1. GENERAL

1.01 SECTION INCLUDES

.1 Provide an Arc Flash Hazard Analysis Study per the requirements described in CSA Z462 Standard for Electrical Safety in the Workplace.

.2 The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are obtained in CSA Z462-08, Annex D, or more recent version of the standard as cited by this Section.

.3 The scope of the studies shall include all existing distribution equipment and all new distribution equipment supplied by the equipment manufacturer under this contract.

1.02 RELATED REQUIREMENTS

.1 Section 26 05 73.16 – Coordination Studies.

.2 Single Line Diagram.

1.03 REFERENCES

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

.1 IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.

.2 IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

.3 IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.

.4 IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.

.5 IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.

.6 IEEE 1584-2018 - Guide for Performing Arc-Flash Hazard Calculations.

.2 American National Standards Institute (ANSI):

.1 ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

.2 ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.

.3 ANSI C37.010-2016 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.

.4 ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

.3 CSA Group:

.1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (28th edition/2021).

.3 CSA Z462:21, Workplace electrical safety.

1.04 SUBMITTALS

.1 Submit the protective device coordination study to the Consultant prior to receiving final review of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.05 CLOSEOUT SUBMITTALS

.1 The results of the protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. Three (3) bound copies of the complete final report shall be submitted. Additional copies of the complete report with input and output data shall be provided on CD in PDF format.

.2 The report shall include the following sections:

.1 Executive Summary.

.2 Descriptions, purpose, basis, and scope of the study.

.3 Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short circuit duties.

.4 Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.

.5 Fault current calculations including a definition of terms and guide for interpretation of the computer printout.

.6 Details of the incident energy and flash protection boundary calculations.

.7 Recommendations for system improvements, where needed.

.8 Single Line Diagram.

.3 Arc flash labels (refer to CSA Z462 Annex Q) shall be provided in hard copy only.

1.06 QUALIFICATIONS

.1 Arc flash hazard analysis studies shall be conducted under the supervision and approval of a licensed Professional Electrical Engineer skilled in performing and interpreting the power system studies.

.2 The licensed Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm.

.3 The licensed Professional Electrical Engineer shall have a minimum of eight (8) years of experience in performing power system studies.

.4 The equipment manufacturer or approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

1.07 COMPUTER ANALYSIS SOFTWARE

.1 The studies shall be performed using the latest revision of the SKM or equivalent.

2. PRODUCTS

2.01 MANUFACTURERS

.1 Independent Testing Organizations:

.1 AC Tesla.

.2 Brosz and Associates.

.3 C-INTECH.

.4 Eastenghouse.

.5 Enkompass.

.6 G.T. Wood.

.2 Electrical distribution manufacturers:

.1 Eaton.

.2 Schneider Electric.

2.02 STUDIES

.1 The contractor shall furnish an Arc Flash Hazard Analysis Study per CSA Z462, reference Section 4.1.8.2.2, 4.3.3.

2.03 DATA COLLECTION

.1 Contractor shall furnish all data as required by the power system studies. The Engineer performing arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

.2 Source combination may include present and future motors and generators.

.3 If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.04 ARC FLASH HAZARD ANALYSIS

.1 The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in CSA Z462 Annex D.

.2 The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, panelboards, and splitters) where work could be performed on energized parts.

.3 The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 112.5 kVA where work could be performed on energized parts.

.4 Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 calories per square centimetre.

.5 When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken

into consideration when determining the clearing time when performing incident energy calculations.

.6 The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

.7 The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

.1 Fault contribution from induction motors should not be considered beyond 3-5 cycles.

.8 Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

.9 For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

.10 When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

.11 Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

.12 Arc Flash calculations shall be based on actual overcurrent protective device clearing time.

.13 Maximum clearing time will be capped at 2 seconds based on IEEE 1584.

.14 Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.05 REPORT SECTIONS

.1 Incident energy and flash protection boundary calculations:

.1 Arcing fault magnitude.

.2 Protective device clearing time.

.3 Duration of arc.

.4 Arc flash boundary.

.5 Working distance.

.6 Incident energy.

.7 Hazard Risk Category.

.8 Recommendations for arc flash energy reduction.

3. EXECUTION

3.01 FIELD ADJUSTMENT

.1 Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

.2 Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

.3 Notify Owner in writing of any required major equipment modifications.

3.02 ARC FLASH WARNING LABELS

.1 The contractor of the Arc Flash Hazard Analysis shall provide a 90 mm (3.5 inch) by 125 mm (5 inch) thermal transfer type label of high adhesion polyester for each work location analyzed.

.2 All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

.3 The label shall include the following information, at a minimum:

.1 Location designation.

.2 Nominal voltage.

.3 Flash protection boundary.

.4 Hazard risk category.

.5 Incident energy.

.6 Working distance.

.7 Engineering firm and issue date.

.8 Labels shall be machine printed, with no field markings.

.4 Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

.1 For each 600 volt, and applicable 208 volt panelboard, one arc flash label shall be provided.

.2 For each motor control centre, one arc flash label shall be provided.

.3 For each low voltage switchboard, one arc flash label shall be provided.

.4 For each switchgear, one flash label shall be provided.

.5 For medium voltage switches one arc flash label shall be provided.

.5 Arc Flash Warning Label General Instructions:

.1 Only qualified electricians who recognize and avoid the electrical and Arc Flash hazards are allowed to place the arc flash warning labels.

.2 Electricians should wear suitable PPE, such as electrical safety boots, Safety Glasses, etc. while performing labeling.

.3 Generally, arc flash label shall be put on a prominent pre-cleaned place on the front of the electrical equipment (such as switchgear, panel, disconnect switch, generator output breaker).

Label should be visible and readable, displayed horizontally, attached flatly and securely, and not allowed to cover other signs or labels on the equipment.

.4 Under the special request of the client, labels could be put on the back of the panel door when the panel is located in clean and finished spaces such as an office area.

.5 When putting a label on small equipment with no space labeling on the wall just beside the equipment is allowed.

.6 Special request may be attached to this General Instruction. For examples, more than one identical label is applied for large equipment; different labels could be applied for different sections of one equipment; for a splitter with several disconnect switches only one label is placed on the splitter for this group.

.7 Take the pictures for each label to indicate both names of the label and equipment and labeling area of the equipment. Email these pictures to the Consultant for quality control and record.

End of Section