THE CITY OF WINNIPEG

BID OPPORTUNITY

BID OPPORTUNITY NO. 609-2009

WATER PUMPING STATIONS ELECTRICAL INSPECTION

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PART B - BIDDING PROCEDURES

B1. CONTRACT TITLE

B1.1 WATER PUMPING STATIONS ELECTRICAL INSPECTION

B2. SUBMISSION DEADLINE

B2.1 The Submission Deadline is 4:00 p.m. Winnipeg time, September 18, 2009.

B2.2 Bids determined by the Manager of Materials to have been received later than the Submission Deadline will not be accepted and will be returned upon request.

B2.3 The Contract Administrator or the Manager of Materials may extend the Submission Deadline by issuing an addendum at any time prior to the time and date specified in B2.1.

B3. SITE INVESTIGATION

B3.1 Further to C3.1, the Contract Administrator or an authorized representative will be available at the Hurst Pumping Station at 9:00 am on August 27, 2009 to provide Bidders access to the Site. Subsequent to the meeting at Hurst Pumping Station, opportunity to access the McPhillips and MacLean Pumping Stations will be provided.

B3.2 The Bidder is advised that they need to attend the initial meeting at Hurst Pumping Station in order to gain access to the other Sites.

B3.3 The Bidder shall not be entitled to rely on any information or interpretation received at the Site investigation unless that information or interpretation is the Bidder's direct observation, or is provided by the Contract Administrator in writing.

B3.4 Cameras are not permitted.

B3.5 The Bidder is responsible for determining:

(a) the location of any utility which can be determined from the records or other information available at the offices of any public authority or person, including a municipal corporation and any board or commission thereof, having jurisdiction or control over the utility;

(b) the nature of the conditions at the Site;

(c) the location, nature, quality or quantity of the materials to be removed or to be employed in the performance of the Work;

(d) all matters concerning access to the Site, power supplies, location of existing services, utilities or materials necessary for the completion of the Work; and

(e) all other matters which could in any way affect his Bid or the performance of the Work.

B4. ENQUIRIES

B4.1 All enquiries shall be directed to the Contract Administrator identified in D3.1.

B4.2 If the Bidder finds errors, discrepancies or omissions in the Bid Opportunity, or is unsure of the meaning or intent of any provision therein, the Bidder shall promptly notify the Contract Administrator of the error, discrepancy or omission at least five (5) Business Days prior to the Submission Deadline.

B4.3 If the Bidder is unsure of the meaning or intent of any provision therein, the Bidder should request clarification as to the meaning or intent prior to the Submission Deadline.

B4.4 Responses to enquiries which, in the sole judgment of the Contract Administrator, require a correction to or a clarification of the Bid Opportunity will be provided by the Contract Administrator to all Bidders by issuing an addendum.

B4.5 Responses to enquiries which, in the sole judgment of the Contract Administrator, do not require a correction to or a clarification of the Bid Opportunity will be provided by the Contract Administrator only to the Bidder who made the enquiry.

B4.6 The Bidder shall not be entitled to rely on any response or interpretation received pursuant to B4 unless that response or interpretation is provided by the Contract Administrator in writing.

B5. ADDENDA

B5.1 The Contract Administrator may, at any time prior to the Submission Deadline, issue addenda correcting errors, discrepancies or omissions in the Bid Opportunity, or clarifying the meaning or intent of any provision therein.

B5.2 The Contract Administrator will issue each addendum at least two (2) Business Days prior to the Submission Deadline, or provide at least two (2) Business Days by extending the Submission Deadline.

B.5.2.1. Addenda will be available on the Bid Opportunities page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/bidopp.asp

B.5.2.2. The Bidder is responsible for ensuring that he has received all addenda and is advised to check the Materials Management Division website for addenda regularly and shortly before the Submission Deadline, as may be amended by addendum.

B5.3 The Bidder shall acknowledge receipt of each addendum in Paragraph 8 of Form A: Bid. Failure to acknowledge receipt of an addendum may render a Bid non-responsive.

B6. SUBSTITUTES

B6.1 The Work is based on the Plant, Materials and methods specified in the Bid Opportunity.

B6.2 Substitutions shall not be allowed unless application has been made to and prior approval has been granted by the Contract Administrator in writing.

B6.3 Requests for approval of a substitute will not be considered unless received in writing by the Contract Administrator at least five (5) Business Days prior to the Submission Deadline.

B6.4 The Bidder shall ensure that any and all requests for approval of a substitute:

(a) provide sufficient information and details to enable the Contract Administrator to determine the acceptability of the Plant, Material or method as either an approved equal or alternative;

(b) identify any and all changes required in the applicable Work, and all changes to any other Work, which would become necessary to accommodate the substitute;

(c) identify any anticipated cost or time savings that may be associated with the substitute;

(d) certify that, in the case of a request for approval as an approved equal, the substitute will fully perform the functions called for by the general design, be of equal or superior substance to that specified, is suited to the same use and capable of performing the same function as that specified and can be incorporated into the Work, strictly in accordance with the proposed work schedule and the dates specified in the Supplemental Conditions for Substantial Performance and Total Performance;

(e) certify that, in the case of a request for approval as an approved alternative, the substitute will adequately perform the functions called for by the general design, be similar in substance to that specified, is suited to the same use and capable of performing the same

function as that specified and can be incorporated into the Work, strictly in accordance with the proposed work schedule and the dates specified in the Supplemental Conditions for Substantial Performance and Total Performance.

B6.5 The Contract Administrator, after assessing the request for approval of a substitute, may in his sole discretion grant approval for the use of a substitute as an “approved equal” or as an “approved alternative”, or may refuse to grant approval of the substitute.

B6.6 The Contract Administrator will provide a response in writing, at least two (2) Business Days prior to the Submission Deadline, only to the Bidder who requested approval of the substitute.

B.6.6.1. The Bidder requesting and obtaining the approval of a substitute shall be entirely responsible for disseminating information regarding the approval to any person or persons he wishes to inform.

B6.7 If the Contract Administrator approves a substitute as an “approved equal”, any Bidder may use the approved equal in place of the specified item.

B6.8 If the Contract Administrator approves a substitute as an “approved alternative”, any Bidder bidding that approved alternative may base his Total Bid Price upon the specified item but may also indicate an alternative price based upon the approved alternative. Such alternatives will be evaluated in accordance with B14.

B6.9 No later claim by the Contractor for an addition to the Total Bid Price because of any other changes in the Work necessitated by the use of an approved equal or an approved alternative will be considered.

B6.10 Notwithstanding B6.2 to B6.9, and in accordance with B7.5, deviations inconsistent with the Bid Opportunity document shall be evaluated in accordance with B14.1(a).

B7. BID SUBMISSION

B7.1 The Bid shall consist of the following components:

(a) Form A: Bid;

(b) Form B: Prices;

B7.2 Further to B7.1, the Bidder should include the written correspondence from the Contract Administrator approving a substitute in accordance with B6.

B7.3 All components of the Bid shall be fully completed or provided, and submitted by the Bidder no later than the Submission Deadline, with all required entries made clearly and completely in ink, to constitute a responsive Bid.

B7.4 Bidders are advised not to include any information/literature except as requested in accordance with B7.1.

B7.5 Bidders are advised that inclusion of terms and conditions inconsistent with the Bid Opportunity document, including the General Conditions, will be evaluated in accordance with B14.1(a)

B7.6 The Bid may be submitted by mail, courier or personal delivery, or by facsimile transmission.

B7.7 If the Bid is submitted by mail, courier or personal delivery, it shall be enclosed and sealed in an envelope clearly marked with the Bid Opportunity number and the Bidder's name and address, and shall be submitted to:

The City of Winnipeg
Corporate Finance Department
Materials Management Division
185 King Street, Main Floor
Winnipeg MB R3B 1J1

B.7.7.1. Samples or other components of the Bid which cannot reasonably be enclosed in the envelope may be packaged separately, but shall be clearly marked with the Bid Opportunity number, the Bidder's name and address, and an indication that the contents are part of the Bidder's Bid Submission.

B7.8 If the Bid is submitted by facsimile transmission, it shall be submitted to (204) 949-1178.

B.7.8.1. The Bidder is advised that the City cannot take responsibility for the availability of the facsimile machine at any time.

B7.9 Bids submitted by internet electronic mail (e-mail) will not be accepted.

B8. BID

B8.1 The Bidder shall complete Form A: Bid, making all required entries.

B8.2 Paragraph 2 of Form A: Bid shall be completed in accordance with the following requirements:

(a) if the Bidder is a sole proprietor carrying on business in his own name, his name shall be inserted;

(b) if the Bidder is a partnership, the full name of the partnership shall be inserted;

(c) if the Bidder is a corporation, the full name of the corporation shall be inserted;

(d) if the Bidder is carrying on business under a name other than his own, the business name and the name of every partner or corporation who is the owner of such business name shall be inserted.

B.8.2.1. If a Bid is submitted jointly by two or more persons, each and all such persons shall identify themselves in accordance with B8.2.

B8.3 In Paragraph 3 of Form A: Bid, the Bidder shall identify a contact person who is authorized to represent the Bidder for purposes of the Bid.

B8.4 Paragraph 10 of Form A: Bid shall be signed in accordance with the following requirements:

(a) if the Bidder is a sole proprietor carrying on business in his own name, it shall be signed by the Bidder;

(b) if the Bidder is a partnership, it shall be signed by the partner or partners who have authority to sign for the partnership;

(c) if the Bidder is a corporation, it shall be signed by its duly authorized officer or officers;

(d) if the Bidder is carrying on business under a name other than his own, it shall be signed by the registered owner of the business name, or by the registered owner's authorized officials if the owner is a partnership or a corporation.

B.8.4.1. The name and official capacity of all individuals signing Form A: Bid should be printed below such signatures.

B.8.4.2. All signatures shall be original.

B8.5 If a Bid is submitted jointly by two or more persons, the word "Bidder" shall mean each and all such persons, and the undertakings, covenants and obligations of such joint Bidders in the Bid and the Contract, when awarded, shall be both joint and several.

B9. PRICES

B9.1 The Bidder shall state a price in Canadian funds for each item of the Work identified on Form B: Prices.

B.9.1.1. Notwithstanding C11.1.1, prices on Form B: Prices shall not include the Goods and Services Tax (GST) or Manitoba Retail Sales Tax (MRST, also known as PST), which shall be extra where applicable.

B9.2 The quantities listed on Form B: Prices are to be considered approximate only. The City will use said quantities for the purpose of comparing Bids.

B9.3 The quantities for which payment will be made to the Contractor are to be determined by the Work actually performed and completed by the Contractor, to be measured as specified in the applicable Specifications.

B9.4 The mark-up factor for material, specified on Form B, Item 6, shall be a percentage, that when multiplied by the base cost, shall represent the Contractor's handling charge and profit to supply the material. The total price for the material shall be the base cost, plus the base cost multiplied by the mark-up factor.

B9.5 The mark-up factor shall be based upon the Contractor's base cost. This base cost shall be the Contractor's procurement cost, or if the material is manufactured by the Contractor, the internal wholesale cost.

B9.6 Prices from Non-Resident Bidders are subject to a Non-Resident Withholding Tax pursuant to the Income Tax Act (Canada).

B10. QUALIFICATION

B10.1 The Bidder shall:

(a) undertake to be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba, or if the Bidder does not carry on business in Manitoba, in the jurisdiction where the Bidder does carry on business; and

(b) be financially capable of carrying out the terms of the Contract; and

(c) have all the necessary experience, capital, organization, and equipment to perform the Work in strict accordance with the terms and provisions of the Contract.

B10.2 The Bidder and any proposed Subcontractor (for the portion of the Work proposed to be subcontracted to them) shall:

(a) be responsible and not be suspended, debarred or in default of any obligations to the City. A list of suspended or debarred individuals and companies is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/debar.stm

B10.3 The Bidder and/or any proposed Subcontractor (for the portion of the Work proposed to be subcontracted to them) shall:

(a) have successfully carried out work similar in nature, scope and value to the Work;

(b) be fully capable of performing the Work required to be in strict accordance with the terms and provisions of the Contract;

(c) have a written workplace safety and health program, if required, pursuant to The Workplace Safety and Health Act (Manitoba);

(d) be regularly engaged in the testing of electrical equipment devices, installations, and systems;

(e) utilize licensed electricians for tasks as required to meet Manitoba regulations; and

(f) use technicians who are regularly employed for testing services. Technicians performing these electrical tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated. These individuals shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. They must evaluate the test data and make a judgment on the continued serviceability or non-serviceability of the specific equipment.

B10.4 The Bidder shall submit, within three (3) Business Days of a request by the Contract Administrator, proof satisfactory to the Contract Administrator of the qualifications of the Bidder and of any proposed Subcontractor.

B10.5 The Bidder shall provide, on the request of the Contract Administrator, full access to any of the Bidder's equipment and facilities to confirm, to the Contract Administrator's satisfaction, that the Bidder's equipment and facilities are adequate to perform the Work.

B10.6 Further to B10.3(c), the Bidder shall, within five (5) Business Days of a request by the Contract Administrator, provide proof satisfactory to the Contract Administrator that the Bidder/Subcontractor has a workplace safety and health program meeting the requirements of The Workplace Safety and Health Act (Manitoba), by providing:

(a) a valid COR certification number under the Certificate of Recognition (COR) Program administered by the Manitoba Construction Safety Association or by the Manitoba Heavy Construction Association's Safety, Health and Environment Program; or

(b) a report or letter to that effect from an independent reviewer acceptable to the City. (A list of acceptable reviewers and the review template are available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt

B10.7 The Bidder shall submit, within three (3) Business Days of a request by the Contract Administrator, proof satisfactory to the Contract Administrator of the qualifications of the Bidder and of any proposed Subcontractor.

B10.8 The Bidder shall provide, on the request of the Contract Administrator, full access to any of the Bidder's equipment and facilities to confirm, to the Contract Administrator's satisfaction, that the Bidder's equipment and facilities are adequate to perform the Work.

B11. OPENING OF BIDS AND RELEASE OF INFORMATION

B11.1 Bid Submissions will not be opened publicly.

B11.2 Following the Submission Deadline, the names of the Bidders and their bid prices (unevaluated, and pending review and verification of conformance with requirements) will be available on the Closed Bid Opportunities (or Public/Posted Opening & Award Results) page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt

B11.3 After award of Contract, the name(s) of the successful Bidder(s) and the Contract Amount(s) will be available on the Closed Bid Opportunities (or Public/Posted Opening & Award Results) page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt

B11.4 The Bidder is advised that any information contained in any Bid may be released if required by City policy or procedures, The Freedom of Information and Protection of Privacy Act (Manitoba), or by other authorities having jurisdiction.

B12. IRREVOCABLE BID

B12.1 The Bid(s) submitted by the Bidder shall be irrevocable for the time period specified in Paragraph 9 of Form A: Bid.

B12.2 The acceptance by the City of any Bid shall not release the Bids of the next two lowest evaluated responsive Bidders and these Bidders shall be bound by their Bids on such Work for the time period specified in Paragraph 9 of Form A: Bid.

B13. WITHDRAWAL OF BIDS

B13.1 A Bidder may withdraw his Bid without penalty by giving written notice to the Manager of Materials at any time prior to the Submission Deadline.

B.13.1.1. Notwithstanding C22.5, the time and date of receipt of any notice withdrawing a Bid shall be the time and date of receipt as determined by the Manager of Materials.

B.13.1.2. The City will assume that any one of the contact persons named in Paragraph 3 of Form A: Bid or the Bidder's authorized representatives named in Paragraph 10 of Form A: Bid, and only such person, has authority to give notice of withdrawal.

B.13.1.3. If a Bidder gives notice of withdrawal prior to the Submission Deadline, the Manager of Materials will:

(a) retain the Bid until after the Submission Deadline has elapsed;

(b) open the Bid to identify the contact person named in Paragraph 3 of Form A: Bid and the Bidder's authorized representatives named in Paragraph 10 of Form A: Bid; and

(c) if the notice has been given by any one of the persons specified in B13.1(a), declare the Bid withdrawn.

B13.2 A Bidder who withdraws his Bid after the Submission Deadline but before his Bid has been released or has lapsed as provided for in B12.2 shall be liable for such damages as are imposed upon the Bidder by law and subject to such sanctions as the Chief Administrative Officer considers appropriate in the circumstances. The City, in such event, shall be entitled to all rights and remedies available to it at law.

B14. EVALUATION OF BIDS

B14.1 Award of the Contract shall be based on the following bid evaluation criteria:

(a) compliance by the Bidder with the requirements of the Bid Opportunity, or acceptable deviation therefrom (pass/fail);

(b) qualifications of the Bidder and the Subcontractors, if any, pursuant to B10 (pass/fail);

(c) Total Bid Price;

(d) economic analysis of any approved alternative pursuant to B6;

B14.2 Further to B14.1(a), the Award Authority may reject a Bid as being non-responsive if the Bid Submission is incomplete, obscure or conditional, or contains additions, deletions, alterations or other irregularities. The Award Authority may reject all or any part of any Bid, or waive technical requirements or minor informalities or irregularities if the interests of the City so require.

B14.3 Further to B14.1(b), the Award Authority shall reject any Bid submitted by a Bidder who does not demonstrate, in his Bid or in other information required to be submitted, that he is responsible and qualified.

B14.4 Further to B14.1(c), the Total Bid Price shall be the sum of the quantities multiplied by the unit prices for each item shown on Form B: Prices.

B.14.4.1. If there is any discrepancy between the Total Bid Price written in figures, the Total Bid Price written in words and the sum of the quantities multiplied by the unit prices for each item, the sum of the quantities multiplied by the unit prices for each item shall take precedence.

B.14.4.2. Further to B14.1(a), in the event that a unit price is not provided on Form B: Prices, the City will determine the unit price by dividing the Amount (extended price) by the approximate quantity, for the purposes of evaluation and payment.

B14.5 This Contract will be awarded as a whole.

B15. AWARD OF CONTRACT

B15.1 The City will give notice of the award of the Contract or will give notice that no award will be made.

B15.2 The City will have no obligation to award a Contract to a Bidder, even though one or all of the Bidders are determined to be responsible and qualified, and the Bids are determined to be responsive.

B.15.2.1. Without limiting the generality of B15.2, the City will have no obligation to award a Contract where:

(a) the prices exceed the available City funds for the Work;

(b) the prices are materially in excess of the prices received for similar work in the past;

(c) the prices are materially in excess of the City's cost to perform the Work, or a significant portion thereof, with its own forces;

(d) only one Bid is received; or

(e) in the judgment of the Award Authority, the interests of the City would best be served by not awarding a Contract.

B15.3 Where an award of Contract is made by the City, the award shall be made to the responsible and qualified Bidder submitting the lowest evaluated responsive Bid in accordance with B14 .

B.15.3.1. Following the award of contract, a Bidder will be provided with information related to the evaluation of his Bid upon written request to the Contract Administrator.

B15.4 Notwithstanding C4.1, the City will issue a Purchase Order to the successful Bidder in lieu of the execution of a Contract.

B15.5 The Contract Documents, as defined in C1.1(n), in their entirety shall be deemed to be incorporated in and to form a part of the Purchase Order notwithstanding that they are not necessarily attached to or accompany said Purchase Order.

PART C - GENERAL CONDITIONS

C1. GENERAL CONDITIONS

C1.1 The *General Conditions for Supply of Services* (Revision 2007 04 12) are applicable to the Work of the Contract.

C.1.1.1. The General Conditions for Supply of Services are available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/gen_cond.stm

C1.2 A reference in the Bid Opportunity to a section, clause or subclause with the prefix "**C**" designates a section, clause or subclause in the *General Conditions for Supply of Services*.

PART D - SUPPLEMENTAL CONDITIONS

GENERAL

D1. GENERAL CONDITIONS

D1.1 In addition to the *General Conditions for Supply of Services*, these Supplemental Conditions are applicable to the Work of the Contract.

D2. SCOPE OF WORK

D2.1 The Work to be done under the Contract shall consist of condition assessment, basic maintenance and performance testing of the specified electrical equipment within the McPhillips, MacLean and Hurst Water Pumping Stations. The Work will also include the replacement of certain electromechanical relays with new electronic relays.

D2.2 The major components of the Work are as follows:

(a) Inspect and test the 4160 V cables between the Manitoba Hydro transformers and the pumping station (not applicable at McPhillips Pumping Station).

(b) Replace the electromechanical overcurrent protective relays on the incoming circuits with new electronic relays (not applicable at Hurst Pumping Station).

(c) Inspect and test the 4160 V switchgear, including all protection relays not being replaced.

(d) Inspect and test the 4160 V motors, starters, and cables.

(e) Inspect and test the 4160/600 V transformers, including primary & secondary cables.

(f) Inspect and test the 600 V switchgear buswork, main breakers, and transfer switches.

(g) Inspect and test the stand-by generators as per CSA C282.

(h) Inspect and test the 600 V MCC buswork for both the Essential and Non-Essential MCCs.

(i) Inspect and test the 600 V motor starters & breakers in the Essential and Non-Essential MCCs.

(j) Inspect and test the UPS distribution transformers and wiring between the 600 V MCC and the UPS panelboards.

(k) Inspect and test the 600 V – 120/208 V transformers and associated protection and cabling.

(l) Inspect and test the 120/208 V panelboards.

(m) Provide a report detailing the inspection and test results.

(n) Provide a quotation to repair defective components using the rates proposed in Form B.

(o) Repair defective components upon approval of the Contract Administrator. Award of this contract does not imply approval of the repair services.

D3. CONTRACT ADMINISTRATOR

D3.1 The Contract Administrator is SNC-Lavalin Inc., represented by:

Curtis Reimer, P.Eng.
SNC-Lavalin Inc.
148 Nature Park Way, Winnipeg, MB R3P 0X7

E-mail curtis.reimer@snclavalin.com

Telephone No. (204) 786-8080
Facsimile No. (204) 786-7934

D3.2 Before commencement of Work, Curtis Reimer will identify additional personnel representing the Contract Administrator and their respective roles and responsibilities for the Work.

D4. CONTRACTOR'S SUPERVISOR

D4.1 Further to C6.19, the Contractor shall employ and keep on the Work, at all times during the performance of the Work, a competent supervisor and assistants, if necessary, acceptable to the Contract Administrator. The supervisor shall represent the Contractor on the Site. The supervisor shall not be replaced without the prior consent of the Contract Administrator unless the supervisor proves to be unsatisfactory to the Contractor and ceases to be in his employ.

D4.2 Before commencement of Work, the Contractor shall identify his designated supervisor and any additional personnel representing the Contractor and their respective roles and responsibilities for the Work.

D.4.2.1. Further to C5.5 Contract Administrator may give instructions or orders to the Contractor's supervisor and such instructions or orders shall be deemed to have been given to the Contractor.

D5. NOTICES

D5.1 Notwithstanding C22.3, all notices of appeal to the Chief Administrative Officer shall be sent to the attention of the Chief Financial Officer at the following address or facsimile number:

The City of Winnipeg
Chief Financial Officer
Administration Building, 3rd Floor
510 Main Street
Winnipeg, MB R3B 1B9

Facsimile No.: (204) 949-1174

SUBMISSIONS

D6. AUTHORITY TO CARRY ON BUSINESS

D6.1 The Contractor shall be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba, or if the Contractor does not carry on business in Manitoba, in the jurisdiction where the Contractor does carry on business, throughout the term of the Contract, and shall provide the Contract Administrator with evidence thereof upon request.

D7. INSURANCE

D7.1 The Contractor shall provide and maintain the following insurance coverage:

(a) commercial general liability insurance, in the amount of at least two million dollars ($2,000,000.00) inclusive, with The City of Winnipeg added as an additional insured; such liability policy to also contain a cross-liability clause, non-owned automobile liability and products and completed operations cover, to remain in place at all times during the performance of the Work;

(a) if required, automobile liability insurance for owned automobiles used for or in connection with the Work in the amount of at least two million dollars ($2,000,000.00), to remain in place at all times during the performance of the Work;

D7.2 Deductibles shall be borne by the Contractor.

D7.3 The Contractor shall provide the Contract Administrator with a certificate(s) of insurance, in a form satisfactory to the City Solicitor, at least two (2) Business Days prior to the commencement of any Work on the Site but in no event later than the date specified in C4.1 for the return of the executed Contract.

D7.4 The Contractor shall not cancel, materially alter, or cause the policy to lapse without providing at least thirty (30) Calendar Days prior written notice to the Contract Administrator.

D8. SECURITY CLEARANCE

D8.1 Each individual proposed to perform Work under the Contract shall be required to obtain a Criminal Record Search Certificate from the police service having jurisdiction at his place of residence.

D8.2 Prior to the commencement of any Work, and during the term of the Contract if additional or replacement individuals are proposed to perform Work, the Contractor shall supply the Contract Administrator with a Criminal Record Search Certificate obtained not earlier than one (1) year prior to the Submission Deadline, or a certified true copy thereof, for each individual proposed to perform the Work.

D8.3 Any individual for whom a Criminal Record Search Certificate is not provided, or for whom a Criminal Record Search Certificate indicates any convictions or pending charges related to property offences or crimes against another person, will not be permitted to perform any Work.

D8.4 Any Criminal Record Search Certificate obtained thereby will be deemed valid for the duration of the Contract subject to a repeated records search as hereinafter specified.

D8.5 Notwithstanding the foregoing, at any time during the term of the Contract, the City may, at its sole discretion and acting reasonably, require an updated criminal records search. Any individual who fails to provide a satisfactory Criminal Record Search Certificate as a result of a repeated criminal records search will not be permitted to continue to perform any Work.

SCHEDULE OF WORK

D9. COMMENCEMENT

D9.1 The Contractor shall not commence any Work until he is in receipt of a notice of award from the City authorizing the commencement of the Work.

D9.2 The Contractor shall not commence any Work on the Site until:

(a) the Contract Administrator has confirmed receipt and approval of:
  (i) evidence of authority to carry on business specified in D6;
  (ii) evidence of the workers compensation coverage specified in C6.14;
  (iii) evidence of the insurance specified in D7; and
  (iv) security clearances specified in D8.

(b) the Contractor has attended a meeting with the Contract Administrator, or the Contract Administrator has waived the requirement for a meeting.

D9.3 The Contractor shall not commence the Work on the Site prior to receipt of written instructions including a schedule of the work, from the Contract Administrator. The Contractor shall not perform any Work outside the scope of the written instructions without prior approval of the Contract Administrator.

D9.4 The Contractor shall commence the Work on the Site within fifteen (15) Working Days of receipt of the notice of award.

D10. TOTAL PERFORMANCE

D10.1 The Contractor shall achieve Total Performance within eighty (80) consecutive Working Days of the commencement of the Work as specified in D9.

D10.2 When the Contractor or the Contract Administrator considers the Work to be totally performed, the Contractor shall arrange, attend and assist in the inspection of the Work with the Contract

Administrator for purposes of verifying Total Performance. Any defects or deficiencies in the Work noted during that inspection shall be remedied by the Contractor at the earliest possible instance and the Contract Administrator notified so that the Work can be re-inspected.

D10.3 The date on which the Work has been certified by the Contract Administrator as being totally performed to the requirements of the Contract through the issue of a certificate of Total Performance is the date on which Total Performance has been achieved.

CONTROL OF WORK

D11. JOB MEETINGS

D11.1 Regular job meetings will be held at a location determined by the Contract Administrator. Allow for twelve progress/scheduling meetings. These meetings shall be attended by a minimum of one representative of the Contract Administrator, one representative of the City and one representative of the Contractor. Each representative shall be a responsible person capable of expressing the position of the Contract Administrator, the City and the Contractor respectively on any matter discussed at the meeting including the Work schedule and the need to make any revisions to the Work schedule. The progress of the Work will be reviewed at each of these meetings.

D11.2 The Contract Administrator reserves the right to cancel any job meeting or call additional job meetings whenever he deems it necessary.

D12. PRIME CONTRACTOR – THE WORKPLACE SAFETY AND HEALTH ACT (MANITOBA)

D12.1 Further to C6.23, the Contractor shall be the Prime Contractor and shall serve as, and have the duties of the Prime Contractor in accordance with The Workplace Safety and Health Act (Manitoba).

D13. SAFETY

D13.1 The Contractor shall be solely responsible for safety at the Site and for compliance with all laws, rules, regulations and practices required by the applicable safety legislation.

D13.2 The Contractor shall be solely responsible for securing the Site, and any existing facility thereon, and for the proper care and protection of the Work already performed.

D13.3 The Contractor shall do whatever is necessary to ensure that:

(a) no person, property, right, easement or privilege is injured, damaged or infringed by reason of the Contractor's activities in performing the Work;

(b) the health and safety of all persons employed in the performance of the Work or otherwise is not endangered by the method or means of its performance;

(c) adequate medical services are available to all persons employed on the Work and at all times during the performance of the Work;

D14. INSPECTION

D14.1 Before beginning or resuming operations upon any portion of the Work, the Contractor shall notify the Contract Administrator so as to enable him to arrange for inspection. If the Contractor fails to notify the Contract Administrator, the Contractor shall, if and when required by the Contract Administrator, forthwith take down or expose and redo that portion of the Work required to facilitate inspection. The cost of such taking down or exposure, and redoing, if any, shall be borne by the Contractor.

D14.2 If and when required by the Contract Administrator, the Contractor shall take down or expose forthwith any portion of the Work where the Contract Administrator determines that the Work is not in accordance with the Contract. The cost of such taking down or exposure, and redoing, if

any, shall fall upon the City if the taking down or exposure indicates that the portion exposed was properly performed, but if otherwise the cost shall be borne by the Contractor.

MEASUREMENT AND PAYMENT

D15. PAYMENT

D15.1 Further to C11, the City may at its option pay the Contractor by direct deposit to the Contractor's banking institution.

D16. PAYMENT SCHEDULE

D16.1 Further to C11, payment shall be in accordance with the following payment schedule:

(a) A maximum of 90% of Form B, Item 1 may be submitted for progress payments prior to the total completion of the associated services. The remaining 10% will be paid out upon total completion of the McPhillips Water Pumping Station inspection services.

(b) A maximum of 90% of Form B, Item 2 may be submitted for progress payments prior to the total completion of the associated services. The remaining 10% will be paid out upon total completion of the MacLean Water Pumping Station inspection services.

(c) A maximum of 90% of Form B, Item 3 may be submitted for progress payments prior to the total completion of the associated services. The remaining 10% will be paid out upon total completion of the Hurst Water Pumping Station inspection services.

(d) For authorized repair services, a maximum of 90% of any quoted amount may be submitted for progress payment prior to the total completion of the associated services.

D16.2 Further to C11, payment shall be in Canadian funds net thirty (30) Calendar Days after receipt and approval of the Contractor's invoice.

WARRANTY

D17. WARRANTY

D17.1 Warranty is as stated in C12.

PART E - SPECIFICATIONS

GENERAL

E1. GENERAL

E1.1 The following Drawings are applicable to the Work:

Drawing No.	Drawing Name/Title
1-0630M-A0001	MacLean Pumping Station – Process & Instrumentation Diagrams, Legend & Details (Sheets 001-003)
1-0630M-A0018	MacLean Pumping Station – Process & Instrumentation Diagram, Electrical Supply
1-0630M-A0019	MacLean Pumping Station – Process & Instrumentation Diagram, Generators 1 & 2
1-0630M-E0001	MacLean Pumping Station - Electrical Single Line Diagram, Legend & Details
1-0630M-E0002	MacLean Pumping Station - Electrical Single Line Diagram, 4160 V Distribution
1-0630M-E0003	MacLean Pumping Station - Electrical Single Line Diagram, 600 V Generators and Essential Switchgear
1-0630M-E0004	MacLean Pumping Station - Electrical Single Line Diagram, 600 V Non-Essential Switchgear and Distribution
1-0630M-E0005	MacLean Pumping Station – Motor Starter Schematic, PP-21
1-0630M-E0006	MacLean Pumping Station – Motor Starter Schematic, PP-23
1-0630M-E0007	MacLean Pumping Station – Motor Starter Schematic, PP-25
1-0630M-E0008	MacLean Pumping Station – UPS Upgrades, Single Line Diagram & Layout
1-0630M-E0012	MacLean Pumping Station - Electrical Equipment Plan, Electrical Room
1-0630M-E0013	MacLean Pumping Station - Electrical Equipment Elevations, 4160V Switchgear & 600V Switchgear/MCC
1-0630M-E0014	MacLean Pumping Station – Control Schematic, 4160V Main Breaker
1-0630M-E0015	MacLean Pumping Station – Three Line Diagram, 4160V Main Breaker
1-0640M-A0001	McPhillips Pumping Station – Process & Instrumentation Diagrams, Legend & Details (Sheets 001-003)
1-0640M-A0018	McPhillips Pumping Station – Process & Instrumentation Diagram, Electrical Supply
1-0640M-A0019	McPhillips Pumping Station – Process & Instrumentation Diagram, Standby Generators
1-0640M-E0001	McPhillips Pumping Station - Electrical Single Line Diagram, Legend & Details
1-0640M-E0002	McPhillips Pumping Station - Electrical Single Line Diagram, 4160 V Distribution
1-0640M-E0003	McPhillips Pumping Station - Electrical Single Line Diagram, 600 V Generators and Switchgear
1-0640M-E0004	McPhillips Pumping Station - Electrical Single Line Diagram, 600 V Distribution
1-0640M-E0005	McPhillips Pumping Station - Electrical Single Line Diagram, Chlorine Building
1-0640M-E0007	McPhillips Pumping Station – Motor Starter Schematic, PP-2
1-0640M-E0008	McPhillips Pumping Station – Motor Starter Schematic, PP-4
1-0640M-E0009	McPhillips Pumping Station – Motor Starter Schematic, PP-6
1-0640M-E0010	McPhillips Pumping Station – Control Schematic, 600V Main Breaker Control (Sheets 001-002)
1-0640M-E0011	McPhillips Pumping Station – UPS Upgrades, Single Line Diagram & Layout
1-0640M-E0013	McPhillips Pumping Station - Electrical Equipment Plan, Electrical & Control Rooms
1-0640M-E0014	McPhillips Pumping Station - Electrical Equipment Plan, Generator Room
1-0640M-E0015	McPhillips Pumping Station - Electrical Equipment Elevations, 4160V Switchgear & 600V Switchgear/MCC
1-0640M-E0016	McPhillips Pumping Station – Control Schematic, 4160V Main Breaker

1-0640M-E0017	McPhillips Pumping Station – Three Line Diagram, 4160V Main Breaker
1-0650M-A0001	Hurst Pumping Station – Process & Instrumentation Diagrams, Legend & Details (Sheets 001-003)
1-0650M-A0017	Hurst Pumping Station – Process & Instrumentation Diagram, Electrical Supply
1-0650M-A0018	Hurst Pumping Station – Process & Instrumentation Diagram, Generators 1 & 2
1-0650M-E0001	Hurst Pumping Station - Electrical Single Line Diagram, Legend & Details
1-0650M-E0002	Hurst Pumping Station - Electrical Single Line Diagram, 4160 V Distribution
1-0650M-E0003	Hurst Pumping Station - Electrical Single Line Diagram, 600 V Distribution
1-0650M-E0005	Hurst Pumping Station – Motor Starter Schematic, PP-11
1-0650M-E0006	Hurst Pumping Station – Motor Starter Schematic, PP-12
1-0650M-E0007	Hurst Pumping Station – Motor Starter Schematic, PP-14
1-0650M-E0008	Hurst Pumping Station – Motor Starter Schematic, PP-15
1-0650M-E0009	Hurst Pumping Station – Motor Starter Schematic, PP-16
1-0650M-E0010	Hurst Pumping Station – Motor Starter Schematic, PP-17
1-0640M-E0011	Hurst Pumping Station – UPS Upgrades, Single Line Diagram & Layout
1-0650M-E0013	Hurst Pumping Station - Electrical Equipment Elevations, 4160V Switchgear & 600V CDP/MCC
1-0650M-E0014	Hurst Pumping Station - Electrical Equipment Plan, Electrical Room

E1.2 The following inspection forms are applicable to the Work:

Form.	Form Name/Title
F-AM	Inspection Form – Analog Meter
F-BKR-AIR-600V	Inspection Form – Air Circuit Breaker, 600V
F-BKR-AIR-4160V	Inspection Form – Air Circuit Breaker, 4160V
F-BKR-MC-600V	Inspection Form – Molded Case Circuit Breaker, 600V
F-BKR-VAC-4160V	Inspection Form – Vacuum Circuit Breaker, 4160V
F-CAP-600V	Inspection Form – Capacitor, 600V
F-CAP-MV	Inspection Form – Capacitor, Medium Voltage
F-CBL-600V	Inspection Form – Cable, 600V
F-CBL-4160V	Inspection Form – Cable, 4160V
F-CPT-600V	Inspection Form – Control Power Transformer, 600V
F-CPT-4160V	Inspection Form – Control Power Transformer, 4160V
F-CT	Inspection Form – Current Transformer
F-DM	Inspection Form – Digital Meter
F-GROUNDING	Inspection Form – Grounding
F-MCC-CDP-600V	Inspection Form – MCC/CDP, 600V
F-MS-FVNR-600V	Inspection Form – Motor Starter, FVNR, 600V
F-MS-FVNR-4160V	Inspection Form – Motor Starter, FVNR, 4160V
F-MTR-4160V	Inspection Form – Motor, 4160V
F-PNL-LV	Inspection Form – Panelboard, Low Voltage
F-PT-600V	Inspection Form – Potential Transformer, 600V
F-PT-4160V	Inspection Form – Potential Transformer, 4160V
F-RELAY-TOC	Inspection Form – Time-Overcurrent Relay
F-RELAY-UV	Inspection Form – Undervoltage Relay
F-SA-MV	Inspection Form – Surge Arrestor, Medium Voltage
F-SGR-600V	Inspection Form – Switchgear, 600V
F-SGR-4160V	Inspection Form – Switchgear, 4160V
F-SW-AIR-ME-4160V	Inspection Form – Switch, Air, Metal Enclosed, 4160V

F-XFMR-DRY-MV	Inspection Form – Transformer, Dry Type, Medium Voltage
F-XFMR-LIQ-MV	Inspection Form – Transformer, Liquid Filled, Medium Voltage
F-XFMR-LV	Inspection Form – Transformer, Dry Type, Low Voltage

E1.3 The following documents are included for information:

(a) MacLean Pumping Station – Electrical Equipment Data

(b) McPhillips Pumping Station – Electrical Equipment Data

(c) Hurst Pumping Station – Electrical Equipment Data

E2. LOCATION AND ACCESS TO FACILITIES

E2.1 The Work specified hereinafter will take place at the following City of Winnipeg water pumping stations:

(a) McPhillips Pumping Station is located at 360 McPhillips Street, just north of the corner of McPhillips Street and Logan Avenue.

(b) MacLean Pumping Station is located at 875 Lagimodiere Boulevard, the corner of Lagimodiere Blvd and Marion Street.

(c) Hurst Pumping Station is located at 900 Waverly Street, (west of Waverley Street on Hurst Way).

E2.2 The City of Winnipeg water pumping facilities are secure buildings, and access will be provided by City personnel. The Contractor will be responsible for coordinating with the Contract Administrator and City as required, to gain access to the facilities. The Contractor must comply with all City policies set forth in this document, and detailed instructions provided after the Work is awarded.

E3. SERVICE REQUIREMENTS

E3.1 The Contractor shall provide all services in accordance with the requirements hereinafter specified.

E3.2 The Contractor shall supply all material and equipment required to perform the inspection, maintenance, testing, upgrades, and repair work.

E3.3 The Contractor shall be knowledgeable of the procedures to complete the test requirements specified and have a good working knowledge of the equipment that is required to perform the testing.

E3.4 The Contractor shall have:

(a) a Professional Engineer on staff who has experience with electrical inspections, testing and designing repairs to electrical equipment if needed; or at least written confirmation that they have a suitable engineer on retainer who will provide immediate service if required;

(b) as a minimum, two electrical technologists on staff with experience maintaining, testing, and trouble-shooting medium and low voltage electrical systems that are included in the specified work.

E3.5 All travel and living expenses associated with the services of the personnel defined above are to be included in the Bid Price.

E3.6 All parties involved must be cognisant of industry-standard safety procedures. It is recognized that an overwhelming majority of the tests and inspections recommended in these specifications are potentially hazardous. Individuals performing these tests shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. All tests shall be

performed with the apparatus de-energized and grounded except where otherwise specifically required to be ungrounded or energized for certain tests.

E3.7 The facilities related to the Work are critical to the delivery of water to the City of Winnipeg. Under no condition shall the station, pumping, or other systems be shut down without prior permission of the Contract Administrator. Similarly, coordination and approval are required prior to returning the equipment back into service. Detailed shutdown schedules will be prepared by the Contract Administrator, and forwarded to the Contractor. The Contractor shall work within the schedule and any procedures given, and shall advise the Contract Administrator of any issues or concerns, prior to performing the Work.

E3.8 Attendance at twelve (12) site planning meetings (four (4) meetings per water pumping station) of three hours duration each, to develop shutdown planning, coordination, and scheduling will be required. Additional meetings may be required and are eligible for Incremental Services, as defined in E8.

E3.9 All required Manitoba Hydro services will be arranged and scheduled by the Contract Administrator and paid directly by the City and shall not be included in the Bid Price.

E4. TEST EQUIPMENT

E4.1 All test equipment shall meet the requirements in E4.5 and be in good mechanical and electrical condition.

E4.2 Field test metering used to check power system meter calibration must be more accurate than the instrument being tested.

E4.3 Accuracy of metering in test equipment shall be appropriate for the test being performed.

E4.4 Wave shape and frequency of test equipment output waveforms shall be appropriate for the test and the tested equipment.

E4.5 The test equipment shall be calibrated as specified below:

(a) The testing organization shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy for each test instrument calibrated.

(b) The firm providing calibration service shall maintain up-to-date instrument calibration instructions and procedures for each test instrument calibrated.

(c) Instruments shall be calibrated in accordance with the following frequency schedule:

(i) Field instruments: Analog, 6 months maximum. Digital, 12 months maximum.

(ii) Laboratory instruments: 12 months maximum.

(iii) Leased specialty equipment: 12 months maximum.

(d) Dated calibration labels shall be visible on all test equipment.

(e) Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.

(f) Calibrating standard shall be of higher accuracy than that of the instrument tested.

E5. INSPECTION AND TEST REPORTS

E5.1 The Contractor shall prepare an individual inspection and test report for each water pumping station that details all investigations and tests in conformance with E5.7.

E5.2 The reports shall be sealed by a Professional Engineer.

E5.3 The Contractor shall furnish five paper copies and two electronic copies on CD of each final report. The electronic copies of the report shall be provided in PDF format.

E5.4 The report shall be neat and organized. Any omissions, inconsistencies, or incomplete work identified by the Contract Administrator shall be corrected and incorporated into the report in the appropriate section, and completely resubmitted as defined in E5.3.

E5.5 A draft of each report shall be completed and sent to the Contract Administrator for review a maximum of one month after the completion of the inspections at the Site.

E5.6 The final report shall be submitted, as defined in E5.3, a maximum of two weeks after the Contractor receives the mark-up of the draft report from the Contract Administrator.

E5.7 The report shall include the following:

(a) Summary of project.

(b) Testing Equipment.

(i) Detail the type, manufacturer, model, and last calibration date of all testing equipment.

(c) Description of equipment tested.

(d) Description of all tests.

(e) Typed inspection forms including:

(i) Identification of the testing organization.

(ii) Equipment identification.

(iii) Humidity, temperature, and other conditions that may affect the results of the tests/calibrations.

(iv) Date of inspections, tests, maintenance, and/or calibrations.

(v) Identification of the testing technician.

(vi) Indication of inspections, tests, maintenance, and/or calibrations performed and recorded, along with charts, and graphs as applicable. All measurements and readings taken shall be noted for inclusion in the report. Where repairs are made, measurements and readings before and after the repair shall be included.

(vii) Indication of expected results, when calibrations are to be performed.

(viii) Indication of “as-found” and “as-left” results, as applicable.

(f) Itemized list of all repaired deficiencies which shall include:

(i) Detailed description of the deficiency.

(ii) The cost associated with the deficiency repair.

(g) Itemized list of all un-repaired deficiencies encountered which shall include:

(i) Detailed description of the deficiency.

(ii) Priority level.

(iii) A cost estimate to repair the deficiency including the estimated hours to repair, labour cost, and material costs.

(h) Analysis and recommendations.

(i) Mark-ups of single line diagrams and other drawings.

E6. SCHEDULING

E6.1 Work shall occur during the week or weekends (day-time, evenings, and night-time) as determined by the schedule to be set up by the Contract Administrator.

E6.2 The Contractor shall provide information, and assist the Contract Administrator, in preparing schedules for the Work.

E6.3 Due to the critical nature of the water pumping stations, scheduling of shutdowns to perform the testing and inspections will require detailed coordination with the Contractor, the City, and the Contract Administrator. Night-time shutdowns will be required for inspections of supply connections and specified “essential” equipment. Night-time shutdowns normally will be

performed between the hours of 23:00 and 06:00, during off-peak city water consumption. The Contractor shall include the cost of expected overtime in the Bid Price.

E6.4 Portions of the Work will be subject to the availability of Manitoba Hydro to perform supply disconnection, open metering enclosures, disconnect metering PTs, and other services as required. Manitoba Hydro's involvement will be coordinated by the Contract Administrator.

E6.5 It is expected that the Work will not be performed during periods of inclement weather, forecasted inclement weather, or during periods of high City water consumption associated with high temperatures and summer "sprinkler" flows.

E6.6 It is possible that equipment failure within the pumping stations could cause an event where the equipment under inspection is immediately required. The City, upon their sole discretion, may delay or stop the Work at any time, require the Contractor to return all or specified electrical equipment into service as soon as possible, and reschedule the Work. The contractor shall be eligible for incremental services, as specified in E8.

E6.7 Schedule E001-E003, preliminary work coordination schedules for McPhillips, MacLean, and Hurst Water Pumping Stations, are included for reference. This is only to provide the Contractor an example of a schedule breakdown and the actual inspection and testing schedule will be dependant on a number of factors such as:

(a) The facility's operational requirements and redundancy configuration.

(b) The availability of Manitoba Hydro for utility shutdowns.

(c) Number of technicians the Contractor has available to complete the inspections.

(d) The time required for the Contractor to perform the inspections based on the personnel and equipment available.

(e) Approval of the schedule by the City.

E7. REPAIR SERVICES

E7.1 It is expected that the inspection work will identify issues for correction and repair. The Contractor shall include all issues found during the inspections in the inspection report.

E7.2 If the correction/repair is determined to be critical to the immediate operation of the facility then the Contractor shall report the issue immediately to the Contract Administrator.

E7.3 The Contractor shall provide a quotation for repair services for each deficiency found. Individual prices shall be provided for each deficiency, with separate labour prices and individual material costs.

(a) The price for material shall be the Contractor base cost, as defined in B9.4, multiplied by the mark-up factor specified in Form B, Item 6.

(b) A price for day-time labour shall be provided for each deficiency. Each price shall be stated in number of hours multiplied by the labour rate specified in Form B, Item 7.

(c) A price for night-time labour shall be provided for each deficiency that requires a night-time shutdown to repair. Each price shall be stated in number of hours multiplied by the labour rate specified in Form B, Item 8.

E7.4 The Contractor shall provide repair services for each deficiency approved by the Contract Administrator, as quoted in E7.3

E7.5 Repair services shall be comprised of the following:

(a) Provision of shop drawing detailing the work, where modifications are made.

(b) Attendance at a site planning meeting to develop shutdown planning, coordination, and scheduling.

(c) Repair of the deficiency.

(d) Re-inspect the repaired equipment as prescribed in the applicable section of E7.

(e) Provide a supplemental report of the repair services performed, including inspection values and results obtained both prior to, and subsequent to the repair work. Include as-built shop drawings.

E7.6 The City reserves the right to request quotes from other contractors where the quotation to repair defective components is excessive, in the opinion of the Contract Administrator.

E7.7 Cleaning of equipment, tightening of bolted connections, lubrication of mechanical mechanisms and other standard maintenance tasks are to be included as part of the Work and will be addressed immediately by the Contractor during the inspections and included in the Bid Price. These items are not considered to be repair services.

E8. INCREMENTAL SERVICES

E8.1 Additional on-site service time may be necessitated due to unforeseen circumstances that may arise during the course of the project such as:

(a) Unforeseen work stoppages due to inclement weather or equipment failure. The City may, upon their sole discretion, delay or stop the Work at any time, and require the Contractor to return all or specified electrical equipment into service as soon as possible. Charges for incremental services are restricted to the extra services required as a result of the work stoppage. For cases were the Contractor is not yet on site, no incremental services may be charged for scheduling changes where at least 24 hours notice is given prior to the Contractor's scheduled time to be on site.

(b) Repair services as described in E7.

(c) Additions by the Contract Administrator to the scope of Work, beyond that are defined herein.

(d) Additional planning meetings beyond that described in E3.8.

E8.2 Additional services are to be paid on an hourly basis at rates specified on Form B.

(a) Labour rates identified are to include the use of the following equipment:

(i) Insulation resistance testing equipment.

(ii) DC overpotential testing equipment.

(iii) Clamp-on grounding tester.

(iv) Any other testing equipment required, that is not specifically identified in Form B.

E8.3 Additional services will not be initiated for reasons of lack of performance or errors in execution.

INSPECTION, TESTING AND MAINTENANCE REQUIREMENTS

E9. MCPHILLIPS PUMPING STATION REQUIREMENTS

E9.1 Background Information – McPhillips Station Electrical Configuration

(i) The McPhillips Pumping Station is fed by a single 4160 V electrical feeder from the Manitoba Hydro Logan Street Substation. The feeder is routed underground from the substation, down Logan Ave. until Maude Street where it is transferred onto poles for further overhead distribution. A branch feeder is taken off at the intersection of Logan Avenue and McPhillips Street to feed McPhillips Pumping Station, which is the first customer on the feeder. The point of delivery is the line side of the 4160 V switchgear, and the feeder cables (believed to be 500 MCM) are owned by Manitoba Hydro.

(ii) The main breaker associated with the switchgear is a 1200 A electrically operated air circuit breaker with electromechanical relay overcurrent protection. An under-voltage relay associated with the main breaker is located in the switchgear, but based upon

Winnipeg Hydro records, is believed to be disconnected. Metering of real and reactive power is provided by the revenue meter, and passed on to the control system via pulse metering contacts.

(iii) Three 4160 V motor starters provide electric power to each of the 597 kW electric motors that drive the pumps. These motor starters contain fuses for short circuit protection and an IQ1000 motor protection relay for overcurrent and ground fault protection. Motor and pump vibration and temperature protection is provided by a Bentley-Nevada monitoring unit, with interlocking provided through the PLC. Additional motor and pump protection is provided through the PLC control system via various sensors and detection units. In addition, each motor is equipped with power factor correction capacitors, connected at the motor terminals.

(iv) The 4160 V switchgear has two fused disconnects that feed 4160/600 V transformers that supply the low voltage essential and non-essential services of the pumping station through the 600 V switchgear. MCC-A and MCC-E are powered from the 600 V switchgear and the essential services are fed from MCC-E and non-essential services from MCC-A. Three 600 V, 100 kW generators are provided to provide standby power for the essential services of the pumping station and the adjacent McPhillips Control Centre. The critical electrical components, such as the PLCs and pump controls, are connected to a 240 V, 10 kVA Uninterruptible Power Supply (UPS).

(v) Details regarding the electrical configuration may be seen on the Electrical Single Lines and Elevation drawings as referenced in the drawing list in E1.1.

E9.2 Expected Operation During Inspections

Inspection of electrical equipment will require shutdowns and will have operational implications. McPhillips Pumping Station is normally shutdown between 23:00 and 6:00 each day, and this provides a regular window for work. McPhillips Pumping Station has three natural gas engine driven pumps, which can be utilized for operation when the 4160 V switchgear is out of service. However, all pumps, including the natural gas driven pumps are still dependent upon the UPS, standby generators, and essential switchgear. Should any of these pieces of equipment be out of service, the work will require a night-time shutdown.

Certain items will require night-time shutdowns to perform the inspections and testing, as indicated in E9.3.

E9.3 Electrical Inspection and Test Scope

(a) Confirm and update the provided drawings, as specified in E12. Provide red-line mark-ups of drawings. Drafting of drawings is not required.

(b) Perform all inspections in accordance with E12 through E45.

(c) Perform a thermographic survey of the equipment identified in E9.6 as specified in E45.

(d) Perform an inspection and test of the main service ground connection as specified in E44.

(e) Perform an inspection and test of the 4160 V main switchgear as specified in E14, which includes the following switchgear components:

(i) main breaker as specified in E26,

(ii) two (2) fused disconnects as specified in E25, and

(iii) associated protection relays as specified in E28.

(f) Perform an inspection and test of the three 4160 V water pump motors including:

(i) three (3) motors as specified in E30,

(ii) feeder cables as specified in E13,

(iii) three (3) motor starters and associated protection as specified in E29, and

(iv) power factor correction capacitors as specified in E31.

(g) Perform an inspection and test of the two dry-type 4160/600 V transformers as specified in E33 including:

(i) primary cables as specified in E13, and
(ii) secondary cables as specified in E35.

(h) Perform an inspection and test of the 600 V switchgear buswork as specified in E15 including: (NIGHT-TIME SHUTDOWN)
(i) three (3) air circuit breakers as specified in E36, and
(ii) associated control wiring and voltage transfer systems as specified in E28.

(i) Perform an inspection and test of the MCC 'A' buswork as specified in E16 including:
(i) two (2) 600 V motor starters as specified in E38 , and
(ii) ten (10) 600 V breakers as specified in E37.

(j) Perform an inspection and test of the MCC 'E' buswork as specified in E16 including: (NIGHT-TIME SHUTDOWN)
(i) eight (8) 600 V motor starters as specified in E38 , and
(ii) nineteen (19) 600 V breakers as specified in E37.

(k) Perform an inspection and test of the three (3) standby generators as specified in E39 including:
(i) the engine generator set, fuel supply system, and transfer switches as specified in CSA C282,
(ii) cables between generators and switchboard as specified in E35,
(iii) switchboard as specified in E16,
(iv) eight (8) switchboard breakers as specified in E37, and
(v) cable between switchboard and 600 V switchgear as specified in E35.

(l) Perform an inspection and test of the UPS distribution system including: (NIGHT-TIME SHUTDOWN)
(i) two (2) transformers as specified in E42, and
(ii) wiring between the 600 V MCC and the UPS panelboard as specified in E35, and
(iii) UPS panelboard as specified in E43.
(iv) *Note that the UPS was recently installed and inspected and inspection of the actual UPS unit is not required.

(m) Perform an inspection and test of the five (5) 600-208/120 V transformers as specified in E42 including the feeder cables as specified in E35. Perform the following during a NIGHT-TIME SHUTDOWN:
(i) T4 (LP-B) Transformer
(ii) Garage Building Essential Lighting Panel Transformer
(iii) LP-C Transformer

(n) Perform an inspection and test of the seven 208/120 V panelboards as specified in E43 including feeder cables as specified in E35. Perform the following during a NIGHT-TIME SHUTDOWN:
(i) LP-B
(ii) Garage Building Essential Lighting Panel
(iii) LP-C

(o) Perform an inspection and test of the 600 V distribution panel in the Chlorine Building as specified in E16 including: (NIGHT-TIME SHUTDOWN)
(i) two (2) feeder cables as specified in E35,
(ii) one (1) 600 V motor starter as specified in E38, and
(iii) six (6) 600 V breakers as specified in E37.

E9.4 Electrical System Functional Tests

The following system functional tests shall be performed:

(a) Interlock operation within the standby generator's switchboard.

(b) Interlock and standby power operation in the 600 V switchgear. (NIGHT-TIME SHUTDOWN)

(c) Interlock operation for 600 V distribution to the Chlorine Building. (NIGHT-TIME SHUTDOWN)

(d) With the assistance of City personnel, verify operation of the PLC status and alarm points for the 4160 V switchgear and motor starters, and the 600V switchgear. Specific points to be tested are:

PLC	Point	Tag	Description
PLC-11	30019	PMZ-910-JQ	Watt Pulses
PLC-11	30021	PMZ-910-QQ	Q-Pulses
PLC-12	00034	PMZ-919-JM	Transfer Switch Control to Hydro
PLC-12	10049	PME-042-MY	Pump 2 Available (MCC Status)
PLC-12	10050	PME-044-MY	Pump 4 Available (MCC Status)
PLC-12	10051	PME-046-MY	Pump 6 Available (MCC Status)
PLC-12	10053	PMZ-910-EAL	Loss of 4160V Alarm
PLC-12	10054	PMZ-910-XM-1	Main CCT Breaker Open Alarm
PLC-12	10055	PMZ-910-XM-2	Feeder Failure Alarm
PLC-12	10056	PMZ-913-XM	Loss of 600V Alarm
PLC-12	10065	PMZ-917-MM	Engine Generator #1 Run
PLC-12	10066	PMZ-917-UA	Engine Generator #1 Alarm
PLC-12	10067	PMZ-918-MM	Engine Generator #2 Run
PLC-12	10068	PMZ-918-UA	Engine Generator #2 Alarm
PLC-12	10069	PMZ-919-EM	Standby Generator Transfer Switch Closed
PLC-12	10079	PMZ-910-YS	Transfer Switch COH Status
PLC-12	10084	PMZ-919-MM	Engine Generator #3 Run
PLC-12	10085	PMZ-919-UA	Engine Generator #3 Alarm
P-PLC-2	10013	PBE-042-MF-1	PP#2 Funct 86 Lockout
P-PLC-4	10013	PDE-044-MF-1	PP#4 Funct 86 Lockout
P-PLC-6	10013	PFE-046-MF-1	PP#6 Funct 86 Lockout

E9.5 Electromechanical Relay Replacement

Install four new overcurrent relays to replace the three existing overcurrent relays associated with the main 4160V breaker.

(a) Phase A, B, and C overcurrent relays:
  (i) Manufacturer & Model : Basler BE1-50/51B-219
  (ii) Install within the existing cases for the A, B, and N relays.

(b) Phase N overcurrent relay (50/51-N):
  (i) Manufacturer & Model : Basler BE1-50/51B-205
  (ii) Case Size: A1
  (iii) Install in new cut-out in door.

(c) Modify wiring as required.

(d) Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of conductors. Markings to be legible, neat, and not hand-written. Wiring to be labelled includes both ends of all CT and overcurrent trip wiring.

(e) Install identification lamacoid above each new and existing relay and power meter on the door.

(i) Lamacoid size: 12 x 70 mm.

(ii) One line of 5 mm high letters.

(iii) Screwed to door.

(iv) Existing Basler undervoltage relay to be identified as “27-1”

(v) Existing electromechanical undervoltage relay to be identified as “27-2”

(vi) Existing lockout relay to be identified as “LO”

(vii) Existing power meter to be identified as “PM-1”

(f) Configure the relay settings shall be configured to match the existing settings or new settings will be provided prior to installation.

(g) Test the relays to validate the operation of the specified settings.

(h) Verify and mark-up the drawings to reflect the installed configuration.

(i) Supply relay test plug, Basler P/N 10095, for the station.

E9.6 Thermographic Survey

The thermographic survey shall include the following equipment:

(a) two (2) 4160/600 V transformers

(b) 600 V switchgear buswork and breakers

(c) MCC ‘A’ buswork, breakers and motor starters

(d) MCC ‘E’ buswork, breakers and motor starters

(e) five (5) 600-208/120 V transformers

(f) two (2) UPS transformers

(g) 600 V distribution panel in the Chlorine Building

E10. MACLEAN PUMPING STATION REQUIREMENTS

E10.1 Background Information – MacLean Station Electrical Configuration

(i) The MacLean Pumping Station receives power from Manitoba Hydro via a single 4160 V supply. The point of delivery is the secondary side of the transformers in the Manitoba Hydro substation located adjacent to the pumping station, with the secondary cables owned by the City.

(ii) Inside the pumping station, the main 4160 V feeder is equipped with an electrically operated circuit breaker with electromechanical relay overcurrent protection. An under-voltage relay associated with the main breaker is located in the switchgear, but based upon Winnipeg Hydro records, is believed to be disconnected. Metering of real and reactive power is provided by the revenue meter, and passed on to the control system via pulse metering contacts.

(iii) Three 4160 V motor starters provide electric power to each of the 522 kW electric motors that drive the pumps. These motor starters contain fuses for short circuit protection and an IQ1000 motor protection relay for overcurrent and ground fault protection. Motor and pump vibration and temperature protection is provided by a Bentley-Nevada monitoring unit, with interlocking provided through the PLC. Additional motor and pump protection is provided through the PLC control system via various sensors and detection units. In addition, each motor is equipped with power factor correction capacitors, connected at the motor terminals.

(iv) The 4160 V switchgear has two fused disconnects that feed 4160/600 V transformers that supply the low voltage essential and non-essential services of the pumping station respectively. The essential bus is backed up by a pair of 600 V, 100kW natural gas powered standby generators. The critical electrical components, such as the PLCs and pump controls, are connected to a 240 V 10 kVA Uninterruptible Power Supply (UPS).

(v) Details regarding the electrical configuration may be seen on the Electrical Single Lines and Elevation drawings as referenced in the drawing list in E1.1.

E10.2 Expected Operation During Inspections

Inspection of electrical equipment will require shutdowns and will have operational implications. MacLean Pumping Station is normally run 24 hours a day. It is however expected that MacLean pumping station can be shut down during the night, provided that summer "sprinkler" flows are not anticipated, and that McPhillips and Hurst Pumping Stations remain fully operational. MacLean Pumping Station has two natural gas engine driven pumps, which can be utilized for operation when the 4160 V switchgear is out of service. However, all pumps, including the natural gas driven pumps are still dependent upon the UPS, standby generators, and essential switchgear. Should any of these pieces of equipment be out of service, the work will require a night-time shutdown.

Certain items will require night-time shutdowns to perform the inspections and testing, as indicated in E10.3.

E10.3 Electrical Inspection and Test Scope

(a) Confirm and update the provided drawings, as specified in E12. Provide red-line mark-ups of drawings. Drafting of drawings is not required.

(b) Perform all inspections in accordance with E12 through E45.

(c) Perform a thermographic survey of the equipment identified in E10.5 as specified in E45.

(d) Perform an inspection and test of the main service ground connection as specified in E44.

(e) Perform an inspection and test of the 4160 V incoming feeder cables from Manitoba Hydro substation as specified in E13.

(f) Perform an inspection and test of the 4160 V main switchgear as specified in E14 and the following switchgear components:
  (i) main breaker as specified in E26,
  (ii) two (2) fused disconnects as specified in E25, and
  (iii) associated protection relays as specified in E28.

(g) Perform an inspection and test of the three (3) 4160 V water pump motors including:
  (i) three (3) motors as specified in E30,
  (ii) feeder cables as specified in E13,
  (iii) three (3) motor starters and associated protection as specified in E29, and
  (iv) power factor correction capacitors as specified in E31.

(h) Perform an inspection and test of the two (2) dry type 4160/600 V transformers as specified in E33 including:
  (i) primary cables as specified in E13, and
  (ii) secondary cables as specified in E35.

(i) Perform an inspection and test of the 600 V switchgear buswork as specified in E15 including: (NIGHT-TIME SHUTDOWN)
  (i) four (4) air circuit breakers as specified in E36 and,
  (ii) associated control wiring and voltage transfer systems as specified in E28.

(j) Perform an inspection and test of the MCC ‘Essential’ buswork as specified in E16 including: (NIGHT-TIME SHUTDOWN)

(i) feeder cables as specified in E35,
(ii) fourteen (14) MCC 'Essential' 600 V motor starters as specified in E38 , and
(iii) ten (10) MCC 'Essential' 600 V breakers as specified in E37.

(k) Perform an inspection and test of the MCC 'Non-Essential' buswork as specified in E16 including:
(i) CDP-B
(ii) supply feeder cables as specified in E35,
(iii) three (3) MCC 'Non-Essential' 600 V motor starters as specified in E38,
(iv) four (4) electric heater contactors, each with multiple contactor stages, and
(v) twenty-nine (29) MCC 'Non-Essential' 600 V breakers as specified in E37.

(l) Perform an inspection and test of the two (2) standby generators as specified in E39 including:
(i) the engine generator set, fuel supply system, and transfer switches as specified in CSA C282,
(ii) cables between the generators and transfer panel as specified in E35, and
(iii) cable between transfer panel and 600 V switchgear as specified in E35.

(m) Perform an inspection and test of the UPS distribution system including: (NIGHT-TIME SHUTDOWN)
(i) Two (2) transformers as specified in E42,
(ii) wiring between the 600 V MCC and the UPS panelboard as specified in E35, and
(iii) UPS panelboard as specified in E43.

*Note that the UPS was recently installed and inspected and inspection of the actual UPS unit is not required.

(n) Perform an inspection and test of the following 600-208/120 V transformers as specified in E42.
(i) LP-A transformer
(ii) LP-B transformer (NIGHT-TIME SHUTDOWN)

(o) Perform an inspection and test of the following 208/120 V panelboards as specified in E43 including feeder cables as specified in E35.
(i) LP-A
(ii) LP-B (NIGHT-TIME SHUTDOWN)

E10.4 Electrical System Functional Tests

The following system functional tests shall be performed:

(a) Standby generator control and transfer panel operation.

(b) Interlock and standby power operation in the 600 V switchgear. (NIGHT-TIME SHUTDOWN)

(c) With the assistance of City personnel, verify operation of the PLC status and alarm points for the 4160 V switchgear and motor starters, and the 600V switchgear. Specific points to be tested are:

PLC	Point	Tag	Description
PLC-11	30019	LMZ-910-JQ	Watt Pulses
PLC-11	30021	LMZ-910-QQ	Q-Pulses
PLC-12	00034	LMZ-919-JM	Transfer Switch Control to Hydro
PLC-12	10049	LME-041-MY	Pump12 Available
PLC-12	10050	LME-043-MY	Pump23 Available

PLC-12	10051	LME-045-MY	Pump25 Available
PLC-12	10054	LMZ-910-XM-1	Main CCT Breaker Open
PLC-12	10055	LMZ-910-XM-2	4160V Power Failure
PLC-12	10056	LMZ-913-XM	600V Power Failure
PLC-12	10065	LMZ-917-MM	Generator #1 Run Status
PLC-12	10066	LMZ-917-UA	Generator #1 General Alarm
PLC-12	10067	LMZ-918-MM	Generator #2 Run Status
PLC-12	10068	LMZ-918-UA	Generator #2 General Alarm
PLC-12	10069	LMZ-919-EM	Standby Generator Voltage
PLC-12	10079	LMZ-919-YS	Transfer Switch COH Status
PLC-12	10087	LMZ-911-TAH	Transformer #1 Hi Winding Temperature
PLC-12	10088	LMZ-912-TAH	Transformer #2 Hi Winding Temperature
P-PLC-1	10013	LAE-041-MF-1	PP#21 Funct 86 Lockout
P-PLC-3	10013	LCE-043-MF-1	PP#23 Funct 86 Lockout
P-PLC-5	10013	LEE-045-MF-1	PP#23 Funct 86 Lockout

E10.5 Electromechanical Relay Replacement

Install four new overcurrent relays to replace the three existing overcurrent relays associated with the main 4160V breaker.

(a) Phase A, B, and B overcurrent relays:
  (i) Manufacturer & Model : Basler BE1-50/51B-219
  (ii) Install within the existing cases for the A, B, and N relays.

(b) Phase B overcurrent relay (50/51-B):
  (i) Manufacturer & Model : Basler BE1-50/51B-205
  (ii) Case Size: A1
  (iii) Install in current electromechanical undervoltage relay position. Modify door as required.

(c) Modify wiring as required.

(d) Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of conductors. Markings to be legible, neat, and not hand-written. Wiring to be labelled includes both ends of all CT and overcurrent trip wiring.

(e) Install identification lamacoid above each new and existing relay and power meter on the door.
  (i) Lamacoid size: 12 x 70 mm.
  (ii) One line of 5 mm high letters.
  (iii) Screwed to door.
  (iv) Existing Basler undervoltage relay to be identified as “27”
  (v) Existing power meter to be identified as “PM-1”

(f) Configure the relay settings shall be configured to match the existing settings or new settings will be provided prior to installation.

(g) Test the relays to validate the operation of the specified settings.

(h) Verify and mark-up the drawings to reflect the installed configuration.

(i) Supply relay test plug, Basler P/N 10095, for the station.

E10.6 Thermographic Survey

The thermographic survey shall include the following equipment:

(a) two (2) 4160/600 V transformers

(b) 600 V switchgear buswork and breakers

(c) MCC 'Essential' buswork, breakers and motor starters

(d) MCC 'Non-Essential' buswork, breakers and motor starters

(e) two (2) 600-208/120 V transformers

(f) two (2) UPS transformers

E11. HURST PUMPING STATION REQUIREMENTS

E11.1 Background Information – Hurst Station Electrical Configuration

(i) Hurst Pumping Station is powered via two independent 4160 V electrical feeders. A pair of 4 MVA pad-mounted transformers, one for each feeder, are located adjacent to the pumping station, and convert the voltage down to the 4160 V utilized by the pumping station. Manitoba Hydro owns these transformers and the point of delivery is the secondary side of the transformers, with the secondary cables owned by the City.

(ii) Each feeder is equipped with an electrically operated vacuum circuit breaker, complete with electronic phase overcurrent (instantaneous and ground) protection. A capacitive trip device is employed to maintain the breaker trip energy. Each feeder has loads consisting of three electric pump motors and station service loads. The 4160 V main busses of each feeder may be tied together via a manual tie breaker, if one of the feeder supply breakers has been opened.

(iii) Feeder 1 supplies power for Pumps PP-11, PP-12, and PP-14 as well as CDP-A via Transformer 3. Feeder 2 supplies power for Pumps PP-15, PP-16, and PP-17 as well as CDP-B via Transformer 4.

(iv) Each motor starter is equipped with a motor rated fused disconnect and an electrically operated contactor for motor starting. PP-11, PP-15, and PP-17 utilize the original Westinghouse Ampguard contactors, while PP-12, PP-14, and PP-16 utilize Joslyn Clark vacuum contactors. These starters contain fuses for short circuit protection and an IQ1000 protection relay for overcurrent and ground fault protection. Other motor and pump protection is provided through the PLC control system via various sensors and detection units. Each motor is equipped with power factor correction capacitors, connected at the motor terminals.

(v) CDP-A and CDP-B are 600 V buses that feed the low voltage station loads. The essential services are fed from CDP-E, which can be powered from either CDP-A or CDP-B via an automatic transfer switch. In addition, CDP-E is backed up by a pair of standby generators, connected via a second transfer switch. The 600 V 75kW generators are powered by natural gas, and connected in a redundant configuration. The critical electrical components, such as the PLCs and pump controls, are connected to a 240 V 10 kVA Uninterruptible Power Supply (UPS), which is fed from the essential supply bus.

(vi) Certain items will require night-time shutdowns to perform the inspections and testing, as indicated in E11.3.

(vii) Details regarding the electrical configuration may be seen on the Electrical Single Lines and Elevation drawings as referenced in the drawing list in E1.1.

E11.2 Expected Operation During Inspections

Inspection of electrical equipment will require shutdowns and will have operational implications. Hurst Pumping Station is normally run 24 hours a day. It is however expected that Hurst pumping station can be shut down during the night, provided that summer "sprinkler" flows are not anticipated, and that McPhillips Pumping and MacLean Pumping Stations remain fully operational. Hurst Pumping Station has two parallel electrical distribution systems for the 4160 V distribution, and this can be utilized to perform a large portion of the work, where only a portion of the station will be out of service. However, all pumps are still dependent upon the

UPS and essential switchgear for operation. Should any of these pieces of equipment be out of service, the work will require a night-time shutdown.

E11.3 Electrical Inspection and Test Scope

(a) Confirm and update the provided drawings, as specified in E12. Provide red-line mark-ups of drawings. Drafting of drawings is not required.

(b) Perform all inspections in accordance with E12 through E45.

(c) Perform a thermographic survey of the equipment identified in E11.5 as specified in E45.

(d) Perform an inspection and test of the main service ground connection as specified in E44.

(e) Perform an inspection and test of the two (2) 4160 V incoming feeder cables from Manitoba Hydro substation (owned by the City) as specified in E13.

(f) Perform an inspection and test of the 4160 V main switchgear as specified in E14 and the following switchgear components:
  (i) two (2) main vacuum breakers as specified in E27,
  (ii) tie breaker as specified in E27 (NIGHT-TIME SHUTDOWN),
  (iii) two (2) fused disconnects as specified in E25, and
  (iv) associated protection relays as specified in E28.

(g) Perform an inspection and test of the six (6) 4160 V water pumps including:
  (i) six (6) motors as specified in E30,
  (ii) feeder cables as specified in E13,
  (iii) six (6) motor starters and associated protection as specified in E29, and
  (iv) power factor correction capacitors as specified in E31.

(h) Perform an inspection and test of the two (2) liquid filled 4160/600 V transformers as specified in E34 including:
  (i) primary cables as specified in E13, and
  (ii) secondary cables as specified in E35.

(i) Perform an inspection and test of the CDP ‘A’ 600 V switchgear buswork as specified in E16 and the following components:
  (i) seven (7) breakers and one (1) tie breaker as specified in E37

(j) Perform an inspection and test of the CDP ‘B’ 600 V switchgear buswork as specified in E16 and the following components:
  (i) six (6) breakers as specified in E37

(k) Perform an inspection and test of the MCC-1 buswork as specified in E16 including:
  (i) feeder cables as specified in E35
  (ii) five (5) MCC ‘Essential’ 600 V motor starters as specified in E38.

(l) Perform an inspection and test of the MCC-2 buswork as specified in E16 including:
  (i) feeder cables as specified in E35, and
  (ii) three (3) MCC ‘Essential’ 600 V motor starters as specified in E38.

(m) Perform an inspection and test of the two (2) standby generators as specified in E39 including:
  (i) the engine generator set, fuel supply system, and the two (2) transfer switches as specified in CSA C282, and
  (ii) cables between the generators and transfer switches as specified in E35.

(n) Perform an inspection and test of the essential power system distribution during a NIGHT-TIME SHUTDOWN, including the following equipment:
  (i) CDP-E as specified in E16 including feeder cables as specified in E35 and six (6) breakers as specified in E37,
  (ii) XFMR-E as specified in E42, including feeder cable as specified in E35

(iii) Panel E as specified in E43, including feeder cable as specified in E35, and

(iv) Panel EE as specified in E16, including feeder cable as specified in E35.

(o) Perform an inspection and test of the UPS distribution system including: (NIGHT-TIME SHUTDOWN)

(i) two (2) transformer as specified in E42,

(ii) wiring between the 600 V MCC and the UPS panelboard as specified in E35, and

(iii) UPS panelboard as specified in E43.

*Note that the UPS was recently installed and inspected and inspection of the actual UPS unit is not required.

(p) Perform an inspection and test of the following 600-208/120 V transformers as specified in E42, including feeder cables as specified in E35:

(i) XFMR-A

(ii) XFMR-B

(q) Perform an inspection and test of the following panelboards as specified in E43, including feeder cables as specified in E35:

(i) Panel A (120/208V)

(ii) Panel B (120/208V)

(iii) Panel AA (347/600V)

(iv) Panel BB (347/600V)

(v) Panel CC (347/600V)

E11.4 Electrical System Functional Tests

The following system functional tests shall be performed:

(a) Interlock operation in the 4160 V switchgear.

(b) Interlock operation within the standby generator's switchboard.

(c) Standby power transfer switch operation. (NIGHT-TIME SHUTDOWN)

(d) Interlock operation in the 600 V switchgear (CDP 'E' and CDP 'A').

(e) With the assistance of City personnel, verify operation of the PLC status and alarm points for the 4160 V switchgear and motor starters, and the 600V switchgear. Specific points to be tested are:

PLC	Point	Tag	Description
PLC-11	30019	HMZ-910-JQ	Feeder 1 Watt Pulses
PLC-11	30021	HMZ-910-QQ	Feeder 1 Q-Pulses
PLC-11	30023	HMZ-911-JQ	Feeder 2 Watt Pulses
PLC-11	30025	HMZ-911-QQ	Feeder 2 Q-Pulses
PLC-12	00022	HMZ-919-JM	Transfer Switch Control Hydro
PLC-12	10033	HME-041-MY	Pump11 Available (MCC Status)
PLC-12	10034	HME-045-MY	Pump15 Available (MCC Status)
PLC-12	10035	HME-047-MY	Pump17 Available (MCC Status)
PLC-12	10039	HMZ-911-XM-1	Breaker Status Feeder2
PLC-12	10041	HMZ-911-XM-2	Feeder2 Failure
PLC-12	10042	HMZ-912-XM	Tie Switch Status
PLC-12	10049	HME-042-MY	Pump12 Available (MCC Status)
PLC-12	10050	HME-044-MY	Pump14 Available (MCC Status)

PLC-12	10051	HME-046-MY	Pump16 Available (MCC Status)
PLC-12	10053	HMZ-910-EAL	4160V Power Failure
PLC-12	10054	HMZ-910-XM-1	Breaker Status Feeder1
PLC-12	10055	HMZ-910-XM-2	Feeder1 Failure
PLC-12	10056	HMZ-913-XM	600V Power Failure
PLC-12	10065	HMZ-917-MM	Generator #1 Run Status
PLC-12	10066	HMZ-917-UA	Generator #1 General Alarm
PLC-12	10067	HMZ-918-MM	Generator #2 Run Status
PLC-12	10068	HMZ-918-UA	Generator #2 General Alarm
PLC-12	10069	HMZ-919-EM	Standby Generator Xfer Switch Status
PLC-12	10079	HMZ-919-YS	Transfer Switch C/H Status
P-PLC-11	10013	HAE-041-MF-1	PP#11 Function 86 Lockout
P-PLC-12	10013	HBE-042-MF-1	PP#12 Function 86 Lockout
P-PLC-14	10013	HDE-044-MF-1	PP#14 Function 86 Lockout
P-PLC-15	10013	HEE-045-MF-1	PP#15 Function 86 Lockout
P-PLC-16	10013	HFE-046-MF-1	PP#16 Function 86 Lockout
P-PLC-17	10013	HGE-047-MF-1	PP#17 Function 86 Lockout

(f)

E11.5 Thermographic Survey

The thermographic survey shall include the following equipment:

(a) two (2) 4160/600 V transformers

(b) CDP-A buswork and breakers

(c) CDP-B buswork and breakers

(d) CDP-E buswork and breakers

(e) MCC-1 buswork, breakers and motor starters

(f) MCC-2 buswork, breakers and motor starters

(g) four (4) 600-208/120 V transformers

(h) two (2) UPS transformers

INPECTION, TESTING AND MAINTENANCE PROCEDURES

E12. GENERAL

(a) All tests are based on NETA standard MTE-2005. Where manufacturer's specifications, tolerances, and/or published data are not available, refer to tables 100.1 to 100.22 in MTE-2005.

(b) Torque all accessible bolted electrical connections. Additional requirements apply as specified.

(c) The existing drawings shall be confirmed for accuracy, and updated where changes are required. The marked up drawings shall be included in the report.

(d) All inspection values, readings, corrections, and assessments shall be clearly recorded for inclusion within the report as specified in E5.6.

(e) Where corrections or repairs are made, record both as found/as left test readings on the inspection sheet. If space is not provided on the inspection form, record the readings in the Note fields or on a separate sheet.

(f) Inspection Forms

(i) The inspection forms to be completed by the Contractor are provided for reference in PDF format.

(ii) Microsoft Word form templates will be provided prior to the work being initiated.

(iii) Make appropriate print-outs of the inspection forms and utilize for entry of data and test results on site.

(iv) Utilizing the Microsoft Word form templates, enter the data recorded manually into the forms electronically.

(v) Complete the inspection forms in the entirety and include them in the report.

(vi) Submit electronic PDF copies of the inspection forms.

(vii) The scope of work required in the specifications is in no way limited by the inspection forms, or spaces provided. Provide additional pages, documents, and forms as required to provide a complete report.

(viii) The inspection forms may be updated during the Work by the City or Contract Administrator. Utilize the latest forms provided.

E13. CABLES, 4160 V

Inspection and testing shall be comprised of the following:

(a) Inspect exposed sections of cables for physical damage and evidence of overheating and corona.

(b) Inspect terminations and splices for physical damage and evidence of overheating and corona.

(c) Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(d) Inspect compression applied connectors for correct cable match and indentation.

(e) Inspect shield grounding and cable support.

(f) Verify that visible cable bends meet or exceed the minimum allowable bending radius.

(g) Measure and record the length of cable.

(h) If cables are terminated through window-type current transformers, inspect to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.

(i) Perform a shield-continuity test on each power cable by ohmmeter method. The shielding must exhibit continuity. Investigate resistance values in excess of 10 ohms per 1000 feet of cable.

(j) Perform an insulation-resistance test on each conductor utilizing a megaohm-meter with a voltage output of at least 2500 V. Individually test each conductor with all other conductors and shields grounded. The test duration shall be one minute. Investigate resistances less than 1000 megaohms.

(k) Perform a Very Low Frequency (VLF) ac high-potential test on all cables. Adhere to all precautions and limits as specified in the applicable NEMA / ICEA Standard for the specific cable. Perform tests in accordance with IEEE Standard 400.2. Test procedure shall be as follows, and the results for each cable test shall be recorded as specified herein. The test voltage shall be sinusoidal with a frequency of 0.1 Hz, and shall not exceed cable manufacturer's maintenance test value or 7 kV RMS (10 kV peak) phase-to-ground. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the over-potential test, the test specimen is considered to have passed the test.

(i) Ensure that the input voltage to the test set is regulated.

(ii) Current-sensing circuits in test equipment shall measure only the leakage current associated with the cable under test and shall not include internal leakage of the test equipment.

(iii) Record wet and dry-bulb temperatures or relative humidity and temperature.

(iv) Test each section of cable individually.

(v) Individually test each conductor with all other conductors grounded. Ground all shields.

(vi) Terminations shall be adequately corona-suppressed by guard ring, field reduction sphere, or other suitable methods as necessary.

(vii) Ensure that the maximum test voltage does not exceed the limits for terminators specified in IEEE Standard 48 or manufacturer's specifications.

(viii) Raise the conductor test voltage to the specified maximum test voltage and hold for five minutes. Record leakage current.

(ix) Apply grounds for a time period adequate to drain all insulation-stored charge.

(l) Perform a Dissipation Factor (Tangent Delta) test on all cables.

(i) Perform tests in accordance with IEEE Standard 400.2.

(ii) The test voltage applied shall be a 0.1 Hz sinusoidal waveform.

(iii) The dissipation factor shall be calculated for an applied voltage of 2400 V (u_o) RMS.

(iv) Provided that the dissipation factor does not rise significantly while raising the voltage, the dissipation factor shall also be calculated for an applied voltage of 4800 V ($2u_o$) RMS.

(m) In the event of a cable failure discovered during testing, assist as required in the repair or replacement of the cable. All services for cable repair or replacement are to be considered as Repair Services.

(n) Affix an inspection sticker or inspection tag in an appropriate place so that it will be conspicuous to all authorized personnel. This inspection notice must include, but is not limited to, identifier of cable, testing company name, date of inspection and the inspector's name. The sticker shall not obscure any equipment nameplates, readouts, or indicators.

E14. SWITCHGEAR ASSEMBLIES, 4160 V

Inspection and testing shall be comprised of the following:

(a) Inspect the switchgear physical, electrical, and mechanical condition including evidence of moisture or corona.

(b) Verify appropriate anchorage, required area clearances, physical damage, and correct alignment.

(c) Inspect all doors, panels, and sections for dents, holes, fit, and missing hardware.

(d) Verify that fuse and / or circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker's address for microprocessor-communication packages.

(e) Verify that current and potential transformer ratios correspond to drawings.

(f) Torque all accessible bolted electrical connections.

(g) Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(h) Confirm correct operation and sequencing of electrical and mechanical interlock systems.

(i) Attempt closure on locked-open devices. Attempt to open locked-closed devices.

(ii) Make key exchange with all devices included in the interlock scheme as applicable.

(i) Clean switchgear.

(j) Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

(k) Inspect insulators for evidence of physical damage or contaminated surfaces.

(l) Verify correct barrier and shutter installation and operation.

(m) Exercise all active components.

(n) Inspect all mechanical indicating devices for correct operation.

(o) Verify that filters are in place and / or vents are clear.

(p) Test operation, alignment, and penetration of instrument transformer withdrawal disconnect, current-carrying and grounding contacts.

(q) Perform point to point ground-resistance tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and / or derived neutral points. Investigate point-to-point resistance values which exceed 0.5 ohm.

(r) Perform insulation-resistance tests at 2500 Vdc for one minute on each bus section, phase-to-phase and phase-to-ground. Note any resistance values less than 1,000 megaohms.

(s) Perform a phase-to-ground overpotential test on each bus section, in accordance with manufacture's published data. Each phase not under test shall be grounded. The test voltages applied for 5 kV rated equipment shall be 11.2 kVac or 16 kVdc. The test voltage shall be applied for one minute. Do not perform this test unless insulation resistance tests performed in (r) are higher than the specified minimum value.

  (i) All bus sections from the termination of the primary cables to every feeder fused disconnect or feeder breaker shall be tested.

  (ii) Ensure that primary cables are disconnected.

  (iii) Ensure that feeder fused disconnects and feeder breakers are open.

(t) Inspect all capacitors as specified in E31.

(u) Inspect all surge arrestors as specified in E17.

(v) Inspect control power transformers as specified in E18.

(w) Inspect all current instrument transformers as specified in E20 with the exception of Manitoba Hydro owned revenue metering transformers.

(x) Inspect potential transformers as specified in E21 with the exception of Manitoba Hydro owned revenue metering transformers.

(y) Inspect all metering devices as specified in E23.

(z) Inspect and test protective relays as specified in E28.

(aa) Perform a system function test to prove the correct interaction of all sensing, processing, and action devices. Perform system function tests upon completion of the maintenance tests defined, as system conditions allow.

  (i) Develop test parameters and perform tests for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements and manufacturer's published data.

  (ii) Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.

  (iii) Verify the correct operation of all sensing devices, alarms, and indicating devices.

(bb) Affix an inspection sticker or inspection tag to each switchgear cell in an appropriate place so that it will be conspicuous to all authorized personnel. This inspection notice must include, but is not limited to, equipment identifier, testing company name, date of inspection and the inspector's name. The sticker shall not obscure any equipment nameplates, readouts, or indicators.

E15. SWITCHGEAR ASSEMBLIES, 600 V

Inspection and testing shall be comprised of the following:

(a) Inspect the switchgear physical, electrical, and mechanical condition including evidence of moisture or corona.

(b) Verify appropriate anchorage, required area clearances, physical damage, and correct alignment.

(c) Inspect all doors, panels, and sections for dents, holes, fit, and missing hardware.

(d) Verify that fuse and / or circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker's address for microprocessor-communication packages.

(e) Verify that current and potential transformer ratios correspond to drawings.

(f) Torque all accessible bolted electrical connections.

(g) Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(h) Confirm correct operation and sequencing of electrical and mechanical interlock systems.

  (i) Attempt closure on locked-open devices. Attempt to open locked-closed devices.

  (ii) Make key exchange with all devices included in the interlock scheme as applicable.

(i) Clean switchgear.

(j) Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

(k) Inspect insulators for evidence of physical damage or contaminated surfaces.

(l) Verify correct barrier and shutter installation and operation.

(m) Exercise all active components.

(n) Inspect all mechanical indicating devices for correct operation.

(o) Verify that filters are in place and / or vents are clear.

(p) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects, current-carrying and grounding contacts.

(q) Perform point to point ground-resistance tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and / or derived neutral points. Investigate point-to-point resistance values which exceed 0.5 ohm.

(r) Perform insulation-resistance tests at 1000 Vdc for one minute on each bus section, phase-to-phase and phase-to-ground. Note any resistance values less than 1,000 megaohms.

(s) Inspect all capacitors as specified in E32.

(t) Inspect control power transformers as specified in E19.

(u) Inspect all current instrument transformers as specified in E20.

(v) Inspect potential transformers as specified in E22.

(w) Inspect all metering devices as specified in E23 and E24.

(x) Inspect and test protective relays as specified in E28.

(y) Perform a system function test to prove the correct interaction of all sensing, processing, and action devices. Perform system function tests upon completion of the maintenance tests defined, as system conditions allow.

  (i) Develop test parameters and perform tests for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements and manufacturer's published data.

(ii) Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.

(iii) Verify the correct operation of all sensing devices, alarms, and indicating devices.

(z) Affix an inspection sticker or inspection tag to each switchgear cell in an appropriate place so that it will be conspicuous to all authorized personnel. This inspection notice must include, but is not limited to, equipment identifier, testing company name, date of inspection and the inspector's name. The sticker shall not obscure any equipment nameplates, readouts, or indicators.

E16. MOTOR CONTROL CENTRE AND DISTRIBUTION SWITCHBOARDS, 600 V

Inspection and testing shall be comprised of the following:

(a) Inspect the CDP/MCC physical, electrical, and mechanical condition including evidence of moisture or corona.

(b) Verify appropriate anchorage, required area clearances, physical damage, and correct alignment.

(c) Inspect all doors, panels, and sections for dents, holes, fit, and missing hardware.

(d) Verify that fuse and / or circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker's address for microprocessor-communication packages.

(e) Verify that current and potential transformer ratios correspond to drawings.

(f) Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(g) Confirm correct operation and sequencing of electrical and mechanical interlock systems.

(i) Attempt closure on locked-open devices. Attempt to open locked-closed devices.

(ii) Make key exchange with all devices included in the interlock scheme as applicable.

(h) Clean CDP/MCC.

(i) Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

(j) Inspect insulators for evidence of physical damage or contaminated surfaces.

(k) Verify correct barrier and shutter installation and operation.

(l) Exercise all active components.

(m) Inspect all mechanical indicating devices for correct operation.

(n) Verify that filters are in place and / or vents are clear.

(o) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects, current-carrying and grounding contacts.

(p) Perform point to point ground-resistance tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and / or derived neutral points. Investigate point-to-point resistance values which exceed 0.5 ohm.

(q) Perform insulation-resistance tests at 1000 Vdc for one minute on each bus section, phase-to-phase and phase-to-ground.

(r) Affix an inspection sticker or inspection tag to each piece of equipment in an appropriate place so that it will be conspicuous to all authorized personnel. This inspection notice must include, but is not limited to, equipment identifier, testing company name, date of inspection and the inspector's name. The sticker shall not obscure any equipment nameplates, readouts, or indicators.

E17. SURGE ARRESTORS, 3 KV

Inspection and testing shall be comprised of the following:

(a) Inspect physical and mechanical condition.

(b) Inspect anchorage, alignment, grounding, and required clearances.

(c) Clean the unit.

(d) Verify that capacitors are electrically connected in their specified configuration.

(e) Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(f) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.

(g) Verify that stroke counter, if present, is correctly mounted and electrically connected.

(h) Perform insulation-resistance tests at 2500 Vdc for one minute from each phase terminal to the case.

(i) Test the grounding connection. Resistance between the arrester ground terminal and the ground system should be less than 0.5 ohm.

E18. CONTROL POWER TRANSFORMERS, > 1000 V

Inspection and testing shall be comprised of the following:

(a) Record the equipment nameplate data for inclusion in the report.

(b) Inspect physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

(c) Verify that primary and secondary fuse ratings or circuit breakers match available drawings. Where drawings are not available, note fuses that appear to be sized incorrectly, based upon application of the Canadian Electrical Code. Mark fuse sizes and type on the drawings, where not shown.

(d) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

(e) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be a minimum of 2500 Vdc for 4160 V windings and 500 Vdc for 120/240 V windings unless otherwise specified by manufacturer.

(f) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage. Confirm correct potential at all devices.

E19. CONTROL POWER TRANSFORMERS, < 1000 V

Inspection and testing shall be comprised of the following:

(a) Record the equipment nameplate data for inclusion in the report.

(b) Inspect physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

(c) Verify that primary and secondary fuse ratings or circuit breakers match available drawings. Where drawings are not available, note fuses that appear to be sized incorrectly, based upon application of the Canadian Electrical Code. Mark fuse sizes and type on the drawings, where not shown.

(d) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be:

  (i) windings < 250 V: 500 Vdc

  (ii) windings > 250 V: 1000 Vdc

E20. CURRENT INSTRUMENT TRANSFORMERS

Inspection and testing shall be comprised of the following:

(a) Inspect physical and mechanical condition.

(b) Record the equipment nameplate data for inclusion in the report.

(c) Ensure that CT shorting bars are removed or installed as required.

(d) Verify that current circuits are grounded and have only one grounding point in accordance with ANSI/IEEE C57.13.3.

(e) Perform an insulation resistance test of the current transformer primary and secondary windings, and wiring to ground at 1000 Vdc. Do not perform this test on solid-state devices. Investigate any resistance values less than 25 megaohms.

(f) Perform a polarity test of each current transformer in accordance with ANSI/IEEE C57.13.1.

(g) Perform a ratio-verification test using the voltage or current method in accordance with ANSI/IEEE C57.13.1. Note any ratio accuracies not within 0.5% of nameplate or manufacturer's published data.

(h) Perform an excitation test on transformers used for relaying applications in accordance with ANSI C57.13.1.

E21. POTENTIAL TRANSFORMERS, > 1000 V

Inspection and testing shall be comprised of the following:

(a) Record the equipment nameplate data for inclusion in the report.

(b) Inspect physical and mechanical condition.

(c) Verify that all required grounding and shorting connections provide contact.

(d) Verify correct operation of transformer withdrawal mechanism and grounding operation.

(e) Verify correct primary and secondary fuse sizes for potential transformers.

(f) Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(g) Perform an insulation resistance test for winding to winding and winding to ground. Test voltages shall be applied for one minute. Do not perform this test with solid-state devices connected. Investigate any resistance values less than 5000 megaohms for 5 kV rated windings. Test voltages shall be:

  (i) 4160 V windings: 2500 Vdc

  (ii) 120 V windings: 500 Vdc

(h) Perform a polarity test on each transformer to verify the polarity marks or H1-X1 relationship as applicable.

(i) Perform a turns ratio verification test. Note any ratio accuracies not within 0.5% of the nameplate or manufacturer's published data.

E22. POTENTIAL TRANSFORMERS, < 1000 V

Inspection and testing shall be comprised of the following:

(a) Record the equipment nameplate data for inclusion in the report.

(b) Inspect physical and mechanical condition.

(c) Verify that all required grounding and shorting connections provide contact.

(d) Verify correct operation of transformer withdrawal mechanism and grounding operation.

(e) Verify correct primary and secondary fuse sizes for potential transformers.

(f) Torque all bolted connections.

(g) Perform an insulation resistance test for winding to winding and winding to ground. Test voltages shall be applied for one minute. Do not perform this test with solid-state devices connected. Investigate any resistance values less than 100 megaohms for 600 V rated windings. Test voltages shall be:

(i) 600 V windings: 1000 Vdc

(ii) 120 V windings: 500 Vdc

(h) Perform a polarity test on each transformer to verify the polarity marks or H1-X1 relationship as applicable.

(i) Perform a turns ratio verification test. Note any ratio accuracies not within 0.5% of the nameplate or manufacturer's published data.

E23. METERING DEVICES, ANALOG

Inspection and testing shall be comprised of the following:

(a) Inspect physical and mechanical condition.

(b) Torque all bolted connections.

(c) Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case-shorting contacts, as applicable.

(d) Clean the unit.

(e) Verify freedom of movement, end play, and alignment of rotating disk(s).

(f) Verify accuracy of meters at a minimum of three points, one of them being 0.

(g) Calibrate meters in accordance with manufacturer's published data.

E24. METERING DEVICES, DIGITAL

Inspection and testing shall be comprised of the following:

(a) Inspect physical and mechanical condition.

(b) Torque all bolted connections.

(c) Record the equipment nameplate data for inclusion in the report.

(d) Verify accuracy of voltage and current at a minimum of two points each.

(e) If required, calibrate meters in accordance with manufacturer's published data.

E25. FUSED DISCONNECT, 4160 V

Inspection and testing shall be comprised of the following:

(a) Note the equipment nameplate data for inclusion in the report.

(b) Inspect physical and mechanical condition.

(c) Inspect anchorage, alignment, grounding, and required clearances.

(d) Clean the unit.

(e) Verify correct blade alignments, blade penetration, travel stops and mechanical operation.

(f) Verify that fuse sizes and types are in accordance with available drawings and short circuit and coordination studies. Note fuse size and type for inclusion in the report.

(g) Verify that expulsion-limiting devices are in place on all fuses having expulsion-type elements.

(h) Verify that each fuse holder has adequate mechanical support and contact integrity.

(i) Verify that phase-barrier mounting is intact.

(j) Verify correct operation of all indicating and control devices.

(k) Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

(l) Measure contact resistance across each switchblade assembly and fuse-holder.

(m) Measure the resistance of all fuses. Investigate fuse resistance values that deviate from each other by more than 15 percent.

(n) Perform insulation resistance tests on the load side of each pole, phase-to-phase and phase-to-ground with switch closed and across each open pole for one minute. The test voltage shall be in accordance with manufacturer's published data or 2500 Vdc. Investigate resistance values less than 1000 megaohms. Load cables are to be disconnected for the test.

E26. AIR CIRCUIT BREAKER, 4160 V

Inspection and testing shall be comprised of the following:

(a) Note the equipment nameplate data for inclusion in the report.

(b) Inspect physical and mechanical condition.

(c) Inspect anchorage, alignment, and grounding.

(d) Inspect arc chutes.

(e) Verify that all maintenance devices are available for servicing and operating the breaker.

(f) Inspect moving and stationary contacts for condition, wear, and alignment.

(g) Clean the unit.

(h) If recommended by manufacturer, slow close/open breaker and check for binding, friction, contact alignment, contact sequence, and penetration.

(i) Perform all mechanical operation tests on the operating mechanism in accordance with manufacturer's published data.

(j) Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(k) Check cell fit and element alignment.

(l) Check racking mechanism.

(m) Inspect puffer operation.

(n) Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

(o) Perform time-travel analysis.

(p) Record as-found and as-left operation-counter readings.

(q) Measure insulation resistance pole-to-pole, pole-to-ground and across open poles. Use a minimum test voltage of 2500 Vdc. Investigate insulation resistances below 1000 megaohms.

(r) Perform insulation-resistance tests on all control wiring with respect to ground. The applied potential shall be 500 Vdc for 300 V rated cable and 1000 Vdc for 600 V rated cable. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow manufacturer's recommendation. Investigate resistances less than 25 megaohms for 300 V cable and 100 megaohms for 600 V cable.

(s) Test capacitor trip device, if present.

(t) Perform a contact/pole-resistance test. Micro-ohm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate values that deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.

(u) With breaker in the test position, make the following tests:

(i) Trip and close breaker with the control switch.

(ii) Trip breaker by operating each of its protective relays.

(iii) Verify mechanism charge, trip-free, and anti-pump functions.

(iv) Verify PLC status changes when breaker is tripped.

(v) Perform an overpotential test on each phase with the circuit breaker closed and the poles not under test grounded. Test voltage should be in accordance with manufacturer's published data. In the absence of manufacturer's published data, the maximum voltage shall not be greater than 11.4 kVac or 16.1 kVdc.

(w) Verify blow-out coil circuit continuity.

E27. VACUUM CIRCUIT BREAKER, 4160 V

Inspection and testing shall be comprised of the following:

(a) Note the equipment nameplate data for inclusion in the report.

(b) Inspect physical and mechanical condition.

(c) Inspect anchorage, alignment, and grounding.

(d) Inspect arc chutes.

(e) Verify that all maintenance devices are available for servicing and operating the breaker.

(f) Inspect moving and stationary contacts for condition, wear, and alignment.

(g) Clean the unit.

(h) Inspect vacuum bottle assemblies.

(i) Measure critical distances such as contact gap as recommended by the manufacturer.

(j) If recommended by manufacturer, slow close/open breaker and check for binding, friction, contact alignment, contact sequence, and penetration.

(k) Perform all mechanical operation tests on the operating mechanism in accordance with manufacturer's published data.

(l) Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(m) Check cell fit and element alignment.

(n) Check racking mechanism.

(o) Inspect vacuum bellows operation.

(p) Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

(q) Perform time-travel analysis.

(r) Record as-found and as-left operation-counter readings.

(s) Measure insulation resistance pole-to-pole, pole-to-ground and across open poles. Use a minimum test voltage of 2500 Vdc. Investigate insulation resistances below 1000 megaohms.

(t) Perform insulation-resistance tests on all control wiring with respect to ground. The applied potential shall be 500 Vdc for 300 V rated cable and 1000 Vdc for 600 V rated cable. For units with solid-state components or control devices that cannot tolerate the applied

voltage, follow manufacturer's recommendation. Investigate resistances less than 25 megaohms for 300 V cable and 100 megaohms for 600 V cable.

(u) Test capacitor trip device, if present.

(v) Perform a contact/pole-resistance test. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate values that deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.

(w) With breaker in the test position, make the following tests:

(i) Trip and close breaker with the control switch.

(ii) Trip breaker by operating each of its protective relays.

(iii) Verify mechanism charge, trip-free, and antipump functions.

(iv) Verify PLC status changes when breaker is tripped.

(x) Perform an overpotential test on each phase with the circuit breaker closed and the poles not under test grounded. Test voltage should be in accordance with manufacturer's published data. In the absence of manufacturer's published data, the maximum voltage shall not be greater than 11.4 kVac or 16.1 kVdc.

(y) Perform a vacuum bottle integrity (overpotential) test across each vacuum bottle with the breaker in the open position in strict accordance with manufacturer's published data. Do not exceed maximum voltage stipulated for this test. Provide adequate barriers and protection against x-radiation during this test. Do not perform this test unless the contact displacement of each interrupter is within manufacturer's tolerance. (Be aware that some dc high-potential test sets are half-wave rectified and may produce peak voltages in excess of the breaker manufacturer's recommended maximum.) If no evidence of distress or insulation failure is observed by the end of the total time of voltage, the test specimen is considered to have passed the test.

E28. PROTECTIVE RELAYS

Inspection and testing shall be comprised of the following:

(a) Inspect relays and cases for physical damage.

(b) Clean the unit.

(c) Perform the following to the relay case:

(i) Tighten case connections.

(ii) Inspect cover for correct gasket seal.

(iii) Clean cover glass. Inspect shorting hardware, connection paddles, and/or knife switches.

(iv) Remove any foreign material from the case.

(v) Verify target reset.

(d) Perform the following inspection of the relay mechanism:

(i) Inspect relay for foreign material, particularly in disk slots of the damping and electromagnets.

(ii) Verify disk clearance. Verify contact clearance and spring bias.

(iii) Inspect spiral spring convolutions. Inspect disk and contacts for freedom of movement and correct travel. Verify tightness of mounting hardware and connections. Burnish contacts. Inspect bearings and/or pivots.

(e) Verify that all settings are in accordance with coordination study or setting sheet supplied. Note the value and compliance of each setting for inclusion in the report. Where no setting is provided, note the current protective relay setting value, and identify this setting in the report.

(f) Perform insulation-resistance test on each circuit-to-frame. Procedures for performing insulation-resistance tests on solid-state relays should be determined from the relay manufacturer's published data.

(g) Inspect targets and indicators.
  (i) Determine pickup and dropout of electromechanical targets.
  (ii) Verify operation of all light-emitting diode indicators.
  (iii) Set contrast for liquid-crystal display readouts.

(h) Verify that each of the relay contacts performs its intended function in the control scheme including breaker trip tests, close inhibit tests, 86 lockout tests, and alarm functions.

(i) For Undervoltage Relays (27):
  (i) Determine dropout voltage.
  (ii) Determine time delay.
  (iii) Determine the time delay at a second point on the timing curve for inverse time relays.

(j) For Instantaneous Overcurrent relay (50):
  (i) Determine pickup.
  (ii) Determine dropout.
  (iii) Determine time delay.

(k) For Time Overcurrent Relay (51):
  (i) Determine minimum pickup
  (ii) Determine time delays at two points on the time current curve.

E29. MOTOR STARTER, 4160 V

Inspection and testing shall be comprised of the following:

(a) Note the equipment nameplate data for inclusion in the report.

(b) Inspect physical and mechanical condition including evidence of moisture and corona.

(c) Inspect anchorage, alignment, and grounding.

(d) Prior to cleaning the unit, perform as-found tests, if required.

(e) Clean the unit.

(f) Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(g) Test electrical and mechanical interlock systems for correct operation and sequencing.

(h) Verify correct barrier and shutter installation and operation.

(i) Exercise active components and confirm correct operation of indicating devices.

(j) Inspect contactors.
  (i) Verify mechanical operation.
  (ii) Inspect and adjust contact gap, wipe, alignment, and pressure in accordance with manufacturer's published data.

(k) Record overload protection settings.

(l) Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

(m) Perform as-left tests.

(n) Perform insulation-resistance tests on contactor(s) for one minute, phase-to-ground and phase-to-phase with the contactor closed, and across each open contact. Test voltage shall be in accordance with manufacturer's published data or 2500 Vdc.

(o) Perform insulation-resistance tests on all control wiring with respect to ground. The applied potential shall be 500 Vdc for 300 V rated cable and 1000 Vdc for 600 V rated cable. For units with solid-state components, follow manufacturer's recommendation.

(p) Perform a DC overpotential test at a maximum test voltage of 12 kVAC.

(q) Perform contact resistance tests.

(r) Measure blowout coil circuit resistance, if applicable.

(s) Measure resistance of power fuses.

(t) Energize contactor using an auxiliary source. Adjust armature to minimize operating vibration where applicable.

(u) Test control power transformers as specified in E18.

(v) Test phase and summation CTs as specified in E20.

(w) Test electronic motor protection devices as follows:

(i) Verify all set points are configured correctly as specified in the data provided.

(ii) Verify current inputs by applying a current source to simulate motor load current. Check the correctness of all current readings on the protective relay.

(iii) Perform secondary current injection tests to ensure the 50/51 relay protective functions are working as per the configured set points.

(iv) Perform ground fault current injection tests to ensure the 50/51G relay protection functions are working as per the configured set points.

(v) Validate relay settings specified in the inspection form using a protective relay test set.

(vi) Verify PLC status changes when motor circuit is tripped.

E30. AC MOTORS, 4160 V

Inspection and testing shall be comprised of the following:

(a) Note the equipment nameplate data for inclusion in the report.

(b) Inspect physical and mechanical condition.

(c) Inspect anchorage, alignment, and grounding.

(d) Inspect air baffles, filter media, cooling fans, slip rings, brushes, and brush rigging. Air baffles and filter media should be clean. Cooling fans should operate. Slip ring wear and brushes should be within manufacturer's tolerances for continued use. Brush rigging should be intact.

(e) Clean the unit.

(f) Inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(g) Verify the application of appropriate lubrication and lubrication systems.

(h) Verify the absence of unusual mechanical or electrical noise or signs of overheating.

(i) Perform insulation-resistance tests in accordance with ANSI/IEEE Standard 43. Test voltage shall be in accordance with manufacturer's published data or 2500 Vdc. Test duration shall be for ten minutes. Calculate polarization index. The dielectric absorption ratio or polarization should not be less than 1.0. The recommended minimum insulation resistance (IR 1 min) test results in megohms should be corrected to 40° C and read as follows:

(i) IR 1 min = kV + 1 megaohms for most windings made before 1970, (kV is the rated machine terminal-to-terminal voltage, in rms kV)

(ii) IR 1 min = 100 megohms for most ac windings built after 1970 (form-wound coils).

(j) Perform dc overpotential tests in accordance with ANSI/IEEE Standard 95 on each winding. If no evidence of distress or insulation failure is observed by the end of the total

time of voltage application during the overpotential test, the test specimen is considered to have passed the test.

(i) Test each winding individually.

(ii) Ground windings not under test.

(iii) Test voltage to be incremented gradually to 7.0 kV.

(iv) Test duration to be one minute after the target test voltage is reached.

(v) Record leakage current in microamps.

(k) Perform phase-to-phase stator resistance test.

(i) Investigate phase-to-phase stator resistance values that deviate by more than 10 percent.

(l) Perform resistance tests on resistance temperature detector (RTD) circuits. RTD circuits should conform to design intent and/or machine protection device manufacturer's specifications.

(m) Test capacitors attached to motor terminals in accordance with E31.

E31. CAPACITORS, 4160 V

Inspection and testing shall be comprised of the following:

(a) Note the equipment nameplate data for inclusion in the report.

(b) Inspect physical and mechanical condition.

(c) Inspect anchorage, alignment, grounding, and required clearances.

(d) Clean the unit.

(e) Verify that capacitors are electrically connected in their specified configuration.

(f) Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(g) Perform insulation-resistance tests at 2500 Vdc for one minute from each phase terminal to the case. Note any resistance values less than 1,000 megaohms.

(h) Measure the capacitance of all terminal combinations. Investigate capacitance values differing from manufacturer's published data.

(i) Measure resistance of internal discharge resistors. Investigate discharge resistor values differing from manufacturer's published data. In accordance with Canadian Electrical Code 26-222, the residual voltage of a capacitor shall be reduced to 50 V within 5 minutes for capacitors rated over 750 V.

E32. CAPACITORS, 600 V

Inspection and testing shall be comprised of the following:

(a) Note the equipment nameplate data for inclusion in the report.

(b) Inspect physical and mechanical condition.

(c) Inspect anchorage, alignment, grounding, and required clearances.

(d) Clean the unit.

(e) Verify that capacitors are electrically connected in their specified configuration.

(f) Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(g) Perform insulation-resistance tests at 1000 Vdc for one minute from each phase terminal to the case. Note any resistance values less than 100 megaohms.

(h) Measure the capacitance of all terminal combinations. Investigate capacitance values differing from manufacturer's published data.

(i) Measure resistance of internal discharge resistors. Investigate discharge resistor values differing from manufacturer's published data. In accordance with Canadian Electrical Code 26-222, the residual voltage of a capacitor shall be reduced to 50 V within 1 minutes for capacitors rated less than 750 V.

E33. TRANSFORMERS, MEDIUM VOLTAGE DRY-TYPE

Inspection and testing shall be comprised of the following:

(a) Note the equipment nameplate data for inclusion in the report.

(b) Inspect physical and mechanical condition including evidence of moisture and corona.

(c) Inspect anchorage, alignment, and grounding.

(d) Clean the unit.

(e) Verify that alarm settings on temperature indicators are as specified and operate within manufacturer's recommendations for specified settings.

(f) Inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(g) Record tap setting. Confirm the tap setting appears reasonable by measuring the voltage during normal facility operation.

(h) Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Calculate polarization index. Minimum insulation-resistance values of transformer insulation should be 1000 megaohms for the 4160 V windings and 100 megaohms for the 600 V windings. Values of insulation resistance less than the values stated should be investigated. The polarization index should not be less than 1.0.

(i) The test duration shall be 10 minutes for each winding.

(ii) 4160 V windings shall be tested at 2500 Vdc.

(iii) 600 V windings shall be tested at 1000 Vdc.

(i) Perform turns-ratio tests at the designated tap position. Turns-ratio test results should not deviate more than one-half percent from either the adjacent coils or the calculated ratio.

(j) Measure the resistance of each winding at the designated tap position.

(k) Measure core insulation resistance at 500 Vdc if the core is insulated and if the core ground strap is removable.

(l) Verify correct secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading. Phase-to-phase and phase-to-neutral secondary voltages should be in agreement with nameplate data.

E34. TRANSFORMERS, MEDIUM VOLTAGE LIQUID-FILLED

Inspection and testing shall be comprised of the following:

(a) Note the equipment nameplate data for inclusion in the report.

(b) Inspect physical and mechanical condition.

(c) Inspect anchorage, alignment, and grounding.

(d) Verify the presence of PCB labelling, if applicable.

(e) Clean bushings and control cabinets.

(f) Verify operation of alarm, control, and trip circuits from temperature and level indicators, pressure relief device, and fault pressure relay, if applicable. Alarm, control, and trip circuits from temperature and level indicators as well as pressure relief device and fault

pressure relay should operate within manufacturer's recommendations for their specified settings.

(g) Inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(h) Verify correct liquid level in tanks and bushings. Liquid levels in the transformer tanks and bushings should be within indicated tolerances.

(i) Record tap setting. Confirm the tap setting appears reasonable by measuring the voltage during normal facility operation.

(j) Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Calculate polarization index. Minimum insulation-resistance values of transformer insulation should be 1000 megaohms for the 4160 V windings and 100 megaohms for the 600 V windings. Values of insulation resistance less than the values stated should be investigated. The polarization index should not be less than 1.0.

(i) The test duration shall be 10 minutes for each winding.

(ii) 4160 V windings shall be tested at 2500 Vdc.

(iii) 600 V windings shall be tested at 1000 Vdc.

(k) Perform turns-ratio tests at the designated tap position. Turns-ratio test results should not deviate by more than one-half percent from either the adjacent coils or the calculated ratio.

(l) Measure the resistance of each winding at the designated tap position. Calculate and record temperature corrected winding-resistance values for a temperature of $20^{o}C$.

(m) If the core ground strap is accessible, remove and measure the core insulation resistance at 500 Vdc.

(n) Remove a sample of insulating liquid in accordance with ASTM D 923. The sample shall be tested for the following.

(i) Dielectric breakdown voltage: ASTM D 877 and/or ASTM D 1816

(ii) Acid neutralization number: ANSI/ASTM D 974

(iii) Specific gravity: ANSI/ASTM D 1298

(iv) Interfacial tension: ANSI/ASTM D 971 or ANSI/ASTM D 2285

(v) Color: ANSI/ASTM D 1500

(vi) Visual Condition: ASTM D 1524

(vii) Measure power factor or dissipation factor in accordance with ASTM D 924.

(o) Remove a sample of insulating liquid in accordance with ASTM D 3613 and perform dissolved-gas analysis (DGA) in accordance with ANSI/IEEE C57.104 or ASTM D3612. Evaluate results of dissolved-gas analysis in accordance with ANSI/IEEE Standard C57.104.

E35. FEEDER CABLES, < 1000 V

Inspection and testing shall be comprised of the following:

(a) Inspect exposed sections of cables for physical damage and evidence of overheating and corona.

(b) Inspect terminations and splices for physical damage and evidence of overheating and corona.

(c) For cables 4/0 AWG or larger, inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(d) Torque all accessible bolted electrical connections.

(e) Inspect compression applied connectors for correct cable match and indentation.

(f) Inspect grounding and cable support.

(g) Verify that visible cable bends meet or exceed the minimum allowable bending radius.

(h) Measure length of cable and record in meters.

(i) If cables are terminated through window-type current transformers, inspect to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.

(j) Perform an insulation-resistance test on each conductor. Individually test each conductor with all other conductors and shields grounded. The test duration shall be one minute. Investigate resistances less than 1000 megaohms. The voltage applied shall be 500 Vdc for 300 V rated cables, and 1000 Vdc for 600 V or 1000 V rated cables.

E36. CIRCUIT BREAKERS, AIR, 600 V

Inspection and testing shall be comprised of the following:

(a) Note the equipment nameplate data for inclusion in the report.

(b) Inspect physical and mechanical condition.

(c) Inspect anchorage, alignment and grounding.

(d) Verify that all maintenance devices are available for servicing and operating the breaker.

(e) Clean the unit.

(f) Torque all accessible bolted power connections.

(g) Inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

(h) Inspect operating mechanism, contacts, and arc chutes for condition, wear and alignment.

(i) Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.

(j) Perform mechanical operator and contact alignment tests on both the breaker and its operating mechanism.

(k) Verify cell fit and element alignment.

(l) Verify racking mechanism operation.

(m) Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

(n) Record operation counter readings, if applicable.

(o) Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. The minimum insulation-resistance should be 100 megaohms.

  (i) 600 V poles shall be tested at 1000 Vdc.

(p) Perform a contact/pole-resistance test.

(q) Perform insulation-resistance tests on all control wiring with respect to ground. The applied potential shall be 500 Vdc for 300 V rated cable and 1000 Vdc for 600 V rated cable. Do not perform this test for units with solid-state components.

(r) Determine long-time pickup and delay by primary current injection. Long-time pickup values should be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. Circuit breakers exceeding specified trip time shall be identified as defective.

(s) Determine short-time pickup and delay by primary current injection. Short-time pickup values should be as specified, and the trip characteristic should not exceed manufacturer's

published time-current tolerance band. Circuit breakers exceeding specified trip time shall be identified as defective.

(t) Determine ground-fault pickup and delay by primary current injection. Ground fault pickup values should be as specified, and the trip characteristic should not exceed manufacturer's published time-current tolerance band. Circuit breakers exceeding specified trip time shall be identified as defective.

(u) Determine instantaneous pickup current by primary current injection. Instantaneous pickup values should be within the tolerances of manufacturer's published data. Circuit breakers exceeding specified trip time shall be identified as defective.

(v) Secondary current injection may be utilized instead of primary current injection, provided that the current transformers are tested in accordance with E20.

(w) Perform minimum pickup voltage test on shunt trip and close coils. Minimum pickup voltage on shunt trip and close coils should be in accordance with manufacturer's published data.

(x) Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, and trip unit battery condition.

(y) Verify correct operation of features such as electrical close and trip operation, trip-free, and antipump function. Reset all trip logs and indicators.

E37. CIRCUIT BREAKERS, INSULATED-CASE/MOLDED CASE, 600 V

Inspection and testing shall be comprised of the following:

(a) Note the equipment nameplate data for inclusion in the report.

(b) Record all adjustable settings.

(c) Inspect physical and mechanical condition.

(d) Inspect anchorage and alignment.

(e) Clean the unit.

(f) Torque all accessible bolted power connections.

(g) Operate the circuit breaker to insure smooth operation.

(h) Perform a contact/pole-resistance test.

(i) For cables 4/0 AWG and larger, inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

E38. MOTOR STARTERS, 600 V

Inspection and testing shall be comprised of the following:

(a) Note the equipment nameplate data for inclusion in the report.

(b) Record all adjustable settings, size of overload etc.

(c) Inspect physical and mechanical condition.

(d) Inspect anchorage, alignment, and grounding.

(e) Clean the unit.

(f) Torque all accessible bolted power connections.

(g) Inspect contactors.

  (i) Verify mechanical operation.

  (ii) Visually inspect and exercise circuit breaker.

(h) Motor-Running Protection

(i) Compare overload element rating with motor full-load current rating to verify correct sizing.

(ii) If motor-running protection is provided by fuses, verify correct fuse rating considering motor characteristics and power-factor correction capacitors.

E39. EMERGENCY STANDBY GENERATORS, 600 V

Inspection and testing shall be comprised of the following:

(a) Complete the full mechanical and electrical inspection, test, and maintenance program as specified in Section 11 of CSA C282. This includes the complete annual inspection, test and maintenance requirements specified in C282.

(b) Complete all tests specified in the manufacturer's manual of operation and maintenance instructions.

(c) Inspection forms are to be provided by the Contractor for this portion of the inspection.

E40. TRANSFER SWITCHES, 600 V

Inspection and testing shall be comprised of the following:

(a) Complete the inspection, test, and maintenance program as specified in Section 11 of CSA C282. This includes the complete annual inspection, test and maintenance requirements specified in C282.

(b) Inspection forms are to be provided by the Contractor for this portion of the inspection.

E41. UPS WIRING AND CONNECTIONS

Inspection and testing shall be comprised of the following:

(a) UPS Input System Test

(i) The secondary winding of the 600/240 V transformer is to be disconnected.

(ii) Close the breaker after the secondary winding of the 600/240 V transformer.

(iii) Close the breaker at the input to the UPS.

(iv) Disconnect the wiring at the input to the UPS.

(v) Set the transfer switch to be in the UPS position, with a temporary ground attached to the transfer switch output terminals.

(vi) Perform an insulation resistance test, at 500 Vdc, of the wiring and equipment from the secondary wiring of 600/240 V transformer to the input of the UPS.

(vii) Perform a low resistance ohmmeter measurement of the system from the secondary wiring of 600/240 V transformer to the input of the UPS.

(b) UPS Output System Test

(i) Disconnect the wiring at the output of the UPS.

(ii) Set the transfer switch to be in the UPS position, with a temporary ground attached to the transfer switch bypass input terminal.

(iii) The primary winding of the 240/240 V transformer is to be disconnected.

(iv) Perform an insulation resistance test, at 500 Vdc, of the wiring and equipment from the output of the UPS to the primary wiring of the 240/240 V transformer.

(v) Perform a low resistance ohmmeter measurement of the system from the output of the UPS to the primary wiring of the 240/240 V transformer.

E42. TRANSFORMERS, LOW VOLTAGE DRY-TYPE

Inspection and testing shall be comprised of the following:

(a) Note the equipment nameplate data for inclusion in the report.

(b) Inspect physical and mechanical condition.

(c) Inspect anchorage, alignment, and grounding.

(d) Clean the unit.

(e) Torque all accessible bolted power connections.

(f) Record the tap setting.

(g) Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Duration of the test is to be one minute. Calculate the dielectric absorption ratio.

(i) 600 V windings shall be tested at 1000 Vdc.

(ii) 120/208 V windings shall be tested at 500 Vdc.

E43. PANELBOARDS, LOW VOLTAGE

Inspection and testing shall be comprised of the following:

(a) Note the equipment nameplate data for inclusion in the report.

(b) Inspect physical and mechanical condition.

(c) Inspect anchorage, alignment, and grounding.

(d) Clean the unit.

(e) Inspect breakers and verify mechanical operation by exercising all circuit breakers.

(f) Torque all accessible bolted power connections including incoming, load neutral and ground connections.

(g) Perform insulation-resistance tests on each bus phase with all other phases grounded.

(i) The main breaker, if present, is to be open for the test. If no main breaker is present, disconnect the supply conductors.

(ii) Open all load breakers.

(iii) Test voltage for all 600/347 V panelboards to be 1000 Vdc.

(iv) Test voltage for all 120/208 V panelboards to be 500 Vdc.

E44. GROUNDING SYSTEM

Inspection and testing shall be comprised of the following:

(a) Identify the location of the existing ground electrode.

(b) Provide a detailed dimensioned sketch of the grounding electrodes or other grounding system.

(c) Verify the ground system is in compliance with the Canadian Electrical Code.

(d) Inspect physical and mechanical condition. Identify any visible corrosion.

(e) Torque all accessible bolted ground connections.

(f) Perform two (2) fall-of-potential or alternative test in accordance with IEEE Standard 81 on the main grounding electrode or system. Investigate a calculated resistance larger than 5 ohms.

(g) Perform continuity tests between the main grounding electrode and grounded points in the electrical distribution system located in the switchgear, transformers, and MCCs. Investigate connections with a resistance greater than 0.5 milliohms.

E45. THERMOGRAPHIC TESTS

Inspection and testing shall be comprised of the following:

(a) Remove all necessary covers prior to thermographic inspection.

(b) Equipment to be inspected shall include all current-carrying devices.

(c) Test Parameters

(i) Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 °C at 30 °C.

(ii) Equipment shall detect emitted radiation and convert detected radiation to a visual signal.

(iii) Thermographic surveys should be performed during periods of maximum possible loading but not less than 40% of rated load of the electrical equipment being inspected. Coordinate with City as required.

(iv) Note all temperature differences larger than 1°C. Investigate all temperature differences larger than 4 °C.

(d) Re-inspect deficient areas with the thermographic camera following repairs and corrections, for deficient areas identified.

(e) Provide a report which shall include the following:

(i) Description of the equipment tested.

(ii) Discrepancies found.

(iii) Temperature difference between the area of concern and the reference area.

(iv) Probable cause of temperature difference.

(v) Identify any repairs made during the thermographic inspection. If no repairs were made, provide recommended action for repair.

(vi) Areas inspected. Identify inaccessible and / or unobservable areas and / or equipment.

(vii) Identify load conditions at time of inspection.

(viii) Provide photographs and thermograms of all areas investigated, with deficient areas identified.

(ix) Provide thermograms of all deficient areas corrected, and identify the load conditions at the time of re-inspection.

SCHEDULE E001: PRELIMINARY SCHEDULE FOR MCPHILLIPS PUMPING STATION

Inspection Task	Qty	# of Shifts	Shutdown and Operational Requirements
Thermographic tests			
Thermographic tests	1	1 Day-time	One day-time shirt for thermographic testing, no shutdown required.
Standby Generators			
Generators	3		
Cables	5		
Switchboard/Transfer Panel	1	2 Day-time	Inspections can be done during the day with minimal pumping as a precaution. Will be performed first to ensure the backup system is fully functional for future inspection shutdowns.
Breakers	8		
Interlock Operation	1		
600V Switchgear (Main)			
Buswork	1		
Breakers	4	1 Night-time	One night-time shutdown required.
Auto-sensing and enabling of standby power	1		
MCC 'Essential' and UPS			
Buswork	1		
Breakers	19		
Motor starters	8		
600-208/120V transformers	4	2 Night-time	Two night-time shutdowns required.
208/120V panel boards	6		
UPS Wiring	1		
UPS Transformers	2		
UPS Panelboard	1		
4160V Main Switchgear			
Main Breaker	1		
Buswork	1	1 Day-time	Operation with natural gas engines and minimal pumping. Manitoba Hydro coordination is required. Replacement relays will be preconfigured with current settings.
Protection Relay Replacement	4		
Water Pump Motors			
Motors	3		
Motor starters	3		
Feeder Cables	3	3 Day-time	Shutdown one motor at a time and perform inspections/testing during the day.
Motor Protection	3		
Power Factor Capacitors	3		
4160/600V Transformers			
Transformers	2		
Fused Disconnects	2	2 Day-time	Transformers can be isolated individually and worked on during the day with minimal pumping as a precaution. Operation of standby generators will be required.
Primary Cables	2		
Secondary Cables	2		
600V Distribution Non-essential (Chlorine Building)			
Breakers	1		
Motor starters	2	1 Day-time	One day-time shift required with minimal pumping.
600-208/120V transformers	2		
208/120V panel boards	3		
600V Switchgear Essential (Chlorine Building)			
Feeder Cables	2		
Buswork	1		
Breakers	2	1 Night-time	One night-time shutdown required.
Motor starters	2		
Interlock Operation	1		
MCC 'Non-Essential'			
Buswork	1		
Breakers	10		
Motor starters	2	1 Day-time	Two day-time shifts required with minimal pumping.
600-208/120V transformers	1		
208/120V panel boards	7		
Ground System Testing			
Point-to-point Resistance Checks	3	1 Day-time	Day-time work, no operational impact.
Fall-of-Potential	2		

SCHEDULE E002: PRELIMINARY SCHEDULE FOR MACLEAN PUMPING STATION

Inspection Task	Qty	# of Shifts	Shutdown and Operational Requirements
Thermographic tests			
Thermographic tests	1	1 Day-time	One daytime shirt for termographic testing, no shutdown required.
Standby Generators			
Generators	2		
Cables	3	2 Day-time	Inspections can be done during the day with minimal pumping as a precaution. Will be performed first to ensure the backup system is fully functional for future inspection shutdowns.
Switchboard/Transfer Panel	1		
Breakers	2		
600V Switchgear (Main)			
Buswork	1		
Breakers	4	1 Night-time	One night-time shutdown required.
Auto-sensing and enabling of standby power	1		
MCC 'Essential' and UPS			
Buswork	1		
Breakers	10		
Motor starters	14		
600-208/120V transformers	2	2 Night-time	Two night-time shutdowns required.
208/120V panel boards	1		
UPS Wiring	1		
UPS Transformers	2		
UPS Panelboard	1		
4160V Main Switchgear			
Incoming Cables	1		
Main Breaker	1	1 Day-time	Operation with natural gas engines and minimal pumping. Manitoba Hydro coordination is required. Replacement relays will be preconfigured with current settings.
Buswork	1		
Protection Relay Replacement	4		
Water Pump Motors			
Motors	3		
Motor starters	3	3 Day-time	Shutdown one motor at a time and perform inspections/testing during the day.
Feeder Cables	3		
Motor Protection	3		
Power Factor Capacitors	3		
4160/600V Transformers			
Transformers	2		
Fused Disconnects	2	2 Day-time	Transformers can be isolated individually and worked on during the day with minimal pumping as a precaution. Operation of standby generators will be required.
Primary Cables	2		
Secondary Cables	2		
MCC 'Non-Essential'			
Buswork	1		
Breakers	29		
Motor starters	7	2 Day-time	Two day-time shift with minimal pumping.
600-208/120V transformers	1		
208/120V panel boards	1		
Ground System Testing			
Point-to-point Resistance Checks	3	1 Day-time	Daytime work, no operational impact.
Fall-of-Potential	2		

SCHEDULE E003: PRELIMINARY SCHEDULE FOR HURST PUMPING STATION

Inspection Task	Qty	Duration	Shutdown and Operational Requirements
Thermographic tests		1 Day-time	One day-time shift for thermographic tests and no shutdown required.
Thermographic tests	1		
Standby Generators		2 Day-time	Inspections can be done during the day with minimal pumping as a precaution. Will be performed first to ensure the backup system is fully functional for future inspection shutdowns.
Generators	2		
Cables	3		
Switchboard/Transfer Panel	1		
Breakers	2		
Interlock operation	1		
4160V Tie Breaker, CDP-E, UPS		2 Night-time	Total operational shutdown. Disconnect both incoming feeders.
Tie Breaker	1		
Interlock operation 4160V switchgear	1		
Protection Relays	1		
Buswork	1		
Breakers	5		
Transfer Switches #1 and #2	2		
600-208/120V transformers	2		
208/120V panel boards	2		
Interlock operation	1		
UPS Wiring	1		
UPS Transformers	2		
UPS Panelboard	1		
"Bank 1" Feeder and Breaker		1 Day-time	"Bank 2" fully operational with minimal pumping. Isolate "Bank 1" and coordinate with Manitoba Hydro to disconnect "Bank 1" feeder.
Incoming Cable "Feeder #1"	1		
Main Breaker	1		
Protection Relays	1		
"Bank 2" Feeder and Breaker		1 Day-time	"Bank 1" fully operational with minimal pumping. Isolate "Bank 2" and coordinate with Manitoba Hydro to disconnect "Bank 2" feeder.
Incoming Cable "Feeder #2"	1		
Main Breaker	1		
Protection Relays	1		
"Bank 1" 4160V Switchgear and XFRMR #3		1 Day-time	"Bank 2" fully operational with minimal pumping. Isolate "Bank 1".
Buswork	1		
4160/600V Transformer	1		
Fused Disconnects	1		
Primary Cables	1		
Secondary Cables	1		
"Bank 2" 4160V Switchgear and XFRMR #4		1 Day-time	"Bank 1" fully operational with minimal pumping. Isolate "Bank 2".
Buswork	1		
Transformers	1		
Fused Disconnects	1		
Primary Cables	1		
Secondary Cables	1		
Water Pump Motors		6 Day-time	Shutdown one motor at a time and perform inspections/testing during the day.
Motors	6		
Motor starters	6		
Feeder Cables	6		
Motor Protection	6		
Power Factor Capacitors	6		
CDP-A		1 Day-time	Isolate CDP-A with minimal pumping. Daytime work (requires confirmation from City)
CDP 'A' Buswork	1		
Breakers	7		
600-208/120V transformers	1		
208/120V panel boards	2		
MCC #1 Buswork	1		
Motor Starters	5		
CDP-A		1 Day-time	Isolate CDP-B with minimal pumping. Daytime work (requires confirmation from City)
CDP 'A' Buswork	1		
Breakers	6		
600-208/120V transformers	1		
208/120V panel boards	3		
MCC #1 Buswork	1		
Motor Starters	3		
Ground System Testing		1 Day-time	Daytime work, no operational impact.
Point-to-point Resistance Checks	3		
Fall-of-Potential	2		