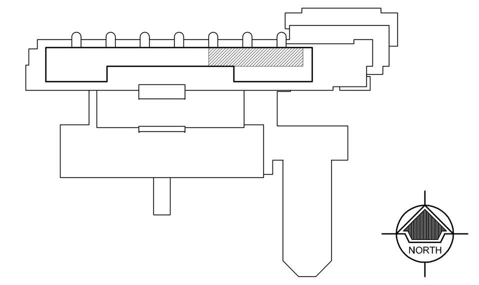

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Phillip Fung

Drawing title/Titre du dessin
ROOF DETAILS

Project No./No. du projet	Sheet/Feuille	Revision no./La Révision no.
R.018297.001	A-102	6

PWGSC – AO – 1000x841

0 10 20 30 40 50 60 70 80 90 100mm

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The following changes in the tender documents are effective immediately. This addendum will form part of the contract documents.

ELCTRICAL SPECIFICATIONS

.1 Section 26 24 19

(1) **Clarification**:

Contractor shall refer to specification for motor starter and controls. No new MCC or additional new MCC section is required within the scope.

.2 Appendix E

(2) **Replace**:

Coordination, Short Circuit Arc Flash Study: Issue for review dated March 12, 2013 with attached final issue dated Oct. 15, 2013 (total of 54 pages).

END OF ELECTRICAL ADDENDUM #E01

Coordination, Device Evaluation, Short Circuit, and Arc Flash Study

for the

Summerland PARC Facility in Summerland, British Columbia

Stantec

One Team.
Infinite Solutions.

Prepared for:
Public Works and Government Services Canada
Pacific Region
800 Burrard Street, 12th floor
Vancouver, B.C.

Prepared by:
Stantec Consulting Limited
1331 Clyde Avenue – Suite 400
Ottawa Ontario, K2C 3G4

October 15, 2013
Final Issue

TABLE OF CONTENTS

PAGE

INTRODUCTION

POWER SYSTEMS STUDIES

Stantec Consulting Ltd. is pleased to submit the following Short Circuit, Protective Device Coordination, and Arc Flash Studies for the Summerland Agriculture and Agri-food Canada Research Centre, in Summerland, British Columbia, Canada. These studies have been prepared in accordance with the pertinent standards, including National Electrical Manufacturer's Association (NEMA), Institute of Electrical and Electronic Engineers (IEEE), InterNational Electrical Testing Association (NETA), National Fire Protection Association (NFPA), Canadian Standards Authority (CSA), American National Standards Institute (ANSI), and other related standards.

The Short Circuit Study was performed to calculate the maximum currents that flow in the electrical system under bolted three-phase and single-phase fault conditions. All main system components are included within the model to determine actual system impedances, including any large motors and generators that may contribute to the fault.

The Device Evaluation Study uses the short circuit values calculated in the Short Circuit Study to verify the ability of existing electrical system components to withstand mechanical and thermal stresses caused by the fault condition. It will also verify whether all protective devices can interrupt the maximum fault duties where they are located.

The Coordination Study is performed to determine the protective device settings and fuse size requirements to ensure proper protection and maximum selectivity in the event of a thermal overload or short circuit fault condition.

The Arc Flash Study uses the results of the Short Circuit and Coordination Study, combined with switchgear characteristics, to assess the level of arc flash hazard present at significant busses within the system.

SCOPE OF STUDIES

The Short-Circuit Study includes all busses from the 8.3kV incoming supply, down to the main low-voltage distribution within the facility shown on the single line.

The Device Evaluation Study includes all protective devices within the scope of the short-circuit study.

The Coordination Study includes the same devices as the Short-Circuit Study, except only the two largest circuit breakers or fuses on each low-voltage distribution panel supplied directly from a main low-voltage switchboard are considered for coordination purposes.

The Arc Flash Hazard Analysis includes the same busses as the Short Circuit Study. All downstream equipment shall be categorized according to CSA Z462 Table 4A and 4B.

Short-Circuit and Arc-Flash Hazard Calculations are performed for the system in its normal configuration i.e. with all normally-closed switches closed, and all normally-open switches open, and when supplied by the emergency generator.

OBJECTIVES

The study was requested by Public Works and Government Services Canada to review the coordination and selectivity of the protective devices within the facilities distribution system, identify any shortcomings in the overcurrent protection including underrated protective devices, and to have arc flash calculations performed in accordance with the CSA standard Z462.

ASSUMPTIONS

1. Short Circuit calculations are performed for a three-phase maximum short circuit fault level of LLL 2718A, and a line to ground maximum short circuit fault level of LG 1967A. These values are provided by Fortis BC. Utility X/R ratios were not provided by Fortis BC, as such an X_1/R_1 of 15 and an X_0/R_0 of 15 will be assumed.
2. The remainder of the data was gathered by site observation by Stantec, supplemented by existing maintenance manuals, shop drawings, and single line drawings as provided by the facility personnel.
3. All cable lengths are estimated based on equipment locations and scaled drawings. The exact routing of cables is not possible to determine due to site conditions.
4. Typical X/R values have been assumed for all transformers.
5. Transformer impedance is determined based on site observation, shop drawings, and transformers with similar kVA ratings.
6. The CT ratios for the ground relays on panel MDC_1's MDC_L feed, 1N panel feed, 2N panel feed, 4N panel feed, and 5N panel feed is assumed to be 1200:5.
7. All pumps below 50hp need not be considered as they will not contribute energy to short circuits as per IEEE standard 1584-2002.

RESULTS AND RECOMMENDATIONS

1. As much infrastructure data as possible was confirmed during site visits and existing documentation such as O&M manuals, shop drawings, test reports, and single line drawings. Recommended Settings are provided to improve coordination with downstream overcurrent devices in the Device Settings Table under Tab D. It is recommended that the study to be updated every 5 years or whenever there are major revisions to the power system.

2. The breakers within the downstream electrical distribution are typically moulded case breakers with thermal magnetic trip units which are not optimal for achieving completely selective coordination. The best possible coordination was achieved with the existing devices. The moulded case breakers trip curves overlap in the short circuit instantaneous region, which cannot be avoided due to the trip unit characteristics, as can be seen in some of the time current curves shown in Appendix C.

3. Within the main 600V panelboard MDC-1, there is no ground fault protection on many of the feeder breakers sized 400A and lower. This can lead to problematic coordination, as shown in TCC G01, as a low level ground fault downstream of the 400A breaker feeding the cooling tower chiller motor, may provide enough fault current to trip the 15kV breaker ground fault relay, but not enough to clear the phase element of the 600V feeder breaker. External ground relay can be installed on the larger feeder breakers (typically those that have an instantaneous curve above 1200A) or those larger feeder breakers can be retrofitted with breakers that have solid state trip units that implement ground fault protection to isolate the ground fault to the individual feeder rather than tripping the upstream main breaker. Note that this recommendation is a good engineering practice, and is not required by Code.

   Also note that the 13.2kV breaker residually connected ground fault relay will only detect a ground fault on the primary of the transformer; however, there is an external FPE GLR-T ground fault relay that detects ground faults on the 600V system and then trips the main 13.2kV breaker.

4. Under normal power the breakers contained within emergency panel MDC_S experience fault levels that exceed their interrupting rating. We are not aware of any possible test series combinations that could be used with these older breakers to achieve a series rated interrupting rating acceptable for this fault duty. It is recommended that the breakers be replaced with equipment rated for a fault level of 35kA minimum. Note that replacing the complete panelboard (and all breakers) at one time may be more cost effective than replacing individual circuit breakers, but may take longer. This also may be an opportunity to increase spare capacity on the panelboard, as there is currently only one free breaker space.

5. The FPE 600V air circuit breaker that feeds the Transfer Switch is using an USD-61 solid state trip unit with LSIG elements. This trip unit is a 1st generation solid state trip unit which uses discrete solid state components and implements peak sensing of current to detect overloads or short circuits. As such, in areas of high harmonics this may result in inaccurate tripping results or nuisance tripping. The characteristics of the solid state electronics also change as the components age resulting in tolerance issues with initial settings and specifications. We would recommend that this trip unit be retrofitted to a new true RMS digital trip unit for this critical load.

6. The existing single line drawings used by the facility personnel are hand marked up hard copies of an original drawing from 1984. AutoCAD drawings are not available. It is recommended that the single line drawings be updated using AutoCAD or equivalent on a regular basis.

APPENDIX A

SHORT CIRCUIT STUDY

The purpose of the Short Circuit Study is to determine the maximum current that will flow in the power system under worst-case three-phase and single line-to-ground fault conditions. Any electrical equipment subjected to these conditions must be rated to safely withstand and/or interrupt these faults. The fault currents calculated in the study are used:

- For selecting interrupting equipment of sufficient short circuit rating.
- To verify the ability of electrical system components to withstand mechanical and thermal stresses caused by the fault condition.
- To determine the time-current coordination of protective relays and fuses. These values are used to show the device “cut off” at the maximum symmetrical fault level of individual bus points

Electrical apparatus manufactured in North America is tested and rated against ANSI, ULC, and NEMA equipment standards, which outline the preferred methods in calculating fault duties for equipment rated to operate at voltage levels:

- Above 1000 volts is considered High and Medium voltage.
- Below 1000 volts is considered Low voltage.

The short circuit calculations depicted in this study were performed using PTW version 7.0, an electrical system modeling software program developed by SKM System Analysis Inc. This software program adheres to the specifications of the American National Standards Institute (ANSI) C37.010, C37.5, and the Institute of Electrical and Electronic Engineers (IEEE) Standard 142.

Short circuit fault contributions include the Utility, large AC motors, and standby generators. DC machines and very small AC motors that do not contribute large fault currents and are excluded from the study. The pre-fault voltage for all calculations is 1.00 Per Unit.

Three types of short-circuits are defined, depending on the time frame of interest taken from the inception of the fault, as:

- First cycle currents
- Interrupting currents
- Time delayed currents

First cycle currents are the initial currents calculated at ½ cycle after fault initiation. First cycle currents relate to the duty devices face when ‘closing against’ or withstanding short-circuit currents, also called ‘close and latch’ currents. These currents often contain DC offset, and are calculated on the premise of no ac decrement in the contributing sources. These currents are used to evaluate the combined withstand and interrupting rating of low voltage protective devices, and to evaluate the closing and latching (or momentary) rating of medium and high voltage circuit breakers.

Interrupting currents are the currents calculated from 2–8 cycles after fault initiation, and are seen by typical protective devices when interrupting a fault. These currents are still asymmetrical (i.e. contain DC offset), but consideration to ac decrement is given due to the elapsed time from the fault inception.

Time delayed currents are the short circuit currents that existing beyond 8 cycles and up to 30 cycles from the fault initiation. They are typically represented by purely symmetrical values in that they do not have any dc offset, induction and synchronous motor contributions are neglected, while contributing generators are assumed to have attained transient or higher value reactances.

Short Circuit Report - ANSI Calculations - Medium Voltage Busses
Utility Fault Levels - 2718A (3 Phase) - Normal Power

Government of Canada

Bus Name		Sym. Fault Amps			Mom. Fault Amps		Interrupting Fault Duty				Source Z
		Amps	MVA	X/R	Based on Sym*1.6	Based on X/R	2 Cycle	3 Cycle	5 Cycle	8 Cycle	Equivalent R+jX (PU)
8,300 Volt Busses											
BC HYDRO_BUS	3 Phase:	2,718	39.1	15.00	4,349	4,136	3,629	3,145	2,900	2,772	0.117 + j1.759
	SLG:	1,967		15.00	3,147	2,993	2,626	2,276	2,099	2,006	0.706 + j10.586
MAIN_BRKR_PRI_BUS	3 Phase:	2,492	35.8	6.60	3,987	3,317	2,749	2,494	2,492	2,492	0.288 + j1.901
	SLG:	1,794		7.23	2,870	2,432	2,014	1,813	1,794	1,794	1.595 + j11.524
MAIN_TX_PRI_BUS	3 Phase:	2,492	35.8	6.60	3,987	3,317	2,749	2,494	2,492	2,492	0.288 + j1.902
	SLG:	1,794		7.23	2,870	2,432	2,014	1,813	1,794	1,794	1.595 + j11.525

Short Circuit Report - ANSI Calculations - Low Voltage Busses
Utility Fault Levels - 2718A (3 Phase) - Normal Power

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Bus Name		Sym. Fault Amps Amps	Sym. Fault Amps MVA	Sym. Fault Amps X/R	Asym. Fault Amps Maximum RMS Amps	Asym. Fault Amps Average RMS Amps	Source Impedance PU Seq. Z1	Source Impedance PU Seq. Z2	Source Impedance PU Seq. Z0	Source Impedance Equivalent R+jX (PU)
600 Volt Busses										
1H_3H_PRI_BUS	3 Phase:	15,693	16.3	1.78	16,148	15,922	6.132	6.132	6.230	0.011 + j0.019
	SLG:	15,685		1.52	15,936	---	---	---	---	0.010 + j0.015
1J_2J_PRI_BUS	3 Phase:	9,118	9.5	.84	9,123	9,121	10.553	10.553	14.769	0.029 + j0.024
	SLG:	8,056		0.77	8,058	---	---	---	---	0.028 + j0.022
1K_2K_PRI_BUS	3 Phase:	9,602	10.0	.88	9,610	9,606	10.021	10.021	13.800	0.027 + j0.024
	SLG:	8,542		0.81	8,546	---	---	---	---	0.026 + j0.021
1N_PRI_BUS	3 Phase:	10,693	11.1	1.63	10,919	10,806	8.998	8.998	12.601	0.017 + j0.028
	SLG:	9,435		1.60	9,619	---	---	---	---	0.016 + j0.026
1Q_PRI_BUS	3 Phase:	1,504	1.6	.13	1,504	1,504	63.994	63.994	100.979	0.228 + j0.031
	SLG:	1,261		0.13	1,261	---	---	---	---	0.227 + j0.030
1R_PRI_BUS	3 Phase:	4,834	5.0	.30	4,834	4,834	19.905	19.905	30.176	0.069 + j0.021
	SLG:	4,130		0.26	4,130	---	---	---	---	0.068 + j0.017
1S_TX_PRI_BUS	3 Phase:	17,655	18.3	2.36	18,847	18,256	5.450	5.450	4.758	0.008 + j0.018
	SLG:	18,527		1.99	19,294	---	---	---	---	0.007 + j0.014
1T_PRI_BUS	3 Phase:	2,507	2.6	.18	2,507	2,507	38.375	38.375	59.979	0.136 + j0.025
	SLG:	2,112		0.17	2,112	---	---	---	---	0.135 + j0.023
1U_PRI_BUS	3 Phase:	8,650	9.0	.80	8,653	8,651	11.125	11.125	15.801	0.031 + j0.025
	SLG:	7,593		0.74	7,595	---	---	---	---	0.030 + j0.023
2H_3H_PRI_BUS	3 Phase:	15,495	16.1	1.73	15,901	15,698	6.210	6.210	6.399	0.011 + j0.019
	SLG:	15,414		1.48	15,633	---	---	---	---	0.010 + j0.016
2N_PRI_BUS	3 Phase:	10,609	11.0	1.62	10,826	10,718	9.070	9.070	12.752	0.017 + j0.028
	SLG:	9,345		1.59	9,523	---	---	---	---	0.016 + j0.026
3N_PRI_BUS	3 Phase:	8,619	9.0	1.01	8,637	8,628	11.164	11.164	16.330	0.028 + j0.029
	SLG:	7,468		0.99	7,481	---	---	---	---	0.027 + j0.027
3S_TX_PRI_BUS	3 Phase:	5,530	5.7	.54	5,530	5,530	17.402	17.402	26.619	0.055 + j0.030
	SLG:	4,700		0.52	4,700	---	---	---	---	0.054 + j0.028
4H_5H_PRI_BUS	3 Phase:	15,894	16.5	1.84	16,405	16,151	6.054	6.054	6.063	0.010 + j0.019
	SLG:	15,964		1.57	16,250	---	---	---	---	0.010 + j0.015

Short Circuit Report - ANSI Calculations - Low Voltage Busses
Utility Fault Levels - 2718A (3 Phase) - Normal Power

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Government of Canada

Bus Name		Sym. Fault Amps Amps	MVA	X/R	Asym. Fault Amps Maximum RMS Amps	Average RMS Amps	Source Impedance PU Seq. Z1	PU Seq. Z2	PU Seq. Z0	Equivalent R+jX (PU)
4N_PRI_BUS	3 Phase:	11,957	12.4	1.83	12,336	12,147	8.048	8.048	10.573	0.014 + j0.025
	SLG:	10,827		1.76	11,125	---	---	---	---	0.013 + j0.023
4S_TX_PRI_BUS	3 Phase:	2,820	2.9	.23	2,820	2,820	34.126	34.126	53.395	0.120 + j0.028
	SLG:	2,373		0.22	2,373	---	---	---	---	0.119 + j0.026
5N_PRI_BUS	3 Phase:	12,321	12.8	1.89	12,759	12,541	7.810	7.810	10.059	0.013 + j0.025
	SLG:	11,245		1.81	11,587	---	---	---	---	0.012 + j0.022
6N_PRI_BUS	3 Phase:	10,565	11.0	1.21	10,624	10,594	9.108	9.108	12.375	0.021 + j0.025
	SLG:	9,443		1.14	9,481	---	---	---	---	0.020 + j0.023
ALTERNATOR	3 Phase:	19,862	20.6	5.66	25,586	22,820	4.845	4.845	3.334	0.003 + j0.017
	SLG:	22,170		5.30	28,136	---	---	---	---	0.002 + j0.013
ATS_LOAD_BUS	3 Phase:	20,219	21.0	7.34	27,502	24,010	4.759	4.759	3.128	0.002 + j0.017
	SLG:	22,828		7.50	31,179	---	---	---	---	0.002 + j0.013
ATS_NORMAL_BUS	3 Phase:	20,219	21.0	7.34	27,502	24,010	4.759	4.759	3.128	0.002 + j0.017
	SLG:	22,828		7.50	31,179	---	---	---	---	0.002 + j0.013
CDP-EP Panel	3 Phase:	18,743	19.5	4.48	22,897	20,875	5.134	5.134	4.030	0.004 + j0.018
	SLG:	20,201		4.10	24,168	---	---	---	---	0.003 + j0.014
CH01_BUS	3 Phase:	16,850	17.5	2.33	17,954	17,407	5.711	5.711	5.305	0.008 + j0.019
	SLG:	17,317		2.01	18,066	---	---	---	---	0.007 + j0.015
CH02_BUS	3 Phase:	16,850	17.5	2.33	17,954	17,407	5.711	5.711	5.305	0.008 + j0.019
	SLG:	17,317		2.01	18,066	---	---	---	---	0.007 + j0.015
CT01_STARTER	3 Phase:	19,606	20.4	4.28	23,702	21,704	4.908	4.908	3.475	0.004 + j0.017
	SLG:	21,746		3.76	25,508	---	---	---	---	0.003 + j0.013
CT01B1_BUS	3 Phase:	18,494	19.2	2.58	20,051	19,280	5.203	5.203	4.209	0.007 + j0.017
	SLG:	19,873		2.11	20,864	---	---	---	---	0.006 + j0.013
CT01B2_BUS	3 Phase:	18,494	19.2	2.58	20,051	19,280	5.203	5.203	4.209	0.007 + j0.017
	SLG:	19,873		2.11	20,864	---	---	---	---	0.006 + j0.013
CT01C_STARTER	3 Phase:	17,969	18.7	2.12	18,878	18,427	5.355	5.355	4.603	0.008 + j0.017
	SLG:	19,035		1.69	19,487	---	---	---	---	0.008 + j0.013
H_PANEL	3 Phase:	13,759	14.3	1.22	13,838	13,798	6.994	6.994	8.012	0.016 + j0.019
	SLG:	13,207		1.02	13,236	---	---	---	---	0.015 + j0.016

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Short Circuit Report - ANSI Calculations - Low Voltage Busses
Utility Fault Levels - 2718A (3 Phase) - Normal Power

Government of Canada

Bus Name		Sym. Fault Amps: Amps	MVA	X/R	Asym. Fault Amps: Maximum RMS Amps	Average RMS Amps	Source Impedance: PU Seq. Z1	PU Seq. Z2	PU Seq. Z0	Equivalent R+jX (PU)
J_PANEL	3 Phase:	11,424	11.9	1.31	11,520	11,472	8.423	8.423	11.024	0.018 + j0.024
	SLG:	10,368		1.22	10,428	---	---	---	---	0.018 + j0.022
K_PANEL	3 Phase:	7,149	7.4	.58	7,149	7,149	13.460	13.460	19.672	0.042 + j0.024
	SLG:	6,202		0.53	6,202	---	---	---	---	0.041 + j0.022
L_PANEL	3 Phase:	6,309	6.6	.53	6,309	6,309	15.252	15.252	22.727	0.049 + j0.026
	SLG:	5,426		0.49	5,426	---	---	---	---	0.048 + j0.024
M_PANEL	3 Phase:	17,284	18.0	2.07	18,100	17,695	5.567	5.567	4.985	0.009 + j0.018
	SLG:	18,021		1.73	18,492	---	---	---	---	0.008 + j0.014
MAIN_TX_SEC_BUS	3 Phase:	21,075	21.9	8.08	29,194	25,312	4.566	4.566	2.147	0.002 + j0.016
	SLG:	25,597		8.49	35,781	---	---	---	---	0.001 + j0.011
MCC_1_PANEL	3 Phase:	17,231	17.9	2.97	19,202	18,230	5.585	5.585	5.036	0.006 + j0.019
	SLG:	17,841		2.64	19,427	---	---	---	---	0.006 + j0.015
MCC_1S	3 Phase:	15,588	16.2	1.80	16,057	15,823	6.173	6.173	6.369	0.011 + j0.019
	SLG:	15,494		1.54	15,756	---	---	---	---	0.010 + j0.016
MCC_E_PANEL	3 Phase:	11,992	12.5	1.52	12,181	12,087	8.024	8.024	10.360	0.016 + j0.024
	SLG:	10,940		1.42	11,069	---	---	---	---	0.015 + j0.022
MCC_ES_BUS	3 Phase:	6,486	6.7	.55	6,486	6,486	14.836	14.836	22.079	0.047 + j0.026
	SLG:	5,581		0.51	5,581	---	---	---	---	0.046 + j0.023
MCC_P1_BUS	3 Phase:	19,862	20.6	5.66	25,587	22,820	4.845	4.845	3.334	0.003 + j0.017
	SLG:	22,170		5.30	28,137	---	---	---	---	0.002 + j0.013
MCC_P2_BUS	3 Phase:	19,895	20.7	5.94	25,893	22,998	4.837	4.837	3.319	0.003 + j0.017
	SLG:	22,221		5.62	28,574	---	---	---	---	0.002 + j0.013
MCC_W_PANEL	3 Phase:	11,992	12.5	1.52	12,181	12,087	8.024	8.024	10.360	0.016 + j0.024
	SLG:	10,940		1.42	11,069	---	---	---	---	0.015 + j0.022
MDC S	3 Phase:	20,123	20.9	7.10	27,189	23,798	4.782	4.782	3.192	0.002 + j0.017
	SLG:	22,631		7.14	30,608	---	---	---	---	0.002 + j0.013
MDC_1	3 Phase:	20,512	21.3	8.22	28,508	24,686	4.691	4.691	2.939	0.002 + j0.017
	SLG:	23,432		8.94	33,057	---	---	---	---	0.001 + j0.012
MDC_A_PRI_BUS	3 Phase:	17,721	18.4	2.56	19,180	18,458	5.430	5.430	4.662	0.007 + j0.018
	SLG:	18,667		2.18	19,691	---	---	---	---	0.006 + j0.014

Short Circuit Report - ANSI Calculations - Low Voltage Busses
Utility Fault Levels - 2718A (3 Phase) - Normal Power

Bus Name		Sym. Fault Amps			Asym. Fault Amps		Source Impedance			
		Amps	MVA	X/R	Maximum RMS Amps	Average RMS Amps	PU Seq. Z1	PU Seq. Z2	PU Seq. Z0	Equivalent R+jX (PU)
MDC_B_PRI_BUS	3 Phase:	11,886	12.4	.83	11,892	11,889	8.095	8.095	10.180	0.022 + j0.019
	SLG:	11,038		0.67	11,039	---	---	---	---	0.022 + j0.015
MDC_C_PRI_BUS	3 Phase:	14,613	15.2	1.24	14,705	14,659	6.585	6.585	7.073	0.015 + j0.018
	SLG:	14,379		1.03	14,410	---	---	---	---	0.014 + j0.014
MDC_D_PRI_BUS	3 Phase:	18,745	19.5	3.92	22,202	20,512	5.133	5.133	3.974	0.005 + j0.018
	SLG:	20,291		3.52	23,447	---	---	---	---	0.004 + j0.014
MDC_E_PRI_BUS	3 Phase:	18,798	19.5	3.98	22,342	20,610	5.119	5.119	3.939	0.004 + j0.018
	SLG:	20,381		3.58	23,639	---	---	---	---	0.004 + j0.014
MDC_F_PRI_BUS	3 Phase:	18,374	19.1	3.56	21,284	19,857	5.237	5.237	4.218	0.005 + j0.018
	SLG:	19,674		3.16	22,207	---	---	---	---	0.004 + j0.014
MDC_G_PRI_BUS	3 Phase:	18,374	19.1	3.56	21,284	19,857	5.237	5.237	4.218	0.005 + j0.018
	SLG:	19,674		3.16	22,207	---	---	---	---	0.004 + j0.014
MDC_L_PRI_BUS	3 Phase:	12,845	13.3	1.99	13,383	13,115	7.491	7.491	9.367	0.012 + j0.024
	SLG:	11,861		1.89	12,278	---	---	---	---	0.011 + j0.022
MDC_M_PRI_BUS	3 Phase:	18,374	19.1	3.56	21,284	19,857	5.237	5.237	4.218	0.005 + j0.018
	SLG:	19,674		3.16	22,207	---	---	---	---	0.004 + j0.014
P_PANEL	3 Phase:	7,455	7.7	.66	7,455	7,455	12.908	12.908	18.833	0.039 + j0.026
	SLG:	6,470		0.61	6,470	---	---	---	---	0.038 + j0.023
P1_VAC1_BUS	3 Phase:	19,579	20.3	4.70	24,187	21,947	4.915	4.915	3.497	0.004 + j0.017
	SLG:	21,677		4.22	26,117	---	---	---	---	0.003 + j0.013
P1_VAC2_BUS	3 Phase:	19,579	20.3	4.70	24,187	21,947	4.915	4.915	3.497	0.004 + j0.017
	SLG:	21,677		4.22	26,117	---	---	---	---	0.003 + j0.013
P2_COMPRESSOR1_BUS	3 Phase:	19,618	20.4	4.90	24,459	22,109	4.905	4.905	3.478	0.004 + j0.017
	SLG:	21,737		4.43	26,477	---	---	---	---	0.003 + j0.013
P2_COMPRESSOR2_BUS	3 Phase:	19,618	20.4	4.90	24,459	22,109	4.905	4.905	3.478	0.004 + j0.017
	SLG:	21,737		4.43	26,477	---	---	---	---	0.003 + j0.013
Q_PANEL	3 Phase:	6,402	6.7	.59	6,402	6,402	15.031	15.031	22.505	0.047 + j0.027
	SLG:	5,493		0.56	5,493	---	---	---	---	0.046 + j0.026
R_PANEL	3 Phase:	13,855	14.4	1.31	13,970	13,912	6.945	6.945	7.918	0.015 + j0.020
	SLG:	13,307		1.12	13,356	---	---	---	---	0.014 + j0.016

Short Circuit Report - ANSI Calculations - Low Voltage Busses
Utility Fault Levels - 2718A (3 Phase) - Normal Power

Government of Canada

Bus Name		Sym. Fault Amps			Asym. Fault Amps		Source Impedance			
		Amps	MVA	X/R	Maximum RMS Amps	Average RMS Amps	PU Seq. Z1	PU Seq. Z2	PU Seq. Z0	Equivalent R+jX (PU)
S_PANEL	3 Phase:	18,562	19.3	3.57	21,526	20,072	5.184	5.184	4.135	0.005 + j0.018
	SLG:	19,936		3.14	22,476	---	---	---	---	0.004 + j0.014
SA_PANEL	3 Phase:	18,272	19.0	2.77	20,070	19,182	5.266	5.266	4.326	0.006 + j0.018
	SLG:	19,501		2.35	20,800	---	---	---	---	0.006 + j0.014
T_PANEL	3 Phase:	5,109	5.3	.46	5,109	5,109	18.835	18.835	28.761	0.062 + j0.028
	SLG:	4,346		0.44	4,346	---	---	---	---	0.061 + j0.027
T2S_BUS	3 Phase:	3,139	3.3	.26	3,139	3,139	30.653	30.653	47.771	0.107 + j0.028
	SLG:	2,647		0.25	2,647	---	---	---	---	0.106 + j0.027
TP_PRI_BUS	3 Phase:	6,309	6.6	.53	6,309	6,309	15.252	15.252	22.727	0.049 + j0.026
	SLG:	5,426		0.49	5,426	---	---	---	---	0.048 + j0.024
208 Volt Busses										
1B_PANEL	3 Phase:	1,504	.5	1.22	1,513	1,508	184.567	184.567	233.923	0.051 + j0.062
	SLG:	1,381		1.19	1,388	---	---	---	---	0.387 + j0.462
1C_PANEL	3 Phase:	1,585	.6	.68	1,585	1,585	175.178	175.178	247.915	0.063 + j0.043
	SLG:	1,392		0.65	1,392	---	---	---	---	0.501 + j0.327
1D_PANEL	3 Phase:	2,058	.7	.63	2,058	2,058	134.905	134.905	198.146	0.049 + j0.031
	SLG:	1,780		0.60	1,780	---	---	---	---	0.401 + j0.242
1F_PANEL	3 Phase:	2,750	1.0	.83	2,751	2,750	100.945	100.945	138.890	0.034 + j0.028
	SLG:	2,445		0.78	2,446	---	---	---	---	0.269 + j0.209
1G_PANEL	3 Phase:	3,942	1.4	1.41	3,988	3,965	70.421	70.421	82.770	0.018 + j0.025
	SLG:	3,729		1.30	3,759	---	---	---	---	0.136 + j0.177
1H_3H_SEC_BUS	3 Phase:	5,854	2.1	3.06	6,564	6,214	47.419	47.419	41.422	0.006 + j0.020
	SLG:	6,112		3.16	6,897	---	---	---	---	0.041 + j0.130
1H_PANEL	3 Phase:	5,393	1.9	2.44	5,788	5,593	51.465	51.465	50.074	0.008 + j0.021
	SLG:	5,442		2.42	5,834	---	---	---	---	0.058 + j0.141
1J_2J_SEC_BUS	3 Phase:	5,773	2.1	2.31	6,142	5,959	48.082	48.082	38.933	0.008 + j0.019
	SLG:	6,173		2.55	6,680	---	---	---	---	0.049 + j0.126
1J_PANEL & 2J_PANEL	3 Phase:	5,294	1.9	1.95	5,501	5,398	52.435	52.435	47.601	0.010 + j0.020
	SLG:	5,464		2.06	5,718	---	---	---	---	0.067 + j0.137

Short Circuit Report - ANSI Calculations - Low Voltage Busses
Utility Fault Levels - 2718A (3 Phase) - Normal Power

Bus Name		Sym. Fault Amps			Asym. Fault Amps		Source Impedance			
		Amps	MVA	X/R	Maximum RMS Amps	Average RMS Amps	PU Seq. Z1	PU Seq. Z2	PU Seq. Z0	Equivalent R+jX (PU)
1K_2K_SEC_BUS	3 Phase:	6,257	2.3	2.32	6,661	6,461	44.359	44.359	35.555	0.008 + j0.018
	SLG:	6,711		2.56	7,263	---	---	---	---	0.045 + j0.116
1K_PANEL & 2K_PANEL	3 Phase:	5,909	2.1	2.06	6,184	6,047	46.973	46.973	40.751	0.009 + j0.018
	SLG:	6,187		2.20	6,533	---	---	---	---	0.056 + j0.123
1L_PANEL	3 Phase:	6,697	2.4	2.63	7,284	6,994	41.445	41.445	37.377	0.006 + j0.017
	SLG:	6,924		2.61	7,522	---	---	---	---	0.043 + j0.112
1M_PANEL	3 Phase:	5,061	1.8	2.95	5,630	5,349	54.845	54.845	52.980	0.008 + j0.022
	SLG:	5,119		2.87	5,663	---	---	---	---	0.054 + j0.154
1N_PANEL	3 Phase:	5,957	2.1	2.61	6,469	6,216	46.595	46.595	42.107	0.007 + j0.019
	SLG:	6,155		2.67	6,716	---	---	---	---	0.047 + j0.127
1N_SEC_BUS	3 Phase:	6,443	2.3	3.09	7,239	6,847	43.082	43.082	34.400	0.006 + j0.018
	SLG:	6,910		3.29	7,866	---	---	---	---	0.035 + j0.115
1P_PANEL & 2P_PANEL & 3P_PANEL	3 Phase:	3,155	1.1	2.03	3,295	3,225	87.979	87.979	80.472	0.017 + j0.034
	SLG:	3,252		2.22	3,438	---	---	---	---	0.105 + j0.234
1Q_PANEL	3 Phase:	954	.3	1.48	968	961	290.870	290.870	260.673	0.071 + j0.104
	SLG:	991		1.65	1,013	---	---	---	---	0.435 + j0.719
1Q_SEC_BUS	3 Phase:	991	.4	1.61	1,011	1,001	279.991	279.991	244.333	0.064 + j0.103
	SLG:	1,040		1.86	1,075	---	---	---	---	0.379 + j0.705
1R_PANEL & 2R_PANEL	3 Phase:	1,061	.4	2.10	1,113	1,087	261.688	261.688	253.387	0.049 + j0.102
	SLG:	1,072		2.18	1,131	---	---	---	---	0.323 + j0.706
1R_SEC_BUS	3 Phase:	1,084	.4	2.28	1,150	1,117	256.166	256.166	243.667	0.045 + j0.101
	SLG:	1,102		2.41	1,180	---	---	---	---	0.290 + j0.698
1S_PANEL	3 Phase:	3,461	1.2	2.90	3,837	3,651	80.198	80.198	77.382	0.011 + j0.033
	SLG:	3,502		2.90	3,882	---	---	---	---	0.078 + j0.225
1S_TX_SEC_BUS	3 Phase:	3,554	1.3	3.09	3,991	3,776	78.094	78.094	72.667	0.010 + j0.032
	SLG:	3,639		3.11	4,092	---	---	---	---	0.070 + j0.218
1T_PANEL	3 Phase:	1,023	.4	1.81	1,055	1,039	271.257	271.257	253.387	0.057 + j0.103
	SLG:	1,047		1.96	1,089	---	---	---	---	0.361 + j0.708
1T_SEC_BUS	3 Phase:	1,046	.4	1.94	1,086	1,067	265.269	265.269	243.667	0.053 + j0.102
	SLG:	1,077		2.14	1,133	---	---	---	---	0.327 + j0.700

Short Circuit Report - ANSI Calculations - Low Voltage Busses
Utility Fault Levels - 2718A (3 Phase) - Normal Power

Bus Name		Sym. Fault Amps			Asym. Fault Amps		Source Impedance			
		Amps	MVA	X/R	Maximum RMS Amps	Average RMS Amps	PU Seq. Z1	PU Seq. Z2	PU Seq. Z0	Equivalent R+jX (PU)
1U_PANEL	3 Phase:	5,575	2.0	2.13	5,861	5,719	49.785	49.785	41.496	0.009 + j0.019
	SLG:	5,911		2.33	6,295	---	---	---	---	0.056 + j0.129
1U_SEC_BUS	3 Phase:	5,726	2.1	2.25	6,067	5,897	48.479	48.479	38.933	0.009 + j0.019
	SLG:	6,139		2.50	6,618	---	---	---	---	0.050 + j0.126
2B_PANEL	3 Phase:	1,170	.4	.78	1,170	1,170	237.240	237.240	322.652	0.081 + j0.063
	SLG:	1,045		0.74	1,045	---	---	---	---	0.640 + j0.475
2C_PANEL	3 Phase:	1,764	.6	.80	1,764	1,764	157.396	157.396	218.809	0.053 + j0.043
	SLG:	1,561		0.78	1,561	---	---	---	---	0.421 + j0.327
2D_PANEL	3 Phase:	2,018	.7	.62	2,018	2,018	137.570	137.570	202.698	0.051 + j0.031
	SLG:	1,743		0.59	1,743	---	---	---	---	0.411 + j0.244
2E_PANEL	3 Phase:	2,306	.8	.69	2,306	2,306	120.381	120.381	173.215	0.043 + j0.030
	SLG:	2,012		0.66	2,012	---	---	---	---	0.345 + j0.228
2F_PANEL	3 Phase:	3,458	1.2	1.32	3,488	3,473	80.260	80.260	103.378	0.021 + j0.028
	SLG:	3,157		1.26	3,178	---	---	---	---	0.164 + j0.207
2H_3H_SEC_BUS	3 Phase:	5,137	1.9	3.23	5,823	5,486	54.036	54.036	48.000	0.007 + j0.022
	SLG:	5,336		3.33	6,091	---	---	---	---	0.045 + j0.149
2L_PANEL	3 Phase:	6,745	2.4	2.77	7,410	7,082	41.152	41.152	36.888	0.006 + j0.017
	SLG:	6,986		2.79	7,685	---	---	---	---	0.040 + j0.112
2N_PANEL	3 Phase:	6,383	2.3	2.53	6,898	6,643	43.483	43.483	38.921	0.007 + j0.017
	SLG:	6,615		2.60	7,183	---	---	---	---	0.045 + j0.117
2N_SEC_BUS	3 Phase:	6,948	2.5	3.03	7,772	7,366	39.951	39.951	31.200	0.005 + j0.016
	SLG:	7,498		3.23	8,506	---	---	---	---	0.033 + j0.106
2S_PANEL	3 Phase:	1,383	.5	1.35	1,396	1,390	200.700	200.700	192.859	0.052 + j0.070
	SLG:	1,401		1.37	1,416	---	---	---	---	0.350 + j0.480
3A_PANEL	3 Phase:	2,288	.8	.77	2,288	2,288	121.336	121.336	182.857	0.042 + j0.032
	SLG:	1,957		0.79	1,958	---	---	---	---	0.334 + j0.263
3B_PANEL	3 Phase:	1,158	.4	.77	1,158	1,158	239.787	239.787	327.098	0.082 + j0.063
	SLG:	1,033		0.74	1,033	---	---	---	---	0.650 + j0.478
3C_PANEL	3 Phase:	1,538	.6	.66	1,538	1,538	180.434	180.434	256.947	0.065 + j0.043
	SLG:	1,348		0.64	1,348	---	---	---	---	0.521 + j0.332

Short Circuit Report - ANSI Calculations - Low Voltage Busses
Utility Fault Levels - 2718A (3 Phase) - Normal Power

Government of Canada

Bus Name		Sym. Fault Amps			Asym. Fault Amps		Source Impedance			
		Amps	MVA	X/R	Maximum RMS Amps	Average RMS Amps	PU Seq. Z1	PU Seq. Z2	PU Seq. Z0	Equivalent R+jX (PU)
3D_PANEL	3 Phase:	2,817	1.0	1.04	2,823	2,820	98.545	98.545	138.310	0.030 + j0.031
	SLG:	2,483		1.01	2,488	---	---	---	---	0.236 + j0.239
3E_PANEL	3 Phase:	2,550	.9	.82	2,551	2,551	108.844	108.844	154.237	0.036 + j0.030
	SLG:	2,240		0.78	2,240	---	---	---	---	0.293 + j0.229
3F_PANEL	3 Phase:	2,904	1.0	.94	2,908	2,906	95.575	95.575	130.164	0.030 + j0.028
	SLG:	2,593		0.89	2,595	---	---	---	---	0.240 + j0.213
3G_PANEL	3 Phase:	4,571	1.6	2.38	4,888	4,731	60.720	60.720	64.390	0.010 + j0.024
	SLG:	4,482		2.29	4,761	---	---	---	---	0.074 + j0.170
3H_PANEL & 2H_PANEL	3 Phase:	4,827	1.7	2.78	5,308	5,070	57.508	57.508	55.732	0.008 + j0.023
	SLG:	4,877		2.81	5,373	---	---	---	---	0.057 + j0.161
3L_PANEL	3 Phase:	6,756	2.4	2.81	7,442	7,104	41.082	41.082	36.774	0.006 + j0.017
	SLG:	7,001		2.83	7,726	---	---	---	---	0.040 + j0.112
3M_PANEL	3 Phase:	5,092	1.8	3.12	5,730	5,416	54.514	54.514	52.392	0.007 + j0.022
	SLG:	5,159		3.06	5,783	---	---	---	---	0.050 + j0.153
3N_PANEL	3 Phase:	4,504	1.6	2.34	4,803	4,655	61.630	61.630	55.732	0.010 + j0.025
	SLG:	4,655		2.49	5,013	---	---	---	---	0.067 + j0.166
3N_SEC_BUS	3 Phase:	4,785	1.7	2.61	5,199	4,994	58.013	58.013	48.000	0.009 + j0.023
	SLG:	5,081		2.84	5,611	---	---	---	---	0.054 + j0.155
3S_PANEL	3 Phase:	4,485	1.6	1.70	4,596	4,541	61.883	61.883	52.227	0.014 + j0.023
	SLG:	4,747		1.93	4,927	---	---	---	---	0.081 + j0.156
3S_TX_SEC_BUS	3 Phase:	4,786	1.7	1.82	4,936	4,861	58.001	58.001	44.444	0.012 + j0.022
	SLG:	5,214		2.11	5,474	---	---	---	---	0.068 + j0.144
4A_PANEL	3 Phase:	1,422	.5	.43	1,422	1,422	195.221	195.221	301.100	0.077 + j0.034
	SLG:	1,204		0.44	1,204	---	---	---	---	0.633 + j0.279
4B_PANEL	3 Phase:	1,141	.4	.76	1,142	1,142	243.194	243.194	333.035	0.084 + j0.064
	SLG:	1,017		0.73	1,017	---	---	---	---	0.663 + j0.481
4C_PANEL	3 Phase:	1,513	.5	.65	1,513	1,513	183.513	183.513	262.225	0.067 + j0.043
	SLG:	1,324		0.63	1,324	---	---	---	---	0.532 + j0.335
4D_PANEL	3 Phase:	2,515	.9	.86	2,517	2,516	110.371	110.371	158.192	0.036 + j0.031
	SLG:	2,198		0.83	2,199	---	---	---	---	0.291 + j0.243

Short Circuit Report - ANSI Calculations - Low Voltage Busses
Utility Fault Levels - 2718A (3 Phase) - Normal Power

Government of Canada

Bus Name		Sym. Fault Amps			Asym. Fault Amps		Source Impedance			
		Amps	MVA	X/R	Maximum RMS Amps	Average RMS Amps	PU Seq. Z1	PU Seq. Z2	PU Seq. Z0	Equivalent R+jX (PU)
4E_PANEL	3 Phase:	2,202	.8	.67	2,202	2,202	126.060	126.060	183.013	0.045 + j0.030
	SLG:	1,914		0.64	1,914	---	---	---	---	0.367 + j0.233
4F_PANEL	3 Phase:	2,845	1.0	.92	2,848	2,847	97.560	97.560	133.750	0.031 + j0.029
	SLG:	2,533		0.87	2,535	---	---	---	---	0.248 + j0.216
4G_PANEL	3 Phase:	4,312	1.6	1.81	4,443	4,378	64.372	64.372	71.163	0.013 + j0.024
	SLG:	4,169		1.68	4,267	---	---	---	---	0.102 + j0.172
4H_5H_SEC_BUS	3 Phase:	9,553	3.4	2.92	10,602	10,084	29.057	29.057	23.111	0.004 + j0.012
	SLG:	10,254		3.04	11,478	---	---	---	---	0.025 + j0.077
4H_PANEL & 5H_PANEL	3 Phase:	8,219	3.0	1.97	8,552	8,386	33.774	33.774	32.927	0.007 + j0.013
	SLG:	8,289		1.92	8,599	---	---	---	---	0.046 + j0.089
4L_PANEL	3 Phase:	6,697	2.4	2.63	7,284	6,994	41.445	41.445	37.377	0.006 + j0.017
	SLG:	6,924		2.61	7,522	---	---	---	---	0.043 + j0.112
4M_PANEL	3 Phase:	5,061	1.8	2.95	5,631	5,350	54.841	54.841	52.971	0.008 + j0.022
	SLG:	5,120		2.87	5,664	---	---	---	---	0.054 + j0.154
4N_PANEL	3 Phase:	6,705	2.4	2.62	7,288	7,000	41.396	41.396	37.771	0.006 + j0.017
	SLG:	6,907		2.66	7,528	---	---	---	---	0.042 + j0.113
4N_SECI_BUS	3 Phase:	7,325	2.6	3.19	8,284	7,812	37.895	37.895	30.045	0.005 + j0.016
	SLG:	7,870		3.37	9,005	---	---	---	---	0.030 + j0.101
4S_PANEL	3 Phase:	1,935	.7	1.36	1,954	1,944	143.474	143.474	127.931	0.037 + j0.050
	SLG:	2,011		1.49	2,041	---	---	---	---	0.230 + j0.344
4S_TX_SEC_BUS	3 Phase:	2,097	.8	1.62	2,140	2,118	132.390	132.390	111.111	0.030 + j0.049
	SLG:	2,227		1.89	2,305	---	---	---	---	0.175 + j0.330
5A_PANEL	3 Phase:	1,399	.5	.43	1,399	1,399	198.471	198.471	306.497	0.079 + j0.034
	SLG:	1,184		0.44	1,184	---	---	---	---	0.645 + j0.282
5B_PANEL	3 Phase:	1,129	.4	.75	1,130	1,130	245.757	245.757	337.494	0.085 + j0.064
	SLG:	1,005		0.72	1,005	---	---	---	---	0.673 + j0.483
5C_PANEL	3 Phase:	1,491	.5	.64	1,491	1,491	186.158	186.158	266.754	0.068 + j0.044
	SLG:	1,303		0.62	1,303	---	---	---	---	0.542 + j0.338
5D_PANEL	3 Phase:	2,737	1.0	1.01	2,742	2,739	101.428	101.428	143.663	0.031 + j0.031
	SLG:	2,403		0.99	2,407	---	---	---	---	0.246 + j0.244

Short Circuit Report - ANSI Calculations - Low Voltage Busses
Utility Fault Levels - 2718A (3 Phase) - Normal Power

Government of Canada

Bus Name		Sym. Fault Amps			Asym. Fault Amps		Source Impedance			
		Amps	MVA	X/R	Maximum RMS Amps	Average RMS Amps	PU Seq. Z1	PU Seq. Z2	PU Seq. Z0	Equivalent R+jX (PU)
5E_PANEL	3 Phase:	3,249	1.2	1.34	3,278	3,263	85.445	85.445	115.159	0.022 + j0.030
	SLG:	2,911		1.31	2,935	---	---	---	---	0.174 + j0.227
5F_PANEL	3 Phase:	3,288	1.2	1.24	3,308	3,298	84.429	84.429	111.406	0.023 + j0.028
	SLG:	2,972		1.19	2,987	---	---	---	---	0.181 + j0.214
5G_PANEL	3 Phase:	3,708	1.3	1.32	3,739	3,723	74.867	74.867	91.720	0.020 + j0.026
	SLG:	3,452		1.22	3,473	---	---	---	---	0.153 + j0.187
5M_PANEL	3 Phase:	5,086	1.8	3.08	5,710	5,403	54.574	54.574	52.498	0.007 + j0.022
	SLG:	5,152		3.02	5,760	---	---	---	---	0.051 + j0.153
5N_PANEL	3 Phase:	6,558	2.4	2.67	7,154	6,860	42.324	42.324	38.921	0.006 + j0.017
	SLG:	6,739		2.70	7,367	---	---	---	---	0.043 + j0.116
5N_SEC_BUS	3 Phase:	7,147	2.6	3.25	8,118	7,640	38.838	38.838	31.200	0.005 + j0.016
	SLG:	7,650		3.42	8,783	---	---	---	---	0.031 + j0.104
6A_PANEL	3 Phase:	1,379	.5	.43	1,379	1,379	201.260	201.260	311.125	0.080 + j0.034
	SLG:	1,167		0.43	1,167	---	---	---	---	0.655 + j0.284
6B_PANEL	3 Phase:	1,120	.4	.74	1,120	1,120	247.897	247.897	341.214	0.086 + j0.064
	SLG:	995		0.71	995	---	---	---	---	0.682 + j0.485
6C_PANEL	3 Phase:	1,467	.5	.63	1,467	1,467	189.252	189.252	272.043	0.069 + j0.044
	SLG:	1,280		0.61	1,280	---	---	---	---	0.554 + j0.340
6D_PANEL	3 Phase:	260	.1	.09	260	260	1066.654	1066.654	Infinite	0.460 + j0.042
	SLG:	218		0.09	218	---	---	---	---	3.804 + j0.356
6E_PANEL	3 Phase:	3,210	1.2	1.32	3,238	3,224	86.467	86.467	117.166	0.023 + j0.030
	SLG:	2,871		1.29	2,893	---	---	---	---	0.178 + j0.229
6F_PANEL	3 Phase:	2,715	1.0	.87	2,717	2,716	102.239	102.239	142.154	0.033 + j0.029
	SLG:	2,403		0.83	2,405	---	---	---	---	0.267 + j0.221
6G_PANEL	3 Phase:	4,048	1.5	1.71	4,149	4,099	68.572	68.572	80.281	0.015 + j0.026
	SLG:	3,832		1.62	3,910	---	---	---	---	0.114 + j0.185
6M_PANEL	3 Phase:	5,086	1.8	3.08	5,710	5,403	54.574	54.574	52.498	0.007 + j0.022
	SLG:	5,152		3.02	5,760	---	---	---	---	0.051 + j0.153
6N_PANEL	3 Phase:	4,626	1.7	2.52	4,994	4,812	59.999	59.999	55.732	0.010 + j0.024
	SLG:	4,740		2.62	5,153	---	---	---	---	0.063 + j0.164

Short Circuit Report - ANSI Calculations - Low Voltage Busses
Utility Fault Levels - 2718A (3 Phase) - Normal Power

Stantec

Government of Canada

Bus Name		Sym. Fault Amps: Amps	Sym. Fault Amps: MVA	Sym. Fault Amps: X/R	Asym. Fault Amps: Maximum RMS Amps	Asym. Fault Amps: Average RMS Amps	Source Impedance: PU Seq. Z1	Source Impedance: PU Seq. Z2	Source Impedance: PU Seq. Z0	Source Impedance: Equivalent R+jX (PU)
6N_SEC_BUS	3 Phase:	4,918	1.8	2.85	5,433	5,178	56.443	56.443	48.000	0.008 + j0.023
	SLG:	5,178		3.04	5,796	---	---	---	---	0.050 + j0.153
MDC_A	3 Phase:	5,640	2.0	2.79	6,205	5,926	49.213	49.213	46.600	0.007 + j0.020
	SLG:	5,742		2.75	6,299	---	---	---	---	0.050 + j0.136
MDC_A_SEC_BUS	3 Phase:	5,927	2.1	3.27	6,740	6,340	46.834	46.834	41.422	0.006 + j0.019
	SLG:	6,164		3.31	7,027	---	---	---	---	0.039 + j0.129
MDC_B	3 Phase:	2,153	.8	2.40	2,305	2,230	128.907	128.907	125.158	0.021 + j0.051
	SLG:	2,174		2.44	2,334	---	---	---	---	0.145 + j0.354
MDC_B_SEC_BUS	3 Phase:	2,209	.8	2.61	2,400	2,306	125.650	125.650	118.666	0.019 + j0.051
	SLG:	2,251		2.70	2,461	---	---	---	---	0.129 + j0.347
MDC_C	3 Phase:	3,428	1.2	2.70	3,746	3,589	80.976	80.976	77.382	0.012 + j0.033
	SLG:	3,479		2.76	3,819	---	---	---	---	0.082 + j0.225
MDC_C_SEC_BUS	3 Phase:	3,521	1.3	2.85	3,890	3,708	78.838	78.838	72.667	0.011 + j0.032
	SLG:	3,615		2.94	4,020	---	---	---	---	0.074 + j0.218
MDC_D	3 Phase:	5,031	1.8	3.25	5,710	5,376	55.177	55.177	52.661	0.007 + j0.023
	SLG:	5,108		3.19	5,779	---	---	---	---	0.049 + j0.156
MDC_D_SEC_BUS	3 Phase:	5,224	1.9	3.62	6,074	5,657	53.132	53.132	48.000	0.006 + j0.022
	SLG:	5,398		3.61	6,272	---	---	---	---	0.041 + j0.149
MDC_E	3 Phase:	5,032	1.8	3.25	5,713	5,378	55.162	55.162	52.661	0.007 + j0.023
	SLG:	5,109		3.20	5,781	---	---	---	---	0.049 + j0.156
MDC_E_SEC_BUS	3 Phase:	5,226	1.9	3.62	6,078	5,660	53.117	53.117	48.000	0.006 + j0.022
	SLG:	5,399		3.61	6,275	---	---	---	---	0.041 + j0.149
MDC_F	3 Phase:	5,021	1.8	3.22	5,689	5,360	55.285	55.285	52.661	0.007 + j0.023
	SLG:	5,101		3.18	5,764	---	---	---	---	0.049 + j0.156
MDC_F_SEC_BUS	3 Phase:	5,214	1.9	3.58	6,050	5,640	53.237	53.237	48.000	0.006 + j0.022
	SLG:	5,391		3.58	6,255	---	---	---	---	0.042 + j0.149
MDC_G	3 Phase:	5,021	1.8	3.22	5,689	5,360	55.285	55.285	52.661	0.007 + j0.023
	SLG:	5,101		3.18	5,764	---	---	---	---	0.049 + j0.156
MDC_G_SEC_BUS	3 Phase:	5,214	1.9	3.58	6,050	5,640	53.237	53.237	48.000	0.006 + j0.022
	SLG:	5,391		3.58	6,255	---	---	---	---	0.042 + j0.149

Short Circuit Report - ANSI Calculations - Low Voltage Busses
Utility Fault Levels - 2718A (3 Phase) - Normal Power

Government of Canada

Bus Name		Sym. Fault Amps			Asym. Fault Amps		Source Impedance			
		Amps	MVA	X/R	Maximum RMS Amps	Average RMS Amps	PU Seq. Z1	PU Seq. Z2	PU Seq. Z0	Equivalent R+jX (PU)
MDC_L	3 Phase:	6,830	2.5	2.91	7,578	7,209	40.640	40.640	35.842	0.006 + j0.017
	SLG:	7,110		2.96	7,916	---	---	---	---	0.037 + j0.111
MDC_L_SEC_BUS	3 Phase:	7,200	2.6	3.32	8,214	7,715	38.553	38.553	31.200	0.005 + j0.016
	SLG:	7,690		3.47	8,858	---	---	---	---	0.030 + j0.104
MDC_M	3 Phase:	5,132	1.8	3.21	5,813	5,478	54.086	54.086	51.462	0.007 + j0.022
	SLG:	5,217		3.17	5,891	---	---	---	---	0.048 + j0.152
MDC_M_SEC_BUS	3 Phase:	5,334	1.9	3.58	6,189	5,770	52.037	52.037	46.800	0.006 + j0.022
	SLG:	5,519		3.58	6,404	---	---	---	---	0.041 + j0.145
T2S_SEC_BUS	3 Phase:	1,552	.6	1.95	1,612	1,582	178.877	178.877	160.001	0.035 + j0.069
	SLG:	1,612		2.18	1,699	---	---	---	---	0.216 + j0.469
TP_SEC_BUS	3 Phase:	3,295	1.2	2.16	3,470	3,383	84.231	84.231	72.667	0.015 + j0.033
	SLG:	3,459		2.39	3,701	---	---	---	---	0.093 + j0.222

Short Circuit Report - ANSI Calculations - Low Voltage Busses
Emergency Power

Government of Canada

Bus Name		Sym. Fault Amps Amps	MVA	X/R	Asym. Fault Amps Maximum RMS Amps	Average RMS Amps	Source Impedance PU Seq. Z1	PU Seq. Z2	PU Seq. Z0	Equivalent R+jX (PU)
600 Volt Busses										
1S_TX_PRI_BUS	3 Phase:	9,102	9.5	4.91	11,355	10,261	10.572	10.572	13.319	0.008 + j0.037
	SLG:	8,377		4.59	10,290	---	---	---	---	0.007 + j0.034
3S_TX_PRI_BUS	3 Phase:	4,700	4.9	.89	4,704	4,702	20.472	20.472	32.037	0.055 + j0.049
	SLG:	3,955		0.88	3,959	---	---	---	---	0.055 + j0.048
4S_TX_PRI_BUS	3 Phase:	2,695	2.8	.39	2,695	2,695	35.705	35.705	56.245	0.120 + j0.047
	SLG:	2,261		0.38	2,261	---	---	---	---	0.119 + j0.046
ALTERNATOR	3 Phase:	9,488	9.9	12.26	14,067	11,900	10.141	10.141	12.372	0.003 + j0.036
	SLG:	8,840		11.86	13,046	---	---	---	---	0.003 + j0.033
ATS_EMERG_BUS	3 Phase:	9,547	9.9	16.12	14,649	12,246	10.079	10.079	12.197	0.002 + j0.036
	SLG:	8,922		16.17	13,694	---	---	---	---	0.002 + j0.032
ATS_LOAD_BUS	3 Phase:	9,547	9.9	16.12	14,649	12,246	10.079	10.079	12.197	0.002 + j0.036
	SLG:	8,922		16.17	13,694	---	---	---	---	0.002 + j0.032
CDP-EP Panel	3 Phase:	9,244	9.6	9.41	13,157	11,294	10.409	10.409	13.020	0.004 + j0.037
	SLG:	8,531		9.05	12,062	---	---	---	---	0.004 + j0.034
CT01_STARTER	3 Phase:	9,457	9.8	9.22	13,413	11,528	10.175	10.175	12.435	0.004 + j0.036
	SLG:	8,805		8.71	12,366	---	---	---	---	0.004 + j0.033
CT01B1_BUS	3 Phase:	9,301	9.7	5.48	11,896	10,641	10.346	10.346	12.806	0.007 + j0.037
	SLG:	8,619		5.03	10,814	---	---	---	---	0.007 + j0.033
CT01B2_BUS	3 Phase:	9,301	9.7	5.48	11,896	10,641	10.346	10.346	12.806	0.007 + j0.037
	SLG:	8,619		5.03	10,814	---	---	---	---	0.007 + j0.033
CT01C_STARTER	3 Phase:	9,248	9.6	4.51	11,317	10,310	10.404	10.404	12.907	0.008 + j0.037
	SLG:	8,565		4.08	10,237	---	---	---	---	0.008 + j0.033
GEN_BUS	3 Phase:	9,593	10.0	18.28	14,918	12,416	10.031	10.031	12.015	0.002 + j0.036
	SLG:	8,999		18.89	14,041	---	---	---	---	0.002 + j0.032
MCC_1S	3 Phase:	8,634	9.0	3.60	10,031	9,346	11.145	11.145	14.622	0.011 + j0.039
	SLG:	7,822		3.38	8,961	---	---	---	---	0.010 + j0.035
MCC_E_PANEL	3 Phase:	7,504	7.8	2.74	8,226	7,869	12.823	12.823	18.502	0.016 + j0.043
	SLG:	6,539		2.66	7,127	---	---	---	---	0.016 + j0.041

Short Circuit Report - ANSI Calculations - Low Voltage Busses
Emergency Power

Government of Canada

Bus Name		Sym. Fault Amps: Amps	MVA	X/R	Asym. Fault Amps: Maximum RMS Amps	Average RMS Amps	Source Impedance: PU Seq. Z1	PU Seq. Z2	PU Seq. Z0	Equivalent R+jX (PU)
MCC_ES_BUS	3 Phase:	5,340	5.5	.96	5,348	5,344	18.018	18.018	27.418	0.047 + j0.045
	SLG:	4,550		0.93	4,555	---	---	---	---	0.046 + j0.043
MCC_P1_BUS	3 Phase:	9,488	9.9	12.26	14,067	11,900	10.141	10.141	12.372	0.003 + j0.036
	SLG:	8,840		11.86	13,046	---	---	---	---	0.003 + j0.033
MCC_P2_BUS	3 Phase:	9,493	9.9	12.86	14,167	11,957	10.136	10.136	12.364	0.003 + j0.036
	SLG:	8,845		12.50	13,148	---	---	---	---	0.003 + j0.033
MCC_W_PANEL	3 Phase:	7,504	7.8	2.74	8,226	7,869	12.823	12.823	18.502	0.016 + j0.043
	SLG:	6,539		2.66	7,127	---	---	---	---	0.016 + j0.041
MDC S	3 Phase:	9,531	9.9	15.53	14,563	12,192	10.096	10.096	12.259	0.002 + j0.036
	SLG:	8,896		15.44	13,583	---	---	---	---	0.002 + j0.032
P1_VAC1_BUS	3 Phase:	9,441	9.8	10.11	13,596	11,621	10.192	10.192	12.492	0.004 + j0.037
	SLG:	8,781		9.63	12,546	---	---	---	---	0.003 + j0.033
P1_VAC2_BUS	3 Phase:	9,441	9.8	10.11	13,596	11,621	10.192	10.192	12.492	0.004 + j0.037
	SLG:	8,781		9.63	12,546	---	---	---	---	0.003 + j0.033
P2_COMPRESSOR1_BUS	3 Phase:	9,447	9.8	10.53	13,693	11,677	10.186	10.186	12.483	0.004 + j0.036
	SLG:	8,787		10.05	12,643	---	---	---	---	0.003 + j0.033
P2_COMPRESSOR2_BUS	3 Phase:	9,447	9.8	10.53	13,693	11,677	10.186	10.186	12.483	0.004 + j0.036
	SLG:	8,787		10.05	12,643	---	---	---	---	0.003 + j0.033
S_PANEL	3 Phase:	9,231	9.6	7.49	12,605	10,988	10.425	10.425	13.033	0.005 + j0.037
	SLG:	8,520		7.11	11,516	---	---	---	---	0.005 + j0.034
SA_PANEL	3 Phase:	9,212	9.6	5.81	11,934	10,620	10.445	10.445	13.042	0.006 + j0.037
	SLG:	8,508		5.45	10,865	---	---	---	---	0.006 + j0.033
T2S_BUS	3 Phase:	2,967	3.1	.44	2,967	2,967	32.430	32.430	50.969	0.107 + j0.047
	SLG:	2,492		0.44	2,492	---	---	---	---	0.106 + j0.046
208 Volt Busses										
1S_PANEL	3 Phase:	3,255	1.2	3.10	3,660	3,461	85.263	85.263	77.382	0.011 + j0.035
	SLG:	3,359		3.04	3,759	---	---	---	---	0.078 + j0.235
1S_TX_SEC_BUS	3 Phase:	3,337	1.2	3.31	3,804	3,574	83.190	83.190	72.667	0.010 + j0.034
	SLG:	3,484		3.26	3,959	---	---	---	---	0.070 + j0.229

Short Circuit Report - ANSI Calculations - Low Voltage Busses
Emergency Power

Stantec — Government of Canada

Bus Name		Sym. Fault Amps			Asym. Fault Amps		Source Impedance			
		Amps	MVA	X/R	Maximum RMS Amps	Average RMS Amps	PU Seq. Z1	PU Seq. Z2	PU Seq. Z0	Equivalent R+jX (PU)
2S_PANEL	3 Phase:	1,354	.5	1.40	1,369	1,361	205.019	205.019	192.859	0.052 + j0.072
	SLG:	1,381		1.40	1,397	---	---	---	---	0.350 + j0.491
3S_PANEL	3 Phase:	4,171	1.5	1.87	4,315	4,243	66.542	66.542	52.227	0.014 + j0.025
	SLG:	4,502		2.06	4,712	---	---	---	---	0.081 + j0.166
3S_TX_SEC_BUS	3 Phase:	4,425	1.6	2.02	4,616	4,521	62.735	62.735	44.444	0.012 + j0.024
	SLG:	4,915		2.27	5,214	---	---	---	---	0.068 + j0.155
4S_PANEL	3 Phase:	1,878	.7	1.43	1,901	1,889	147.812	147.812	127.931	0.037 + j0.052
	SLG:	1,969		1.54	2,002	---	---	---	---	0.230 + j0.355
4S_TX_SEC_BUS	3 Phase:	2,027	.7	1.70	2,076	2,052	136.964	136.964	111.111	0.030 + j0.051
	SLG:	2,172		1.95	2,256	---	---	---	---	0.175 + j0.341
T2S_SEC_BUS	3 Phase:	1,511	.5	2.01	1,577	1,544	183.642	183.642	160.001	0.035 + j0.071
	SLG:	1,582		2.23	1,673	---	---	---	---	0.216 + j0.480

APPENDIX B

DEVICE EVALUATION STUDY

The purpose of a Device Evaluation Study is to ensure that the equipment in an electrical system exhibits the characteristics necessary for safe and effective operation under the worst-case fault conditions. Each component must be able to withstand the thermal and mechanical stresses arising from the flow of maximum fault current through it, and additionally, each protective device must be able to interrupt the maximum potential fault current at its present location. Equipment ratings, in conjunction with Short Circuit Study results, are used to assess the suitability of each component in the system.

Non-protective devices must be able to, without malfunctioning and overheating, carry the worst-case fault current for a number of cycles prior to interruption by the appropriate overcurrent device. The short-circuit ratings of devices are not defined in the same manner, and consequently, devices of different types are evaluated differently. However, the basic requirement is that the short-circuit rating of each component is in excess of the maximum fault current that may flow through it, as revealed by the Short Circuit Study.

It must also be verified that the protective devices under study are of sufficiently high rating to function as required when subjected to the worst-case First Cycle Currents and Interrupting Currents determined through the Short Circuit Study.

Low voltage circuit breakers and fuses are evaluated according to their ability to interrupt the maximum current that may occur within the first ½ cycle of the fault condition. Medium and high voltage circuit breakers are evaluated according to their ability to close and latch during the first ½ cycle of the worst-case fault condition as well as their ability to interrupt the maximum fault current that may be present in cycles 2 through 8. Protective devices that fail to adhere to the following criteria are over-dutied and should be replaced:

- A low voltage breaker or fuse must have an interrupting rating that exceeds the First Cycle Current
- A medium/high voltage breaker must have a closing and latching rating (also referred to as momentary rating or asymmetrical rating) that exceeds the First Cycle Current.
- A medium or high voltage breaker must have an interrupting rating that exceeds its calculated interrupting duty. The interrupting duty of each breaker is determined by the cycle in which the breaker is expected to interrupt the fault, the maximum current flow expected during that cycle, and the basis on which the breaker is rated (i.e. whether the breaker is rated in terms of symmetrical or total fault current.)

The devices within the scope of this study were evaluated in accordance with American National Standards Institute (ANSI) C37.010, C37.5 and the Institute of Electrical and Electronic Engineers (IEEE) Standard 1015, using PTW-Equipment Evaluation version 7.0, an electrical system modeling software program developed by SKM System Analysis Inc.

Device Evaluation Report - ANSI Calculations - Medium Voltage Devices
Utility Fault Levels - 2718A (3 Phase) - Normal Power

Government of Canada

Bus Name / Device Name	Bus Voltage / Dev. Voltage	Interrupting Evaluation: Max. S.C. Amps / Dev. Int. Duty	Interrupting Evaluation: Sys. X/R Ratio / Test X/R	Interrupting Evaluation: Sym. Rating	Momentary Evaluation: Max. Mom Amps / Dev. Mom. Duty	Dev C/L Rating	Series Rating	Dev. Pass/Fail
8,300 Volt Busses								
MAIN_BRKR_PRI_BUS	**8,300**	**2,492**	**6.6**		**3,317**			
MAIN_BRKR (FPE RM17.5-75)	18,000	2,492	15.0	32,500	3,317	74,000		Pass
MAIN_ISOLATION_SWITCH (FPE IS)	15,000	2,492	15.0	40,000	3,317	62,000		Pass

Device Evaluation Report - ANSI Calculations - Low Voltage Devices
Utility Fault Levels - 2718A (3 Phase) - Normal Power

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Bus Name / Device Name	Bus Voltage / Device Voltage	Bus Max S.C. Amps / Device Fault Duty	System X/R Ratio / Device Test X/R	Device Sym. Rating	Series Rating	Device Pass/Fail
600 Volt Busses						
MDC S	**600**	**22,631**	**7.1**			
30 (FPE 250)	600	24,369	4.9	18,000		Fail
31 (FPE 250)	600	24,369	4.9	18,000		Fail
80 (FPE 250)	600	24,369	4.9	18,000		Fail
81 (Federal Pioneer CHED)	600	27,109	3.2	18,000		Fail
82 (Federal Pioneer CHED)	600	27,109	3.2	18,000		Fail
83 (FPE 250)	600	24,369	4.9	18,000		Fail
84 (Federal Pioneer CHED)	600	27,109	3.2	18,000		Fail
85 (FPE 250)	600	24,369	4.9	18,000		Fail
86 (Federal Pioneer CHED)	600	27,109	3.2	18,000		Fail
87 (Federal Pioneer CHED)	600	27,109	3.2	18,000		Fail
88 (FPE CE-E)	600	24,369	4.9	18,000		Fail
89 (Federal Pioneer CHED)	600	27,109	3.2	18,000		Fail
90 (GE THED)	600	27,109	3.2	18,000		Fail
91 (GE THED)	600	27,109	3.2	18,000		Fail
CDP-EP BKRK (SQUARE D JL)	600	24,369	4.9	50,000		Pass
Cooling Tower #2 BRKR (FPE 250)	600	24,369	4.9	18,000		Fail
MCC_M BRKR (GE TFJ)	600	27,109	3.2	18,000		Fail
MCC-ES BRKR (Federal Pioneer CHED)	600	27,109	3.2	18,000		Fail
MDC_D (52-27) (FPE 250)	600	24,369	4.9	18,000		Fail
Panel 3S XMER BRKR (Federal Pioneer CHED)	600	27,109	3.2	18,000		Fail
MDC_1	**600**	**23,432**	**8.9**			
20 (GE TB1)	600	26,149	4.9	200,000		Pass
21 (GE TB4)	600	26,149	4.9	200,000		Pass
22 (GE TB1)	600	26,149	4.9	200,000		Pass
23 (GE TB1)	600	26,149	4.9	200,000		Pass
24 (GE TB1)	600	26,149	4.9	200,000		Pass
25 (General Electric TB4)	600	26,149	4.9	200,000		Pass
26 (General Electric TB4)	600	26,149	4.9	200,000		Pass
27 (General Electric TB4)	600	26,149	4.9	200,000		Pass
28 (GE TB1)	600	26,149	4.9	200,000		Pass
29 (GE TB4)	600	26,149	4.9	200,000		Pass
32 (General Electric TB4)	600	26,149	4.9	200,000		Pass

Bus Name / Device Name	Bus Voltage / Device Voltage	Bus Max S.C. Amps / Device Fault Duty	System X/R Ratio / Device Test X/R	Device Sym. Rating	Series Rating	Device Pass/Fail
33 (General Electric TB4)	600	26,149	4.9	200,000		Pass
40 (General Electric TB4)	600	26,149	4.9	200,000		Pass
41 (GE TB1)	600	26,149	4.9	200,000		Pass
42 (GE TB1)	600	26,149	4.9	200,000		Pass
43 (General Electric TB4)	600	26,149	4.9	200,000		Pass
44 (General Electric TB4)	600	26,149	4.9	200,000		Pass
45 (GE TB4)	600	26,149	4.9	200,000		Pass
46 (General Electric TB4)	600	26,149	4.9	200,000		Pass
47 (General Electric TB4)	600	26,149	4.9	200,000		Pass
48 (General Electric TB4)	600	26,149	4.9	200,000		Pass
49 (General Electric TB4)	600	26,149	4.9	200,000		Pass
50 (General Electric TB4)	600	26,149	4.9	200,000		Pass
51 (GE TB4)	600	26,149	4.9	200,000		Pass
52 (General Electric TB4)	600	26,149	4.9	200,000		Pass
53 (General Electric TB4)	600	26,149	4.9	200,000		Pass
54 (General Electric TB4)	600	26,149	4.9	200,000		Pass
55 (General Electric TB4)	600	26,149	4.9	200,000		Pass
56 (General Electric TB4)	600	26,149	4.9	200,000		Pass
57 (GE TB4)	600	26,149	4.9	200,000		Pass
58 (GE TB1)	600	26,149	4.9	200,000		Pass
59 (GE TB1)	600	26,149	4.9	200,000		Pass
60 (GE TB1)	600	26,149	4.9	200,000		Pass
61 (GE TB1)	600	26,149	4.9	200,000		Pass
62 (General Electric TB4)	600	26,149	4.9	200,000		Pass
63 (FPE 50H-3)	635	24,623	6.6	50,000		Pass
63 FUSE (FEDERAL PACIFIC LCL-1200)	600	26,149	4.9	200,000		Pass
64 (GE TB4)	600	26,149	4.9	200,000		Pass
65 (General Electric TB4)	600	26,149	4.9	200,000		Pass
208 Volt Busses						
MDC_A	**208**	**5,742**	**2.7**			
3A_BRKR (GE TJD)	240	5,742	4.9	22,000		Pass
4A_BRKR (GE TEB)	240	6,494	1.8	10,000		Pass
5A_BRKR (GE TEB)	240	6,494	1.8	10,000		Pass
6A_BRKR (GE TEB)	240	6,494	1.8	10,000		Pass

Device Evaluation Report - ANSI Calculations - Low Voltage Devices
Utility Fault Levels - 2718A (3 Phase) - Normal Power

Government of Canada

Bus Name Device Name	**Bus Voltage** Device Voltage	**Bus Max S.C. Amps** Device Fault Duty	**System X/R Ratio** Device Test X/R	Device Sym. Rating	Series Rating	Device Pass/Fail
MDC_B	**208**	**2,174**	**2.4**			
1B_BRKR (GE TEB)	240	2,379	1.8	10,000		Pass
2B_BRKR (GE TEB)	240	2,379	1.8	10,000		Pass
3B_BRKR (GE TEB)	240	2,379	1.8	10,000		Pass
4B_BRKR (GE TEB)	240	2,379	1.8	10,000		Pass
5B_BRKR (GE TEB)	240	2,379	1.8	10,000		Pass
6B_BRKR (GE TEB)	240	2,379	1.8	10,000		Pass
MDC_C	**208**	**3,479**	**2.8**			
1C_BRKR (GE TEB)	240	3,939	1.8	10,000		Pass
2C_BRKR (FPE CQD)	240	3,939	1.8	10,000		Pass
3C_BRKR (GE TEB)	240	3,939	1.8	10,000		Pass
4C_BRKR (GE TEB)	240	3,939	1.8	10,000		Pass
5C_BRKR (GE TEB)	240	3,939	1.8	10,000		Pass
6C_BRKR (GE TEB)	240	3,939	1.8	10,000		Pass
MDC_D	**208**	**5,108**	**3.2**			
1D_BRKR (GE TEB)	240	6,019	1.8	10,000		Pass
2D_BRKR (GE TEB)	240	6,019	1.8	10,000		Pass
3D_BRKR (FPE CQD)	240	6,019	1.8	10,000		Pass
4D_BRKR (FPE CQD)	240	6,019	1.8	10,000		Pass
5D_BRKR (FPE CQD)	240	6,019	1.8	10,000		Pass
6D_BRKR (GE TEB)	240	6,019	1.8	10,000		Pass
MDC_E	**208**	**5,109**	**3.2**			
2E_BRKR (GE TEB)	240	6,021	1.8	10,000		Pass
3E_BRKR (FPE CQD)	240	6,021	1.8	10,000		Pass
4E_BRKR (GE TEB)	240	6,021	1.8	10,000		Pass
5E_BRKR (FPE CQD)	240	6,021	1.8	10,000		Pass
6E_BRKR (FPE CQD)	240	6,021	1.8	10,000		Pass
MDC_F	**208**	**5,101**	**3.2**			
1F_BRKR (GE TEB)	240	6,002	1.8	10,000		Pass
2F_BRKR (FPE CQD)	240	6,002	1.8	10,000		Pass
3F_BRKR (FPE CQD)	240	6,002	1.8	10,000		Pass
4F_BRKR (FPE CQD)	240	6,002	1.8	10,000		Pass
5F_BRKR (FPE CQD)	240	6,002	1.8	10,000		Pass

Bus Name Device Name	Bus Voltage Device Voltage	Bus Max S.C. Amps Device Fault Duty	System X/R Ratio Device Test X/R	Device Sym. Rating	Series Rating	Device Pass/Fail
6F_BRKR (FPE CQD)	240	6,002	1.8	10,000		Pass
MDC_G	**208**	**5,101**	**3.2**			
1G_BRKR (GE TEB)	240	6,002	1.8	10,000		Pass
3G_BRKR (GE TEB)	240	6,002	1.8	10,000		Pass
4G_BRKR (FPE CQD)	240	6,002	1.8	10,000		Pass
5G_BRKR (FPE CQD)	240	6,002	1.8	10,000		Pass
6G_BRKR (GE TJD)	240	5,101	4.9	22,000		Pass
MDC_L	**208**	**7,110**	**3.0**			
1L_BRKR (Federal Pioneer CED6)	240	7,110	3.2	18,000		Pass
2L_BRKR (Federal Pioneer CJJ)	240	7,110	4.9	42,000		Pass
3L_BRKR (FPE CQD)	240	8,207	1.8	10,000		Pass
4L_BRKR (Federal Pioneer CED6)	240	7,110	3.2	18,000		Pass
MDC_M	**208**	**5,217**	**3.2**			
1M_BRKR (FPE CQD)	240	6,133	1.8	10,000		Pass
3M_BRKR (Federal Pioneer CED6)	240	5,217	3.2	18,000		Pass
4M_BRKR (Federal Pioneer CJJ)	240	5,217	4.9	42,000		Pass
5M_BRKR (Federal Pioneer CED6)	240	5,217	3.2	18,000		Pass
6M_BRKR (FPE CQD)	240	6,133	1.8	10,000		Pass

APPENDIX C

COORDINATION STUDY

A Coordination Study involves the selection of the proper overcurrent protective devices including circuit breakers trip units, overcurrent relays, and fuses. It additionally involves the specification of the appropriate settings, if any, for each selected protective device. The goal is to select and configure devices in the manner most effective in minimizing the potential damage to electrical apparatus and the risk of human injury during fault or thermal overloads conditions.

It is also important that devices be coordinated such that the equipment closest to the fault will be selectively isolated with minimal disruption to adjacent portions of the distribution system. In the event of a fault or overload condition, only the fuse or breaker nearest the fault should be configured to trip, thereby de-energizing the smallest portion of the system necessary. Larger upstream breakers should not respond to the abnormality, ensuring that the remaining portions of the system are not unnecessarily disrupted.

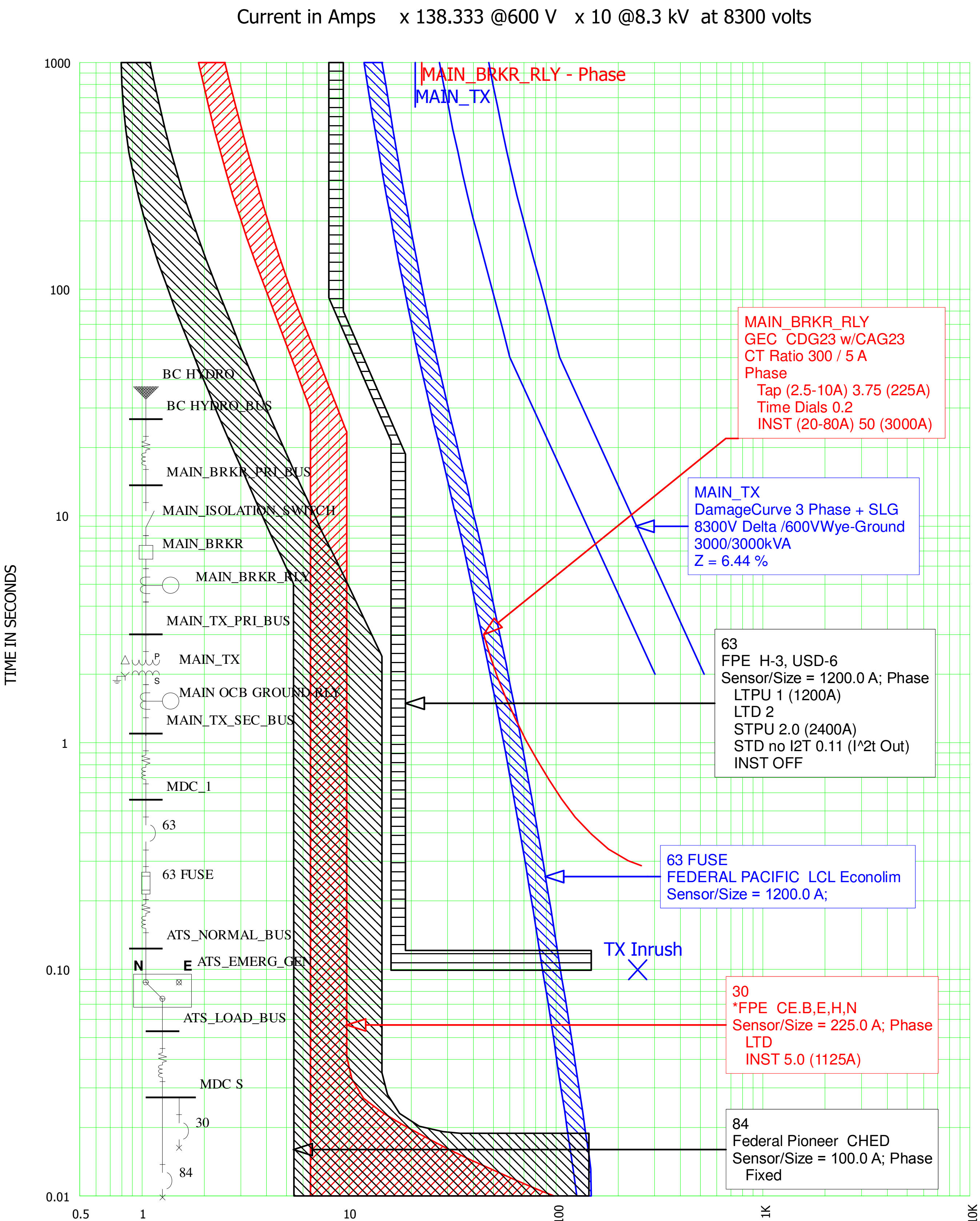
Prior to the coordination study the following steps are performed.

- Electrical system data is gathered, the characteristics of all pertinent electrical components are identified, and the system is modeled using a single line diagram.
- An equivalent circuit model is realized and a short circuit study is conducted in order to determine the maximum fault levels at each relevant bus within the scope of the study.
- Time-current characteristics are obtained for all overcurrent protective devices within the scope of the study.
- The time-current characteristics of system fuses, low voltage breakers, overcurrent relays, and equipment thermal damage curves are computer generated and are graphically displayed on log-log paper as time versus current magnitudes.

Once these preliminary steps have been completed, the effectiveness of the present network of protective devices and their configurations is determined through examination of the generated graphs. Improperly protected electrical equipment, instances of miscoordination, potential human hazards, and any other shortcomings in the present configuration are identified, and strategies to alleviate such problems are explored. Provided that it is in accordance with the power system requirements, the strategy providing the greatest degree of selectivity without compromising equipment protection and safety is recommended.

Overcurrent device characteristics vary widely and selectivity of these devices is often sacrificed for protection and vice versa depending on the power system requirements. An understanding of the power system's requirements combined with good engineering judgment is essential to ensure good coordination when compromising between these and other factors.

The graphics depicted in this study were generated using PTW-CAPTOR version 7.0, an electrical system modeling software program developed by SKM System Analysis Inc. In developing the protective device settings, consideration is given to both isolation of faults and protection of equipment such as cable, motors, and transformers. Minimum requirements for equipment protection as outlined in the Canadian Electrical Code and publications of the Canadian Standards Association are followed in all cases. The coordination study in this report is based on Standard IEEE-242.



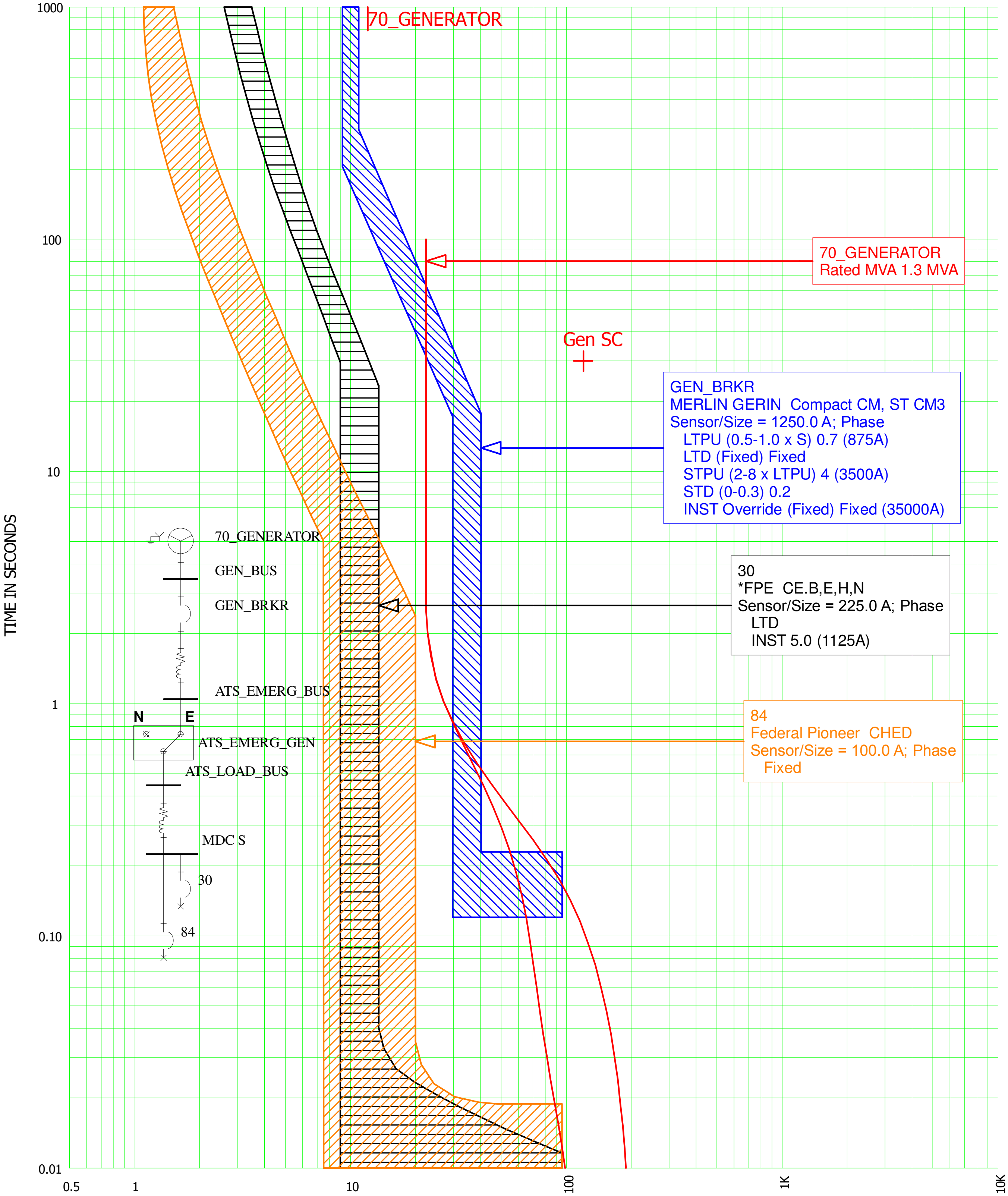
Stantec

Summerland

Graph: 001 - Feed to MDC_S - Normal
Phase Overcurrent Protection
Date: October 8, 2013

Government of Canada

Current in Amps x 100 at 600 volts

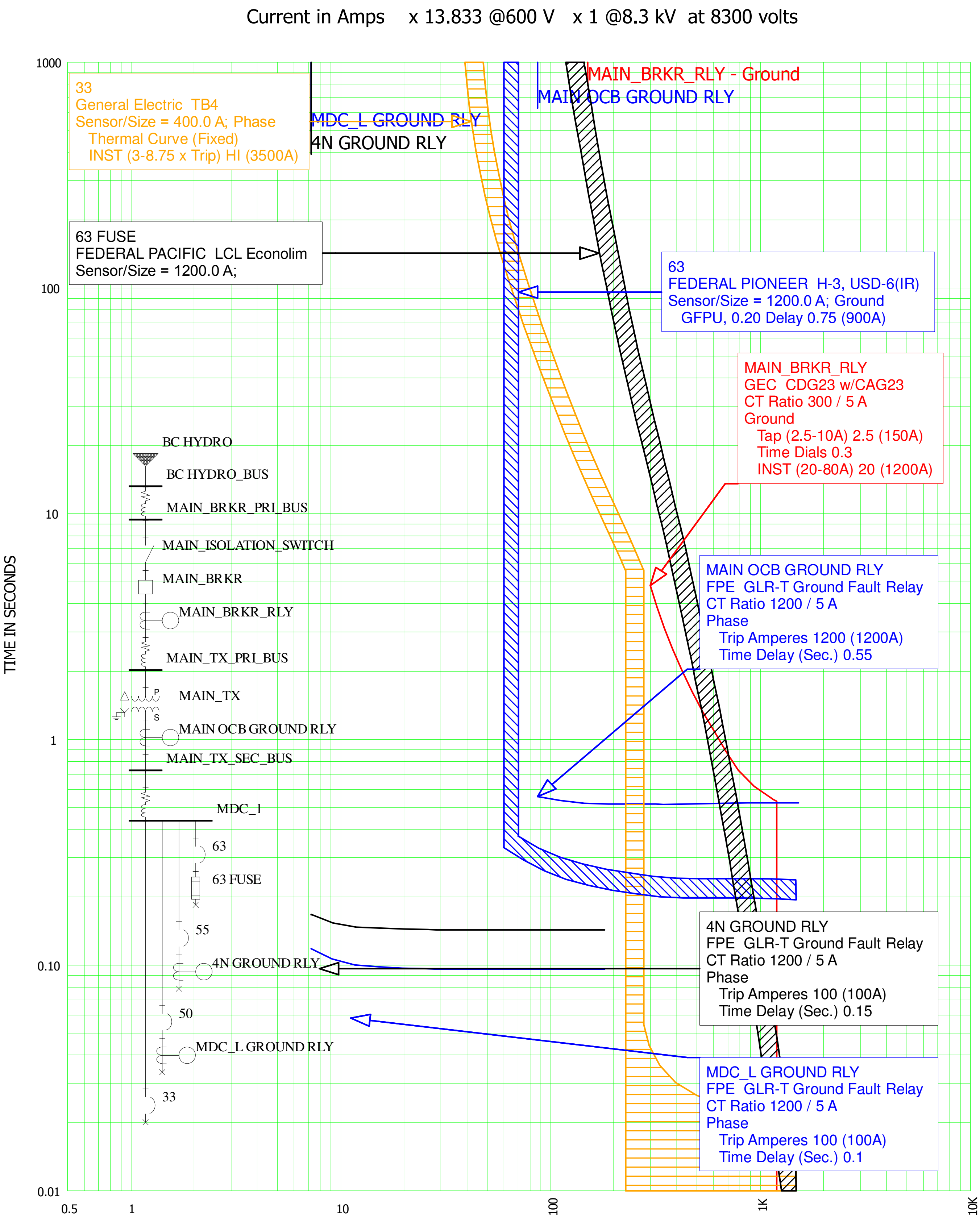


Stantec

Summerland

Graph: 002 - Feed to MDC_S - Emergency
Phase Overcurrent Protection
Date: October 8, 2013

Government of Canada

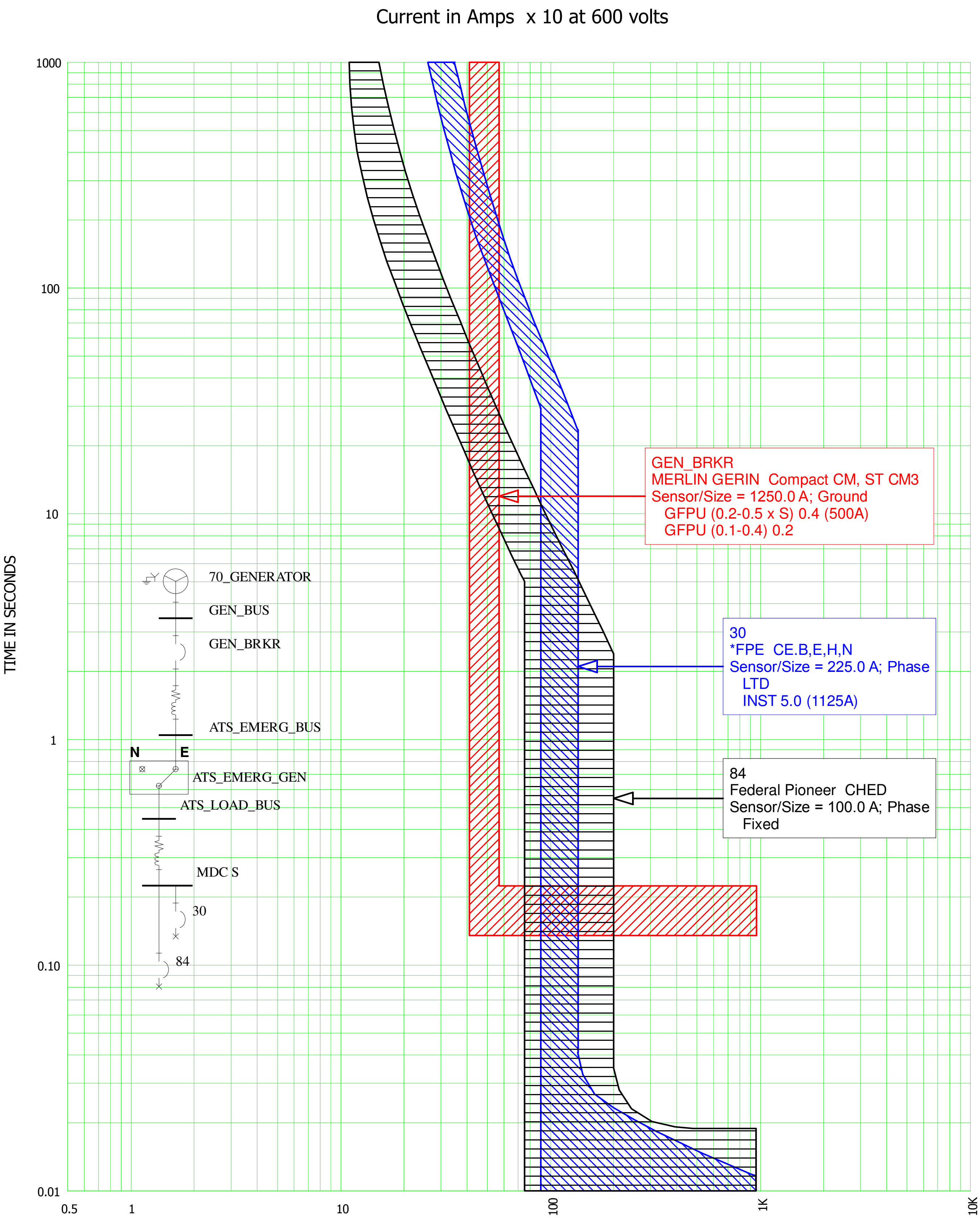


Summerland

Graph: G01 - MDC_1 - Ground
Phase Overcurrent Protection
Date: October 8, 2013

Stantec

Government of Canada



Stantec

Summerland

Graph: G02 - MDC_S - Ground
Phase Overcurrent Protection
Date: October 8, 2013

Government of Canada

APPENDIX D

High Voltage Overcurrent Relays

Description	Graph/Curve	Manufacturer/Model	IEEE Number/Curve	CT Ratio/Sensor	Tap Range/Setting	Time Dial Range/Setting	Inst. Range/Setting
8kV Main Breaker - Phase Relay	001	GEG CDG23		300:5	Tap (2.5-10A) 3.75	Time Dial 0.3	Inst (20-80) 50 (3000A)
Recommended Setting:	001	GEG CDG23		300:5	Tap (2.5-10A) 3.75	Time Dial 0.2	Inst (20-80) 50 (3000A)
8kV Main Breaker - Ground Relay	G01	GEG CDG23		300:5	Tap (2.5-10A) 2.5	Time Dial 0.3	Inst (20-80) 50 (3000A)*
8kV Main TX Secondary - Ground Relay	G01	FPE GLR-T		1200:5*	Trip (1-12)x100 12x	Time Delay (Inst-1.0) 0.55	
Panel MDC_1 Feed to Panel 5N Ground Relay		FPE GLR-T		1200:5*	Trip (1-12)x100 1x	Time Delay (Inst-1.0) 0.1	
Panel MDC_1 Feed to Panel 4N Ground Relay	G01	FPE GLR-T		1200:5*	Trip (1-12)x100 1x	Time Delay (Inst-1.0) 0.15	
Panel MDC_1 Feed to Panel 2N Ground Relay		FPE GLR-T		1200:5*	Trip (1-12)x100 1x	Time Delay (Inst-1.0) 0.1	
Panel MDC_1 Feed to Panel 1N Ground Relay		FPE GLR-T		1200:5*	Trip (1-12)x100 1x	Time Delay (Inst-1.0) 0.1	
Panel MDC_1 Feed to MDC_L Ground Relay	G01	FPE GLR-T		1200:5*	Trip (1-12)x100 1x	Time Delay (Inst-1.0) 0.1	

Transformers

Description	Graph/Curve	Manufacturer/Serial No.	kVA/Class	Voltage Ratio	Configuration	Impedance
Main Transformer	001	FPE	3000kVA ANN 4000kVA ANF	8300V/ 600(347)V	Delta- Wye Solid GND	6.44%

Molded Case Circuit Breakers with Solid State Trip Units

Description	Graph/Curve	Breaker/Trip Unit	Sensor/Plug	Long Delay P.U./Time	Short Delay P.U./Time	Instantaneous P.U.	Ground P.U./Time
Generator Circuit Breaker	002, G02	MG Compact CM1250 ST-CM3	In=1250A	Ir/In 0.7 (875A)	Im/Ir=6(5250A) t=B(0.2)	Fixed at 35kA	Ig/In=0.5 t=0.2
Recommended Settings:	002, G02	MG Compact CM1250 ST-CM3	In=1250A	Ir/In 0.7 (875A)	Im/Ir=4(3500A) t=B(0.2)	Fixed at 35kA	Ig/In=0.5 t=0.2
Panel MDC_1, Brkr to ATS/MDC_S	001 Curve 63	FPE H-3 USD LSIG	1600AF 1200AT	LTPU=1* LTD=2*	STPU=2.0* STD=0.11*	OFF	GFPU=0.75(900A)* GT=0.2*
Recommended Settings:	001 Curve 63	FPE H-3 USD LSIG	1600AF 1200AT	LTPU=1 LTD=2	STPU=2.0 STD=0.11	OFF	GFPU=0.75(900A) GT=0.2

Low Voltage Fuses

Description	Graph/Curve	Manufacturer	Type	Fuse Speed	Current Rating	Voltage Rating
Panel MDC_1, Brkr Limiter to ATS/MDC_S	001	FPE	LCL-1200	time-delay	1200A	600V

Downstream Panelboards or other Enclosures c/w Significant Circuit Breakers or Fuses

Description/Amps, Volts, Configuration	Graph/Curve	Largest Device/Type	Trip/Instantaneous	2nd Largest Device/Type	Trip/Instantaneous

Downstream Panelboards or other Enclosures c/w Significant Circuit Breakers or Fuses

Description/Amps, Volts, Configuration	*Graph/Curve*	*Largest Device/Type*	*Trip/Instantaneous*	*2nd Largest Device/Type*	*Trip/Instantaneous*
MDC_1 600A, 600V, 3PH-4W	001, G01	GE, TB4 Thermal-Mag	400A HI (3500A)	GE, TB1 Thermal-Mag	100A Fixed
MDC_A 600A, 120(208)V, 3PH-4W		GE, TJD* Thermal-Mag	350A Fixed	GE, TEB Thermal-Mag	100A Fixed
MDC_B 225A, 120(208)V, 3PH-4W		GE, TEB Thermal-Mag	100A Fixed	GE, TEB Thermal-Mag	100A Fixed
MDC_C 400A, 120(208)V, 3PH-4W		FPE, CQD Thermal-Mag	125A Fixed	GE, TEB Thermal-Mag	100A Fixed
MDC_D 600A, 120(208)V, 3PH-4W		FPE, CQD Thermal-Mag	175A Fixed	GE, TEB Thermal-Mag	100A Fixed
MDC_E 600A, 120(208)A, 3PH-4W		FPE, CQD Thermal-Mag	200A Fixed	GE, TEB Thermal-Mag	100A Fixed
MDC_F 600A, 120(208)A, 3PH-4W		FPE, CQD Thermal-Mag	175A Fixed	GE, TEB Thermal-Mag	100A Fixed
MDC_G 600A, 120(208)A, 3PH-4W		GE, TJD* Thermal-Mag	350A Fixed	FPE, CQD Thermal-Mag	200A Fixed
MDC_L 1200A, 120(208)A, 3PH-4W		FPE, CJJ* Thermal-Mag	350A LO (1050A)	FPE, CQD* Thermal-Mag	200A Fixed
MDC_M 600A, 120(208)A, 3PH-4W		FPE, CJJ* Thermal-Mag	250A LO (750A)	FPE, CQD* Thermal-Mag	175A Fixed
MDC_S 1200A, 347(600)V, 3PH-4W	002, 003	FPE, CHFK Thermal-Mag	225A HI (2250A)	GE, THED Thermal-Mag	100A Fixed

Generators

Description	*Graph/Curve*	*Manufacturer/Serial No.*	*kVA/Amperage*	*Voltage/RPM*	*Configuration./Frequency*	*Xd/Xd'/Xd''*
Generator	002	SIMPOWER	1250kVA 1204A	600V 1800rpm	3 Phase 0.8PF	

APPENDIX E

ARC FLASH HAZARD ANALYSIS

An arc fault is initiated by current passing between two conducting metals through ionized gas or vapor caused by a flashover or by breakdown of insulating material. When an arc fault occurs, it produces an explosion with a significant amount of destructive energy. An electrical arc produces temperatures that can exceed 35,000°F, melting and vaporizing copper and other materials. The expansion of copper during vaporization (to 67,000 times its original volume) as well as heating of surrounding air; creates immense sound and pressure waves, intense light, molten metal, as well as shrapnel. All of this occurs in a fraction of a second and will continue until the arc fault is cleared by an overcurrent protective device.

An Arc Flash Hazard Analysis is conducted in order to determine the risk of personal injury present as a result of exposure to incident energy from an electrical arc flash at various points within an electrical system. Once this level of risk is ascertained, measures can be taken to mitigate the risk through the development of strategies with the goal of minimizing burn injuries. Such strategies may include specification of the rating of *Personal Protective Equipment* **(PPE)**, de-energization of equipment prior to performing work, and the application of arc-resistant switchgear. The requirement to apply appropriate warning labels on electrical apparatus identifying arc flash hazards has been incorporated into the Canadian Electrical Code to increase the level of awareness of personnel of the hazard to which they may be exposed while working on or near live electrical equipment:

Canadian Electrical Code, Part I - 2012

2-306 Shock and flash protection (see Appendix B)

(1) Electrical equipment such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centres that are installed in other than dwelling units and are likely to require examination, adjustment, servicing, or maintenance while energized shall be field marked to warn persons of potential electric shock and arc flash hazards.

(2) The marking referred to in Subrule (1) shall be located so that it is clearly visible to persons before examination, adjustment, services, or maintenance of the equipment.

The field marking of equipment may be a warning label signifying a shock and arc flash hazard, containing specific information pertaining to the electrical equipment, including the level of hazard present, PPE recommendations, the maximum level of incident energy that could result from an electrical arc event, and the relevant working boundaries. Alternatively, a generic label signifying a shock or arc flash hazard is permitted and an Arc Flash Hazard Report can be consulted to determine the particular information regarding the potential hazard present and other relevant parameters for each piece of electrical equipment within the system. Whether the specific information for electrical equipment is included on a warning label affixed to the equipment or within an Arc Flash Hazard Report, it is determined by performing arc flash hazard calculations in accordance with IEEE-1584-2002 'IEEE Guide for Performing Arc-Flash Hazard Calculations'. CSA Z462-2012 'Workplace Electrical Safety', which is based on the NFPA 70E-2012 'Standard for Electrical Safety in the Workplace', is used to assist in the determination of the severity of potential exposure, the establishment of safe work practices, and selection of appropriate PPE to protect against shock and flash hazards.

This Arc Flash Hazard analysis was performed using PTW version 7.0, developed by SKM System Analysis Inc., incorporating the findings from the short-circuit and protective device evaluation studies. The short circuit study is performed to determine the 3-phase bolted fault current at each point of assessment and the coordination study is used to determine the time required for protective devices to isolate short-circuit/overload conditions. These parameters, in conjunction with switchgear characteristics, are used to calculate the incident energy and establish the flash protection boundary. It should be noted that the models used in this study are based upon measured arc current incident energy under a specific set of test conditions and on theoretical work, thus the severity of real arc exposures may differ from that indicated due to limitations of the calculation methods currently available.

CSA Z462 defines a series of boundaries relating to electrical safety when working on energized equipment. Only "qualified" personnel can enter these boundaries and are required to wear the appropriate PPE within these boundaries. The four protection boundaries are shown in Figure 1 below: *Flash Protection Boundary, Limited Approach Boundary, Restricted Approach Boundary,* and the *Prohibited Approach Boundary.*

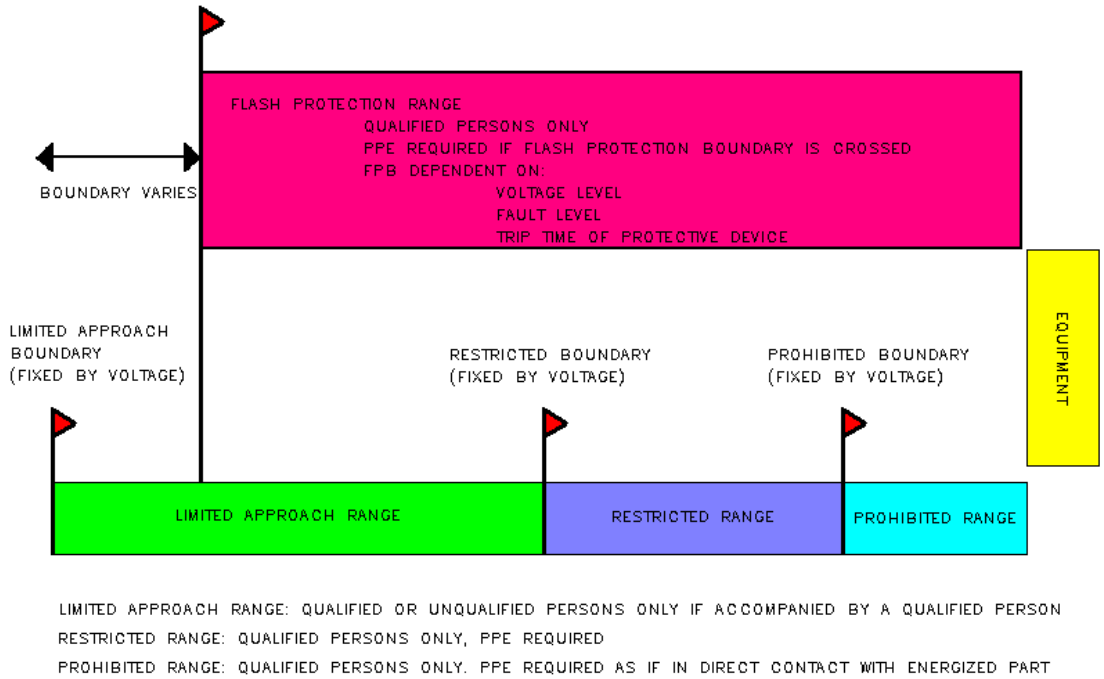


Figure 1: Working Boundaries

The significance of the four boundaries/ranges is as follows. The first three boundaries describe the level of shock hazard and are fixed based only on the operating voltage of the particular piece of electrical equipment. The *Limited Approach Boundary* (**LAB**) is the distance from an exposed energized circuit part at which a shock hazard exists. For that reason, a person is not permitted to cross this boundary and enter the limited approach range for a particular piece of equipment unless he or she is, or is accompanied by, a qualified person.

A qualified person is defined by z462 as one who shall be trained in and knowledgeable about the construction and operation of electrical equipment or a specific work method and trained to recognize and avoid the electrical hazards that might be present with respect to that equipment or work method. Within the *Restricted Boundary* (**RB**), there is an increased risk of shock due to an arc over combined with inadvertent movement of personnel, so only qualified persons are permitted and can only cross the restricted approach boundary with the appropriate PPE.

Work within the *Prohibited Boundary* (**PB**) is considered to be the same as being in direct contact with the energized equipment. Therefore, a person must not cross the prohibited approach boundary unless he or she is protected accordingly.

The final working boundary, the *Flash Protection Boundary* (**FPB**), is defined as the distance from exposed energized parts that a person could receive a second-degree burn should an arc flash occur. This boundary is not determined based on operating voltage but is determined by performing an Arc Flash Hazard Analysis.

CSA Z462 specifies the requirement of PPE for workers within the flash protection boundary. All parts of the body that may be exposed to the arc flash must be covered by the appropriate type and quality of PPE. The entire PPE set may be comprised of Arc Resistant **(AR)** clothing, helmet or headgear, face shield, safety glasses, gloves, shoes, etc. depending upon the magnitude of the calculated *Incident Energy* **(IE)**. The protective clothing should limit the incident energy reaching the chest/face of the worker to no more than 1.2 cal/cm^2. AR clothing provides thermal insulation and is also self-extinguishing.

It should be noted that PPE is the last line of defence when it comes to protection against arc flash hazards and it is not intended to prevent all injuries, but to mitigate the impact of an arc flash upon the individual. The analysis presented herein is not intended to imply that workers should be permitted to perform work on exposed energized equipment or circuit parts. Working on energized equipment should only be done if de-energizing the equipment is infeasible due to its design or operational limitations, or if doing so would introduce additional or increased hazards.

The table shown below is adapted from CSA Z462 Table 5. It defines five (5) levels of Hazard/Risk categories for various levels of calculated incident energies at the typical *Working Distance* **(WD)**. Examples of typical protective clothing that cover the torso are also provided in this table. Please note, other PPE required to protect various parts of the body are assumed and are identified within Z462, and include items like hard hat, safety classes, and electrical insulating gloves (if working directly on live equipment).

CSA Z462 TABLE 5
'Hazard/Risk categorization of protective clothing and personal protective equipment'

HAZARD/RISK CATEGORY	INCIDENT ENERGY	DESCRIPTION OF CLOTHING
0	N/A	Non-melting, flammable materials (e.g. untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight of at least 4.5 oz/yd^2
1	4 cal/cm^2	Arc-rated AR shirt and AR pants or AR coverall
2	8 cal/cm^2	Arc-rated AR shirt and AR pants or AR coverall
3	25 cal/cm^2	Arc-rated AR shirt and AR pants or AR coverall, and arc flash suit selected so that the system arc rating meets the required minimum
4	40 cal/cm^2	Arc-rated AR shirt and AR pants or AR coverall, and arc flash suit selected so that the system arc rating meets the required minimum

The Table 5 from CSA Z462 then lists detailed protective clothing sets and equipment requirements based on each of the hazard/risk classification levels. All parts of the body that may be exposed to the arc flash must be covered by the appropriate type and quality of PPE. The entire PPE set may be comprised of AR clothing, helmet or headgear, face shield, safety glasses, gloves, shoes, etc. depending upon the magnitude of the calculated incident energy. The protective clothing should limit the incident energy reaching the chest/face of the worker to 1.2cal/cm^2 or less. AR clothing provides thermal insulation and is also self-extinguishing. When work on or near energized circuit parts is performed within the flash protection boundary, personnel should be equipped with PPE appropriate for the hazard/risk classification of the switchgear. The latest version of the Z462 source document should be referenced to ensure adequate PPE is being used for the various tasks being performed within the facility.

As part of this project, two types of labels are provided for the distribution equipment within this facility. Most downstream distribution equipment within the facility can be covered with the default hazard/risk categories from CSA Z462 Tables 4A and 4B. This table is the simplest method for determining PPE requirements as it provides typical risk categories associated with performing various activities on or near live electrical equipment within the flash protection boundary. These risk categories provided are based on specific fault levels and fault clearing times and, as a result, cannot be applied to all installations of electrical equipment within a distribution system. The guidelines provided in Tables 4A and 4B are applicable to all devices outside the scope of detailed IEEE 1584 calculations within this study.

All distribution equipment that does not require detailed IEEE 1584 calculations will be labelled with standard CSA Z462 Table 4A and 4B labels similar to that of Figure 2. For example, this label is the standard label that will be applied to Panel boards with a voltage rating above 240V and up to 600V. It identifies that operating a switch or circuit breaker with the panel covers off is a Hazard/Risk Category (HRL) 1 operation and does not require Insulating Gloves or Insulating Tools. With this information at hand, facility personnel would use PPE rated for HRL 1 from Table 5 of CSA Z462 for this specific operation. Similarly, standard labels will be generated for other electrical equipment such as Transformers, MCCs, Splitters, Disconnects, etc. that meet the requirements of CSA Z462 Table 4A and 4B. All the labels will provide specific tasks related to the equipment with a corresponding hazard risk category.

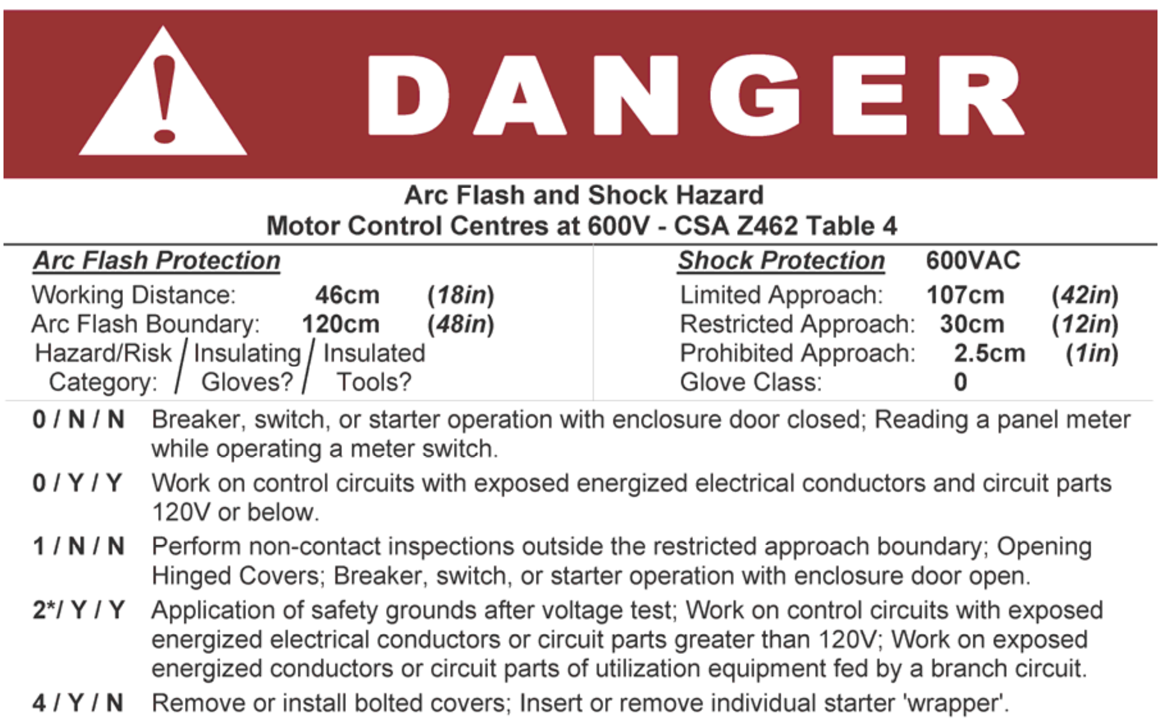


Figure 2: Sample Standard Arc Flash Label

Some switchgear cannot be covered by CSA Z462 Table 4A, they are usually the main switchboards and distribution equipment found the furthest upstream in the system closest to the main power source(s), where higher potential fault energies are encountered and intentional clearing delays are often applied to protective devices to aid in protective device coordination. As such, detailed calculations are performed on these areas of the system with the intention of identifying cases where the risk may be significantly greater than those identified in Table 4A. These devices are included within our detailed arc flash table, and will be provided with detailed arc flash labels as per Figure 3. Similar to the labels shown in Figure 2, the labels illustrated by Figure 3 identifies the Hazard/Risk Category and actual Incident Energy present at the specific piece of electrical equipment. However, this HRL does not change regardless of the task being performed at the equipment and thus the appropriate PPE for this HRL is required no matter which tasks are being performed. This HRL is used by the worker to wear appropriate PPE based on Table 5 of the CSA Z462.

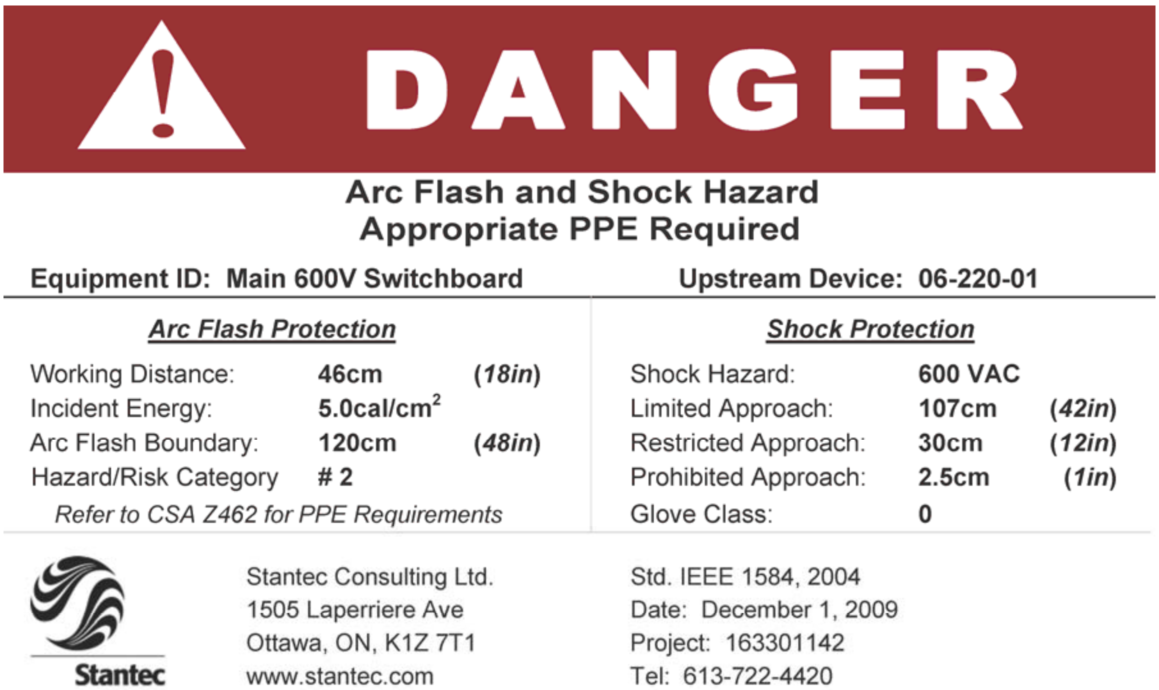


Figure 3: Sample Specific Arc Flash Label

Arc Flash Report - IEEE 1584 Calculations
Maximum Fault Duty - Worst Case

Government of Canada

Bus Name	Equipment Type	Upstream Protective Device Clearing Fault	Bolted Fault Current		Arcing Fault Current		Clearing Time (ms)	Arc Flash Hazard Analysis Results			
			@ Bus	Through Prot.	@ Bus	Through Prot.		FPB (mm)	WD (mm)	IE (ca/cm2)	CSA Z462 PPE Cat.
8,300 Volt Busses											
BC HYDRO_BUS	SWG (153)	MaxTripTime @2.0s	2,710	2,710	2,680	2,680	2,000	4,970.9	914	6.21	Level 2
MAIN_BRKR_PRI_BUS	SWG (153)	MaxTripTime @2.0s	2,480	2,480	2,460	2,460	2,000	4,516.3	914	5.65	Level 2
MAIN_TX_PRI_BUS	SWG (153)	MAIN_BRKR_RLY	2,480	2,490	2,460	2,470	374	806.0	914	1.06	Level 0
600 Volt Busses											
1H_3H_PRI_BUS	PNL (25)	47	14,660	14,660	11,180	11,180	25	393.9	457	.94	Level 0
1J_2J_PRI_BUS	PNL (25)	48	8,780	8,780	6,970	6,970	25	288.7	457	.56	Level 0
1K_2K_PRI_BUS	PNL (25)	49	9,230	9,230	7,300	7,300	25	297.5	457	.59	Level 0
1N_PRI_BUS	PNL (25)	52	10,180	10,180	7,990	7,990	10	180.6	457	.26	Level 0
1Q_PRI_BUS	PNL (25)	59	1,490	1,490	1,360	1,360	16	74.8	457	.06	Level 0
1R_PRI_BUS	PNL (25)	60	4,750	4,750	3,950	3,950	16	151.4	457	.19	Level 0
1S_TX_PRI_BUS	PNL (25)	86	16,270	16,270	12,310	12,310	19	354.0	457	.79	Level 0
1T_PRI_BUS	PNL (25)	61	2,470	2,470	2,170	2,170	16	102.0	457	.10	Level 0
1U_PRI_BUS	PNL (25)	62	8,350	8,350	6,650	6,650	25	279.9	457	.53	Level 0
2H_3H_PRI_BUS	PNL (25)	64	14,490	14,490	11,060	11,060	25	391.1	457	.93	Level 0
2N_PRI_BUS	PNL (25)	53	10,100	10,100	7,930	7,930	10	179.8	457	.26	Level 0
3N_PRI_BUS	PNL (25)	54	8,300	8,300	6,620	6,620	25	278.9	457	.53	Level 0
3S_TX_PRI_BUS	PNL (25)	87	5,390	5,390	4,450	4,450	20	185.3	457	.27	Level 0
4H_5H_PRI_BUS	PNL (25)	65	14,830	14,830	11,300	11,300	25	396.8	457	.95	Level 0
4N_PRI_BUS	PNL (25)	55	11,320	11,320	8,810	8,810	10	192.7	457	.29	Level 0
4S_TX_PRI_BUS	PNL (25)	88	2,780	2,780	2,410	2,410	18	119.3	457	.13	Level 0
5N_PRI_BUS	PNL (25)	56	11,640	11,640	9,040	9,040	10	196.0	457	.30	Level 0
6N_PRI_BUS	PNL (25)	57	10,090	10,090	7,920	7,920	25	314.0	457	.65	Level 0
ALTERNATOR	PNL (25)	91	18,110	18,150	13,580	13,620	19	377.8	457	.87	Level 0
ATS_EMERG_BUS	PNL (25)	GEN_BRKR	7,960	7,960	6,370	6,370	230	1,051.6	457	4.69	Level 2
ATS_LOAD_BUS	PNL (25)	63	18,440	18,630	13,810	13,960	121	1,183.8	457	5.69	Level 2

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Bus Name	Equipment Type	Upstream Protective Device Clearing Fault	Bolted Fault Current @ Bus	Bolted Fault Current Through Prot.	Arcing Fault Current @ Bus	Arcing Fault Current Through Prot.	Clearing Time (ms)	FPB (mm)	WD (mm)	IE (ca/cm2)	CSA Z462 PPE Cat.
ATS_NORMAL_BUS	PNL (25)	63	18,440	18,630	13,810	13,960	121	1,183.8	457	5.69	Level 2
CDP-EP Panel	PNL (25)	CDP-EP BKRK	17,180	17,180	12,940	12,940	16	331.7	457	.71	Level 0
CH01_BUS	PNL (25)	32	15,640	15,640	11,870	11,870	25	409.8	457	1.00	Level 0
CH02_BUS	PNL (25)	33	15,640	15,640	11,870	11,870	25	409.8	457	1.00	Level 0
CT01_STARTER	PNL (25)	89	17,900	17,930	13,430	13,460	19	370.1	457	.84	Level 0
CT01B1_BUS	PNL (25)	91	16,950	17,000	12,780	12,820	19	362.9	457	.82	Level 0
CT01B2_BUS	PNL (25)	91	16,950	17,000	12,780	12,820	19	362.9	457	.82	Level 0
CT01C_STARTER	PNL (25)	90	16,510	16,550	12,480	12,500	19	352.5	457	.78	Level 0
GEN_BUS	PNL (25)	MaxTripTime @2.0s	8,010	8,010	6,410	6,410	2,000	2,856.2	457	24.16	Level 3
H_PANEL	PNL (25)	20	12,990	12,990	8,500	8,500	14	229.0	457	.38	Level 0
J_PANEL	PNL (25)	21	10,860	10,860	8,480	8,480	25	328.5	457	.69	Level 0
K_PANEL	PNL (25)	22	6,950	6,950	5,620	5,620	16	190.8	457	.28	Level 0
L_PANEL	PNL (25)	23	6,150	6,150	5,020	5,020	16	177.2	457	.25	Level 0
M_PANEL	PNL (25)	24	16,030	16,030	12,140	12,140	10	238.0	457	.41	Level 0
MAIN_TX_SEC_BUS	PNL (25)	MAIN_BRKR_RLY	19,300	19,340	12,240	12,270	825	3,522.8	457	34.09	Level 4
MCC_1_PANEL	PNL (25)	29	15,950	15,950	12,090	12,090	25	414.7	457	1.02	Level 0
MCC_1S	PNL (25)	83	14,510	14,510	11,070	11,070	10	224.0	457	.37	Level 0
MCC_E_PANEL	PNL (25)	30	11,330	11,330	8,820	8,820	12	215.6	457	.35	Level 0
MCC_ES_BUS	PNL (25)	82	6,310	6,310	5,140	5,140	19	199.1	457	.31	Level 0
MCC_P1_BUS	PNL (25)	84	18,110	18,150	13,580	13,620	19	377.8	457	.87	Level 0
MCC_P2_BUS	PNL (25)	85	18,140	18,190	13,600	13,650	10	257.0	457	.46	Level 0
MCC_W_PANEL	PNL (25)	31	11,330	11,330	8,820	8,820	16	252.8	457	.45	Level 0
MDC S	PNL (25)	63	18,340	18,540	13,740	13,890	121	1,180.0	457	5.66	Level 2
MDC_1	SWG (32)	MAIN_BRKR_RLY	18,740	18,770	11,290	11,310	960	4,547.7	610	23.06	Level 3
MDC_A_PRI_BUS	PNL (25)	40	16,390	16,390	12,390	12,390	25	421.5	457	1.05	Level 0
MDC_B_PRI_BUS	PNL (25)	41	11,350	11,350	7,510	7,510	16	231.0	457	.39	Level 0

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Bus Name	Equipment Type	Upstream Protective Device Clearing Fault	Bolted Fault Current @ Bus	Bolted Fault Current Through Prot.	Arcing Fault Current @ Bus	Arcing Fault Current Through Prot.	Clearing Time (ms)	FPB (mm)	WD (mm)	IE (ca/cm2)	CSA Z462 PPE Cat.
MDC_C_PRI_BUS	PNL (25)	42	13,750	13,750	8,960	8,960	12	219.2	457	.36	Level 0
MDC_D_PRI_BUS	PNL (25)	43	17,240	17,240	12,980	12,980	25	434.8	457	1.10	Level 0
MDC_E_PRI_BUS	PNL (25)	44	17,290	17,290	13,010	13,010	25	435.5	457	1.10	Level 0
MDC_F_PRI_BUS	PNL (25)	45	16,930	16,930	12,770	12,770	25	430.0	457	1.08	Level 0
MDC_G_PRI_BUS	PNL (25)	46	16,930	16,930	12,770	12,770	25	430.0	457	1.08	Level 0
MDC_L_PRI_BUS	PNL (25)	50	12,110	12,110	9,380	9,380	10	200.8	457	.31	Level 0
MDC_M_PRI_BUS	PNL (25)	51	16,930	16,930	12,770	12,770	25	430.0	457	1.08	Level 0
P_PANEL	PNL (25)	25	7,230	7,230	5,830	5,830	25	256.6	457	.46	Level 0
P1_VAC1_BUS	PNL (25)	84	17,870	17,910	13,420	13,450	19	374.7	457	.86	Level 0
P1_VAC2_BUS	PNL (25)	84	17,870	17,910	13,420	13,450	19	374.7	457	.86	Level 0
P2_COMPRESSOR1_BUS	PNL (25)	85	17,900	17,960	13,440	13,480	10	255.8	457	.46	Level 0
P2_COMPRESSOR2_BUS	PNL (25)	85	17,900	17,960	13,440	13,480	10	255.8	457	.46	Level 0
Q_PANEL	PNL (25)	26	6,230	6,230	5,090	5,090	25	234.5	457	.40	Level 0
R_PANEL	PNL (25)	27	13,070	13,070	10,060	10,060	25	367.4	457	.83	Level 0
S_PANEL	PNL (25)	80	17,030	17,030	12,830	12,830	10	246.9	457	.43	Level 0
SA_PANEL	PNL (25)	81	16,790	16,790	12,670	12,670	19	360.8	457	.81	Level 0
T_PANEL	PNL (25)	28	5,000	5,000	4,150	4,150	16	156.3	457	.21	Level 0
T2S_BUS	PNL (25)	82	2,860	2,860	2,110	2,110	32	151.3	457	.19	Level 0
TP_PRI_BUS	PNL (25)	58	6,150	6,150	5,020	5,020	16	177.2	457	.25	Level 0
208 Volt Busses											
1B_PANEL	PNL (25)	1B_BRKR	1,490	1,490	1,140	1,140	2,000	458.3	457	1.20	Level 0
1C_PANEL	PNL (25)	1C_BRKR	1,570	1,570	1,180	1,180	2,000	458.3	457	1.20	Level 0
1D_PANEL	PNL (25)	1D_BRKR	2,030	2,030	1,420	1,420	2,000	1,462.5	457	8.06	Level 3
1F_PANEL	PNL (25)	1F_BRKR	2,710	2,710	1,480	1,480	2,000	1,502.0	457	8.41	Level 3
1G_PANEL	PNL (25)	1G_BRKR	3,880	3,880	1,900	1,900	2,000	1,772.5	457	11.04	Level 3
1H_3H_SEC_BUS	PNL (25)	47	5,750	5,750	2,950	2,950	25	164.3	457	.22	Level 0

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Bus Name	Equipment Type	Upstream Protective Device Clearing Fault	Bolted Fault Current @ Bus	Bolted Fault Current Through Prot.	Arcing Fault Current @ Bus	Arcing Fault Current Through Prot.	Clearing Time (ms)	FPB (mm)	WD (mm)	IE (ca/cm2)	CSA Z462 PPE Cat.
1H_PANEL	PNL (25)	47	5,300	5,300	2,790	2,790	25	159.6	457	.21	Level 0
1J_2J_SEC_BUS	PNL (25)	48	5,670	5,670	2,920	2,920	29	179.5	457	.26	Level 0
1J_PANEL & 2J_PANEL	PNL (25)	48	5,200	5,200	2,750	2,750	31	177.6	457	.25	Level 0
1K_2K_SEC_BUS	PNL (25)	49	6,140	6,140	3,090	3,090	25	168.9	457	.23	Level 0
1K_PANEL & 2K_PANEL	PNL (25)	49	5,800	5,800	2,970	2,970	25	164.9	457	.22	Level 0
1L_PANEL	PNL (25)	1L_BRKR	6,570	6,570	3,240	3,240	20	151.3	457	.19	Level 0
1M_PANEL	PNL (25)	51	4,980	4,980	2,660	2,660	29	167.4	457	.23	Level 0
1N_PANEL	PNL (25)	52	5,850	5,850	2,540	2,540	2,000	2,142.4	457	15.07	Level 3
1N_SEC_BUS	PNL (25)	52	6,320	6,320	2,680	2,680	2,000	2,220.8	457	15.99	Level 3
1P_PANEL & 2P_PANEL & 3P_PANEL	PNL (25)	58	3,110	3,110	1,920	1,920	2,000	458.3	457	1.20	Level 0
1Q_PANEL	PNL (25)	59	940	940	830	830	2,000	458.3	457	1.20	Level 0
1Q_SEC_BUS	PNL (25)	59	980	980	850	850	2,000	458.3	457	1.20	Level 0
1R_PANEL & 2R_PANEL	PNL (25)	60	1,050	1,050	890	890	2,000	458.3	457	1.20	Level 0
1R_SEC_BUS	PNL (25)	60	1,070	1,070	910	910	2,000	458.3	457	1.20	Level 0
1S_PANEL	PNL (25)	86	3,410	3,410	2,040	2,040	2,000	458.3	457	1.20	Level 0
1S_TX_SEC_BUS	PNL (25)	86	3,500	3,500	2,080	2,080	2,000	458.3	457	1.20	Level 0
1T_PANEL	PNL (25)	61	1,010	1,010	870	870	2,000	458.3	457	1.20	Level 0
1T_SEC_BUS	PNL (25)	61	1,030	1,030	880	880	2,000	458.3	457	1.20	Level 0
1U_PANEL	PNL (25)	62	5,480	5,480	2,850	2,850	25	161.5	457	.22	Level 0
1U_SEC_BUS	PNL (25)	62	5,620	5,620	2,900	2,900	25	163.0	457	.22	Level 0
2B_PANEL	PNL (25)	2B_BRKR	1,160	1,160	960	960	2,000	458.3	457	1.20	Level 0
2C_PANEL	PNL (25)	2C_BRKR	1,740	1,740	1,280	1,280	2,000	458.3	457	1.20	Level 0
2D_PANEL	PNL (25)	2D_BRKR	1,990	1,990	1,400	1,400	2,000	1,449.4	457	7.94	Level 2
2E_PANEL	PNL (25)	2E_BRKR	2,280	2,280	1,540	1,540	2,000	1,541.4	457	8.78	Level 3
2F_PANEL	PNL (25)	45	3,410	3,410	1,740	1,740	50	175.6	457	.25	Level 0
2H_3H_SEC_BUS	PNL (25)	64	5,050	5,050	2,690	2,690	2,000	2,227.7	457	16.07	Level 3

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Bus Name	Equipment Type	Upstream Protective Device Clearing Fault	Bolted Fault Current		Arcing Fault Current		Clearing Time (ms)	Arc Flash Hazard Analysis Results			
			@ Bus	Through Prot.	@ Bus	Through Prot.		FPB (mm)	WD (mm)	IE (ca/cm2)	CSA Z462 PPE Cat.
2L_PANEL	PNL (25)	2L_BRKR	6,620	6,620	3,250	3,250	25	174.8	457	.25	Level 0
2N_PANEL	PNL (25)	53	6,260	6,260	2,660	2,660	2,000	2,211.5	457	15.88	Level 3
2N_SEC_BUS	PNL (25)	53	6,810	6,810	2,820	2,820	2,000	2,298.9	457	16.92	Level 3
2S_PANEL	PNL (25)	82	1,370	1,370	1,070	1,070	2,000	458.3	457	1.20	Level 0
3A_PANEL	PNL (25)	40	2,260	2,260	1,300	1,300	50	145.4	457	.18	Level 0
3B_PANEL	PNL (25)	3B_BRKR	1,140	1,140	950	950	2,000	458.3	457	1.20	Level 0
3C_PANEL	PNL (25)	3C_BRKR	1,520	1,520	1,160	1,160	2,000	458.3	457	1.20	Level 0
3D_PANEL	PNL (25)	3D_BRKR	2,780	2,780	1,770	1,770	2,000	1,690.1	457	10.21	Level 3
3E_PANEL	PNL (25)	3E_BRKR	2,520	2,520	1,650	1,650	2,000	1,614.6	457	9.48	Level 3
3F_PANEL	PNL (25)	3F_BRKR	2,870	2,870	1,540	1,540	2,000	1,540.2	457	8.77	Level 3
3G_PANEL	PNL (25)	3G_BRKR	4,500	4,500	2,110	2,110	29	144.6	457	.18	Level 0
3H_PANEL & 2H_PANEL	PNL (25)	64	4,750	4,750	2,580	2,580	2,000	2,164.9	457	15.33	Level 3
3L_PANEL	PNL (25)	3L_BRKR	6,630	6,630	2,770	2,770	2,000	2,269.8	457	16.57	Level 3
3M_PANEL	PNL (25)	3M_BRKR	5,010	5,010	2,270	2,270	27	145.1	457	.18	Level 0
3N_PANEL	PNL (25)	54	4,430	4,430	2,460	2,460	2,000	2,097.2	457	14.55	Level 3
3N_SEC_BUS	PNL (25)	54	4,710	4,710	2,560	2,560	2,000	2,156.2	457	15.23	Level 3
3S_PANEL	PNL (25)	87	4,410	4,410	2,450	2,450	2,000	458.3	457	1.20	Level 0
3S_TX_SEC_BUS	PNL (25)	87	4,700	4,700	2,560	2,560	2,000	458.3	457	1.20	Level 0
4A_PANEL	PNL (25)	4A_BRKR	1,410	1,410	1,100	1,100	2,000	458.3	457	1.20	Level 0
4B_PANEL	PNL (25)	4B_BRKR	1,130	1,130	940	940	2,000	458.3	457	1.20	Level 0
4C_PANEL	PNL (25)	4C_BRKR	1,500	1,500	1,150	1,150	2,000	458.3	457	1.20	Level 0
4D_PANEL	PNL (25)	4D_BRKR	2,480	2,480	1,640	1,640	2,000	1,604.2	457	9.38	Level 3
4E_PANEL	PNL (25)	4E_BRKR	2,180	2,180	1,490	1,490	2,000	1,509.0	457	8.48	Level 3
4F_PANEL	PNL (25)	4F_BRKR	2,810	2,810	1,520	1,520	2,000	1,525.7	457	8.63	Level 3
4G_PANEL	PNL (25)	4G_BRKR	4,240	4,240	2,380	2,380	2,000	2,055.8	457	14.08	Level 3
4H_5H_SEC_BUS	PNL (25)	65	9,330	9,330	4,140	4,140	25	204.9	457	.32	Level 0

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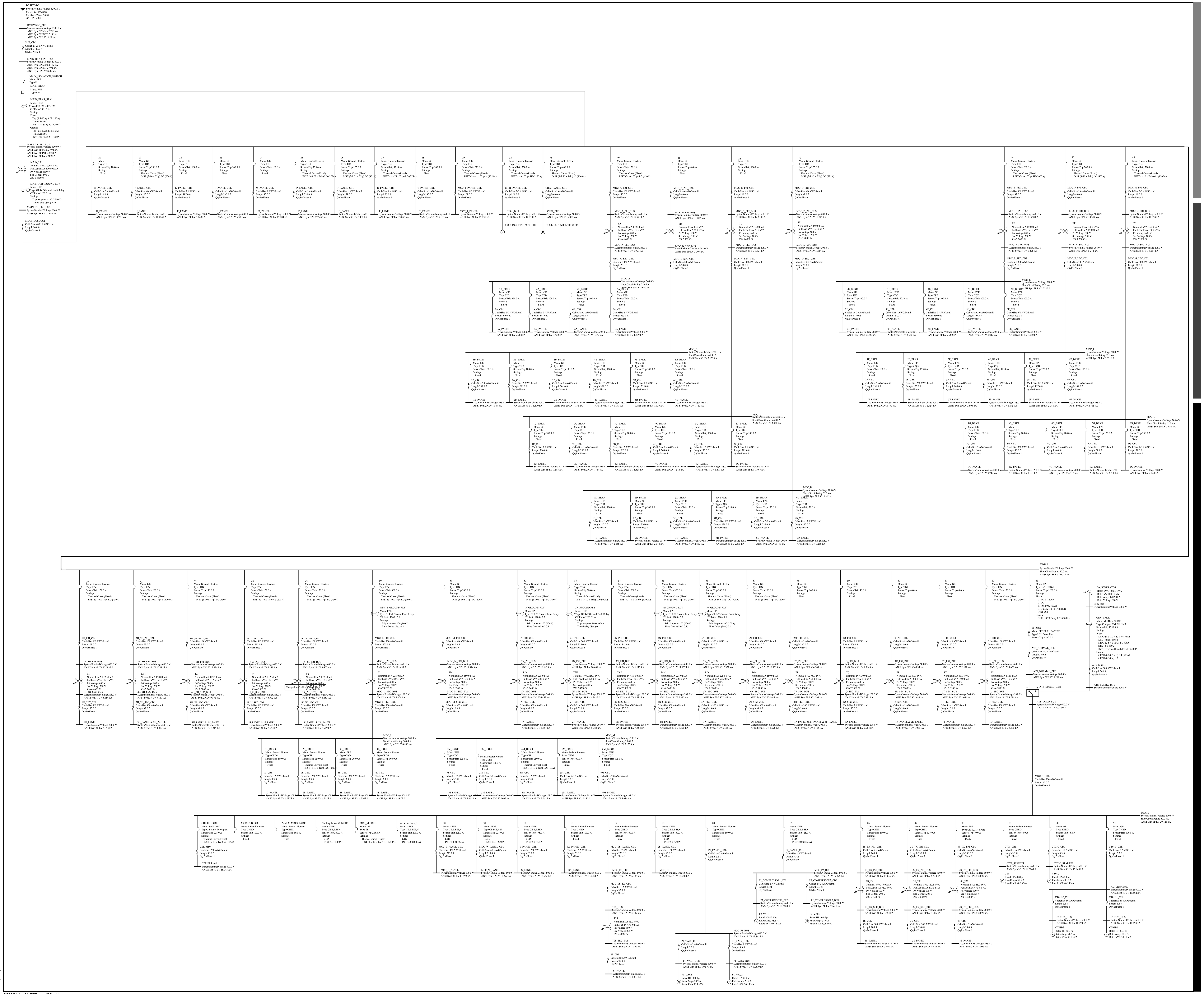
Bus Name	Equipment Type	Upstream Protective Device Clearing Fault	Bolted Fault Current @ Bus	Bolted Fault Current Through Prot.	Arcing Fault Current @ Bus	Arcing Fault Current Through Prot.	Clearing Time (ms)	Arc Flash Hazard Analysis Results FPB (mm)	WD (mm)	IE (ca/cm2)	CSA Z462 PPE Cat.
4H_PANEL & 5H_PANEL	PNL (25)	65	8,050	8,050	3,730	3,730	25	191.3	457	.29	Level 0
4L_PANEL	PNL (25)	4L_BRKR	6,570	6,570	3,240	3,240	20	151.3	457	.19	Level 0
4M_PANEL	PNL (25)	4M_BRKR	4,980	4,980	2,660	2,660	25	153.2	457	.20	Level 0
4N_PANEL	PNL (25)	55	6,580	6,580	2,750	2,750	2,000	2,261.9	457	16.48	Level 3
4N_SECI_BUS	PNL (25)	55	7,180	7,180	2,930	2,930	47	240.4	457	.42	Level 0
4S_PANEL	PNL (25)	88	1,910	1,910	1,360	1,360	2,000	458.3	457	1.20	Level 0
4S_TX_SEC_BUS	PNL (25)	88	2,070	2,070	1,440	1,440	2,000	458.3	457	1.20	Level 0
5A_PANEL	PNL (25)	5A_BRKR	1,380	1,380	1,080	1,080	2,000	458.3	457	1.20	Level 0
5B_PANEL	PNL (25)	5B_BRKR	1,120	1,120	930	930	2,000	458.3	457	1.20	Level 0
5C_PANEL	PNL (25)	5C_BRKR	1,470	1,470	1,130	1,130	2,000	458.3	457	1.20	Level 0
5D_PANEL	PNL (25)	5D_BRKR	2,700	2,700	1,730	1,730	2,000	1,667.8	457	9.99	Level 3
5E_PANEL	PNL (25)	5E_BRKR	3,200	3,200	1,960	1,960	2,000	1,804.8	457	11.37	Level 3
5F_PANEL	PNL (25)	5F_BRKR	3,240	3,240	1,680	1,680	2,000	1,630.6	457	9.63	Level 3
5G_PANEL	PNL (25)	5G_BRKR	3,650	3,650	1,820	1,820	2,000	1,723.3	457	10.54	Level 3
5M_PANEL	PNL (25)	5M_BRKR	5,000	5,000	2,270	2,270	27	145.2	457	.18	Level 0
5N_PANEL	PNL (25)	56	6,430	6,430	2,710	2,710	2,000	2,239.0	457	16.20	Level 3
5N_SEC_BUS	PNL (25)	56	7,010	7,010	2,880	2,880	49	243.2	457	.42	Level 0
6A_PANEL	PNL (25)	6A_BRKR	1,360	1,360	1,070	1,070	2,000	458.3	457	1.20	Level 0
6B_PANEL	PNL (25)	6B_BRKR	1,110	1,110	930	930	2,000	458.3	457	1.20	Level 0
6C_PANEL	PNL (25)	6C_BRKR	1,450	1,450	1,120	1,120	2,000	458.3	457	1.20	Level 0
6D_PANEL	PNL (25)	6D_BRKR	260	260	260	260	1,380	177.9	457	.18	Level 0
6E_PANEL	PNL (25)	6E_BRKR	3,170	3,170	1,940	1,940	2,000	1,794.9	457	11.27	Level 3
6F_PANEL	PNL (25)	6F_BRKR	2,680	2,680	1,730	1,730	2,000	1,661.9	457	9.93	Level 3
6G_PANEL	PNL (25)	6G_BRKR	3,990	3,990	2,280	2,280	2,000	1,996.9	457	13.43	Level 3
6M_PANEL	PNL (25)	51	5,000	5,000	2,670	2,670	29	167.7	457	.23	Level 0
6N_PANEL	PNL (25)	57	4,550	4,550	2,500	2,500	30	163.0	457	.22	Level 0

Arc Flash Report - IEEE 1584 Calculations
Maximum Fault Duty - Worst Case

Government of Canada

Bus Name	Equipment Type	Upstream Protective Device Clearing Fault	Bolted Fault Current @ Bus	Bolted Fault Current Through Prot.	Arcing Fault Current @ Bus	Arcing Fault Current Through Prot.	Clearing Time (ms)	FPB (mm)	WD (mm)	IE (ca/cm2)	CSA Z462 PPE Cat.
6N_SEC_BUS	PNL (25)	57	4,840	4,840	2,610	2,610	29	166.0	457	.23	Level 0
MDC_A	PNL (25)	40	5,540	5,540	2,870	2,870	25	162.2	457	.22	Level 0
MDC_A_SEC_BUS	PNL (25)	40	5,820	5,820	2,970	2,970	25	165.1	457	.22	Level 0
MDC_B	PNL (25)	41	2,130	2,130	1,470	1,470	2,000	458.3	457	1.20	Level 0
MDC_B_SEC_BUS	PNL (25)	41	2,180	2,180	1,490	1,490	2,000	458.3	457	1.20	Level 0
MDC_C	PNL (25)	42	3,380	3,380	2,030	2,030	2,000	458.3	457	1.20	Level 0
MDC_C_SEC_BUS	PNL (25)	42	3,470	3,470	2,070	2,070	2,000	458.3	457	1.20	Level 0
MDC_D	PNL (25)	43	4,950	4,950	2,250	2,250	39	178.7	457	.26	Level 0
MDC_D_SEC_BUS	PNL (25)	43	5,130	5,130	2,720	2,720	31	178.2	457	.25	Level 0
MDC_E	PNL (25)	44	4,950	4,950	2,650	2,650	2,000	2,206.7	457	15.82	Level 3
MDC_E_SEC_BUS	PNL (25)	44	5,140	5,140	2,720	2,720	2,000	2,245.2	457	16.28	Level 3
MDC_F	PNL (25)	45	4,940	4,940	2,650	2,650	29	167.0	457	.23	Level 0
MDC_F_SEC_BUS	PNL (25)	45	5,120	5,120	2,720	2,720	29	168.9	457	.23	Level 0
MDC_G	PNL (25)	46	4,940	4,940	2,650	2,650	2,000	2,204.4	457	15.79	Level 3
MDC_G_SEC_BUS	PNL (25)	46	5,120	5,120	2,720	2,720	2,000	2,242.9	457	16.25	Level 3
MDC_L	PNL (25)	50	6,700	6,700	2,790	2,790	2,000	2,281.0	457	16.70	Level 3
MDC_L_SEC_BUS	PNL (25)	50	7,060	7,060	2,890	2,890	49	242.4	457	.42	Level 0
MDC_M	PNL (25)	51	5,040	5,040	2,690	2,690	29	168.1	457	.23	Level 0
MDC_M_SEC_BUS	PNL (25)	51	5,240	5,240	2,760	2,760	29	170.0	457	.24	Level 0
T2S_SEC_BUS	PNL (25)	82	1,530	1,530	1,170	1,170	2,000	458.3	457	1.20	Level 0
TP_SEC_BUS	PNL (25)	58	3,250	3,250	1,970	1,970	2,000	458.3	457	1.20	Level 0

APPENDIX F



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Permit-Seal

Client/Project

Summerland PARC Facility

SHORT CIRCUIT DEVICE EVALUATION COORDINATION & ARC FLASH STUDY

Summerland BC Canada

Title

ELECTRICAL SINGLE LINE DRAWING

Project No.	Scale
115612049	N.T.S.

Drawing No.	Sheet	Revision
F-1	of	0

ORIGINAL SHEET – ISO A1