

THE CITY OF WINNIPEG

BID OPPORTUNITY

BID OPPORTUNITY NO. 644-2005

KENASTON UNDERPASS PUMPING STATION

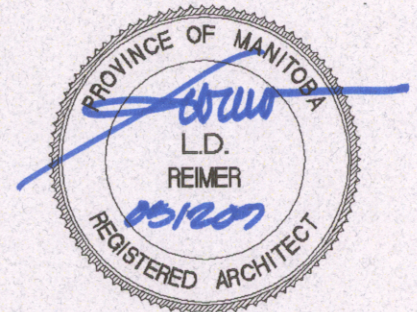
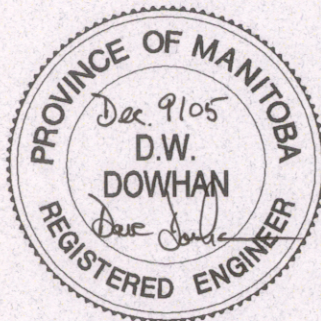
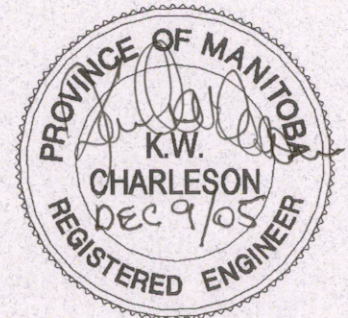
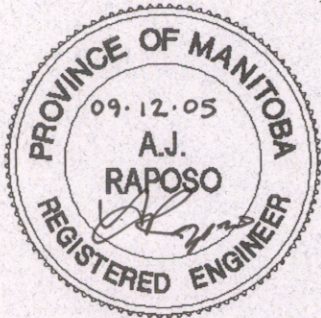


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STANTEC CONSULTING LTD. - ENVIRONMENTAL SCREENING REPORT TABLE 6.3

PRECAST TRAFFIC BARRIER DRAWING CW-315

PART B - BIDDING PROCEDURES

B1. PROJECT TITLE

B1.1 Kenaston Underpass Pumping Station

B2. SUBMISSION DEADLINE

B2.1 The Submission Deadline is 12:00 noon Winnipeg time, January 6, 2006.

B2.2 Bid Submissions 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 GC:3.1, the Bidder may make an appointment to view the Site by contacting the Contract Administrator.

B3.2 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.

B4. ENQUIRIES

B4.1 All enquiries shall be directed to the Contract Administrator identified in D4.1.

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 notify the Contract Administrator of the error, discrepancy or omission, or request a clarification as to the meaning or intent of the provision at least five (5) Business Days prior to the Submission Deadline.

B4.3 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.

B4.4 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.

B4.5 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.

- B5.2.1 Addenda will be available on the Bid Opportunities page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at <http://www.winnipeg.ca/matmgt>.
- B5.2.2 The Bidder is responsible for ensuring that he has received all addenda and is advised to check the Materials Management Branch internet site for addenda shortly before submitting his Bid.
- B5.3 The Bidder shall acknowledge receipt of each addendum in Paragraph 10 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.
- B6.6.1 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 shall base his Total Bid Price upon the specified item. Such alternatives will be evaluated in accordance with B15.

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.

B7. BID SUBMISSION

B7.1 The Bid Submission consists of the following components:

- (a) Form A: Bid;
- (b) Form B: Prices;
- (c) Form G1: Bid Bond and Agreement to Bond, or
Form G2: Irrevocable Standby Letter of Credit and Undertaking, or
a certified cheque or draft;

B7.2 All components of the Bid Submission 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.

B7.3 The Bid Submission shall be submitted enclosed and sealed in an envelope clearly marked with the Bid Opportunity number and the Bidder's name and address.

B7.3.1 Samples or other components of the Bid Submission 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.

B7.4 Bid Submissions submitted by facsimile transmission (fax) or internet electronic mail (e-mail) will not be accepted.

B7.5 Bid Submissions shall be submitted to:

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

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.

B8.2.1 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 12 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 and the corporate seal, if the corporation has one, should be affixed;
 - (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.
- B8.4.1 The name and official capacity of all individuals signing Form A: Bid shall be printed below such signatures.
- B8.4.2 All signatures shall be original and shall be witnessed except where a corporate seal has been affixed.
- 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 Submission 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 Work identified on Form B: Prices.
- 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 At quantities for which payment will be made to the Contractor are to be determined by the Work actually performed by the Contractor, to be measured as specified in the applicable Specifications.

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;
 - (b) be responsible and not be suspended, debarred or in default of any obligation to the City;
 - (c) be financially capable of carrying out the terms of the Contract;
 - (d) have all the necessary experience, capital, organization, and equipment to perform the Work in strict accordance with the terms and provisions of the Contract;
 - (e) have successfully carried out work, similar in nature, scope and value to the Work;
 - (f) employ only Subcontractors who:
 - (i) are responsible and not suspended, debarred or in default of any obligation 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 Branch internet site at <http://www.winnipeg.ca/matmgt>); and

- (ii) have successfully carried out work similar in nature, scope and value to the portion of the Work proposed to be subcontracted to them, and are fully capable of performing the Work required to be done in accordance with the terms of the Contract;
 - (g) have a written workplace safety and health program in accordance with The Workplace Safety and Health Act (Manitoba);
- B10.2 Further to B10.1(g), the Bidder shall, within three (3) Business Days of a request by the Contract Administrator, provide proof satisfactory to the Contract Administrator that the Bidder 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 - Option 1 administered by the Manitoba Heavy Construction Association's Safety, Health and Environment Program; or
 - (b) a valid COR certification number under the Certificate of Recognition (COR) Program administered by the Manitoba Construction Safety Association; or
 - (c) 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 Branch internet site at <http://www.winnipeg.ca/matmgt.>)
- B10.3 The Bidder shall be prepared to 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.
- B10.4 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. BID SECURITY

- B11.1 The Bidder shall provide bid security in the form of:
 - (a) a bid bond, in the amount of at least ten percent (10%) of the Total Bid Price, and agreement to bond of a company registered to conduct the business of a surety in Manitoba, in the form included in the Bid Submission (Form G1: Bid Bond and Agreement to Bond); or
 - (b) an irrevocable standby letter of credit, in the amount of at least ten percent (10%) of the Total Bid Price, and undertaking issued by a bank or other financial institution registered to conduct business in Manitoba and drawn on a branch located in Winnipeg, in the form included in the Bid Submission (Form G2: Irrevocable Standby Letter of Credit and Undertaking); or
 - (c) a certified cheque or draft payable to "The City of Winnipeg", in the amount of at least fifty percent (50%) of the Total Bid Price, drawn on a bank or other financial institution registered to conduct business in Manitoba.
- B11.1.1 If the Bidder submits alternative bids, the bid security shall be in the amount of the specified percentage of the highest Total Bid Price submitted.
- B11.2 The bid security of the successful Bidder and the next two lowest evaluated responsive and responsible Bidders will be released by the City when a Contract for the Work has been duly executed by the successful Bidder and the performance security furnished as provided herein. The bid securities of all other Bidders will be released when a Contract is awarded.

- B11.2.1 Where the bid security provided by the successful Bidder is in the form of a certified cheque or draft pursuant to B11.1(c), it will be deposited and retained by the City as the performance security and no further submission is required.
- B11.2.2 The City will not pay any interest on certified cheques or drafts furnished as bid security or subsequently retained as performance security.
- B11.3 The bid securities of all Bidders will be released by the City as soon as practicable following notification by the Contract Administrator to the Bidders that no award of Contract will be made pursuant to the Bid Opportunity.

B12. OPENING OF BIDS AND RELEASE OF INFORMATION

- B12.1 Bid Submissions will be opened publicly, after the Submission Deadline has elapsed, in the office of the Corporate Finance Department, Materials Management Branch, or in such other office as may be designated by the Manager of Materials.
- B12.1.1 Bidders or their representatives may attend.
- B12.1.2 Bid Submissions determined by the Manager of Materials, or his designate, to not include the bid security specified in B11 will not be read out.
- B12.2 After the public opening, the names of the Bidders and their Total Bid Prices as read out (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 Branch internet site at <http://www.winnipeg.ca/matmgt>.
- B12.3 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 Branch internet site at <http://www.winnipeg.ca/matmgt>.
- B12.4 The Bidder is advised that any information contained in any Bid Submission may be released if required by City policy or procedures, by The Freedom of Information and Protection of Privacy Act (Manitoba), by other authorities having jurisdiction, or by law.

B13. IRREVOCABLE BID

- B13.1 The Bid(s) submitted by the Bidder shall be irrevocable for the time period specified in Paragraph 11 of Form A: Bid.
- B13.2 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 until a Contract for the Work has been duly executed and the performance security furnished as herein provided, but any Bid shall be deemed to have lapsed unless accepted within the time period specified in Paragraph 11 of Form A: Bid.

B14. WITHDRAWAL OF BIDS

- B14.1 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.
- B14.1.1 Notwithstanding GC:23.3, 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.

- B14.1.2 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 12 of Form A: Bid, and only such person, has authority to give notice of withdrawal.
- B14.1.3 If a Bidder gives notice of withdrawal prior to the Submission Deadline, the Manager of Materials shall:
- (a) retain the Bid Submission until after the Submission Deadline has elapsed;
 - (b) open the Bid Submission to identify the contact person named in Paragraph 3 of Form A: Bid and the Bidder's authorized representatives named in Paragraph 12 of Form A: Bid; and
 - (c) if the notice has been given by any one of the persons specified in B14.1.3(b), declare the Bid withdrawn.
- B14.2 A Bidder who withdraws his Bid after the Submission Deadline but before his Bid has been released or has lapsed as provided for in B13.2 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, including the right to retain the Bidder's bid security.

B15. EVALUATION OF BIDS

- B15.1 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 (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.
- B15.2 Further to B15.1(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 if the interests of the City so require.
- B15.3 Further to B15.1(b), the Award Authority shall reject any Bid submitted by a Bidder who does not demonstrate, in his Bid Submission or in other information required to be submitted, that he is responsible and qualified.
- B15.4 Further to B15.1(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.
- B15.4.1 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.

B16. AWARD OF CONTRACT

- B16.1 The City will give notice of the award of the Contract by way of a letter of intent, or will give notice that no award will be made.
- B16.2 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.

- B16.2.1 Without limiting the generality of B16.2, 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.
- B16.3 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.
- B16.4 The award of this Contract is contingent upon the Federal Government approving funding for the Work from the Canada Strategic Infrastructure Fund. Bidders are advised that Federal funding is contingent on a satisfactory Environmental Assessment Review. If sufficient funding for this Contract is not approved by the Federal Government, the City shall have the right not to award the Contract.

PART C - GENERAL CONDITIONS

C.1 GENERAL CONDITIONS

- C.1.1 The *General Conditions for Construction Contracts* (Revision 2000 11 09) are applicable to the Work of the Contract.
- C.1.2 The *General Conditions for Construction Contracts* are available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at <http://www.winnipeg.ca/matmgt>.

PART D - SUPPLEMENTAL CONDITIONS

GENERAL

D1. GENERAL CONDITIONS

- D1.1 In addition to the *General Conditions for Construction Contracts*, these Supplemental Conditions are applicable to the Work of the Contract.
- D1.2 The General Conditions are amended by striking out “The City of Winnipeg Act” wherever it appears in the General Conditions and substituting “The City of Winnipeg Charter”.
- D1.3 The General Conditions are amended by striking out “Bid Opportunity Package” wherever it appears in the General Conditions and substituting “Bid Opportunity”.
- D1.4 The General Conditions are amended by striking out “Bid Opportunity Submission” wherever it appears in the General Conditions and substituting “Bid Submission”.
- D1.5 The General Conditions are amended by deleting GC:6.16 and GC:6.17. The City of Winnipeg is now within the jurisdiction of the Manitoba Ombudsman pursuant to The Ombudsman Act.

D2. SCOPE OF WORK

- D2.1 The Work to be done under the Contract shall consist of Construction of a complete and operating pumping station.
- D2.2 The major components of the Work are as follows:
- (a) Forcemain, Land Drainage Sewers
 - (b) Excavation, Shoring, Dewatering
 - (c) Substructure
 - (d) Superstructure
 - (e) Overhead Crane System
 - (f) Process Mechanical and Domestic Plumbing
 - (g) HVAC
 - (h) Electrical
 - (i) Emergency Generator

D3. SUMMARY OF WORK

- D3.1 Work Under this Contract
- D3.1.1 The Work under this Contract consists of construction of the Kenaston Underpass Pump Station for the City of Winnipeg.
- D3.2 Work Included
- D3.2.1 The Work includes the following components:
- (a) Construction of a new pump station facility consisting of three (3) submersible pumps producing a combined flow of 1070 litres/second, in ground concrete pump well, sub level concrete mechanical room, pump house building, mechanical and electrical works, standby natural gas generator, crane system and associated works as specified in the Contract.

- (b) Total Performance shall not be issued for the Work until all components are placed in operation by the Contractor, and are operating satisfactorily.

D3.3 Work Not Included

D3.3.1 The following components of the project are not included in the Work under this Contract:

- (a) Finish Grading Site Work
- (b) Road Work
- (c) Bridge Work

D3.4 Documents Required

D3.4.1 Maintain at the jobsite at least one copy of each of the following:

- (a) Drawings
- (b) Specifications
- (c) Addenda
- (d) Change Orders, Field Orders, Notices
- (e) Reviewed Shop Drawings
- (f) Modifications to the Contract
- (g) Field Test Reports
- (h) Construction Schedule
- (i) Manufacturer's Installation and Application Instructions
- (j) Occupational Health and Safety Regulations and Workers' Compensation Board Regulations;

and have readily available any referenced or specified Standards.

D3.5 Specifications

D3.5.1 Sentence structure in parts of the specifications is abbreviated, and phrases such as "shall be," and "the Contractor shall" are deliberately omitted. Such sentences shall be read as though they are complete.

D3.5.2 The use of the word "provide" means "supply and install"; or "supply labour and materials for the installation of". It does not mean supply only.

D3.5.3 The word "concealed" in connection with piping, electrical work, controls and wherever used in other sections shall mean "hidden from sight" as in ceiling spaces or furred out spaces, and not normally visible to persons in the construction area..

D3.5.4 The word "exposed" in connection with piping, electrical work, controls and whenever used in other sections shall mean visible to persons within a building, in normal working areas.

D3.6 Standards

D3.6.1 Wherever standards (e.g., CSA, ASTM and others), are referred to in this Contract the current edition at the date of closing of the Bid Opportunity shall apply.

D3.6.2 Where there is a clear conflict between the referenced Standard and the Contract, the Contract shall apply.

D3.6.3 Where there is an ambiguity between a Standard and any term of this Contract, the Contract Administrator shall, in the first instance, give an interpretation of the intent of the Contract.

D4. ABBREVIATIONS

D4.1 Abbreviations - Specifications, Methods, Standards

D4.1.1 General

ASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ARCA	Alberta Roofing Contractors Association
ASCE	American Society of Civil Contract Administrators
ASTM	American Society for Testing and Materials
AWPA	American Wood Preservers Associations
AWS	American Welding Society
BCLMA	B.C. Lumber Manufacturer's Association
CAN	National Standard of Canada
CCA	Canadian Construction Association
CISC	Canadian Institute of Steel Construction
CITC	Canadian Institute of Timber Construction
CPCI	Canadian Prestressed Concrete Institute
CRCA	Canadian Roofing Contractors Association
CSA	Canadian Standards Association
CWB	Canadian Welding Bureau
ISO	International Organization for Standardization
NBC	National Building Code
PCI	Prestressed Concrete Institute
PMBC	Plywood Manufacturer's Association
SJI	Steel Joist Institute
SSPC	Steel Structures Painting Council
WCB	Worker's Compensation Board

D4.1.2 Utilities

API	American Petroleum Institute
AWWA	American Water Works Association
CGA	Canadian Gas Association
CGSB	Canadian General Standards Board
CSPI	Corrugated Steel Pipe Institute
IAO	Insurer's Advisory Organization
RTAC	Roads and Transportation Association of Canada
ULC	Underwriters Laboratories of Canada
USA	United States of America Standards (ASA)

D4.1.3 Mechanical

AFBMA	Anti Friction Bearing Manufacturer's Association
AGMA	American Gear Manufacturer's Association
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
ACR	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Contract Administrators
NFPA	National Fire Protection Association
SAE	Society of Automotive Contract Administrators

D4.1.4 Electrical

AIEE	American Institute of Electrical Contract Administrators
CEC	Canadian Electrical Code
EEMAC	Electrical and Electronic Manufacturers Association of Canada

IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Contract Administrators
IES	Illuminating Contract Administrators Society
IPCEA	Insulated Power Cable Contract Administrator's Association
LEMA	Lighting Equipment Manufacturer's Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code

D4.1.5 Use of Abbreviations

- (a) These abbreviations refer to Specifications, Methods and Standards issued by the respective Association, and the abbreviations are used in the specifications.
- (b) Alphanumeric designations following the abbreviations denote the specification, method, or standard.

D4.2 Abbreviations - Metric

D4.2.1 General

- (a) The specifications are metric and metric usage is based upon SI units in accordance with CSA Standard CAN/CSA-Z234.1 Canadian Metric Practice Guide. In this specification SI units are abbreviated in accordance with the Metric Units and Abbreviations below.

- (b) Linear Measure

Metre	m
Millimetre	mm
Kilometre	km
micrometre	micro-m

- (c) Area

quare metre	m ²
quare millimetre	mm ²
hectare	ha

- (d) Volume

Cubic metre	m ³
Litre	L

- (e) Mass and Density

Kilogram	kg
Gram	g
Tonne	t
Kilogram per metre	kg/m
Gram per metre	g/m
Kilogram per square metre	kg/m ²
Gram per square metre	g/m ²
Kilogram per cubic metre	kg/m ³

- (f) Temperature

Degree Celcius	°C
----------------	----

- (g) Force, Pressure, Stress

Newton	N
Kilonewton	kN
Pascal	Pa
Kilopascal	kPa
Megapascal	Mpa

(h) Velocity, Rate of Flow		
Metre per second		m/s
Metre per hour		m/h
Kilometre per hour		km/h
Litre per second		L/s
Cubic metre per second		m ³ /s
(i) Power, Energy, Heat, Work		
Watt		W
Kilowatt		kW
Kilowatt hour		kWh
Joule		J
(j) Electricity		
Ampere		A
Volt		V

D5. CONTRACT ADMINISTRATOR

D5.1 The Contract Administrator is Stantec Consulting Ltd., represented by:
Antonio (Tony) Raposo, P.Eng. 905 Waverley Street
Winnipeg, MB
R3T 5P4
Telephone No. (204) 489-5900 Direct Line (204) 488-5714
Facsimile No. (204) 459-9012

D5.2 At the pre-construction meeting, Tony Raposo, P.Eng. will identify additional personnel representing the Contract Administrator and their respective roles and responsibilities for the Work.

D6. CONTRACTOR'S SUPERVISOR

D6.1 At the pre-construction meeting, the Contractor shall identify his designated supervisor and any additional personnel representing the Contractor and their respective roles and responsibilities for the Work.

D6.2 At least two (2) business days prior to the commencement of any Work on the Site, the Contractor shall provide the Contract Administrator with a phone number where the supervisor identified in D5.1 or an alternate can be contacted 24 hours a day to respond to an emergency.

D7. NOTICES

D7.1 Except as provided for in GC:23.2.2, all notices, requests, nominations, proposals, consents, approvals, statements, authorizations, documents or other communications to the Contractor shall be sent to the address or facsimile number identified by the Contractor in Paragraph D5.1 of Form A: Bid.

D7.2 All notices, requests, nominations, proposals, consents, approvals, statements, authorizations, documents or other communications to the City, except as expressly otherwise required in D7.3, D7.4 or elsewhere in the Contract, shall be sent to the attention of the Contract Administrator at the address or facsimile number identified in D5.1.

- D7.3 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 Administrative Officer Secretariat
Administration Building, 3rd Floor
510 Main Street
Winnipeg MB R3B 1B9
Facsimile No.: (204) 949-1174

- D7.4 All notices, requests, nominations, proposals, consents, approvals, statements, authorizations, documents or other communications required to be submitted or returned to the City Solicitor shall be sent to the following address or facsimile number:

The City of Winnipeg
Corporate Services Department
Legal Services Division
185 King Street, 3rd Floor
Winnipeg MB R3B 1J1
Facsimile No.: (204) 947-9155

D8. FURNISHING OF DOCUMENTS

- D8.1 Upon award of the Contract, the Contractor will be provided with five (5) complete sets of the Bid Opportunity. If the Contractor requires additional sets of the Bid Opportunity, they will be supplied to him at cost.

SUBMISSIONS

D9. SAFE WORK PLAN

- D9.1 The Contractor shall provide the Contract Administrator with a Safe Work Plan at least five (5) Business Days prior to the commencement of any Work on the Site but in no event later than the date specified in GC:4.1 for the return of the executed Contract.
- D9.2 The Safe Work Plan should be prepared and submitted in the format shown in the City's template which is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at <http://www.winnipeg.ca/matmgt>.

D10. INSURANCE

- D10.1 The City shall provide and maintain the following Project Insurance Coverages:
- D10.1.1 Builder's Risk Insurance in the amount of one hundred percent (100%) of the total project cost.
- (a) The Contractor shall be responsible for all deductibles.
- D10.1.2 Wrap-Up Liability Insurance in an amount of no less than 10 million dollars (\$10,000,000.00).
- (a) The Contractor shall be responsible for all deductibles.
- D10.1.3 The City of Winnipeg will carry such insurance to cover all parties engaged in the Work in this Contract including The City of Winnipeg, The Province of Manitoba, The Federal Government of Canada and their ministers, officers, employees and agents, The Department of National Defence and the Contract Administrator as additional insureds.

Provision of this insurance by the City of Winnipeg is not intended in any way to relieve the Contractor from his obligations under the terms of the Contract. Specifically, losses relating to deductibles for insurance, as well as losses in excess of limits of coverage and any risk of loss that is not covered under the terms of the insurance provided by the City of Winnipeg remains with the Contractor.

D10.2 The Contractor shall provide and maintain the following insurance coverage at all times during the performance of the Work:

D10.2.1 Automobile liability insurance for owned and non-owned automobiles used for or in connection with the work in the amount of at least two million dollars (\$2,000,000.00).

D10.2.2 Deductibles shall be borne by the Contractor;

D10.2.3 The Contractor shall not cancel, materially alter, or cause the policy to lapse without providing at least fifteen (15) Calendar Days prior written notice to the Contract Administrator;

D10.2.4 The Contractor shall provide the Contract Administrator with evidence of insurance of the policy at least two (2) Business Days prior to the commencement of any Work on the Site but in no event later than seven (7) Calendar Days from notification of the award of Contract.

D11. PERFORMANCE SECURITY

D11.1 The Contractor shall provide and maintain performance security until the expiration of the warranty period in the form of:

- (a) a performance bond of a company registered to conduct the business of a surety in Manitoba, in the form attached to these Supplemental Conditions (Form H1: Performance Bond), in the amount of fifty percent (50%) of the Contract Price; or
- (b) an irrevocable standby letter of credit issued by a bank or other financial institution registered to conduct business in Manitoba and drawn on a branch located in Winnipeg, in the form attached to these Supplemental Conditions (Form H2: Irrevocable Standby Letter of Credit), in the amount of fifty percent (50%) of the Contract Price; or
- (c) a certified cheque or draft payable to "The City of Winnipeg", drawn on a bank or other financial institution registered to conduct business in Manitoba, in the amount of fifty percent (50%) of the Contract Price.

D11.1.1 Where the performance security is in the form of a certified cheque or draft, it will be deposited by the City. The City will not pay any interest on certified cheques or drafts furnished as performance security.

D11.2 If the bid security provided in his Bid Submission was not a certified cheque or draft pursuant to B11.1(c), the Contractor shall provide the City Solicitor with the required performance security within seven (7) Calendar Days of notification of the award of the Contract by way of letter of intent and prior to the commencement of any Work on the Site but in no event later than the date specified in GC:4.1 for the return of the executed Contract.

D12. SUBCONTRACTOR LIST

D12.1 The Contractor shall provide the Contract Administrator with a complete list of the Subcontractors whom the Contractor proposes to engage (Form J: Subcontractor List) 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 GC:4.1 for the return of the executed Contract.

D13. EQUIPMENT LIST

D13.1 The Contractor shall provide the Contract Administrator with a complete list of the equipment which the Contractor proposes to utilize (Form K: Equipment List) at or prior to pre-construction meeting, or 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 the GC:4.1 for the return of the executed Contract.

D14. DETAILED WORK SCHEDULE

D14.1 The Contractor shall provide the Contract Administrator with a detailed work schedule 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 GC:4.1 for the return of the executed Contract.

D14.2 The detailed work schedule shall consist of a Gantt chart for the Work acceptable to the Contract Administrator.

D14.3 Further to D14.2, the Gantt chart shall show the time on a weekly basis, required to carry out the Work of each trade. The time shall be on the horizontal axis, and the type of trade shall be on the vertical axis.

SCHEDULE OF WORK

D15. COMMENCEMENT

D15.1 The Contractor shall not commence any Work until he is in receipt of a letter of intent from the Award Authority authorizing the commencement of the Work.

D15.2 The Contractor shall not commence any Work on the Site until:

- (a) the Contract Administrator has confirmed receipt and approval of:
 - (i) evidence that the Contractor is 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;
 - (ii) evidence of the workers compensation coverage specified in GC:6.14;
 - (iii) the Safe Work Plan specified in D.9;
 - (iv) evidence of the insurance specified in D10;
 - (v) the performance security specified in D11;
 - (vi) the Subcontractor list specified in D12;
 - (vii) the detailed work schedule specified in D13;
- (b) the Contractor has attended a pre-construction meeting with the Contract Administrator, or the Contract Administrator has waived the requirement for a pre-construction meeting.

D15.3 The Contractor shall commence the Work on the Site within seven (7) Working Days of receipt of the letter of intent.

D15.4 The City intends to award this Contract on January 20, 2006.

D16. RESTRICTED WORK HOURS

D16.1 Further to clause 3.10 of CW 1130, the Contractor shall require written permission 48 hours in advance from the Contract Administrator for any Work to be performed between 2000 hours and 0700 hours, or on Saturdays, Sundays, Statutory Holidays and or Civic Holidays.

D17. WORK BY OTHERS

D17.1 Work by others on or near the Site will include but not necessarily be limited to:

- (a) Kenaston Underpass Railway Bridge Construction;
- (b) Placement and Construction of ballast and track on CN Rail MainLine.
- (c) Manitoba Hydro utility relocation
- (d) Feedermain and watermain relocation
- (e) MTS utilities relocation
- (f) Group Telecom cable relocation
- (g) Kenaston Blvd. reconstruction

D18. SUBSTANTIAL PERFORMANCE

D18.1 The Contractor shall achieve Substantial Performance by August 4, 2006.

D18.2 When the Contractor considers the Work to be substantially performed, the Contractor shall arrange, attend and assist in the inspection of the Work with the Contract Administrator for purposes of verifying Substantial 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 reinspected.

D18.3 The date on which the Work has been certified by the Contract Administrator as being substantially performed to the requirements of the Contract through the issue of a certificate of Substantial Performance is the date on which Substantial Performance has been achieved.

D19. TOTAL PERFORMANCE

D19.1 The Contractor shall achieve Total Performance by August 18, 2006.

D19.2 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 the inspection shall be remedied by the Contractor at the earliest possible instance and the Contract Administrator notified so that the Work can be reinspected.

D19.3 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.

D20. LIQUIDATED DAMAGES

D20.1 If the Contractor fails to achieve Substantial Performance in accordance with the Contract by the day fixed herein for Substantial Performance, the Contractor shall pay the City Five Thousand dollars (\$5000) per Calendar Day for each and every Calendar Day following the day fixed herein for Substantial Performance during which such failure continues.

D20.2 If the Contractor fails to achieve Total Performance in accordance with the Contract by the day fixed herein for Total Performance, the Contractor shall pay the City Five Thousand dollars (\$5000) per Calendar Day for each and every Calendar Day following the day fixed herein for Total Performance during which such failure continues.

D20.3 The City may reduce any payment to the Contractor by the amount of any liquidated damages assessed.

CONTROL OF WORK

D21. JOB MEETINGS

- D21.1 Regular weekly job meetings will be held at the Site. 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.
- D21.2 The Contract Administrator reserves the right to cancel any job meeting or call additional job meetings whenever he deems it necessary.

D22. PRIME CONTRACTOR – THE WORKPLACE SAFETY AND HEALTH ACT (MANITOBA)

- D22.1 Further to GC:6.26, 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).

WARRANTY

D23. WARRANTY

- D23.1 Notwithstanding GC:13.2, the warranty period shall begin on the date of Total Performance and shall expire two (2) years thereafter unless extended pursuant to GC:13.2.1 or GC:13.2.2, in which case it shall expire when provided for thereunder.
- D23.2 Notwithstanding GC:13.2 or D24.1, the Contract Administrator may permit the warranty period for a portion or portions of the Work to begin prior to the date of Total Performance if:
- (a) a portion of the Work cannot be completed because of unseasonable weather or other conditions reasonably beyond the control of the Contractor but that portion does not prevent the balance of the Work from being put to its intended use.

FORM H1: PERFORMANCE BOND
(See D11)

KNOW ALL MEN BY THESE PRESENTS THAT

_____ ,
(hereinafter called the "Principal"), and

_____ ,
(hereinafter called the "Surety"), are held and firmly bound unto **THE CITY OF WINNIPEG** (hereinafter called the "Obligee"), in the sum of

_____ dollars (\$_____)

of lawful money of Canada to be paid to the Obligee, or its successors or assigns, for the payment of which sum the Principal and the Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS the Principal has entered into a written contract with the Obligee dated the

_____ day of _____, 20____, for:

BID OPPORTUNITY NO. 644-2005

KENASTON UNDERPASS PUMPING STATION

which is by reference made part hereof and is hereinafter referred to as the "Contract".

NOW THEREFORE the condition of the above obligation is such that if the Principal shall:

- (a) carry out and perform the Contract and every part thereof in the manner and within the times set forth in the Contract and in accordance with the terms and conditions specified in the Contract;
- (b) perform the Work in a good, proper, workmanlike manner;
- (c) make all the payments whether to the Obligee or to others as therein provided;
- (d) in every other respect comply with the conditions and perform the covenants contained in the Contract; and
- (e) indemnify and save harmless the Obligee against and from all loss, costs, damages, claims, and demands of every description as set forth in the Contract, and from all penalties, assessments, claims, actions for loss, damages or compensation whether arising under "The Workers Compensation Act", or any other Act or otherwise arising out of or in any way connected with the performance or non-performance of the Contract or any part thereof during the term of the Contract and the warranty period provided for therein;

THEN THIS OBLIGATION SHALL BE VOID, but otherwise shall remain in full force and effect. The Surety shall not, however, be liable for a greater sum than the sum specified above.

AND IT IS HEREBY DECLARED AND AGREED that the Surety shall be liable as Principal, and that nothing of any kind or matter whatsoever that will not discharge the Principal shall operate as a discharge or release of liability of the Surety, any law or usage relating to the liability of Sureties to the contrary notwithstanding.

IN WITNESS WHEREOF the Principal and Surety have signed and sealed this bond the

_____ day of _____, 20____ .

SIGNED AND SEALED
in the presence of:

(Witness)

(Name of Principal)

Per: _____ (Seal)

Per: _____

(Name of Surety)

By: _____ (Seal)
(Attorney-in-Fact)

**FORM H2: IRREVOCABLE STANDBY LETTER OF CREDIT
(PERFORMANCE SECURITY)**
(See D11)

(Date)

The City of Winnipeg
Corporate Services Department
Legal Services Division
185 King Street, 3rd Floor
Winnipeg MB R3B 1J1

RE: PERFORMANCE SECURITY - BID OPPORTUNITY NO. 644-2005

KENASTON UNDERPASS PUMPING STATION

Pursuant to the request of and for the account of our customer,

(Name of Contractor)

(Address of Contractor)

WE HEREBY ESTABLISH in your favour our irrevocable Standby Letter of Credit for a sum not exceeding in the aggregate

Canadian dollars.

This Standby Letter of Credit may be drawn on by you at any time and from time to time upon written demand for payment made upon us by you. It is understood that we are obligated under this Standby Letter of Credit for the payment of monies only and we hereby agree that we shall honour your demand for payment without inquiring whether you have a right as between yourself and our customer to make such demand and without recognizing any claim of our customer or objection by the customer to payment by us.

The amount of this Standby Letter of Credit may be reduced from time to time only by amounts drawn upon it by you or by formal notice in writing given to us by you if you desire such reduction or are willing that it be made.

Partial drawings are permitted.

We engage with you that all demands for payment made within the terms and currency of this Standby Letter of Credit will be duly honoured if presented to us at:

(Address)

and we confirm and hereby undertake to ensure that all demands for payment will be duly honoured by us.

All demands for payment shall specifically state that they are drawn under this Standby Letter of Credit.

Subject to the condition hereinafter set forth, this Standby Letter of Credit will expire on

(Date)

It is a condition of this Standby Letter of Credit that it shall be deemed to be automatically extended from year to year without amendment from the present or any future expiry date, unless at least 30 days prior to the present or any future expiry date, we notify you in writing that we elect not to consider this Standby Letter of Credit to be renewable for any additional period.

This Standby Letter of Credit may not be revoked or amended without your prior written approval.

This credit is subject to the Uniform Customs and Practice for Documentary Credit (1993 Revision), International Chamber of Commerce Publication Number 500.

(Name of bank or financial institution)

Per: _____
(Authorized Signing Officer)

Per: _____
(Authorized Signing Officer)

FORM K: EQUIPMENT
(See D14)

KENASTON UNDERPASS PUMPING STATION

<p>1. Category/type: LDS Works</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p>
<p>2. Category/type: Earthmoving/Excavation</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p>
<p>3. Category/type: Compaction and Grading</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p>

FORM K: EQUIPMENT
(See D14)

KENASTON UNDERPASS PUMPING STATION

<p>4. Category/type: Pumping Station Construction</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p>
<p>5. Category/type: Miscellaneous</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p>
<p>6. Category/type: Miscellaneous</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p> <p>Make/Model/Year: _____ Serial No.: _____</p> <p>Registered owner: _____</p>

PART E - SPECIFICATIONS

GENERAL

E1. APPLICABLE SPECIFICATIONS, STANDARD DETAILS AND DRAWINGS

- E1.1 *The City of Winnipeg Standard Construction Specifications* in its entirety, whether or not specifically listed on Form B: Prices, shall apply to the Work.
- E1.1.1 *The City of Winnipeg Standard Construction Specifications* is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at <http://www.winnipeg.ca/matmgt>.
- E1.1.2 The version in effect three (3) Business Days before the Submission Deadline shall apply.
- E1.1.3 Further to GC:2.4(d), Specifications included in the Bid Opportunity shall govern over *The City of Winnipeg Standard Construction Specifications*.
- E1.2 The following drawings are applicable to the Work:

	<i>Drawing Title</i>	<i>Drawing No.</i>	<i>Size</i>
GENERAL			
	Covering & Drawing List	P-3258-146	A1
CIVIL			
	Site Plan	P-3258-147	A1
	Forcemain and Land Drainage Sewer – Sta. 1+200 to Pumping Station	05699	A1
STRUCTURAL			
	Structural – Well Foundation Plan, Mechanical & Baffle Framing Plans	P-3258-148	A1
	Structural – Main Floor Plan, Roof Plan, and Schedules	P-3258-149	A1
	Structural – Notes	P-3258-150	A1
	Structural – Building Sections	P-3258-151	A1
	Structural – Building Sections	P-3258-152	A1
	Structural – Details and Sections	P-3258-153	A1
	Structural – Details and Sections	P-3258-154	A1
ARCHITECTURAL			
	Architectural – Main Floor Plan and Section	P-3256-155	A1
	Architectural – Building Sections	P-3256-156	A1
	Architectural – Roof and Wall Sections	P-3256-157	A1
	Architectural – Stair Details	P-3256-158	A1
	Architectural – Elevations	P-3256-159	A1
PLUMBING			
	Plumbing – Main Floor and Basement Floor Plan Plumbing Layouts and Schematics	P-3258-160	A1
PROCESSING			
	Processing – Main Floor Plan, Section and Processing Schematic	P-3258-161	A1
	Processing – Basement and Wet Well Floor Plans and Section	P-3258-162	A1
	Processing – Miscellaneous Mechanical Details	P-3258-163	A1
MECHANICAL			
	Mechanical – HVAC – Mechanical Floor Plan and Details	P-3258-164	A1
	Mechanical – HVAC – Mechanical Sections	P-3258-165	A1

	Drawing Title	Drawing No.	Size
ELECTRICAL			
	Electrical – Site Plan and MCC Details	P-3258-166	A1
	Electrical – Floor Plans and Details	P-3258-167	A1
	Electrical – Miscellaneous Control Wiring Diagrams	P-3258-168	A1
	Electrical – Miscellaneous Control Wiring Diagrams	P-3258-169	A1

E2. SOILS INVESTIGATION REPORTS

- E2.1 The Geotechnical Reports are available on the City website and are presented as follows:
- (a) Geotechnical Reports for Kenaston Underpass Project Prepared by: UMA Professional Engineering and Consulting Services, March 2005.
 - (b) Additional Geotechnical Investigation “Bedrock and Test Caisson” Prepared by: UMA Professional Engineering and Consulting Services, October 2005.
- E2.2 The soils information presented in the Geotechnical Reports and shown on the drawings is primarily for design purposes and the City does not guarantee the information is free from errors or discrepancies.
- E2.3 No test hole shall be drilled without the approval of the Contract Administrator.
- E2.4 Further to GC:3.1, the Contractor shall make his own investigation as to the soil conditions, which will be encountered in the Work. The City assumes no responsibility for failure or neglect on the part of the Contractor to determine the working conditions at the Site.

DIVISION 1 – GENERAL REQUIREMENTS

E3. OFFICE FACILITIES

- E3.1 The Contractor shall supply office facilities meeting the following requirements:
- (a) The field office shall be for the exclusive use of the Contract Administrator.
 - (b) The building shall be conveniently located near the Site of the Work.
 - (c) The building shall have a minimum floor area of 25 square metres, a height of 2.4m with two windows for cross ventilation and a door entrance with a suitable lock.
 - (d) The building shall be suitable for all weather use. It shall be equipped with an electric heater and air conditioner so that the room temperature can be maintained between 20-25°C.
 - (e) The building shall be adequately lighted with florescent fixtures, and have a minimum of three wall outlets.
 - (f) The building shall be furnished with two desks, one drafting table, table 2m x 1.2m, one stool, one four drawer legal size filing cabinet, and a minimum 12 chairs.
 - (g) A portable toilet shall be located near the field office building. The toilet shall have a locking door and be for the exclusive use of the Contract Administrator and other personnel from the City.
 - (h) The field office building and the portable toilet shall be cleaned on a weekly basis immediately prior to each site meeting. The Contract Administrator may request additional cleaning when he deems it necessary.
- E3.2 The Contractor shall be responsible for all installation and removal costs, all operating costs, and the general maintenance of the office facilities.

E3.3 The office facilities will be provided from the date of the commencement of the Work to the date of Total Performance.

E4. CONSTRUCTION FACILITIES

E4.1 Temporary Utilities

(a) The Contractor shall be responsible for the cost of all temporary utilities.

E4.1.1 Natural Gas, Gasoline and Other Fuels

(a) Provide and pay all costs for natural gas, gasoline and other fuels required for the performance of the Work, in accordance with governing regulations and ordinances, and the Contract.

(b) Furnish and install all necessary temporary piping and upon completion of the Work remove all such temporary piping.

E4.1.2 Water

(a) Further to Clause 3.7 of CW 1120-1, provide all costs for all water required for the performance of the Work, in accordance with governing regulations and ordinances, and the Contract.

(b) Furnish and install all necessary temporary piping and upon completion of the Work remove all such temporary piping.

E4.1.3 Electricity and Lighting

(a) Provide and pay all costs for electricity and artificial lighting required for the performance of the Work, in accordance with governing regulations and ordinances, and the Contract.

(b) Furnish and install all necessary temporary wiring, distribution boxes, panels, etc., and upon completion of the Work, remove all such temporary installations.

E4.1.4 Heating and Ventilation

(a) Provide and pay all costs for heating and ventilating, coverings, and enclosures as necessary to protect and perform the Work.

(b) Furnish and install all necessary temporary equipment, piping, wiring, ducting, and other materials to perform the Work and upon completion of the Work, remove all such temporary equipment.

(c) Temporary heating and ventilating shall be in accordance with all governing regulations and ordinances, and the Contract.

(d) Temporary heating and ventilating shall be provided to:

(i) Facilitate progress of the Work

(ii) Protect the Work and Product and Material against dampness

(iii) Prevent moisture condensation on surfaces

(iv) Provide an atmosphere for curing Material as required

(v) Provide adequate ventilation to meet safety regulations

(vi) Prevent hazardous accumulation of dust, fumes, mist, vapours or gases in areas occupied during construction

(vii) Ventilate storage spaces containing hazardous or volatile materials.

E4.1.5 Sanitary Facilities

(a) Furnish and install a temporary toilet building with sanitary toilet for use of all workmen; comply with all minimum requirements of Manitoba Health or other public agencies having jurisdiction; maintain in a sanitary condition at all times.

E4.1.6 Fire Protection

- (a) Provide and pay all costs for adequate fire protection of the Work and adjacent property.
- (b) Furnish and install temporary extinguishers, hydrants and other equipment, and upon completion of the Work remove all such temporary equipment.

E4.2 Construction Aids

E4.2.1 Temporary Plant

- (a) Provide, arrange for, maintain and pay for all temporary items such as, but not limited to, stairs, ladders, scaffolding, ramps, transportation of labour and material, runways, chutes, hoists, elevators, tools, templates, as required for the completion of the Work.
- (b) The location of such items shall be such as to prevent inference with, marking of, or damages to any portion of the Work.
- (c) All such items shall conform to all applicable national and local ordinances regulating safety and to the National Building Code of Canada, and to the requirements of the Contract.

E4.2.2 Temporary Enclosures

- (a) Furnish, install and maintain for the duration of construction all required scaffolds, tarpaulins, barricades, canopies, warning signs, steps, bridges, platforms and other temporary construction necessary for proper completion of the Work in compliance with all pertinent safety and other regulations.
- (b) During the Kenaston Underpass Pump Station project, a temporary chain link fence 1.8 m in height shall be erected around the perimeter of the Work. The Contractor shall be responsible for maintaining the chain link fence in a proper working condition. Provide a 6 m wide lockable gate. The cost of this work shall be incidental to the Contract.

E4.2.3 Falsework and Temporary Construction Supports

- (a) The Contractor shall be responsible for means and methods used for the falsework and temporary construction supports.
- (b) The Contract requires that the Contractor employ a qualified Registered Professional Engineer for the design of temporary works, and design in accordance with CSA S269.1.
- (c) Record design calculations and drawings to show that temporary works are adequate. Provide design loads, material details, and dimensions. Sign and seal design calculations and drawings, and revisions thereto.
- (d) The Contract Administrator's approval to proceed with falsework and temporary construction supports shall not relieve the Contractor of his responsibility under the Contract, The Contract Administrator's review shall be for general conformance to the intent of design and for permanent effects on the Site, or areas adjacent to the Site.

E4.2.4 Temporary Excavation

- (a) The Contractor is responsible for the means and methods of making temporary excavations in order to install components of the Work.

E4.2.5 Winter Construction

- (a) Special construction methods required to perform the Work in severe weather shall be the responsibility of the Contractor.
- (b) Where the specifications call for work to be performed within a given temperature range or above a minimum temperature. It shall be the Contractor's responsibility to

provide all temporary enclosures and heat necessary to provide the conditions specified.

- (c) Where compaction of backfill is specified, the Contractor shall perform the Work in a manner such that compaction can be achieved.
- (d) Where weather conditions are such that compaction of backfill consisting of excavated materials is not possible, the Contractor shall provide unfrozen granular material for backfill, at the Contractor's expense.

E4.2.6 Access Roads

- (a) Construct temporary access roads as necessary to perform the Work, and maintain temporary access roads until construction is over or until permanent access is established.
- (b) Locations and drainage facilities for temporary access roads are subject to the approval of the Contract Administrator.
- (c) No direct payment will be made to the Contractor for construction of temporary access roads.

E4.2.7 Protection – General

- (a) Remove fences and other structures from the Site of the Work, as necessary to perform the Work.
- (b) Remove only those items that must be removed, or are clearly shown on the drawings to be removed.
- (c) Protect all remaining trees, plants, fences and other items from damage during construction.

E4.2.8 Protection – Trees

- (a) The Contractor shall take the following precautionary steps to prevent damage from construction activities to existing boulevard trees within the limits of the construction area.
 - (i) The Construction shall not stockpile materials and soil or park vehicles and equipment on boulevards within 2 metres of trees.
 - (ii) Trees identified to be at risk by the Contract Administrator are to be strapped with 25 x 100 x 2400mm wood planks, or suitably protected as approved by the Contract Administrator.
 - (iii) Excavation shall be performed in a manner that minimizes damage to the existing root systems. Where possible, excavation shall be carried out such that the edge of the excavation shall be a minimum of 1.5 times the diameter (measured in inches), with the outcome read in feet, from the closest edge of the trunk. Where roots must be cut to facilitate excavation, they shall be pruned neatly at the face of excavation.
 - (iv) Operation of equipment within the dripline of the trees shall be kept to the minimum required to perform the work required. Equipment shall not be parked, repaired, refuelled, construction materials shall not be stored, and earth shall not be stockpiled within the dripline of trees. The dripline of a tree shall be considered to be the ground surface directly beneath the tips of its outermost branches. The Contractor shall ensure that the operations do not cause flooding or sediment deposition on areas where trees are located.
 - (v) Work on the Site shall be carried out in such a manner so as to minimize damage to existing tree branches. Where damage to branches does occur, they shall be neatly pruned.

- (b) All damage to existing trees caused by the Contractor's activities shall be repaired to the requirements and satisfaction of the Contract Administrator and the City Forester or his designate.
- (c) No separate measurement or payment will be made for the protection of trees.
- (d) Elm trees cannot be trimmed between April 1 and July 31, inclusive.

E4.2.9 Existing Utilities and Structures

- (a) Existing utilities and structures include pipes, culverts, ditches or other items which are a part of an existing sewerage, drainage or water system; or which are a part of gas, electrical, telephone, television, telecommunications, or other utility system. Also included are sidewalks, curbs, gutters, swales, poles, fences or any other structures encountered during construction.
- (b) The Contractor shall be responsible for location, protection, removal or replacement of existing utilities and structures, or for repair of any damage that may occur during construction.
- (c) Existing utilities and structures may be shown on the drawings, or described in the specifications. Such information is shown for design purposes and the existence, location and detail given is information that is obtained during the design period and is not necessarily complete, correct or current.
- (d) The Contractor shall pay all costs and be responsible for establishing locations and state of use of all existing utilities that may affect the Work. The Contractor shall make satisfactory arrangements with the utilities companies involved for the location, protection and inspection of existing utilities.
- (e) Notice in writing shall be given by the Contractor to the utilities companies at least 48 hours before work commences in the vicinity of existing utilities.
- (f) The Contractor shall pay all the costs involved in protection of utilities, inspection of utilities, and all costs due to delays because of existing utilities and structures.
- (g) The Contractor shall provide for the uninterrupted flow of all water courses, sewers and drains encountered during the Work.
- (h) Access shall be maintained to all existing structures such as valves, hydrants, meter chambers and control structures at all times during construction.
- (i) If interruption of service provided by an existing utility is necessary, the planned shut-down shall be approved by the owners of the utilities. Requests for shut-down shall be made by the Contractor in writing at least 48 hours in advance.
- (j) The Contractor shall notify all customers or make arrangements with the utility company to notify all customers 24 hours in advance of a shut-down.
- (k) Unless otherwise specified the Contractor shall make arrangements for relocation of existing utilities that the Contract Administrator requests to be relocated; and the actual relocation shall be constructed by the owner of the utility. The Contractor will be reimbursed the invoiced cost of the relocation. No extra payment is permitted for delays, or standby time.

E4.3 Temporary Controls

E4.3.1 Noise Controls

- (a) Perform the Work in conformity with all municipal by-laws with respect to noise, hours of work, night work and holiday work. Night work (after 9:00 p.m.) or holiday work requires the written permission of the Contract Administrator.

- E4.3.2 Dust Control
- (a) Perform the Work in a manner that will not produce an objectionable amount of dust. Dust control measures shall be paid for by the Contractor.
- E4.3.3 Pollution Control
- (a) Perform the Work in conformance with the applicable sections of the Provincial Regulations with respect to air and water pollution control requirements.
- E4.3.4 Disposal Of Wastes
- (a) Burying of rubbish and waste on Site is not permitted.
 - (b) Disposal of waste or volatile materials into waterways, storm or sanitary sewers is not permitted.
 - (c) Pumping or draining water containing silt in suspension into waterways, sewers or drainage systems is prohibited.
 - (d) Abide by requirements of Statute, Bylaw and Regulations respecting disposal of wastes.
 - (e) Obtain required Permits for waste disposal.
- E4.3.5 Work Adjacent to Waterways
- (a) Do not operate construction equipment in waterways, nor remove borrow material nor dump fill material into waterways, except as approved and permitted by the appropriate authorities. Obtain any required Permits.
- E4.3.6 Traffic Control
- (a) The Contractor shall obtain approval to block traffic temporarily if it is necessary to do so to perform the Work. Obtain the written approval of applicable municipal departments, the City of Winnipeg and the Contract Administrator. At least 48 hours prior to actually blocking traffic notify the following:
 - (i) Roadway Authority
 - (ii) Public Works Departments
 - (iii) Utilities Companies
 - (iv) Fire Department
 - (v) Police Department
 - (b) The Contractor shall supply all barriers, barricades, warning signs, detours, fences, flagmen and all other devices to protect the public. All applicable safety standards shall be followed.
 - (c) Provision of flagmen, traffic signs, and other traffic controls shall be the Contractor's responsibility and shall be in accordance with the Manual of Temporary Traffic Control in Work Areas on City Streets, most recent edition. This manual can be found on the City's website at www.winnipeg.ca/publicworks/transportation/manual-2003-04-23.pdf.
 - (d) The Contractor, meeting local regulations, shall provide adequate construction parking.
 - (e) Obtain permits as required to use public roads or streets for haul routes.

E5. WORK SEQUENCE

E5.1 Work Sequence

- E5.1.1 The Work shall generally be executed in the following sequence:
- (a) Excavation and shoring.

- (b) Complete all concrete substructure works.
- (c) Install emergency generator.
- (d) Construct Superstructure.
- (e) Install crane system.
- (f) Complete mechanical and electrical work.
- (g) Coordinate building servicing with Hydro and MTS for natural gas supply lines and telephone services.

E6. CONTRACTOR'S USE OF PREMISES

E6.1 The Worksite

E6.1.1 The City will provide the lands legally upon which the Work is to be constructed. This shall include the proposed Pump house site, and Municipal rights of way adjacent to the Worksite. Note that the Contractor must not utilize property extending beyond the limits shown on the drawings.

E6.2 Contractor's Use of the Worksite

E6.2.1 The Contractor shall have exclusive use and control of the Site.

E6.2.2 The City shall have unfettered use of thoroughfares, streets, lanes and other areas within the Site.

E6.2.3 During the Contractor's use of a particular Area of the Site to execute the Work, the Contractor shall be responsible primarily for security and for ensuring compliance with Health and Safety Regulations.

E6.2.4 The Contractor shall be responsible for access to the Site by means of temporary roads, tote roads, or agreements with the appropriate authorities to use existing means of access.

E6.2.5 The City has arranged for the Contractor to have access to the Site via Clarke access road off Sterling Lyon Parkway.

E7. COORDINATION

E7.1 General

E7.1.1 Although the specifications set forth the work of various trades under separate Sections or Clauses, it is not intended that the work of that trade is limited to or includes all work set forth in that particular Section or Clause. The Contractor shall delegate the extent of the Work to be done by the various trades and shall coordinate execution of the Work by all trades.

E7.1.2 Neither the Contract Administrator nor the City will be an arbitrator to establish limits of any agreements between the Contractor and his SubContractors.

E7.2 Mechanical and Electrical Coordination

E7.2.1 The Contractor shall examine the electrical, mechanical, structural and architectural drawings before beginning the Work and report to the Contract Administrator any discrepancies or interferences.

E7.2.2 Electrical and mechanical system layouts shown on the drawings may be diagrammatic and locations of outlets, fittings and equipment are approximate. Exact routing of conduits, wiring, pipes and tables shall be determined and coordinated by the Contractor to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.

E7.2.3 Obtain the Contract Administrator's approval for locations of outlets, fittings and equipment.

E7.3 Cutting and Patching

E7.3.1 The Contractor shall do all cutting, fitting, or patching of the Work that may be required to make its several parts come together properly and fit it to receive or be received by work of the Contract.

E7.3.2 Any cost caused by cutting and patching due to ill-timed work shall be borne by the Contractor.

E7.3.3 The Contractor shall not endanger any adjacent property or portion of the Work by cutting, digging or any other method, and shall be responsible for any damages caused by him.

E7.3.4 Coordinate the Work to minimize the amount of cutting and patching required.

E7.3.5 Do no cutting that may impair the strength of structures. Obtain the Contract Administrator's approval before cutting, boring or sleeving load-bearing members.

E7.3.6 Make cuts clean and smooth and make patches equivalent to new work.

E7.3.7 Provide openings, holes and sleeves as required for process mechanical, building mechanical, electrical and all other components of the Work. Provide openings in pre-cast work and cast-in-place work.

E7.3.8 Drill or field cut smaller openings or holes and cast openings larger than 100 mm diameter.

E7.4 Concealment

E7.4.1 Conceal pipes, ducts, conduits within walls and ceilings of finished areas, as required by the Contract.

E8. FIELD CONTRACT ADMINISTERING

E8.1 Field Contract Administering

E8.1.1 General

- (a) The Contract Administrator will provide detailed layout of the Work on two (2) occasions: 1) for the initial excavation limits and 2) for the wet well corners, limited as follows:
- (i) The Contractor shall be responsible for the correctness of the elevations and dimensions from the references provided by the Contract Administrator.
 - (ii) The layout of the Work shall be in accordance with the Work Schedule, which is prepared by the Contractor, submitted to the Contract Administrator for review and is updated monthly.
 - (iii) If the Contractor requests a change in layout procedure or sequence, he shall submit the request to the Contract Administrator, giving a minimum of 48 hours notice of new or revised activities, unless otherwise agreed between the Contract Administrator and the Contractor.
 - (iv) The notice requesting a change shall be extended to 96 hours whenever a long weekend is involved.

E8.1.2 Major Structures

- (a) The Contract Administrator will provide a baseline, reference points and a bench mark.

E8.1.3 Survey Assistance

- (a) The Contractor shall supply acceptable survey assistants to the Contract Administrator to assist in measuring, surveying, driving stakes and such other work as the Contract Administrator requires to lay out the Work.
- (b) For setting out line and stakes, one assistant shall be provided.
- (c) For survey levelling and preparation of grade sheets, one assistant shall be provided.
- (d) Survey assistants shall not be changed without the approval of the Contract Administrator.
- (e) If the Contractor fails to provide survey assistants that are acceptable to the Contract Administrator, the Contract Administrator will obtain assistants and deduct the cost and expenses thereof from the Progress Payment Certificates.

E8.1.4 Construction Stakes and Materials

- (a) The Contractor shall provide construction stakes including laths and hubs and any other required materials including flagging, ribbon, chalk, etc.

E9. REGULATORY REQUIREMENTS

E9.1 General

- E9.1.1 If the National Building Code of Canada applies to the Work, the standards of the Work shall conform to or exceed the minimum standards of the National Building Code of Canada.
- E9.1.2 The attention of the Contractor is drawn to the requirements of the Manitoba Builders' Lien Act and regulations there under.
- E9.1.3 Where the Work under this Contract is carried out within the requirements of the Manitoba Public Works Act, the Manitoba Public Works Act shall apply.
- E9.1.4 All other Manitoba acts and regulations thereof shall apply and the Contractor shall comply with the requirements thereof as though they had been specifically named in these specifications.

E9.2 Burning

- E9.2.1 Restrictions of federal, provincial and municipal authorities shall be complied with, and permits shall be obtained by the Contractor.

E9.3 Regulations, Standards and Codes

- E9.3.1 Codes, Standards and Regulations are specified in other sections of the specifications and the Work shall be done in accordance with those Codes, Standards and Regulations where applicable.

E9.4 Permits

- E9.4.1 The Contractor is required to obtain all Permit's for this project.

E10. IDENTIFICATION SYSTEMS

E10.1 General

- E10.1.1 All systems shall be installed and identified in accordance with the specified identification systems.

E10.2 Electrical

- E10.2.1 Electrical conductors shall be identified by Color Code as specified in E68 – General Electrical Provisions.
- E10.2.2 Buried conduits shall be identified in accordance with local codes and as specified in E68 – General Electrical Provisions and E68 – Conduit, Conduit Fastenings and Conduit Fittings.
- E10.2.3 Name plates shall be provided for electrical panels and equipment and are specified in E68 – General Electrical Provisions

E10.3 Mechanical

- E10.3.1 Mechanical and process equipment shall be labelled in accordance with E51 – Process Mechanical – General Provisions. Piping shall be Color coded as specified in E51 – Process Mechanical – General Provisions.
- E10.3.2 Painting specifications in E49 – Painting shall apply.

E11. SUBMITTALS

E11.1 General

- E11.1.1 Submittals are required in accordance with the provisions of this Specification Clause, to determine whether the specified Material and Product are furnished and installed in accordance with design intent as expressed in the Contract.
- E11.1.2 Individual submittals as required are detailed in other sections of the specifications.
- E11.1.3 Until submissions are reviewed, work involving relevant Product or Material may not proceed.
- E11.1.4 Where the phrase "or approved equivalent alternative" occurs in the Contract, do not assume that Material, Product or methods will be accepted as equal by the Contract Administrator unless the item has been specifically accepted for the Work by the Contract Administrator in writing.

E11.2 Identification of Submittals

Identify each submittal and resubmittal by showing at least the following information:

- (a) Name, address and telephone number of the submitter, and a name of an individual for contact.
- (b) Drawing number and specification number to which the submittal applies.
- (c) Whether an original submittal or resubmittal.
- (d) Confirmation of prior review by the Contractor.
- (e) Date of submittal or resubmittal.
- (f) Authorized signature of the Submitter.

E11.3 Coordination of Submittals

- E11.3.1 Prior to submittal for the Contract Administrator's review, coordinate all material:
 - (a) Determine and verify field dimensions and conditions and conformance with specifications, including Material, catalogue numbers, type numbers and similar data.
 - (b) Coordinate requirements between trades.
 - (c) Coordinate with requirements under laws, regulations, etc.

- (d) Secure required approvals of public agencies, inspection agencies and standards agencies and show proof of approvals acquisition.
- (e) Indicate any deviations from the intent of design as expressed in the Contract and request specific review of these deviations.

E11.4 Timing of Submittals

- E11.4.1 Make submittals far enough in advance to allow adequate time for coordination, Contract Administrator's review, revisions and re-submittals, and for supply and delivery in time for the scheduled installation in the Work.
- E11.4.2 Allow at least ten working days for the Contract Administrator's review after receipt of submittals.
- E11.4.3 Costs due to delays in making submittals shall be borne solely by the Contractor.

E12. SHOP DRAWINGS

- E12.1 Shop drawings shall be completed and submitted in accordance with CW-1110.

E13. DRAWINGS OF RECORD

E13.1 Record During Construction

- E13.1.1 The Contractor shall keep one complete set of all construction drawings on the Site.
- E13.1.2 On the site set of contract drawings, the Contractor shall record any changes that are made during the actual construction of the Work. The purpose of recording these changes is to provide drawings of record at the end of the Work. The Contractor shall be responsible for the adequacy and the reliability of the information recorded on the drawings of record.
- E13.1.3 At the completion of the construction period, the Contractor shall turn over the set of construction drawings that have been marked up with changes during the course of the Work to the Contract Administrator to permit the Contract Administrator to prepare drawings of Record for the Work.

E14. MATERIAL AND INSTALLATION

E14.1 Quality

- E14.1.1 Material and Product supplied and installed shall be new.
- E14.1.2 Material and Product supplied shall conform to these specifications and to specified standards.
- E14.1.3 Workmanship shall be the best quality, executed by workmen experienced and skilled in their respective trades.
- E14.1.4 Ensure full cooperation among all trades and coordination of the Work with continuous supervision.
- E14.1.5 Use Material of one manufacturer for Material of the same type or classification. Do not mix different manufacturer's Material in the Work or in parts of the Work.

E14.2 Manufacturer's Instructions

- E14.2.1 Unless otherwise specified, comply with the manufacturer's/supplier's instructions for Material or Product and installation methods.

E14.2.2 Notify the Contract Administrator in writing of any conflict between these Contract specifications and the instructions of the manufacturer/supplier.

E14.3 Fastenings

E14.3.1 Provide metal fastenings and accessories in the same texture, Color and finish as the base metal in which they occur. Prevent electrolytic action between dissimilar metals. Use non-corrosive fasteners, anchors and spacers for securing exterior work, or work that may be located in a corrosive atmosphere.

E14.3.2 Space anchors within limits of load bearing or shear capacity and ensure that they provide positive permanent anchorage.

E14.3.3 Space fastening evenly and lay out neatly.

E14.4 Delivery and Storage

E14.4.1 Deliver, store and maintain packaged Material and Product with manufacturer's seals and labels intact.

E14.4.2 Prevent damage and soiling of Material and Product.

E14.4.3 Store Material and Product in accordance with instructions of the manufacturer/supplier.

E14.4.4 Provide suitable areas or buildings where storage is weatherproof, if dry areas are recommended by the manufacturer/supplier.

E14.4.5 Material shall have name plates displaying Material data and serial numbers.

E14.4.6 Comply with Work Place Hazardous Materials Information Systems requirements.

E15. ENVIRONMENTAL PROTECTION PLAN

E15.1 The Contractor shall plan and implement the Work of this Contract strictly in accordance with the requirements of the Environmental Protection Plan as herein specified.

E15.2 The Contractor is advised that at least the following acts, regulations and by-laws apply to the Work and are available for viewing online at the applicable websites or at the office of the Contract Administrator.

E15.3 Federal

- (a) Canadian Labour Code
- (b) Workplace Health and Safety Act
- (c) Canada Transportation Act
- (d) Canadian Environmental Assessment Act and Regulations
- (e) Canadian Environmental Protection Act and Regulations
- (f) Migratory Birds Convention Act and Regulations
- (g) Species at Risk Act
- (h) Railway Safety Act and Notice of Railway Work Regulation
- (i) Transportation of Dangerous Goods Act and Regulations

E15.4 Province of Manitoba

- (a) The Environment Act
- (b) Litter Regulation
- (c) Waste Disposal Grounds Regulation

- (d) Storage and Handling of Gasoline and Associated Products Regulation
- (e) The Dangerous Goods Handling and Transportation Act
- (f) Polychlorinated Biphenyl Storage (PCB) Site Regulation
- (g) Environmental Accident Reporting Regulations
- (h) Generator Registration and Carrier Licensing Regulation
- (i) Manifest Regulation
- (j) The Fires Prevention Act and Regulation
- (k) The Public Health Act
- (l) Collection and Disposal of Wastes Regulation
- (m) The Ozone Depleting Substances Act and Regulations
- (n) The Waste Reduction and Prevention Act and Regulations
- (o) The Workplace Safety and Health Act and Regulations
- (p) The City Act
- (q) The Contaminated Sites Act
- (r) The Heritage Resources Act
- (s) The Sustainable Development Act
- (t) And current applicable associated regulations (Note: Provincial regulations updated as of September 1999)

E15.5 City of Winnipeg

City of Winnipeg By-Laws (<http://Winnipeg.ca/clerks/docs/bylaws/bylaws.stm>) application to the Kenaston Underpass Bridge Construction includes the following:

- (a) Alarms By-Lay 4676/87
- (b) Anti-Litter By-Law 1075/75
- (c) Development Fees By-Law No. 6965/97
- (d) Electrical Inspections By-Law 7436/99
- (e) Encroachment on Streets By-Law 692/74
- (f) Fire Prevention By-Law 1322/76
- (g) Noise Control By-Law 2480/79
- (h) Sewer By-Law 7070/97
- (i) Pigeon Control By-Law 978/75
- (j) Solid Waste By-Law 1340/76
- (k) Waterworks By-Law 504/73
- (l) Traffic By-Law 1573/77
- (m) City of Winnipeg Noise Policy and Guidelines.

E15.6 The Contractor is advised that the Environmental Approval has been issued for this project.

E15.7 The Contractor is advised that the Environmental Screening Report for the Kenaston Underpass Project, dated March 2005, applies to the Work and is available for viewing at the office of the Contract Administrator. A specific reference of the Environmental Screening Report Table 6.3 is included and describes the mitigation measures to be adhered to by the Contractor.

E15.8 The Contractor is advised that the following environmental protection measures apply to the Work.

E15.9 Materials Handling and Storage

- (a) Storage of construction materials shall be confined to the defined lay down areas as shown on the contract drawings.
- (b) Construction materials shall not be deposited or stored on or near drainage ditches unless written acceptance from the Contract Administrator is received in advance.
- (c) Construction materials and debris shall be prevented from entering the land drainage system. In the event that materials and/or debris inadvertently enter the land drainage system, the Contractor shall be required to remove the material and restore the land drainage system to its original condition.

E15.9.1 Fuel Handling and Storage

- (i) The Contractor shall obtain all necessary permits from Manitoba Environment for the handling and storage of fuel products and shall provide copies to the Contract Administrator.
- (ii) All fuel handling and storage facilities shall comply with The Dangerous Goods and Transportation Act Storage and Handling of Petroleum Products Regulation and any local land use permits.
- (iii) Fuels, lubricants, and other potentially hazardous materials as defined in The Dangerous Goods and Transportation Act and regulations shall be stored and handled within the approved storage areas.
- (iv) The Contractor shall ensure that all fuel storage containers are inspected daily for leaks and spillage.
- (v) Products transferred from the fuel storage area(s) to the Site shall not exceed the daily usage requirement.
- (vi) When servicing requires the drainage or pumping of fuels, lubricating oils or other fluids from equipment, a groundsheet of suitable material (such as HDPE) and size shall be spread on the ground to catch the fluid in the event of a leak or spill.
- (vii) Refuelling of mobile equipment and vehicles shall take place at least 100 metres from a watercourse.
- (viii) The area around storage Sites and fuel lines shall be distinctly marked and kept clear of snow and debris to allow for routine inspection and leak detection.
- (ix) A sufficient supply of materials, such as absorbent material and plastic oil booms, to clean up minor spills shall be stored on the Site. The Contractor shall ensure that additional material can be made available on short notice.

E15.9.2 Waste Handling and Disposal

- (i) The construction area shall be kept clean and orderly at all times during and at completion of construction.
- (ii) At no time during construction shall personal or construction waste be permitted to accumulate for more than one day at any location on the Site, other than at a dedicated storage area as may be approved by the Contract Administrator.
- (iii) The Contractor shall during and at the completion of construction, clean-up the construction area and all resulting debris shall be deposited at a Waste Disposal Ground operating under the authority of Manitoba Regulation #150/91. Exceptions are liquid industrial and hazardous wastes, which require special disposal methods (refer to Section 30.5.D).
- (iv) Indiscriminate dumping, littering, or abandonment shall not take place.
- (v) No on-site burning of waste is permitted.

- (vi) Waste storage areas shall not be located so as to block natural drainage.
- (vii) Runoff from a waste storage area shall not be allowed to cause siltation of a watercourse.
- (viii) Waste storage areas shall be left in a neat and finished appearance and/or restored to their original condition to the satisfaction of the Contract Administrator.
- (ix) Equipment shall not be cleaned near watercourses; contaminated water from onshore cleaning operations shall not be permitted to enter watercourses.

E15.9.3 Dangerous Goods/Hazardous Waste Handling and Disposal

- (i) Dangerous goods/hazardous waste are identified by, and shall be handled according to, The Dangerous Goods Handling and Transportation Act and Regulations.
- (ii) The Contractor shall be familiar with The Dangerous Goods Handling and Transportation Act and Regulations.
- (iii) The Contractor shall have staff on Site that is trained and certified in the handling of the dangerous/hazardous goods, when said dangerous/hazardous goods are being utilized on Site for the performance of the Work.
- (iv) Different waste streams shall not be mixed.
- (v) Disposal of dangerous goods/hazardous wastes shall be at approved hazardous waste facilities.
- (vi) Liquid hydrocarbons shall not be stored or disposed of in earthen pits on Site.
- (vii) Used oils shall be stored in appropriate drums, or tankage until shipment to waste oil recycling centres, incinerators, or secure disposal facilities approved for such wastes.
- (viii) Used oil filters shall be drained, placed in suitable storage containers, and buried or incinerated at approved hazardous waste treatment and disposal facilities.
- (ix) Dangerous goods/hazardous waste storage areas shall not be located so as to block natural drainage.
- (x) Runoff from a dangerous goods/hazardous waste storage area shall not be allowed to cause siltation of a watercourse.
- (xi) Dangerous goods/hazardous waste storage areas shall be left in a neat and finished appearance and/or restored to their original condition to the satisfaction of the Contract Administrator.

E15.9.4 Emergency Response

- (i) The Contractor shall ensure that due care and caution is taken to prevent spills.
- (ii) The Contractor shall report all major spills of petroleum products or other hazardous substances with significant impact on the environment and threat to human health and safety (as defined in Table 1 below) to Manitoba Environment, immediately after occurrence of the environmental accident, by calling the 24-hour emergency phone number (204) 945-4888.
- (iii) The Contractor shall designate a qualified supervisor as the on-Site emergency response coordinator for the project. The emergency response coordinator shall have the authority to redirect manpower in order to respond in the event of a spill.
- (iv) The following actions shall be taken by the person in charge of the spilled material or the first person(s) arriving at the scene of a hazardous material accident or the on-Site emergency response coordinator:
 - (v) Notify emergency-response coordinator of the accident:

- ◆ identify exact location and time of accident
 - ◆ indicate injuries, if any
 - ◆ request assistance as required by magnitude of accident (Manitoba Environment 24-hour Spill Response Line (204) 945-4888, Police, Fire Department, Ambulance, company backup)
- (vi) Attend to public safety:
- ◆ stop traffic, roadblock/cordon off the immediate danger area
 - ◆ eliminate ignition sources
 - ◆ initiate evacuation procedures if necessary
- (vii) Assess situation and gather information on the status of the situation, noting:
- ◆ personnel on Site
 - ◆ cause and effect of spill
 - ◆ estimated extent of damage
 - ◆ amount and type of material involved
 - ◆ proximity to waterways, sewers, and manholes
- (viii) If safe to do so, try to stop the dispersion or flow of spill material:
- ◆ approach from upwind
 - ◆ stop or reduce leak if safe to do so
 - ◆ dyke spill material with dry, inert absorbent material or dry clay soil or sand
 - ◆ prevent spill material from entering waterways and utilities by dyking
 - ◆ prevent spill material from entering manholes and other openings by covering with rubber spill mats or dyking
- (ix) Resume any effective action to contain, clean up, or stop the flow of the spilled product.
- (x) The emergency response coordinator shall ensure that all environmental accidents involving contaminants shall be documented and reported to Manitoba Environment according to The Dangerous Goods Handling and Transportation Act Environmental Accident Report Regulation 439/87.
- (xi) When dangerous goods are used on Site, materials for containment and cleanup of spill material (e.g. absorbent materials, plastic oil booms, and oversized recovery drums) shall be available on Site.
- (xii) Minor spills of such substances that may be contained on land with no significant impact on the environment may be responded to with in-house resources without formal notification to Manitoba Environment.
- (xiii) City emergency response, 9-1-1, shall be used if other means are not available.

Table 1		
Spills That Must be Reported to the Manitoba Conservation as Environmental Accidents		
Classification	Hazard	Reportable Quantity/Level
1	Explosives	All
2.1	Compressed Gas (flammable)	100 L*
2.2	Compressed Gas	100 L*
2.3	Compressed Gas (toxic)	All
2.4	Compressed Gas (corrosive)	All
3	Flammable Liquids	100 L
4	Flammable Solids	1 kg

Table 1		
Spills That Must be Reported to the Manitoba Conservation as Environmental Accidents		
Classification	Hazard	Reportable Quantity/Level
5.1 PG** I & II	Oxidizer	1 kg or 1 L
PG III	Oxidizer	50 kg or 50 L
5.2	Organic Peroxide	1 kg or 1 L
6.1 PG I	Acute Toxic	1 kg or 1 L
PG II & III	Acute Toxic	5 kg or 5 L
6.2	Infectious	All
7	Radioactive	Any discharge or radiation level exceeding 10 mSv/h at the package surface and 200 uSv/h at 1 m from the package surface
8	Corrosive	5 kg or 5 L
9.1	Miscellaneous (except PCB mixtures)	50 kg
9.1	PCB Mixtures	500 g
9.2	Aquatic Toxic	1 kg or 1 L
9.3	Wastes (chronic toxic)	5 kg or 5 L
*Container capacity (refers to container water capacity)		
**PG = Packing Group(s)		

E15.9.5 Noise

- (i) Noise-generating activities shall be limited to the hours indicated in the City of Winnipeg Noise Bylaw, and the Province of Manitoba Environment Act Licence, unless otherwise accepted in writing, in advance by the Contract Administrator.
- (ii) The Contractor shall be responsible for scheduling work to avoid potential noise problems and/or employ noise reduction measures to reduce noise to acceptable limits. The Contractor shall also demonstrate to the Contract Administrator that Works to be performed during the night-time period, on Sundays, and Holidays as stated in the Licence shall not exceed the approved limit.

E15.9.6 Dust

- (i) Dust control practices implemented by the Contractor during construction shall include regular street cleaning and dampening of construction access roads and work areas with water or approved chemicals at an adequate frequency to prevent the creation of dust.
- (ii) Only water or chemicals approved by the Contract Administrator shall be used for dust control. The use of waste petroleum or petroleum by-products is not permitted.
- (iii) The Contractor shall ensure that trucks which are used to haul excavated material and backfill material to and from the Site utilize tarpaulin covers during transport to prevent material from falling onto the street and creating dust.
- (iv) Stockpiled soils shall be covered with tarpaulin covers to prevent the creation of dust.

E15.9.7 Erosion Control

- (i) The Contractor shall develop a sediment control plan prior to beginning construction to the satisfaction of the Contract Administrator.
- (ii) Sediment control fencing, or other such erosion control structures, shall be employed wherever construction activity increases the potential for runoff to carry sediment into a drainage channel or other watercourse. The Contractor shall inspect all such structures daily during heavy construction activity in the areas of the structures and after a heavy rainfall to ensure their continued integrity.

- (iii) All areas disturbed during construction shall be landscaped and revegetated with native and/or introduced plant species in order to restore and enhance the Site and to protect against soil erosion unless otherwise indicated.
- (iv) The disturbed surface shall be revegetated so as to create a dense root system in order to defend against soil erosion on the right-of-way and any other disturbed areas susceptible to erosion.
- (v) The loss of topsoil and the creation of excessive dust by wind during construction shall be prevented by the addition of temporary cover crop, water, or tackifier, if conditions so warrant.

E15.9.8 Runoff Control

- (i) Measures shall be undertaken to ensure that runoff containing suspended soil particles is minimized from entering the land drainage system to the extent possible to the satisfaction of the Contract Administrator.
- (ii) Areas that are heavily disturbed and vulnerable to erosion or gulying shall be dyked to redirect surface runoff around the area prior to spring run-off.
- (iii) Construction activities on erodible slopes shall be avoided during spring run-off and heavy rainfall events.

E15.9.9 Vegetation

- (i) Right-of-way clearing shall be restricted to areas identified on the contract drawings.
- (ii) Rare, endangered, or threatened plant species shall be protected as specified in the Environmental Screening Report, if encountered.
- (iii) Vegetation shall not be disturbed without written permission from the Contract Administrator.
- (iv) The Contractor shall protect plants or trees, which may be at risk of accidental damage as specified in the Environment Screening Report. Such measures may include protective fencing or signage and shall be approved in advance by the Contract Administrator.
- (v) Herbicides and pesticides shall not be used adjacent to any surface watercourses.
- (vi) Trees or shrubs shall not be felled into watercourses.
- (vii) Areas where vegetation is removed during clearing, construction, and decommissioning activities, shall be revegetated as soon as possible in accordance with the landscaping plans forming part of the Contract, or as directed by the Contract Administrator.
- (viii) Trees damaged during construction activities shall be examined by bonded tree care professionals. Viable trees damaged during construction activities shall be pruned according to good practice by bonded tree care professionals.
- (ix) Damaged trees which are not viable shall be replaced at the expense of the Contractor.

E15.9.10 Landscaping

- (i) Construction waste (excluding common construction gravel, sand etc.) shall be removed to a minimum depth of 600 mm below final grade in all areas that are to be backfilled with suitable material and revegetated in accordance with Standard City Practice.
- (ii) The Contractor shall adhere to the landscaping plan for maintenance of initial stages and development stages of the plant community.

E15.9.11 Heritage Resources

- (i) If heritage material is located during the construction and soil removal process, all work shall cease and the Contractor shall immediately contact the Contract Administrator. The Historic Resources Branch, Manitoba Culture, Heritage and

Tourism, or the Project Archaeologist, shall be contacted by the Contract Administrator to determine the nature and extent of the archaeological material and to arrange for its recovery. The archaeological remains shall be recovered by salvage excavation upon authorization by the Contract Administrator, having consulted with the Historic Resources Branch, Manitoba Department of Culture, Heritage and Tourism.

- (ii) The Contractor shall be prepared to continue his work elsewhere on the project while the Archaeologist investigates the finding and determines its heritage value.
- (iii) The Contractor is advised that he may be denied access to such areas of the project until such time as a thorough archaeological investigation is conducted or the find is deemed to have no heritage value.
- (iv) Construction and excavation work shall not resume until the Contract Administrator, having consulted with the Historic Resources Branch, Manitoba Culture, Heritage and Tourism, or the project archaeologist, authorizes a resumption of work.
- (v) If human remains are uncovered during the construction and soil removal process, all work shall cease and the Historic Resources Branch, Manitoba Culture, Heritage and Tourism shall be contacted by the Contract Administrator. The Historic Resources Branch shall contact The City of Winnipeg Police.
- (vi) If the human remains are not considered forensic, i.e., no foul play suspected, they shall be removed by the Historic Resources Branch, Manitoba Culture, Heritage and Tourism or the project archaeologist and turned over to the Province.
- (vii) If the human remains are considered forensic, The City of Winnipeg Police shall be responsible for their removal.
- (viii) Additional information may be obtained by contacting: Archaeological Assessment Services, Historic Resources Branch

E15.9.12 Construction Traffic

- (i) Workforce parking shall be limited to the areas designated for such as detailed in the Contract, or as otherwise may be directed by the Contract Administrator.
- (ii) The Contractor shall adhere to the Standard Provisions of the Standard Construction Specifications, and of the Manual of Temporary Traffic Control in Work Areas on City Streets of The City of Winnipeg, Works & Operations Division.
- (iii) The Contractor's lay down area, work area, and access road shall be fenced and gated to secure the Site and materials and to discourage pedestrian entrance to construction areas and to control any potential hazard to the public, particularly children.
- (iv) For circumstances where the Contract Administrator has accepted Site access of special equipment or material, the Contractor shall provide adequate flagmen for traffic control in the vicinity of any public buildings.

E15.9.13 Access

- (i) The Contractor shall maintain access to affected residential properties.
- (ii) The Contractor shall provide or maintain general and off-street access to any affected business during construction.

E16. COMMISSIONING

E16.1 General

- E16.1.1 The Contractor shall provide, commission and turn over to the City a complete operating Pump Station and associated works.
- E16.1.2 For commissioning purposes the term Pump Station shall mean the Work of this Contract entirely.

- E16.1.3 Testing and commissioning shall normally proceed in three steps:
- (a) Hydrostatically test the wet well for concrete integrity.
 - (b) Test pump performance using draw-down testing.
 - (c) Commission the emergency generator.
 - (d) Commission all HVAC systems.
 - (e) Test all other individual items and items forming sub-systems, ready for operation.
 - (f) Commission the Work of this Contract entirely.
 - (g) Turn over the Work to the City.
- E16.1.4 Testing and commissioning shall be performed by the Contractor, in the presence of the Contract Administrator.
- E16.1.5 Testing shall be performed in two phases:
- (a) Static Testing, and
 - (b) Dynamic Testing.
- E16.2 Preparation
- E16.2.1 Establish a written detailed procedure and schedule and submit to the Contract Administrator at least 2 weeks in advance.
- E16.2.2 Follow the procedure and schedule unless otherwise agreed.
- E16.2.3 Inspect all Material and Product to ensure that the Work is complete, that Material and Product are in place and secure, and that the recommendations of the manufacturer/supplier have been complied with for lubrication, cooling fluids and all other requirements.
- E16.2.4 Inspect and clean all pipe, vessels and equipment, and all electrical connections.
- E16.3 Personnel
- E16.3.1 Provide competent, experienced, factory trained technical personnel to supervise the installation, inspection, testing and commissioning of Material supplied and installed under this Contract.
- E16.3.2 The Contractor shall provide and pay for all such personnel, regardless of the length of time required to commission the Work.
- E16.3.3 Use of the Contractor's personnel during commissioning of mechanical and electrical work will not be accepted in lieu of factory trained personnel.
- E16.4 Testing Individual Equipment
- E16.4.1 Every individual item of equipment shall be tested by itself and in combination with related items to ensure that the item and the subsystem are in perfect operating condition, comply with specified requirements and are ready for operation.
- E16.4.2 All testing, checking, calibration, adjustments, making of connections, setting, lubrication and other requirements shall be carried out and a brief report submitted to the Contract Administrator for each item tested individually.
- E16.4.3 Other sections of the specifications may contain specific testing, cleaning, disinfecting, balancing and operation requirements that are to be followed in conjunction with this Section.
- E16.4.4 Inspection and testing shall include, but shall not be limited to:

- (a) soundness - without damaged parts,
- (b) completeness in all details as specified,
- (c) correctness of setting, alignment and arrangements of parts,
- (d) adequacy and correctness of packing, sealing and lubrication.

E16.5 Commissioning

- E16.5.1 Commissioning shall include the Contractor's operation of the facilities as a complete system for one (1) calendar day, followed by the City's staff operating the facilities under the guidance of the Contractor for one (1) additional calendar day. These are minimum times based upon demonstration of satisfactory operation.
- E16.5.2 During the Commissioning period the Contractor shall appoint one qualified person to lead the commissioning group of Contractor's personnel, Subcontractor's personnel and manufacturer's / supplier's representatives.
- E16.5.3 Operation of any part of an existing system shall be performed by the City only.
- E16.5.4 The Contract Administrator may order changes in procedure, operation methods or may take whatever actions are necessary to ensure correct commissioning.
- E16.5.5 During the commissioning period, the Contractor shall demonstrate that the operation of the facility as a whole, as well as all components, is correct and in accordance with the Contract requirements.
- E16.5.6 All components shall be demonstrated over the entire range of operation specified, including variations in flow, pressures, speeds and controls.
- E16.5.7 All malfunctions, alarms, safety devices, interlocks, and annunciation shall be demonstrated by simulation of malfunctions as necessary.
- E16.5.8 During the initial commissioning period, only the Contractor shall operate the systems installed in this Contract, and the City's personnel shall observe and receive operation instructions.
- E16.5.9 During the second period of the commissioning the City's personnel will operate the facility under the guidance and supervision of the Contractor. At the end of the commissioning period the City will assume complete responsibility for operation of the facility.

E16.6 Installation Assistance and Inspections

- E16.6.1 The Contractor shall coordinate with the suppliers for the provision of the supplier services for all equipment specified herein. The Contractor shall coordinate and expedite the provision of these field services for the pump, gen-set, MCC and HVAC equipment and include all the related costs in the Bid Submission.
- E16.6.2 The Contractor shall ensure that skilled servicemen from the suppliers of equipment have instructed the Contractor in the proper installation of the equipment and that the Contractor has obtained and understands all necessary written installation instructions.
- E16.6.3 Toward the end of the installation period, after informing the Contract Administrator, notify the supplier to send his skilled servicemen to check over the completed installation of equipment specified. The servicemen shall make a detailed check of the installation including alignment, belt tension, bolt tensions, running clearances, lubrication and workmanship and all other items as required to ensure proper operation of the equipment. Promptly remedy any defects to the satisfaction of the supplier's skilled servicemen. The equipment shall then be run and tested in the presence of the serviceman, the Contractor and the Contract Administrator.
- E16.6.4 The supplier's skilled serviceman shall then certify that the installation is satisfactory.

E16.7 Equipment Start-Up Assistance

- E16.7.1 Notify the Contract Administrator fourteen (14) calendar days ahead of the date when start-up is to take place. Have the supplier send a skilled serviceman to the Site. The visit to Site may be concurrent with the check of satisfactory installation if mutually agreed by the supplier, the Contractor and the Contract Administrator.
- E16.7.2 On his start-up visit the supplier's skilled serviceman shall make all necessary checks to equipment and if necessary advise the Contractor as to any further checking, flushing or cleaning required prior to confirming that the equipment is ready to run.
- E16.7.3 The Contractor and the supplier's skilled representative shall then operate the equipment for at least four (4) hours to demonstrate to themselves the operation of the equipment and controls and shall take all necessary remedial steps to ensure satisfactory operation.
- E16.7.4 The Contractor shall then notify the Contract Administrator of his readiness to demonstrate the operation of the equipment and the Contract Administrator shall arrange to promptly attend such demonstration together with the City's representative.
- E16.7.5 The Contractor and the serviceman shall then demonstrate to the Contract Administrator's satisfaction that the equipment is properly aligned, that there is not pipe stress, etc. The Contractor shall carry out such tests as required by the Contract Administrator. All pieces of equipment shall be tested in the presence of the Contract Administrator to ascertain that the equipment conforms with the Contract requirements (i.e. pump flow tests, power draw tests, emergency generator, instruments, HVAC and other electrical system). The results of such tests shall be recorded by the Contractor on forms whose format has been agreed to by the Contract Administrator and the completed forms, signed by the Contractor, shall be given to the Contract Administrator. The Contractor shall arrange to provide all chemicals to demonstrate satisfactory operation.
- E16.7.6 Should the demonstration reveal any defects then such shall be promptly rectified by the Contractor and the demonstration of the equipment repeated to the satisfaction of the Contract Administrator. Should such repeat demonstration require a second, or subsequent visit to the Site by the Contract Administrator and / or City's representative, then the additional costs incurred shall be paid for by the Contractor. Upon satisfactory completion of this demonstration the equipment shall then be commissioned as scheduled by the Contractor and approved by the Contract Administrator.

E17. CONTRACT CLOSE OUT

E17.1 Cleanup

- E17.1.1 Maintain the working area in a clean and orderly manner as the Work progresses, and upon completion of construction, remove all waste materials, and all temporary facilities from the Site.
- E17.1.2 Remove surplus or salvaged materials belonging to the Contractor from the Site.
- E17.1.3 Vacuum clean interior building areas when ready for painting, and continue vacuuming as needed.
- E17.1.4 Remove grease, dust, dirt, stains, labels, finger prints and other foreign materials from sight on exposed interior and exterior finished surfaces, including glass and other polished surfaces.
- E17.1.5 Clean lighting reflectors, lenses and other lighting surfaces.
- E17.1.6 Broom clean paved surfaces, rake clean other surfaces of ground.
- E17.1.7 Remove debris and surplus materials from roof areas and accessible concealed spaces.

E17.1.8 Remove snow and ice from access to the building.

E17.2 Record Documents

E17.2.1 As specified in other sections of the specifications, the Contractor is required to prepare record drawings, to provide survey notes, to supply test results or other documents. Such information shall be turned over to the Contract Administrator before Total Completion is issued.

E17.2.2 Record documents shall be neat, legible and accurate.

E17.3 Operation Manuals

E17.3.1 Prepare operation and maintenance manuals and submit four copies to the Contract Administrator before Total Completion.

E17.3.2 Operation and maintenance manuals are specified in general in this section, with regard to numbers of binders, preparation, marking, general arrangement, format and general contents. Requirements for mechanical, process equipment, electrical work and other items may be specified in other sections of the specifications, however the general format shall be in accordance with this section.

E17.3.3 Provide the services of a qualified and experienced company to prepare manuals. Acceptable agency: Dynacom Communications Inc. or approved equal.

E17.3.4 Prepare sets of manuals for various divisions using identical bindings, and the same indexing system and format for all manuals.

E17.3.5 Provide 215 x 280 mm extension type catalogue binders bound with heavy weight bright blue fabric, hot stamped in silver lettering front and spine. Acropress, Cerlox or similar light weight or special hole binders are not acceptable.

E17.3.6 Letter each binder as follows:

Front Face

- Full identification of title of project
- Contract Administrator - full identification title
- Design Consultants - full identification title
- Contractor - full identification title
- Sub Contractors - full identification title

Spine

- full identification of title of project
- copy number

E17.3.7 Arrange each individual binder as follows, using colored divider tabs which shall be laminated mylar plastic and which shall be colored according to section of the manual.

E17.3.8 Each division of the manual ie. mechanical, electrical, process equipment etc. shall be a complete manual and shall in general be in the following format with the divider tabs as noted:

(a) Tab 1.0 Title Page

- job name & Owner's name
- address, telephone number and complete name of:
- Prime Consultant
- Sub Consultant
- General Contractor
- Sub Contractor
- index of all divider tabs

(b) Tab 1.1 List of drawings

- (c) Tab 1.2 Description of Systems
- (d) Tab 1.3 Operation of Systems
- (e) Tab 1.4 Maintenance & Lubrication (information for all equipment having moving parts).
- (f) Tab 1.5 List of suppliers and addresses of same
- (g) Tab 2.0, 2.1 etc. - Certifications
- (h) Tab 3.0, 3.1 etc. - Manufacturers data, Shop drawings, Bulletins

E17.3.9 Provide, in addition to mechanical, electrical equipment details:

- (a) Guarantees and warranties showing names and addresses of manufacturer and guarantee commencement and expiry date
- (b) valve lists giving numbers, types, service and location.
- (c) certificates and inspection reports by the manufacturers and their representatives.

DIVISION 2 – SITE CONSTRUCTION

E18. STRUCTURAL EXCAVATION AND BACKFILL

E18.1 Description

- (a) This section specifies requirements for excavation, backfilling and embankments for structures.
- (b) The Work includes:
 - (i) Temporary shoring, pumping and well point dewatering systems required to render excavations dry and firm.
 - (ii) Excavation of all material including removal of unsuitable materials; disposal of excess and unsuitable materials and backfilling to lines and grades shown on the drawings.
 - (iii) Supply of materials and construction of granular fills.

E18.2 Related Work

- (a) E26 - Structural Concrete.

E18.3 Design of Temporary Works

- (a) Engage the services of a Professional Engineer registered in Manitoba, to design and inspect cofferdams, shoring, timbering and bracing required for the Work.
- (b) Submit signed and stamped design drawings and supporting data for review by the Contract Administrator. Submittals shall be at least two weeks prior to commencement of construction.

E18.4 Excavated Materials

- (a) Excavated materials on Site are the property of the City. The Contractor shall dispose of excess materials as directed by the Contract Administrator. Useable excavated material can be used as backfill if permitted by Contract Administrator.

E18.5 Quality Assurance

- (a) Refer to E14 - Material and Installation.
- (b) Submit to the Contract Administrator a list of sources of materials including sand, gravel and borrow materials.

- (c) Provide samples, test results, sieve analyses and reports for preliminary approval of materials.
- (d) Preliminary approval of materials does not constitute general acceptance. Acceptance depend upon satisfactory field test results and performance in place.

E18.6 Quality Control Testing

- (a) Refer to E14 - Material and Installation
- (b) Moisture density curves to ASTM D698.
- (c) Sieve analyses to ASTM C136.
- (d) Field densities to ASTM D2167-84 or to ASTM D2922.
- (e) Minimum quality control test frequencies specified as follows are the minimum number required. The Contractor shall perform as many tests as are necessary to ensure that the Work conforms to the requirements of the Contract regardless of the minimum number required.
- (f) Provide moisture/density curves for each type of material from each source to be compacted to a specified density.
- (g) Field Densities:
 - (i) One field density for every 2000 m² of 150 mm compacted layers of backfill and embankment.
 - (ii) One field density for every 100 m² of 150 mm compacted layers of backfill under slabs.

E18.7 Equipment

- (a) Equipment used for dewatering the excavation shall be of a suitable and rugged type to assure continuous operation.
- (b) Make provisions as necessary to prevent flotation or damage to the Work in case of accidental stoppage of dewatering equipment.

E18.8 Materials

- (a) Backfill shall be either compacted granular backfill or compacted native backfill as shown on the drawings. All backfill materials shall be of a quality acceptable to the Contract Administrator and shall be free from large or frozen lumps, organic material or other unsuitable materials.
- (b) Granular fill shall comply with CW2030.

E18.9 Site Preparation

- (a) Clear and strip the Site to an extent as detailed on the drawings. Prepare sufficient space around the Site for stockpiling the excavated material necessary to construct embankments or to be used for backfilling.

E18.10 Excavation

- (a) The Contractor shall provide the Contract Administrator with a complete drawing showing the limits of the proposed excavation at least two (2) business days prior to the commencement of any Work on the Site, or within two (2) business days of a request, by the Contract Administrator for this drawing. This drawing shall include all elevations related to the excavation, limits of excavation, slopes, and location of shoring (as required). The drawing shall include a plan and elevation.

- (b) Excavate and remove all materials whatever their nature and condition to depths and dimensions necessary for the construction of the structure and piping to the limits shown on drawings.
- (c) Minimize disturbance to the supporting soil. Do not use large equipment at the bottom of the excavation without written consent of the Contract Administrator.
- (d) Dewatering
 - (i) It is the responsibility of the Contractor to remove water from trenches and excavations, regardless of origin.
 - (ii) Provide pumps and other equipment and materials necessary to keep excavators free of water while work is in progress.
 - (iii) Reroute ditches and other water courses that may conflict with the excavation as required.
 - (iv) Equipment used for dewatering shall be of a suitable and rugged type to ensure continuous operation.
 - (v) Make provision as necessary to prevent flotation or damage to the Work in case of accidental stoppage of de-watering equipment.
 - (vi) Protect excavations against flooding and damage due to surface run-off.
 - (vii) Dispose of the water away from the Work in a manner such that there is no damage to the Work or other property or persons.
 - (viii) Excavate to depth greater than shown on drawings if considered necessary by the Contract Administrator.
 - (ix) Fill with concrete (15 Mpa strength at 28 days) to proper grade at the Contractors own expense when any overexcavation has been carried out without prior approval from the Contract Administrator.
 - (x) Dispose of surplus or unsuitable material off the Site at the Contractors own expense when directed by the Contract Administrator.
 - (xi) Protect open excavations against freezing and excessive moisture.
 - (xii) Protect side slopes and excavations by diverting surface water away from the excavations.
 - (xiii) Blasting is not allowed as a method of excavation unless approved in writing by the Contract Administrator.

E18.11 Inspection

- (a) Notify the Contract Administrator for inspection after the excavation is completed.
- (b) Do not place any material on the soil until the Contract Administrator has inspected the depth of excavation and the character of the foundation material.

E18.12 Backfill Against Walls

- (a) Backfill only after the structures have been properly braced and tested such that concrete has reached 2/3 of the specified 28 day strength.
- (b) Place granular fill or approved native backfill as shown on the drawings.
- (c) Do not use frozen material for backfill.
- (d) Place granular material in layers not more than 200 mm in compacted thickness and compacted to 98% Standard Proctor Density. Do not over compact.
- (e) Place native material in layers not more than 150 mm in compacted thickness and compact to 98% Standard Proctor Density. Do not over compact.

- (f) Carry out backfilling evenly around structures to minimize unbalanced lateral earth pressure.
- (g) Keep heavy equipment at least 1.5m away from structures. Compact this portion using suitable light equipment.

E18.13 Backfill Under Slabs On Grade

- (a) Use granular fill and sand meeting requirements of CW-2030.
- (b) Do not use frozen material.
- (c) Typical slab on grade construction shall consist of:
 - (i) Granular material compacted to 98% Standard Proctor Density.
 - (ii) 0.25 mm polyethylene.
 - (iii) 50 mm layer of moistened and compacted sand.
 - (iv) Concrete slab.

E18.14 Embankments and Grading

- (a) Place all fills and embankments to elevations, contours and slopes shown on drawings.
- (b) Place and compact embankments as specified in E18-12 - Backfill Against Walls.
- (c) Grade top layer carefully to a smooth regular surface, with a minimum thickness of 150 mm of topsoil selected from the stripped stockpile.

E19. Site Work and Excavation

E19.1 General

E19.1.1 Description

- (a) This section specifies requirements for excavation and for site work for buildings.
- (b) Included in the work of this section are:
 - (i) Site preparation, demolition, clearing, stripping
 - (ii) Trenching and Backfilling for underground piping
 - (iii) Grading

E19.1.2 Submittals

- (a) At least 2 weeks before beginning work, the Contractor shall submit to the Contract Administrator for review, a complete and detailed outline of the procedures and methods that he/she will employ for this section of the Work.
- (b) The Contractor shall not begin work until the Contract Administrator has reviewed the submittal.

E19.1.3 Product Delivery, Storage and Handling

- (a) Deliver materials to the Site and store in a manner such that granular materials are kept in separate piles and manufactured materials are stored according to the recommendations of the manufacturer.

E19.1.4 Job Conditions and Regulations

- (a) Perform work under observation of Manitoba Workplace Health and Safety.
- (b) Perform work in a manner that will cause the least disruption to traffic.
- (c) The Contractor is responsible for posting of warning and traffic signs; supply and placing of barricades and protective hoarding.

E19.1.5 Disposal

- (a) All materials on site whether stockpiled, stored or excavated are the property of the City, and the City reserves the right to keep any part or all of the material.
- (b) The Contractor shall dispose of debris, waste, unsuitable material, rock or excess material at sites to be located by the Contractor.
- (c) The Contractor shall be responsible for all costs associated with disposal.

E19.2 Products

E19.2.1 Granular Materials

- (a) Granular Fill shall comply with CW2030.

E19.3 Execution

E19.3.1 Site Preparation

- (a) Clearing
 - (i) Cut, remove and dispose of all timber, brush, windfall, stumps and rubbish except such trees and shrubs as are designated for preservation.
 - (ii) Trim branches from timber and salvage usable timber. Salvaged timber shall be the property of the Contractor.
 - (iii) Dispose of branches and debris in accordance with E19.1.5.
 - (iv) Excavate, remove and dispose of roots, stumps, logs.
- (b) Demolition
 - (i) Demolish and remove from the Site all objects designated for removal as well as any obstructions, fences or debris. Salvageable items, as designated by the Contract Administrator, are to be deposited in the City's storage yard.
 - (ii) Items, which are hidden or buried, shall be removed if they are in the way of the structure or trenches. Structures and underground pipes which are not in the way, but are to be abandoned, may be left in place and capped or plugged.
- (c) Stripping
 - (i) Strip the Site to the limits shown on the drawings, or strip those areas specified or ordered in writing.
 - (ii) Strip all areas to be excavated for structures, pipes or roadways.
 - (iii) Strip the full depth of topsoil or organic material.
 - (iv) Stockpile topsoil temporarily and dispose of stripped material that is not suitable as topsoil.
 - (v) Disposal of unsuitable material shall be in accordance with E19.1.5.
- (d) Stockpiling
 - (i) Prepare space within the limits shown on the drawings for the Contractor's use for stockpiling excavated material and borrow materials.

E19.3.2 Excavation and Backfill

- (a) All excavation, and backfilling shall be as per CW2030.

E19.3.3 Embankments and Grading

- (a) Place all fills and embankments to elevations, contours and slopes shown on the drawings.
- (b) Compaction shall be to 95% of the maximum density as determined by the Standard Proctor Compaction Test.

- (c) Grade the top layer to a smooth regular surface.
- (d) If there is insufficient suitable material from excavation, supply and place common fill and compact to 95% of the maximum density as determined by the Standard Proctor Compaction Test.
- (e) If there are surplus materials after backfilling and embankments and grading are complete, remove surplus materials from the Site.
- (f) Grade the Site as necessary for grassed areas, gravelled areas, parking lots, roadways, sidewalks and curbs and gutters.

E19.3.4 Drainage

- (a) Grade the Site as shown on the drawings to provide drainage.

E19.3.5 Roadways and Parking Areas

E20. AGGREGATES - GENERAL

E20.1 Description

- (a) Refer to CW-2030 for all aggregate requirements.

E21. PRESSURE MAINS

E21.1 Description

- (a) This description shall amend and supplement Standard Specifications CW 2110-R8 and shall apply for specification requirements for the installation of Forcemain pipe.

E21.2 Materials

E21.2.1 750 mm PVC Forcemain Pipe

- (a) 750 mm Forcemain in accordance with AWWA – C905, PR 80, DR 51.
- (b) Where practical, pipe lengths used shall be the longest size manufactured to minimize the number of joints in the length of the line.
- (c) The PVC fittings shall be manufactured in accordance with the PVC series pipe noted in this Specification and shall conform to CSA B137.3.
- (d) The Contract Administrator may at any time require the Contractor to produce certification by an independent testing agency that materials used conform to the specified standards, and the costs of such certifications shall be borne by the Contractor.
- (e) Testing laboratories or agencies to test materials shall be independent testing agencies approved by the Contract Administrator.
- (f) Contractor shall submit pipe jointing procedures as recommended by the pipe manufacturer.
- (g) Material requirements for pipe bedding, backfill, and concrete shall be in accordance with CW2110-R8.
- (h) Mechanical Pipe Restraints shall be used at each bend in the 750 mm forcemain. The pipe restraints shall be Uni-Flange Series 1360, manufactured by the Ford Meter Box Company, Inc.

E21.3 Construction Methods

E21.3.1 Method of Pipe Installation for 750mm Forcemain

- (a) Forcemain to be installed by open cut and, where shown on drawings, by trenchless methods in accordance with these specifications.
- (b) Where field conditions are such that a cored hole cannot be made, the Contractor shall install the pipe in an open trench with the appropriate Class of backfill. No additional payment will be made for pipe required to be installed in shafts.

E21.3.2 Unloading, Shoring, Hauling, Stringing

- (a) Unloading, stockpiling, loading, hauling, stringing shall be done in such a manner as to prevent damage to pipe, lining, coating, fittings, and other materials.
- (b) Use only equipment approved by the Contract Administrator
- (c) Protect material from exposure to sunlight or from any condition that may harm pipe, linings or coating. Handle PVC pipe in cold weather in accordance with the manufacturer's recommendations.
- (d) String pipe without interfering with access for constructions, land owners and tenants.

E21.3.3 Trench Inspection

- (a) Check trench bottom for stability and notify the Contract Administrator.
- (b) Remove unstable soil from bottom of trench and replace with compacted 20mm down limestone if ordered by the Contract Administrator.

E21.3.4 Trench Widths

- (a) Widths of trenches shall be such that pipes can be laid and jointed properly and backfill placed and compacted properly.
- (b) Trench walls shall be vertical to 300mm above the top of the pipe and the width at this location shall not exceed the maximum.
- (c) Trench Width – Single Pipe
 - (i) Minimum – nominal pipe diameter plus 400mm
 - (ii) Maximum – nominal pipe diameter plus 600mm

E21.3.5 Bedding and Backfilling Shafts

- (a) Backfill of shaft within or partially within existing or proposed pavement area shall be class 3 as shown in standard drawing SD-002 as specified in Section CW 2030-R6.
- (b) Bedding for coring shaft be supplemented by a foundation of 100mm of mechanical compacted 20mm down limestone or a concrete skin coat (conforming to Clause 2.16 of CW 2160-R6) or equal.

E21.3.6 Pipelaying – General

- (a) Lay pipes with the bell ends facing in direction of laying operations.
- (b) Cut pipes where necessary to install fittings. Make cuts in accordance with the manufacturer's recommendations using recommended cutting tools and cut pipes squarely and accurately.
- (c) Pipe deflections at joint shall not exceed those specified by the pipe manufacturer.
- (d) Do not lay pipe in water or when, in the opinion of the Contract Administrator, trench conditions are unsuitable.
- (e) Cover open ends of installed pipe, when piping laying is not in progress to keep out trench water.
- (f) Heat gaskets as necessary for pipelaying in cold weather conditions.

- E21.3.7 Lowering Pipe and Accessories into Trench
- (a) Use implements, tools and facilities satisfactory to Contract Administrator, and use care to prevent damage to pipe and material. Do not drop pipe or materials into the trench.
 - (b) Cover pipe ends if necessary to keep clean.
- E21.3.8 Inspection of Pipe and Accessories
- (a) Inspect for defects immediately before lowering into the trench.
 - (b) Clean pipe and fittings before installation.
 - (c) Inspect pipe for ovality, gouges, or cuts, and reject any pipe having cuts deeper than 10% of the pipe wall thickness.
- E21.3.9 Laying the 750mm PVC Pipe
- (a) Clean the bell and spigot ends of the pipes.
 - (b) Insert the rubber ring with care so that the ring is in the correct position and is seated evenly around the pipe.
 - (c) Do not lubricate the rubber ring.
 - (d) Lubricate the spigot end, covering the bevelled end and the entire circumference of pipe, using a brush, cloth, hand, sponge or glove.
 - (e) Insert the spigot end into bell so that it is in contact with ring. Push the spigot end in until the reference mark on spigot end is flush with the end of the bell, using a bar and block or other approved equipment.
 - (f) Cut pipe to make square cut and bevel the ends using a bevelling tool. Locate the reference mark the proper distance from the bevel end.
 - (g) Lay PVC pipe in accordance with the recommendations of manufacturer of the pipe.
- E21.3.10 Hydrostatic Testing – General
- (a) The Contractor shall supply all testing equipment and personnel to perform hydrostatic test.
 - (b) Personnel shall be qualified to operate testing equipment and testing equipment shall be approved by Contract Administrator. Test pumps shall be motor driven and shall be complete with pressure gauges. An approved pressure recorder shall be provided to continuously record line pressure over 24 hour period.
 - (c) The Contractor shall advise the Contract Administrator 24 hours in advance of filling the line for testing.
- E21.3.11 Pressure Test
- (a) Pressure test after backfill in the pipe zone is complete and concrete thrust block are cured.
 - (b) Apply hydrostatic pressure of 1.5 times operating pressure or 690 kPa whichever is greater.
 - (c) Inspect all pipe joints for leakage.
 - (d) Repair leaks or replace defective pipe.
- E21.3.12 Leakage Test
- (a) Leakage test shall be performed on all pressure pipe systems, after backfilling is complete.
 - (b) Test in sections not exceeding 500m of main, or obtain the approval of the Contract Administrator to test larger sections.

- (c) Test procedures are similar for all types of pipe installed, however leakage allowances shall be in accordance with the specified allowance for each type of pipe.
- (d) Fill the system with water and expel air. If necessary install temporary taps to expel air and plug these after testing is completed.
- (e) Apply test pressure by means of test pump equipped with a measurable volume container acceptable to the Contract Administrator.
- (f) Test pressures shall be:
 - (i) 750mm Polyvinyl Chloride pipe – 1.50 times the operating pressure at the lowest part of the system or the rated pressure class of pipe, whichever is less.
 - (ii) Do not vary test pressures more than 5 psi.
- (g) Maintain test pressures for a duration of two hours.
- (h) Repair and test until leakage is within specified limits.

E21.3.13 Leakage Allowances

- (a) Allowable leakage will be determined by Contract Administrator using formula

$$L = NDP / 128,300$$

Where L = allowable leakage in litres per hour
N = number of joints in the test section
D = Nominal pipe diameter in millimetres
P = square root of the test pressure in kPa

- (b) The number of joints is estimated from the length of pipe installed.
- (c) An additional allowance is made when testing against closed metal seated valves. This allowance is 0.0012 litres per hour for each millimetre in nominal valve size.

E21.3.14 Thrust Blocks

- (a) Thrust blocks shall be installed at all bends on the 750mm forcemain as shown on the drawings. The thrust blocks will be used in conjunction with the mechanical pipe restraints (as specified in section E21.2.1 of this Specification) to improve the strength of the bends. Concrete used for thrust blocks shall conform to CW 2160 and where ever possible shall be bear against smooth cut, undisturbed soil. The thrust blocks shall be keyed a minimum 0.3m into undisturbed soil and the dimensions shall correspond to what is shown on drawing C01 for each different angle of bend. A 0.20mm (8mil) polyethylene sheeting bond breaker shall be place between the bend and the thrust block. The Contract Administrator shall inspect all thrust block formwork before any concrete is placed.

E21.3.15 Installation Period

- (a) The installation of the 750 forcemain shall not take place before June 5, 2006 to accommodate the watermain and feedermain relocations and removals. Care must be taken when working with heavy machinery around any of the existing or relocated pressure lines.

E22. LAND DRAINAGE SEWERS

E22.1 Description

- (a) This Specification shall amend and supplement Standard Specification CW2130-R9.

E22.2 Materials

E22.2.1 Reinforced Precast Concrete Pipe

- (a) Reinforced concrete jacking pipe shall be designed and manufactured in accordance with ASTM Standard C76 and the minimum strength class noted on the drawings or as required to withstand all forces imposed on the pipe due to jacking, whichever requirement is greater.
- (b) Where practical, pipe lengths used shall be the longest size manufactured to minimize the number of joints in each section of sewer.
- (c) Notwithstanding the pipe classes noted on the contract drawings the Contractor may elect to have the reinforced concrete pipe designed by direct design methods in accordance with the American Society of Civil Contract Administrators (ASCE) Standard Practice for concrete Pipe Design (SIDD). If direct design methods are employed the following minimum design requirements shall apply:
 - (i) Arching coefficients and earth pressure distribution shall be based on a Type 2 Standard installation.
 - (ii) Minimum soil density shall be 1920 kg/m³ for shafts backfilled in boulevard areas and 2160 kg/m³ for shafts backfilled in pavement areas.
 - (iii) Wall thickness shall conform to ASTM C76 for either a Wall B or Wall C.
 - (iv) Concrete strength and reinforcing steel requirements shall be determined for each section based on the greatest height of cover in that section. The design shall not further be broken down between sections.
 - (v) Minimum live loading requirements shall be based on the equivalent live load due to an AASHTO HS20 design vehicle.
 - (vi) Under no circumstances shall the design cross section be less than required to facilitate installation by jacking methods.
- (d) Where the Contractor elects to have reinforced concrete pipe design carried out by direct design methods, as opposed to the pipe classes noted on the drawings, the Contractor shall make a shop drawing submission (stamped with the seal of a Professional Engineer, Registered in the Province of Manitoba) in accordance with Clause 1.5 of CW1110-R1 summarizing all structural analysis and pipe wall design for each unique design section.
- (e) Each direct design pipe shall be clearly marked internally to designate its strength class in a manner approved by the Contract Administrator.

E22.2.2 Flowable Cement-Stabilized Fill

- (a) Flowable cement-stabilized fill for filling abandoned sewers or other underground voids shall be Concrete Mix Design D) in accordance with clause 2.16 of CW2160-R6.

E22.3 Construction Methods

E22.3.1 Method of Pipe Installation for 750 mm Diameter LDS

- (a) Land Drainage sewer to be installed by coring methods. Coring shall conform to Clause 3.4 of CW 2130-R9.
- (b) Where field conditions are such that a cored hole cannot be made, the Contractor shall install the pipe in an open trench with the appropriate Class of backfill. No additional payment will be made for pipe required to be installed in shafts.

E22.3.2 Bedding and Backfilling Shafts

- (a) Shafts to accommodate a tunnelling or jacking machine shall be constructed with a concrete foundation of sufficient cross section and trueness to adequately support and

align the machine during tunnelling operations. Concrete Mix Design in accordance with Clause 2.16 of CW 2160-R6.

- (b) Bedding for coring shafts shall be supplemented by a foundation of 100 mm of mechanically compacted 20 mm down limestone or a concrete skin coat of cement-stabilized fill (conforming to Clause 2.1 of CW 2030-R6) or equal.

E22.3.3 Submission of Construction Methodology

- (a) Trench excavation, placement and removal of shoring, bracing, or trench boxes shall be undertaken in a manner that will permit the proper bedding and backfill of Land Drainage Sewers.
- (b) Prior to the commencement of construction, the Contractor will be responsible to prepare a submission on construction method in the affected area for the review and approval of the Contract Administrator. Review and approval of the Contractor's proposed construction method shall in no way relieve the Contractor of responsibility for successful execution of the Work in accordance with the Contract.
- (c) The Contractor's submission on construction methodology in the affected area must address the following minimum considerations:
 - (i) Proposed method of construction.
 - (ii) Specialized equipment employed for use.
 - (iii) Additional design considerations as a result of the Contractor's proposed construction method.
 - (iv) Any design revisions required to accommodate the Contractor's proposed construction method.
 - (v) Other concerns that may be raised by the Contract Administrator in response to the Contractor's submission.
- (d) No Work shall commence on this portion of the project until review and approval of the Contractor's submission on construction methodology.
- (e) The steel can for the shaft approximately 15m west of the pump station shall be left in place after the installation of the proposed pipe is completed. The Contractor shall provide a secure cap for the steel can, complete with a secured lid surrounded by temporary fencing. The can shall remain in place until the Contractor selected for the underpass portion of the contract can connect to the 750 LDS and remove the can. This Contract shall be undertaken some time around April of 2006 and the connection and return of the can by July 2006.

E22.3.4 Reinforced Sections for Tunnel Sewer

- (a) Where construction is carried out by tunnelling it shall be reinforced at the following locations in accordance with the standard details for reinforcing noted on the contract drawings:
 - (i) At each shaft location for the full extent of the shaft to a distance 1.5 m beyond each shaft face.
 - (ii) At locations where connections are proposed to be made, for a distance equal to the width of the proposed excavation plus 1.5 m in either direction. The Contractor shall employ suitable means to control the width of excavation during reconnection operations.
 - (iii) At locations where cave-ins occur.

E22.3.5 Unauthorized Excavation

- (a) Unauthorized excavation during tunnelling shall be refilled with concrete of equal strength to the final tunnel lining at the Contractor's expense.

E22.3.6 Design Diameters

- (a) Internal diameters shown on the drawings are the minimum required. The Contractor may elect to increase these diameters to facilitate the use of tunnelling equipment. Prior to proceeding with a larger diameter, the Contractor must obtain written approval for the increased diameter from the Contract Administrator. All costs associated with increasing the diameter shall be borne by the Contractor.

E22.3.7 Utilities Relocations

- (a) All utility relocations, unless specifically noted otherwise, shall be the sole responsibility of the Contractor.

E23. CONNECTION OF 750 MM FORCEMAIN TO PUMP STATION

E23.1 Description

- (a) This Specification shall cover the 750 mm Forcemain connection to the pump station.

E23.2 Materials

E23.2.1 Pipe

- (a) 750 mm Forcemain in accordance with AWWA – C905, PR 80, DR 51 Reducer Coupling
- (b) Contractor to use a Ford Steel Reducing Coupler (Style FC6)

E23.3 Construction Methods

- (a) A sleeve shall be cast into the wall of the pump station and the reducer coupling mentioned above shall be secured to the sleeve to connect the pipe to the wall.

E23.4 Measurement and Payment.

- (a) The connection of 750mm LDS to the pump station will be will be measured on a unit basis. The number to be paid for shall be the total number of connections in accordance with this Specification and accepted by the Contract Administrator.

E24. CONNECTION OF 750 MM LDS TO PUMP STATION

E24.1 Description

- (a) This Specification shall cover the 750mm LDS connection to the pump station.

E24.2 Materials

E24.2.1 Reinforced precast concrete pipe C76-III

- (a) 750 mm

E24.3 Construction Methods

- E24.3.1** The Contractor shall secure the 750m LDS pipe to the pump station by having the 750mm LDS pipe protrude through the wall of the pump station by a minimum of 0.3m. The Contractor shall chip the concrete away from the end off the pipe to expose the reinforcing steel inside of the pipe and bend in back and tie it into the steel reinforcement of the pump station. The Contractor shall then cast the closure so that no steel reinforcing is exposed and there are no voids between the pump station and the LDS pipe.

E24.3.2 Backfilling at the Connection

- Contractor shall take extra care when backfilling the pipe connection to the building as to not compromise the coupling attaching the pipe to the wall.

E25. DANGEROUS WORK CONDITIONS

- E25.1 Further to Clause GC 6.26 of the General Conditions, the Contractor shall be aware that underground chambers, manholes, and sewers are considered a confined space and shall follow the "Guidelines for Confined Entry Work" as published by the Manitoba Workplace Safety and Health Division.
- E25.2 The Contractor shall be aware of the potential hazard that can be encountered in underground chambers, manholes and sewers such as explosive gases, toxic gases, and oxygen deficiency.
- E25.3 The air in a confined space must be tested before entry and continuously during the time that personnel are inside the space. Equipment for continuous monitoring of gases must be explosion-proof and equipped with a visible and audible alarm. The principal tests are for oxygen deficiency, explosion range and toxic gases. Testing equipment must be calibrated in accordance with manufacturer's specifications.
- E25.4 The Contractor shall ventilate all confined spaces including underground chambers, tunnels, pipes and shafts as required and approved by the Manitoba Workplace Safety and Health Act. If no ventilation is supplied, a worker must wear a respirator or supplied air to enter the confined space.
- E25.5 Workers must wear a respirator or supplied air at all times when entering an underground chamber, manhole, or sewer where live sewage is present.
- E25.6 The Contractor shall provide a photoionization detector (PID) on Site at all times to monitor potential hydrocarbon vapours in the confined spaces. The gas detector and safety equipment conforming to the Manitoba Workplace Safety and Health Act shall be made available to the Contract Administrator for his use during inspections. In addition, the Contract Administrator shall collect discrete air samples for laboratory analysis.
- E25.7 The Contract Administrator may issue a stop work order to the Contractor if the above guidelines are not being followed. The Contractor shall not resume his operations until the Contract Administrator is satisfied the Contractor is following the appropriate procedures. The Contractor shall have no claim for extra time or costs due to the stop of work order for not following these safety guidelines.

DIVISION 3 – CONCRETE

E26. STRUCTURAL CONCRETE

- E26.1 Description
- (a) This Specification shall cover the preparation of Portland Cement Concrete for, and all concreting operations related to the construction of Portland Cement Concrete works as specified herein.
 - (b) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all work as hereinafter specified.
- E26.2 Materials
- E26.2.1 General
- (a) The Contractor shall be responsible for the supply, safe storage and handling of all materials set forth in this Specification.
- E26.2.2 Handling and Storage

- (a) All materials shall be handled and stored in a careful and workmanlike manner, to the satisfaction of the Contract Administrator. Storage of materials shall be in accordance with CSA Standard CAN/CSA A23.1-2000.

E26.2.3 Testing

- (a) All materials supplied under this Specification shall be subject to inspection and testing by the Contract Administrator by the testing laboratory designated by the Contract Administrator. All costs for material testing shall be covered by the City. Testing shall be undertaken by a CSA certified laboratory designated by the Contract Administrator. There shall be no charge to the City for any materials taken by the Contract Administrator for testing purposes.
- (b) All materials shall conform to CSA Standard CAN/CSA A23.1-2000.
- (c) All testing of materials shall conform to CSA Standard CAN/CSA A23.2-2000.
- (d) All materials shall be approved by the Contract Administrator at least seven (7) days before any construction is undertaken. If, in the opinion of the Contract Administrator, such materials, in whole or in part, do not conform to the specification detailed herein or are found to be defective in manufacture or have become damaged of transit, storage or handling operations, then such material shall be rejected by the Contract Administrator and replaced by the Contractor at his own expense.

E26.2.4 Aggregates

- (a) The Contractor shall furnish in writing to the Contract Administrator the location of the sources where aggregate will be obtained in order that it may be inspected and tentatively approved by the Contract Administrator. Changes in the source of aggregate supply during the course of the Contract will not be permitted without notification in writing to and the expressed approval of the Contract Administrator.
- (b) Fine Aggregate
 - (i) Fine aggregate shall consist of sand having clean, hard, strong, durable, uncoated grains free from injurious amounts of dust, soft or flaking particles, shale, alkali, organic matter or other deleterious substances. Fine aggregate shall be well graded throughout and shall conform to the following grading requirements.

Sieve Size	Percent of Total Dry Weight Passing Each Sieve
10000	100%
5000	95% - 100%
2500	80% - 90%
1250	50% - 90%
630	25% - 65%
315	10% - 35%
160	2% - 10%

- (ii) The fineness modulus of fine aggregate shall not be less than 2.2 or more than 3.1 unless otherwise approved by the Contract Administrator.
- (c) Course Aggregate Standard
 - (i) Standard course aggregate shall be used for all the concrete described and required in this Specification.

- (ii) Standard course aggregate shall consist of natural gravel, crushed stone, or other approved materials of similar characteristics, having clean, hard, strong, durable, uncoated particles, free from injurious amounts of soft, friable, thin, elongated, or laminated pieces, alkali, organic, or other deleterious matter. Course aggregate shall be well graded throughout and shall conform to the grading requirements in the following table.

Sieve Size	Percent Passing
20000	100%
14000	90% - 100%
10000	45% - 75%
5000	0% - 15%
2500	0% - 5%

E26.2.5 Cement

- (a) All cement shall be as specified on the project drawings, conforming to requirements of CSA Standard CAN/CSA-A5.

E26.2.6 Supplementary Cementing Materials

- (a) Use of pozzolans, fly ash or silica fume will be permitted for use in Structural Concrete supplied under this Specification up to a maximum of 15% of cement content.

E26.2.7 Water

- (a) Water used for mixing concrete shall be clean and free from injurious amounts of oil, acid, alkali, organic matter or other deleterious substances. It shall be equal to potable water in physical and chemical properties.

E26.2.8 Admixtures

- (a) No admixtures, other than Air-Entraining Agent and Water Reducing Agent, as specified below, shall be used without the written authorization of the Contract Administrator, unless otherwise specified in these Specifications. It shall be the Contractor's responsibility that each admixture is compatible with all other constituent materials, with respect to the proper performance of the admixture as well as with respect to the proper performance of the other constituents in the presence of the admixture.
 - (i) Air-Entraining Agent
 - ◆ The air-entraining agent shall conform to the requirements of ASTM Standard C260 and shall produce a satisfactory air-void system and an air content within the ranges specified in CSA Standard CAN/CSA-A23.1-2000 for each class of concrete.
 - (ii) Water-Reducing Agent
 - ◆ The water reducing agent shall be Type WN and shall conform to the requirements of ASTM Standard C494.
 - (iii) Other Admixtures
 - ◆ No other admixtures will be authorized for use in Portland Cement Concrete, unless authorized in writing by the Contract Administrator.

E26.2.9 Floor Hardener

- (a) Non-metallic floor hardener: premixed abrasion resistant hardener.

- (b) Products shall be as manufactured by Master Builders Co. Ltd. or approved equivalent.

E26.2.10 Concrete Curing Compound

- (a) Chlorinated rubber type compound conforming to CSA-A23.1, Type 1.
- (b) On colored floors, wax-free curing and sealing compound "Floor Coat" as manufactured by Master Builders Co. Ltd., or approved equivalent alternate.
- (c) Where topping or waterproofing is to be applied, ensure adequate surface preparation of the concrete for proper bonding (Clause 21, CSA-A23.1).

E26.2.11 Slurry Coat

- (a) Slurry coat mix to be 2 parts sand, 1 part cement and 1 part water.

E26.2.12 Patching Mortar

- (a) The patching mortar shall be made of the same material and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than 1 part cement to 2 parts sand by damp loose volume. White Portland Cement shall be substituted for a part of the grey Portland Cement on exposed concrete in order to produce a color matching the color of the surrounding concrete, as determined by a trial patch unless patch is located in a painted area. The quantity of mixing water shall be no more than necessary for handling or placing.

E26.2.13 Formwork

- (a) Unless otherwise indicated on the drawings, all formwork shall comply as follows:
- (b) Formwork materials shall conform to CSA Standard CAN/CSA-A23.1-2000 and American Concrete Publication SP-4 "Formwork for Concrete".
- (c) Form sheeting plywood shall be exterior Douglas Fir, concrete form grade, conforming to CSA 0121, a minimum of 20 mm thick.
- (d) Boards used for formwork shall be fully seasoned and free from defects such as knots, warps, cracks, etc., which may mark the concrete surface.
- (e) No formwork accessories will normally be allowed to be left in place within 50 mm of the surface following form removal. However, if the Contract Administrator does permit these items to be left in place, they must be made from a non-rusting material or galvanized steel; and they shall not stain, blemish, or spall the concrete surface for the life of the concrete.
- (f) Forms for exposed surfaces may be either new plywood or steel as authorized by the Contract Administrator.
- (g) Studding shall be spruce or pine and shall have such dimensions and spacing that they shall withstand, without distortion, all the forces to which the forms will be subjected.
- (h) All forms are incidental to these works and must be removed by the Contractor once adequate strength and curing of the concrete has been achieved.

E26.2.14 Waterstop

- (a) The Waterstop, as indicated on the drawings shall be incidental to the supply and placement of concrete.

E26.2.15 Plain Formliner

- (a) Plain formliner shall be Zemdrain by Dupont, or equal as accepted by the Contract Administrator. This formliner shall be used on all exterior exposed formed surfaces.

E26.2.16 Expanding Grout

- (a) Where non-shrink grout is used, it shall be Sika 212 Non-Shrink Grout, or equal as accepted by the Contract Administrator. The minimum compressive strength of the grout at 28 days shall be 56 MPa.

E26.2.17 Epoxy Grout

- (a) Where epoxy grout is used, it shall be Sika Tallygrout 100, or equal as accepted by the Contract Administrator.

E26.3 Concrete Design Requirements

E26.3.1 Mix Design Statement

- (a) For each type of concrete used, the Contractor shall provide the Contract Administrator with a Mix Design Statement, certifying the constituent materials and mix proportions that will be used in the Portland Cement Concrete. The Contractor shall include, in the certification, the following information:
 - (i) List the product name and source of all proposed constituent materials of the concrete including cement, coarse aggregate, fine aggregate, water, water reducing agent, and air entraining admixture. A statement is required indicating that the constituent materials proposed for each mix design are compatible with each other, thereby providing concrete with good long-term durability capabilities.
 - (ii) Supply recent records of each mix design for concrete quality control tests including slump, total air content, and 7 and 28-day compressive strengths. The Contractor shall supply reasonable evidence that the mix designs submitted will produce concrete with the specified strength, workability and yield.
 - (iii) When previously satisfactory strength data on the proposed mix is not available, the Contract Administrator may request the preparation of field trial batches in order that the concrete be tested prior to construction. Such field trial batches shall be carried out in similar conditions and using similar equipment, batching, and mixing procedures as will be used in the actual construction. The number of trial batches required shall be determined by the Contract Administrator and shall depend on the class of concrete materials.
 - (iv) Supply recent test information, on coarse aggregates of water absorption and abrasion.
 - (v) Supply recent information, if available on coarse aggregate alkali-silica reactivity.
 - (vi) Supply recent information on tests performed on Portland Cement, fly ash and silica fume.
 - (vii) Supply any other information deemed applicable.
- (b) The Contractor shall perform the following tests and submit the results to the Contract Administrator prior to the start of construction.
 - (i) Determine the gradation of fine and coarse aggregates in accordance with CSA Test Method A23.2-2A. Results shall be within acceptable limits specified herein.
 - (ii) The Contractor shall submit test data showing that the Contractor's proportioning and mixing equipment, procedures and concrete mix constituent materials are capable of producing a satisfactory air-void system in the hardened concrete. Prior to Site mobilization, the Contractor shall prepare and cast representative test specimens of each type of concrete using the same proportioning and mixing equipment and procedures, and the same concrete admixtures as will be employed for the supply and placement of each type of structural concrete.

- (iii) The cost for batching, casting, and testing trial batch specimens shall be incidental to the Supply and Placement of Structural Concrete. No measurement or separate payment will be made for this work
- (iv) The Mix Design Statement shall be submitted to the Contract Administrator at least twenty-one (21) days prior to the delivery of any concrete to the Site. Once accepted by the Contract Administrator, all concrete shall be supplied in accordance with this Statement, which shall be called the Job Mix Formula.
- (v) No changes in the job mix formula will be permitted without following the above procedure.

E26.3.2 Concrete Supply

- (a) Unless otherwise specified in these Specifications of the Contract, only the use of a certified ready-mixed concrete plant will be permitted in accordance with Standard Specification CW 3310-R9. Concrete shall be proportioned, mixed and delivered in accordance with the requirements of CSA Standard CAN/CSA-A23.1-2000, "Production of Concrete", except that the transporting of ready-mixed concrete in non-agitating equipment is not permitted without the written permission of the Contract Administrator.
- (b) Unless otherwise directed by the Contract Administrator, the discharge of ready-mixed concrete shall be completed within 1½ hours after the introduction of the mixing water to the cement and aggregates.
- (c) The Contractor shall maintain all equipment used for handling and transporting the concrete in a clean condition and proper working order.

E26.3.3 Equipment

- (a) General
 - (i) All equipment shall be of a type accepted by the Contract Administrator. The equipment shall be in good working order, kept free from hardened concrete or foreign materials, and shall be cleaned at frequent intervals.
 - (ii) The Contractor shall have sufficient standby equipment available on short notice at all times.
- (b) Vibrators
 - (i) The Contractor shall have sufficient numbers of concrete vibrators and experienced operators on Site to properly consolidate all concrete in accordance with ACI 309. The type and size of vibrators shall be appropriate for the particular application, the size of the pour, and the amount of reinforcing and shall conform to standard construction procedures.
 - (ii) The Contractor shall have standby vibrators available at all times during the pour.
- (c) Miscellaneous Equipment
 - (i) The Contractor shall provide all miscellaneous equipment as required to properly and thoroughly execute and complete all operations related to the supply and placement of structural concrete.

E26.3.4 Concrete Mix Requirements

- (a) As shown on the project drawings.

E26.4 Construction Methods

E26.4.1 Scope of Work

- (a) It is intended that this Specification covers the construction of cast-in-place concrete items, as indicated on the drawings:

E26.4.2 Formliner

- (a) Plain formliner shall be used on all exposed formed surfaces. The installation of the formliner shall be in strict accordance with the manufacturer's recommendations. The supply and use of the plain formliner finish shall be considered incidental to the works of this Specification and no separate payment will be made.

E26.4.3 Formwork and Shoring

- (a) Formwork shall be designed, erected, braced and maintained to safely support all vertical and lateral loads until such loads can be supported by the concrete all in accordance with CSA Standard CAN/CSA S269.3.
- (b) Forms shall be clean before use. Plywood and other wood surfaces shall be sealed against absorption of moisture from the concrete by a factory-applied liner.
- (c) Form accessories to be partially or wholly embedded in the concrete, such as ties and hangers, shall be commercially manufactured types. The portion remaining within the concrete shall leave no metal within 50 mm of the surface when the concrete is exposed to view. Spreader cones on ties shall not exceed 25 mm in diameter.
- (d) All exposed edges shall be chamfered 25 mm unless otherwise noted on the drawings.
- (e) Brace shores horizontally in two directions and diagonally in the same two vertical planes so that they can safely withstand all dead and moving loads to which they will be subjected.
- (f) The loads and lateral pressures outlined in Part 3, Section 102 of "Recommended Practice for Concrete Formwork", (ACI 347) and wind loads as specified by the National Building Code shall be used for design. Additional design considerations concerning factors of safety for formwork elements and allowable settlements outlined in Section 103 of the above reference shall apply.
- (g) Formwork shall be constructed to permit easy dismantling and stripping and such that removal will not damage the concrete. Provision shall be made in the formwork for shores to remain undisturbed during stripping where required.
- (h) Forms shall be constructed and maintained so that the completed work is within minus 3 mm or plus 6 mm of the dimensions shown on the drawings.
- (i) Formwork shall be cambered, where necessary to maintain the specified tolerances, to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to construction loads.
- (j) Forms shall be sufficiently tight to prevent leakage of grout or cement paste.
- (k) Form panels shall be constructed so that the contact edges are kept flush and aligned.

E26.4.4 Concrete Specialities

- (a) Provide and install all concrete specialities as shown on the plan and/or as necessary to complete the concrete work.
- (b) Included are fibreboard expansion joint covers, water stop and bond breakers.

E26.4.5 Placing Concrete

- (a) The Contract Administrator must be notified at least 48 hours prior to concrete placing so that an adequate inspection may be made of formwork, shoring, reinforcement, and related Works. Concrete placed without required prior notification will be rejected.
- (b) Equipment for mixing or conveying concrete shall be thoroughly flushed with clean water before and after each pour. Water used for this purpose shall be discharged

outside the forms. Pumping of concrete will be allowed only on permission from the Contract Administrator and all equipment and processes are subject to acceptance.

- (c) Concrete shall be conveyed from the mixer to the place of final deposit by methods, which will prevent segregation and a marked change in consistency.
- (d) Runways for concrete buggies shall be supported directly by the formwork and not on reinforcement.
- (e) Before depositing any concrete, all debris shall be removed from the space to be occupied by the concrete, and any mortar splashed upon the reinforcement or forms shall be removed.
- (f) Placing of concrete, once started, shall be continuous. No concrete shall be placed on concrete, which has sufficiently hardened to cause the formation of seams of "cold joints" within the section. If placing must be interrupted, construction joints shall be located where shown on the drawing or as accepted by the Contract Administrator, failure to do so will result in rejection and removal of concrete.
- (g) Concrete shall be placed as nearly as possible in its final position. Rakes or mechanical vibrators shall not be used to transport concrete.
- (h) The maximum drop of free concrete into the forms shall not be greater than 1.5 m otherwise rubber tubes or pouring ports spaced not more than 1.5 m vertically and 2.5 m horizontally shall be used. The Contractor shall obtain the Contract Administrator's acceptance prior to pouring concrete of all placing operations.
- (i) All concrete, during and immediately after depositing, shall be consolidated by mechanical vibrators so (if recommended by producer) that the concrete is thoroughly worked around the reinforcement, around embedded items and into the corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Mechanical vibrators shall have a minimum frequency of 7000 revolutions per minute immersed.
- (j) At water tight horizontal joints, apply the first layer of new concrete above the joint with an excess of mortar, obtained by omitting 20 to 50 percent of coarse aggregate from the normal mix.
- (k) Vibrators shall be inserted systematically into the concrete at intervals such that the zones of influence of the vibrator overlap (generally 300 to 900 mm). Apply the vibrator at any point until the concrete is sufficiently compacted (5 to 15 seconds), but not long enough for segregation to occur. Spare vibrators in working condition shall be kept on the Site during all placing operations.
- (l) Concrete shall not be placed during rain or snow unless adequate protection is provided for formwork and concrete surfaces.

E26.4.6 Finishing of Concrete Surfaces

- (a) To CSA-A23.1 and as specified herein:
- (b) Reservoir wall and base slab finish.
 - (i) Use on concrete surfaces not exposed to view in the completed structure.
 - (ii) Chip off fins and irregular projections.
 - (iii) Patch honeycomb and fill tie holes with mortar containing approved bonding agent. Mix according to manufacturer's directions.
- (c) Floated surface finish.
 - (i) Strike off the compacted concrete to the cross section and elevation shown on the plans. Keep a slight excess of concrete in front of the screed at all times.

- (ii) Obtain a uniform surface by floating with wood or metal floats as necessary. If floating is not completed before excess water appears at the surface, remove this water before continuing with floating.
 - (iii) Add or remove concrete during floating as required to obtain a surface with no more than 3 mm deviation from the required surface in any 3 metre length.
 - (iv) Do not overwork the concrete surface. Float only enough to obtain a dense uniform surface.
- (d) Broomed finish (Exterior Slabs on Grade)
- (i) After completion of Article E27.4.6 (c), broom to produce a non-slip surface with regular corrugations not more than 3 mm deep.
- (e) Troweled finish (Main Floor and Mechanical Floor Finish)
- (i) After completion of Article E27.4.6 (c), trowel to produce a dense smooth finish.
 - (ii) Steel trowel in accordance with CAN / CSA A23.1 – M94 Class A.
 - (iii) Follow with second steel trowelling to produce smooth burnished surface.
 - (iv) Do not sprinkle dry cement and sand mixture over concrete surfaces.
 - (v) Apply curing compound to manufacturer's instructions except on concrete to receive protective coating.
- (f) Workmanship for Floor Slabs
- (i) Steel trowel concrete slabs to be left exposed.
 - (ii) Where floor drains occur, floors shall be level around walls and have a minimum 1% uniform pitch to drains, unless indicated otherwise on plans.
 - (iii) Concrete which is to receive protective coating shall be cleaned free of dirt, oil, loose material and laitance.
 - (iv) Concrete slabs to receive protective coating to be screeded off to true lines and levels shown and left ready to receive finish.
- (g) Areas which are exterior walkways, driveways or landings, shall receive a broomed non-slip surface.

E26.5 General Curing

- (a) Curing shall be according to CSA-A23.1 and as specified herein.
- (b) Prevent loss of moisture from concrete surfaces for at least seven days after concreting.
- (c) Protect exposed concrete slab surfaces as follows, subject to approval by the Contract Administrator.
- (d) Use curing compound for floors.
- (e) Maintain concrete temperatures as recommended according to CSA-A23.1.

E26.6 Form Removal

- (a) Forms shall not be removed until removal operations will cause no damage to concrete surfaces.
- (b) Beam and slab soffit forms shall not be removed until sufficient strength has been attained for support of the applied dead and live loads and to minimize deflections.
- (c) See Clause 11 CSA-A23.1 for specific requirements.

E26.7 Patching and Finishing of Hardened Concrete

- (a) Patching, if required and if allowed, shall be done immediately after stripping.
- (b) Methods of patching and repair shall be submitted to the Contract Administrator and accepted before repair work is started.

- (c) All form ties shall be cut back a minimum of 25 mm and all tie holes shall be neatly patched and rubbed down.

E26.8 Grouting

- (a) Grout underside of steel columns and beam bearing plates with expanding grout to manufacturer's instructions.

E26.9 Cold Weather Requirements

- (a) When the air temperature is at or below 5°C, or when there is a possibility of it falling to that limit within 24 hours of placing, the requirements according to CSA-A23.1 shall be met.
- (b) Withdraw protection and heating gradually so that air temperature around the concrete does not drop more than 15 Celsius degrees per day.
- (c) Concrete shall be protected from alternate freezing and thawing for 14 days.
- (d) Provide enclosures for heating such that air circulation is maintained.
- (e) Frozen concrete will be rejected.

E26.10 Hot Weather Concrete Work

- (a) Hot weather shall be considered to be an air temperature in the shade, of 23°C or greater.
- (b) Hot weather methods shall conform to CSA-A23.1.
- (c) The concrete temperature at the time of placing in hot weather shall not exceed those specified in CSA-A23.1. In the event that this limit is exceeded the concrete operations shall be suspended until the constituent materials of concrete are cooled.
- (d) Retarding admixtures shall be used only if approved by the Contract Administrator prior to use in the concrete.
- (e) The use of ice may be required to lower the temperature of concrete for large pours.
- (f) Moderate Drying Conditions – When surface evaporation exceeds 0.75 kg/m²/h, windbreaks shall be erected around the sides of the structural element.
- (g) Severe Drying Conditions - When surface moisture evaporation exceeds, additional measures shall be taken to prevent rapid loss of moisture from the surface of the concrete. Such additional measures shall consist of the following:
 - (i) Erecting sunshades over the concrete during finishing and placing operations.
 - (ii) Lowering the concrete temperature.
 - (iii) Applying fog spray immediately after placement and before finishing. Care shall be taken to prevent accumulation of water that may reduce the quality of the cement paste.
 - (iv) Beginning the concrete curing immediately after trowelling.
- (h) The nomograph, Figure D1, Appendix D of CSA Standard CAN/CSA A23.1-2000 shall be used to estimate surface moisture evaporation rates.

E26.11 Quality Control

E26.11.1 Inspection

- (a) All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Contract Administrator including all operations from the selection and production of materials through to final acceptance of the Work. The Contractor shall be wholly responsible for the control of all operations incidental thereto notwithstanding any inspection or acceptance that may have been previously given. The Contract Administrator reserves the right to

reject any materials or works, which are not in accordance with the requirements of this Specification.

E26.11.2 Access

- (a) The Contract Administrator shall be afforded full access for the inspection and control testing of concrete and constituent materials, both at the Site and at any plant used for the production of concrete, to determine whether the concrete is being supplied in accordance with this Specification.

E26.11.3 Joints

- (b) Construction, and/or control joints shall be provided where shown on the plans or as otherwise accepted in writing by the Contract Administrator.
- (c) At water tight horizontal joints, apply the first layer of new concrete above the joint with an excess of mortar, obtained by omitting 20 to 50 percent of coarse aggregate from the normal mix.
- (d) Allow at least 2 hours after placing concrete in supporting columns or walls before placing in beams, girders or slabs above.
- (e) Place beams, girders, brackets, column capitals and haunches monolithically with the floor system, unless otherwise approved by the Contract Administrator.
- (f) See typical details for isolation joints at columns, and other locations.

E26.11.4 Concrete Quality Testing

- (a) The Contractor will retain and pay for the services of an independent testing agency for testing as follows:
- (b) Allow for casual labour and expenses in conjunction with testing.
- (c) Concrete Cylinder tests:
 - (i) At least one set of 3 cylinders will be made for each days concreting or for each 40 cubic metres of concrete placed, for each type of concrete mix.
 - (ii) Cylinders shall be taken at the point of deposit of the concrete.
 - (iii) For each test slump and air content will be taken and 3 standard cylinders will be prepared and cured under laboratory conditions.
 - (iv) One cylinder from each test will be broken at 7 days and the remaining cylinders at 28 days.
 - (v) When temperatures are below 5°C additional field cured cylinders will be prepared to verify that adequate strength is attained.
- (d) Test results shall be delivered directly from the test laboratory to the Contract Administrator and to the Contractor.
- (e) Test reports shall include:
 - (i) project name
 - (ii) date and time of sampling
 - (iii) supplier, truck and departure time
 - (iv) specified strength and admixtures
 - (v) cement type
 - (vi) exact location in structure
 - (vii) slump and air content
 - (viii) maximum aggregate size
 - (ix) test strength and age at time of test
 - (x) date cylinder received by lab

- (xi) testing technician identification
- (xii) weather and temperature information.
- (f) If any tests reveal concrete not meeting Specifications, the Contract Administrator may enforce one or more remedial procedures such as:
 - (i) change in mix design
 - (ii) change in concrete supplier
 - (iii) additional testing by coring or impact hammer
 - (iv) replacement of work
 - (v) other procedures as necessary
- (g) The costs of remedial work to bring concrete to meet specifications shall be borne by the Contractor.

E26.11.5 Corrective Action

- (g) If the results of the tests indicate that the concrete is not of the specified quality, the Contract Administrator shall have the right to implement additional testing, as required, to further evaluate the concrete at the Contractor's expense. The Contractor shall, at his own expense, correct such work or replace such materials found to be defective under this Specification in an approved manner to the satisfaction of the Contract Administrator.

E27. CONCRETE ACCESSORIES

E27.1 Description

- (a) This section specifies requirements for concrete joint materials including ribbed waterstop and joint filler.

E27.2 Related Work

- (a) Concrete Reinforcement- E28
- (b) Structural Concrete – E26.
- (c) Hydrostatic Testing – E29

E27.3 Reference Standards

- (a) Concrete Materials And Methods Of Concrete Construction - CSA-A23.1.
- (b) Falsework for Construction Purposes – CSA-S269.1.

E27.4 Submittals

- (a) Submit shop drawings of all concrete accessories in accordance with Section E12 Shop Drawings.
- (b) Show material sizes and installation methods.
- (c) Submit samples of waterstop and joint filler to be use, if so requested by the Contract Administrator.
- (d) Submit documentation indicating Contractor's experience in installing products and acceptance by the manufacturer that the Contractor has retained a certified installer.

E27.5 Materials

- (a) Ribbed waterstops: extruded PVC with shop welded corner and intersecting pieces.
 - (i) Wirestop waterstop, type CR-6316 (152 mm width, 4.8 mm thickness) manufactured by the Paul Murphy Plastics Company or approved equal.
 - (ii) Expandable Waterstop: Volclay RX or approved equal.

- (b) Joint Fillers:
 - (i) 13 mm thick bituminous impregnated fibre board; to ASTM D1751-73 (1978): Flexcell or approved equal.
 - (ii) Vapour barrier; 0.25 mm (10 mil) thick, clear polyethylene film.
- (c) Waterstops
 - (i) Install waterstops to provide continuous water seal. Do not distort or pierce waterstop to hamper performance. Do not displace reinforcement when installing waterstops. Use equipment to manufacturer's requirements to field splice waterstops. Tie waterstops rigidly in place.
 - (ii) Only straight heat sealed butt joints permitted in field. Use factory welded corners and intersections.
- (d) Joint Fillers
 - (i) Use 13 mm thick joint filler to separate slabs and beams from existing vertical surfaces and extend joint filler from bottom of slab and beams to finished slab surfaces unless indicated otherwise.
 - (ii) Use joint filler where indicated on the drawings.
- (e) Vapour Barrier
 - (i) Install vapour barrier all exterior under slabs on grade.
 - (ii) Vapour barrier shall be installed between the slab and base material.
 - (iii) Lap joints 150 mm and seal.

E28. CONCRETE REINFORCEMENT

E28.1 Description

- (a) This section specifies requirements for the supply, fabrication and placing of reinforcing steel, including necessary supports, spacers, and related accessories.

E28.2 Related Work

- (a) Structural Concrete – E –26.
- (b) Concrete Accessories – E-27.

E28.3 Reference Standards

- (a) Concrete Materials and Methods of Concrete Construction CSA-A23.1.
- (b) Billet-Steel Bars for Concrete Reinforcement - CSA-G30.18.
- (c) Welded Steel Wire Fabric for Concrete Reinforcement - CSA-G30.5.
- (d) ACI Detailing Manual - ACI 315.80.
- (e) CRSI Manual of Standard Practice.

E28.4 Submittals

- (a) Submit shop drawings in accordance with E12 - Shop Drawings.
- (b) Submit bending schedules and placing drawings.
- (c) Show bar size, spacing, location and quantities to permit correct placement without reference to structural drawings.
- (d) Provide details to show placement of reinforcing where special conditions occur.
- (e) Details shall be in accordance with ACI 315.

- (f) Submit certificates and mill tests for the material supplied as requested by the Contract Administrator.

E28.5 Product Delivery, Storage and Handling

- (a) Ship bar reinforcement in standard bundles, easily identifiable and marked in accordance with the bar lists.
- (b) Store reinforcement to prevent deterioration or contamination by dirt, detrimental rust, loose scale, paint, oil or other foreign substances that will destroy or reduce bond.
- (c) Do not straighten or rebend reinforcement in any manner.
- (d) Do not use bars kinked or bent by improper handling or storage.

E28.6 Reinforcing Steel

- (a) Reinforcing steel to meet CSA-G30.18 as shown on drawings:
 - (i) All bars shall be 400 MPa grade
- (b) Welded steel wire fabric to CSA-G30.5, provide in flat sheets only.

E28.7 Chairs, Bolsters, Bar Supports, Spacers

- (a) Provide adequate support of reinforcement (according to CRSI Manual of Standard Practice).
- (b) For exposed or architectural concrete surfaces use accessories which are plastic coated, stainless steel or as indicated on the drawings.
- (c) Precast concrete block supports must be equal in strength and quality to the concrete in the structure.
- (d) Chairs, bolster bar supports and spacers shall have sufficient strength to support the reinforcing under normal construction conditions. Brick shall not be used for bar supports.

E28.8 Fabrication

- (a) Fabricate reinforcing steel from bar sizes and grades indicated within the following tolerances:
 - (i) Sheared length: plus or minus 25 mm.
 - (ii) Depth of truss bar: plus or minus 13 mm.
 - (iii) Stirrups, ties and spirals: plus or minus 13 mm.
 - (iv) Location of bends: plus or minus 25 mm.
- (b) Unless otherwise indicated, fabricate in accordance with CSA-A23.1.

E28.9 Inspection

- (a) Notify Contract Administrator to permit inspection after placement is completed. Reinforcing for all concrete pours shall be inspected after placing and prior to concreting.
- (b) Provide adequate notice of scheduled pours to facilitate inspection of reinforcement (minimum of 24 hours).

E28.10 Placing of Reinforcement

- (a) Place reinforcement as shown on the reviewed shop drawings and in accordance with CSA-A23.1.
- (b) Support reinforcement in position as follows:
 - (i) Beams, walls, and columns - laterally support reinforcement with supports in pairs on opposite faces.

- (ii) Do not use supports which will be forced into the supporting formwork or soil by the weight of the reinforcement or other construction loads.
- (iii) Separate layers of bars by precast mortar blocks, bars or equally suitable devices. Do not use pebbles, pieces of broken stone or brick, metal pipe or wooden blocks.
- (c) Do not place bars on layers of fresh concrete as the Work progresses or install bars during placing of concrete.
 - (i) Provide concrete cover as detailed on the drawings.

E28.11 Welding of Reinforcement

- (a) Welding of reinforcing bars is not permitted.

E28.12 Splicing of Reinforcement

- (a) Splice bars only as shown on the drawings or approved by the Contract Administrator.
- (b) Bar splices shall conform to CSA3-A23.3, Type B, unless noted.
- (c) Lap adjacent sheets of wire fabric to provide an overlap of at least one cross wire spacing plus 50 mm, measured between outermost cross wires of each sheet.

E28.13 Details

- (a) Corner Bars: Install corner bars in walls and beams to match the larger size of normal reinforcement unless otherwise noted on the drawings.
- (b) Openings in slabs or walls: Unless otherwise noted, install 2 additional 15 M bars on all sides of every opening, one near each concrete face or the number of bars intercepted, divided equally between the two sides, whichever is greater. Bars to extend one lap length past each side of the opening.

E29. HYDROSTATIC TESTING

E29.1 Description

- (a) This section specifies requirements for hydrostatic testing of concrete structures.

E29.2 Equipment Supplied by the Contractor

- (a) All equipment and material required for testing, flushing and disinfection shall be supplied by the Contractor as part of the Work. This includes water for testing, flushing and disinfection.

E29.3 Water

- (a) Water for hydrostatic testing shall be clean potable water.
- (b) Water for hydrostatic testing not containing chemicals or any substances likely to harm the Work.

E29.4 Safety

- (a) The toxicity of any product should be investigated by the Contractor. The need for ventilation when installing and required protective equipment, such as gloves, goggles and masks also should be checked prior to application.

E29.5 Hydrostatic Testing

- (a) Hydraulic structures shall be subjected to hydrostatic testing upon completion.
- (b) The Contractor shall, prior to testing, finish the structures and shall repair any areas which appear to be inadequate.

- (c) Testing shall be done after completion of repairs and finishing work, and after concrete has adequately cured, but before backfilling.
- (d) Structures shall be filled slowly to the "high" level alarm elevation and left to stand for 3 days.
- (e) Testing to be done before backfilling has occurred.
- (f) There shall be no persistently damp areas on exterior faces, nor any visible leakage at any point. Following this 3 day visual inspection test, the water level shall be brought to the original level.
- (g) The hydrostatic test will begin at this time and will last for three days. There shall be no persistently damp areas on exterior faces, nor any visible leakage at any point. The rate of loss of water shall not exceed 1/10 of 1% of the total volume per day.
- (h) In case of inadequacies, the structure shall be emptied, the deficiencies repaired and the hydrostatic test shall then be repeated.
- (i) The Contractor shall supply, install and remove a liquid level measuring device with a sharp pointed metal probe with a locking or clamping screw. The device shall have a scale graduated in millimetres.

DIVISION 4 – MASONRY

E30. MASONRY - GENERAL

E30.1.1 Section Includes:

- (a) All new masonry work as specified and indicated on drawings.
- (b) Review drawings and coordinate masonry work with work of other trades to determine full extent of work required.

E30.2 References

- (a) CSA A82.1 Burned Clay Brick (Solid Masonry Units Made From Clay or Shale).
- (b) CSA A179 Mortar and Grout for Unit Masonry.
- (c) CSA A371 Masonry Construction for Buildings.
- (d) CSA A370 Connectors for Masonry.
- (e) CSA A165 Series (CSA-A165.1) CSA Standards on Concrete Masonry Units.

E30.3 Shop Drawings

- (a) Submit shop drawings in accordance with E12 - Shop Drawings.
- (b) Indicate sizes and dimensions, materials, finishes, anchoring and installation methods and details. Affix setting numbers to shop drawings after final review redistribution.

E30.4 Samples

- (a) Submit samples in accordance with E11 - Submittals.

E30.5 Delivery, Storage and Handling

- (a) Storage space on the Site is limited.
- (b) Deliver and store materials only areas in designated by Contract Administrator.

E30.6 Protection

- (a) Protect masonry and other work from marking and other damage. Protect completed work from mortar droppings. Use non-staining coverings.
- (b) Provide temporary bracing of masonry work during and after erection until permanent lateral support is in place.

E30.7 Masonry Units

- (a) Burned clay brick to CSA A82.1, Type FBX, Grade SW, Size [90 x 390 x 90 mm].
Acceptable product: IXL. Montego Smooth.
- (b) Standard concrete masonry units: to CSA A165 Series:
 - (i) Classification: H/15/A/M standard weight and H/15/C/M lightweight to CSA A165.1-M. Use lightweight units for fire rated partitions.
 - (ii) Size: modular, as indicated.
 - (iii) Special shapes: provide square units for exposed corners. Provide purpose made shapes for lintels and bond beams. Provide additional special shapes as indicated.

E30.8 Mortar Materials

- (a) Mortar and grout: to CSA A179.
- (b) Cement:
 - (i) For concrete unit masonry, clay brick: normal Portland to CSA-A5..
- (c) Colored mortar: ground colored natural aggregates or metallic oxide pigments. Acceptable products: Northern Pigment Extra Strong Mortar Color. Color selected by Contract Administrator.
- (d) Admixture: No admixtures or other constituents permitted except upon approval of Contract Administrator.
- (e) Grout: to CSA A179, Table 3.
- (f) Mortar types: Type S with a 28 day strength of 12.5 MPa.

E30.9 Accessories

- (a) Connectors: to CSA A370, corrosion resistant or non-corroding connectors at exterior cavity walls.
- (b) Wire reinforcement: Truss or ladder type to CSA A370 Galvanized, 3.75 mm side and cross rods, width 50 mm less than masonry.
- (c) Weep hole tubes: purpose made plastic, designed to drain cavities to exterior by means of 9 mm diameter sloped tubing.

E30.10 Execution

E30.10.1 Workmanship

- (a) Do masonry work in accordance with CSA A371, except where specified otherwise.
- (b) Do masonry mortar and grout work in accordance with CSA A179, except where specified otherwise.
- (c) Install masonry connectors and reinforcement in accordance with CSA A370 and CSA A371, unless specified otherwise.
- (d) Build masonry plumb, level, and true to line, with vertical joints in alignment where applicable.
- (e) Layout coursing and bond to achieve correct coursing heights, and continuity of bond above and below openings, with minimum of cutting.

- (f) Masonry courses to be of uniform height, both vertical and horizontal joints to be of equal and uniform thickness.
- (g) Remove chipped, cracked, and otherwise damaged units in exposed masonry and replace with undamaged units.
- (h) Where new masonry abuts fully set masonry, clean existing surfaces and dampen if necessary to obtain bond.

E30.10.2 Jointing

- (a) Strike flush all joints concealed in walls and joints in walls to receive plaster, tile, insulation, or other applied material except paint of similar thin finish coating.
- (b) For patchwork in exposed masonry match adjacent jointing.
- (c) For exposed concrete block provide concave joints

E30.10.3 Horizontal Reinforcing

- (a) Provide continuous horizontal truss type wire reinforcing spaced at vertical intervals 400 mm maximum,
- (b) Overlap splices minimum 150 mm.

E30.10.4 Reinforced Lintels

- (a) Install reinforced masonry lintels over openings. Make joints in lintels to match adjacent walls. End bearing not less than 200 mm.
- (b) Place and grout reinforcing in accordance with CSA S371. Use 20 MPa (2900 psi) grout or concrete.

E30.10.5 Joining of Work

- (a) Where necessary to temporarily stop horizontal runs of masonry, and in building corners:
- (b) Step-back masonry diagonally to lowest course previously laid.
- (c) Do not "tooth" new masonry.
- (d) Fill in adjacent courses before heights of stepped masonry reach 1200 mm.

E30.10.6 Cutting

- (a) Cut out neatly for electrical switches, outlet boxes, and other recessed or built-in objects.
- (b) Make cuts straight, clean, and free from uneven edges. Use masonry saw where necessary.

E30.10.7 Building-In

- (a) Build in items required to be built into masonry.
- (b) Prevent displacement of built-in items during construction. Check plumb, location and alignment frequently, as work progresses.
- (c) Brace door jambs to maintain plumb. Fill spaces between jambs and masonry with mortar.

E30.10.8 Provisions for Other Trades

- (a) Provide openings in masonry walls where required or indicated.
- (b) Accurately locate chases and openings and neatly finish to the required sizes.

- (c) Where masonry encloses conduit or piping, bring to proper level indicated and as directed. Do not cover pipe or conduit chases or enclosures until advised that work has been inspected and tested.

E30.10.9 Provision for Movement

- (a) Leave minimum 3 mm space below shelf angles. Install backer rod and sealant in accordance with E33.4.6.
- (b) Leave 6 mm space between top of non-load bearing walls and partitions and structural elements.

E30.10.10 Cleaning

- (a) Clean all new masonry work, and exposed patchwork.
- (b) Allow mortar droppings on unglazed units to partially dry then remove by means of trowel, followed by rubbing lightly with small piece of block and finally by brushing.
- (c) For final cleaning brush clean with fibre bristle brush, preferably dry, or with minimum amounts of water.
- (d) For clay brick and glazed masonry units use only proprietary cleaning agents approved by masonry manufacturer.

E31. MORTAR AND MASONRY GROUT

E31.1 Related Work

- (a) Masonry - General E30.

E31.2 References

- (a) Canadian Standards Association (CSA)
- (b) CSA A179 Mortar and Grout For Unit Masonry.

E31.3 Products

E31.3.1 Materials

- (a) Use same brands of materials and source of aggregate for entire project.
- (b) Mortar and grout: CSA A179.
- (c) Use aggregate passing 1.18 mm sieve where 6 mm thick joints are indicated.
- (d) Grout: As per structural drawings.
- (e) Mortar: Type S to CSA A179.

E31.3.2 Mixing

- (a) Accurately and consistently measure all ingredients, including water, to consistently produce batches matching approved samples.
- (b) Pointing mortar: pre-hydrate pointing mortar by mixing ingredients dry, then mix again adding just enough water to produce damp unworkable mix that will retain its form when pressed into ball. Allow to stand for not less than 1 hour nor more than 2 hours then remix with sufficient water to produce mortar of proper consistency for pointing.

E31.3.3 Construction

- (a) Do masonry mortar and grout work in accordance with CSA A179 except where specified otherwise.

E32. MASONRY REINFORCEMENT AND CONNECTORS

E32.1 Related Work

- (a) Masonry General, E30.
- (b) Masonry Accessories, E33.

E32.2 References

- (a) Canadian Standards Association (CSA)
- (b) CSA A23.1 Concrete Materials and Methods of Concrete Construction.
- (c) CSA A370 Connectors for Masonry.
- (d) CSA A371 Masonry Construction for Buildings.
- (e) CSA G30.3 Cold-Drawn Steel Wire for Concrete Reinforcement.
- (f) CSA G30.12 Billet-Steel Bars for Concrete Reinforcement.
- (g) CSA G30.14 Formed Steel Wire For Concrete Reinforcement.
- (h) CSA G30.18 Billet-Steel Bars for Concrete Reinforcement.
- (i) CSA S304.1 Masonry Design for Buildings.
- (j) CSA W186 Welding of Reinforcing Bars in Reinforced Concrete Construction.
- (k) CSA A179 Mortar and Grout For Unit Masonry.

E32.3 Source Quality Control

- (a) Upon request, provide Contract Administrator with certified copy of mill test report of reinforcement steel and connectors, showing physical and chemical analysis, minimum 5 weeks prior to commencing reinforcement work.
- (b) Upon request inform Contract Administrator of proposed source of material to be supplied.

E32.4 Shop Drawings

- (a) Submit shop drawings in accordance with E12 - Shop Drawings.
- (b) Shop drawings consist of bar bending details, lists and placing drawings.
- (c) On placing drawings, indicate sizes, spacing, location and quantities of reinforcement and connectors.

E32.5 Products

E32.5.1 Reinforcement

- (a) Bar reinforcement: to CSA A371 and CSA G30.18, Grade 400.
- (b) Wire reinforcement: to CSA A371 and CSA G30.14, ladder type. Prefabricated corners and intersections.
- (c) Corrosion protection: to CSA S304, galvanized to CSA-S304 and CSA-A370. See Structural.

E32.5.2 Connectors

- (a) Connectors: to CSA A370 and CSA S304 and as specified below.
- (b) Corrosion protection: to CSA S304, galvanized to CSA S304 and CSA A370.
- (c) Fasteners:
 - (i) Masonry: concrete/masonry anchors, length to penetrate minimum 25 mm into solid substrate, hot dipped galvanized. Gripcon Concrete Masonry Fastening System or equal.

- (d) Masonry ties for exterior masonry veneer on concrete block backup walls:
 - (i) Block Shear Connector assembly as manufactured by Fero Holdings Ltd. Consisting of connector plate, V-Tie and polyethylene insulation support.
 - (ii) Connector plate: sheet steel to ASTM-570. Length to suit block width plus insulation and air space.
 - (iii) V-Tie (wire tie): 4.76 mm diameter cold drawn steel wire to CSA G30.3. Length to extend to centre line of masonry veneer wythe.
 - (iv) Hot dipped galvanized to CSA A370 with 458/g/m²/side zinc coating.

E32.5.3 Fabrication

- (a) Fabricate reinforcing in accordance with CSA A23.1.
- (b) Fabricate connectors in accordance with CSA A370.
- (c) Obtain Contract Administrator's approval for locations of reinforcement splices other than shown on placing drawings.
- (d) Ship reinforcement and connectors, clearly identified in accordance with drawings.

E32.6 Execution

E32.6.1 General

- (a) Supply and install masonry connectors and reinforcement in accordance with CSA A370, CSA A371, CSA A23.1 and CSA S304.1 unless indicated otherwise.
- (b) Prior to placing mortar, notify Contract Administrator for review of placement of reinforcement and connectors.
- (c) Installation of masonry ties for exterior veneer on concrete block back-up walls:
 - (i) Spacing: 600 mm on centre vertical intervals; 800 mm horizontal intervals.
 - (ii) Set connector plates in mortar joints of backup walls, in accordance with manufacturer's instructions.
 - (iii) Coordinate spacing with cavity wall insulation to ensure connector plates are centred on horizontal joints of insulation boards.
 - (iv) Install insulation supports over connector plates to hold insulation boards tight to backup walls. Provide one insulation support at each connector plate.
 - (v) Insert wire ties into connector plates and embed into mortar joints of masonry veneer wythe. Ensure wire ties are aligned and level with horizontal joints of masonry veneer.

E32.6.2 Reinforced Lintels and Bond Beams

- (a) Reinforce masonry lintels and bond beams as indicated.
- (b) Place and grout reinforcement in accordance with CSA S304.

E32.6.3 Grouting

- (a) Grout masonry in accordance with CSA S304 and as indicated.

E32.6.4 Metal Anchors

- (a) Supply and install metal anchors as indicated.

E32.6.5 Lateral Support and Anchorage

- (a) Supply and install lateral support and anchorage in accordance with CSA S304.1 and as indicated. See Structural.

- E32.6.6 Field Bending
- (a) Do not field bend reinforcement and connectors except where indicated or authorized by Contract Administrator.
 - (b) Replace bars and connectors that develop cracks or splits.
- E32.6.7 Field Touch-up
- (a) Touch up damaged and cut ends of epoxy coated or galvanized reinforcement steel and connectors with compatible finish to provide continuous coating.

E33. MASONRY ACCESSORIES

E33.1 Related Work

- (a) Masonry procedures, E30.
- (b) Mortar and Masonry Grout, E31.
- (c) Masonry Reinforcement and Connectors, E32.

E33.2 References

- (a) American Society for Testing and Materials (ASTM)
- (b) ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- (c) ASTM D 2240 - Standard Test Method for Rubber Property - Durometer Hardness.
- (d) Canadian Standards Association (CSA)
- (e) CSA A371 - Masonry Construction for Buildings.
- (f) Canadian General Standards Board (CGSB)
- (g) CAN/CGSB-51.32 - Sheathing, Membrane, Breather Type.

E33.3 Products

E33.3.1 Materials

- (a) Air barrier membrane: as specified E44 - Air Barriers.
- (b) Cavity wall insulation: as specified in E40 - Board Insulation.
- (c) Exterior wall sheathing paper: to CAN/CGSB-51.32 single ply type Typar.
- (d) Control joint fillers and sealants: as specified in E43 - Joint Sealers.
- (e) Nailing inserts: purpose-made of 0.6 mm thick (24 gauge) galvanized steel inserts for setting in mortar joints,
- (f) Masonry flashing: for insulated cavity walls use the same material as used for the air barrier membrane.
- (g) Masonry flashing: self-adhesive modified bitumen sheet membrane: minimum 1.0 mm thick. Use primers recommended by manufacturer. Acceptable products: Bakelite Blueskin SA, WR Grace Perm-A-Barrier, Soprema Colphene 1500.
- (h) Metal drip edge:
 - (i) Brake formed of 0.6 mm (24 gauge) galvanized sheet steel commercial quality to ASTM A653 with Z275 designation zinc coating. Prefinished with Stelcolor 8000 Series coil coating. Color selected by the City of Winnipeg.
 - (ii) Form drip edge to extend 100 mm under base course, with 6 - 9 mm formed drip at front edge.

E33.4 Execution

E33.4.1 Cavity Wall Air Barrier

- (a) Install cavity wall air barrier membrane in accordance with E44 - Air Barriers.

E33.4.2 Cavity Wall Insulation

- (a) Install cavity wall insulation in accordance with E40 - Board Insulation and as specified below.
- (b) Coordinate with installation of masonry ties. Install insulation boards with long dimension horizontal, with masonry ties centred on horizontal joints of insulation boards.
- (c) As installation progresses, install polyethylene insulation supports over connector plates to hold insulation boards tight to backup walls. Provide one insulation support on every masonry tie.

E33.4.3 Masonry Flashing

- (a) Building flashings in masonry in accordance with CSA A371 and as follows.
- (b) Install flashings under exterior masonry bearing on foundation walls, slabs, shelf angles, angle lintels over openings and elsewhere indicated. Install flashings under weep hole courses.
- (c) In cavity walls and veneered walls carry flashings from front edge of masonry, under outer wythe, then up backing not less than 150 mm, bond to backup wall and seal top edge water tight.
- (d) Install flashings under sheathing paper, where applicable.
- (e) For self-adhesive bitumen sheet membranes prime and seal substrates to manufacturers recommendations. Ensure full and positive bond.
- (f) Lap joints 150 mm and seal.

E33.4.4 Sheathing Paper

- (a) Install exterior wall sheathing paper behind masonry veneer as indicated.
- (b) Staple or nail to panel sheathing. Overlap upper sheets over lower sheet to shed moisture.
- (c) Install sheathing paper over masonry flashings.

E33.4.5 Metal Drip Edge

- (a) In addition to masonry flashing provide metal drip edge at base course.
- (b) Align drip edge straight and even. Overlap joints minimum 20 mm.

E33.4.6 Expansion and Control Joints

- (a) Build vertical control joints in masonry as indicated.
- (b) Build expansion joints in masonry at building expansion joints as indicated.
- (c) Install joint fillers and sealants in expansion and control joints as specified in E43– Joint Sealers.

E33.4.7 Weep Holes

- (a) Building weep holes in masonry cavity walls and masonry veneer wall construction by providing weep holes at base courses and over masonry flashings.
- (b) Space weep holes as follows:
 - (i) For 400 mm length masonry units: 800 mm on centre.

- (c) Leave out the bottom 50 mm of mortar from vertical joints. Ensure all mortar is removed to provide clear passage to cavity.
- (d) Keep weep holes free from mortar droppings and debris to allow free air movement and positive drainage of moisture.

E33.4.8 Nailing Inserts

- (a) Install nailing inserts in mortar joints at 400 mm on centre each way, for attachment of wall strapping.

E34. BRICK MASONRY UNITS

E34.1 Related Work

- (a) Masonry General: E30.
- (b) Masonry mortar and grout for masonry: E31.
- (c) Masonry reinforcing and connectors: E32.
- (d) Masonry accessories: E33.

E34.2 References

- (a) American Society for Testing and Materials (ASTM)
- (b) ASTM C 126 Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units.
- (c) Canadian Standards Association (CSA)
- (d) CSA A82.1 Burned Clay Brick (Solid Masonry Units Made From Clay or Shale).
- (e) CSA A82.3 Calcium Silicate (Sand-Lime) Building Brick.
- (f) CSA A82.8 Hollow Clay Brick.
- (g) CSA A165 Series - CSA Standards on Concrete Masonry Units.

E34.3 Products

E34.3.1 Face Brick

- (a) Hollow clay brick: to CSA A82.8.
 - (i) Type: I(H).
 - (ii) Size: 90x 90 x 390mm.
 - (iii) Color and texture: to match sample selected by the City.
 - (iv) Provide units with finished ends where ends exposed.
 - (v) Acceptable products: IXL.

E34.4 Execution

E34.4.1 Installation

- (a) Face brick - exterior masonry veneer:
 - (i) Bond: stretcher.
 - (ii) Coursing height: 200 mm for two bricks and two joints.
 - (iii) Jointing: concave] where exposed or where paint or similar thin finish coating is specified.
- (b) Mixing and blending: mix units within each pallet and with other pallets to ensure uniform blend of color and texture.
- (c) Clean unglazed clay masonry as work progresses.

E34.4.2 Cleaning Concrete Brick Masonry

- (a) Clean concrete brick masonry as work progresses.
- (b) Allow mortar droppings on masonry to partially dry then remove by means of trowel, followed by rubbing lightly with small piece of brick and finally by brushing.

DIVISION 5 – METALS

E35. STRUCTURAL STEEL

E35.1 Description

- (a) This section specifies requirements for supply, fabrication and installation of structural steel.
- (b) The Work includes design, installation and removal of any bracing or other measures necessary to ensure stability of the steel framework during construction.

E35.2 Related Work

- (a) Miscellaneous Metal – E37.
- (b) High Build Glaze Coatings – E48.

E35.3 Reference Standards

- (a) Steel Structures for Buildings - CSA-S16.1
- (b) Welded Steel Construction (Metal Arc Welding) - CSA-W59
- (c) Structural Quality Steels - CSA-G40.21

E35.4 Design

- (a) Design in accordance with the standards referenced in E35.3.
- (b) Design all the temporary systems to maintain stability of the Work at all phases of construction.
- (c) Design of all members and connections not detailed on the drawings shall be carried out and stamped by a Professional Engineer registered in the Province of Manitoba.

E35.5 Submittals

E35.5.1 Submit certificates for the material supplied as requested by the Contract Administrator.

E35.5.2 Shop drawings showing all details shall be prepared by the Contractor and submitted for review by the Contract Administrator prior to fabrication.

E35.5.3 In addition to specific details, the shop drawings must include, the following items:

- (a) Drawings showing details of connections designed by the Contractor.
- (b) All dimensions shall be correct at 20°C unless otherwise shown.
- (c) Weld procedure identification shall be shown on the shop details.
- (d) All material splice locations shall be shown on the drawings.

E35.5.4 All structural steel shop drawings shall be signed and sealed by a Professional Engineer registered in the Province of Manitoba. Drawings not sealed will be rejected unchecked.

E35.6 Materials

E35.6.1 Structural Steel

- (a) Unless noted otherwise, steel to conform to the following.

- (b) Wide flange sections: to CSA –G40.21-350W.
- (c) Other Sections and Plate: to CSA-G40.21-300W.
- (d) Hollow Structural Sections: to CSA-G40.21-350W Class C or H.

E35.6.2 Bolts

- (a) Bolts, nuts and washers: to ASTM-A325.
- (b) Anchor bolts, nuts and washers: to ASTM-A307.
- (c) Studs to CSA-W59 - M1989.

E35.6.3 Welding

- (a) All welding material to CSA-W59.

E35.6.4 Primer

- (a) Shop paint primer to be consistent with paint products in Section E48 – High Build Glazed Coatings.

E35.6.5 Hot Dip Galvanizing

- (a) To CSA-G164.

E35.7 Execution

E35.7.1 Inspection

- (a) Notify the Contract Administrator in advance as required to allow inspection of fabrication (including welding) and erection.
- (b) Provide access to allow inspection of fit, welding, bolting and other aspects of the Work.

E35.7.2 Surface Preparation, Priming and Painting

- (a) Blastcleaning: Unless otherwise noted, all steel components shall be sandblast cleaned after fabrication in accordance with the Steel Structures Painting Council Standard (SSPC) No. SP6. Essentially this is a surface from which all oil, grease, dirt, rust, scale and foreign matter have been completely removed except for slight shadows, streaks, or discolorations caused by rust stain or mill scale oxide binder.
- (b) Crane columns, beams and associated steel shall be primed and painted.
- (c) All other structural steel shall be hot dipped galvanized.
- (d) Shop Primer: Steel surfaces for the crane shall receive one shop coat of primer. Splice areas and areas in contact with concrete shall be blastcleaned but not painted and shall be kept free from overspray.
- (e) Application Conditions: Application of primer or paint must be at a temperature of not less than 5°C for a period of not less than 12 hours to dry the paint. During primer application and curing, all necessary means shall be provided to assure that the members are protected against the effects of the weather. Primer shall not be applied upon damp or frosted surfaces.
- (f) Thickness: (Primer) Unless otherwise specified, one coat of shop primer shall be applied and shall be 0.040 mm to 0.065 mm thick when dry.
- (g) Any damage on galvanized metal shall be given one coat of touch-up coating for galvanized metal.
- (h) Painting: of crane steel shall be as per E48.

E35.7.3 Fabrication

- (a) Take field measurements as necessary to ensure that items fabricated in the shop will fit the structure.
- (b) Reinforce hanger holes or openings for pipes or ducts with steel plates sized and welded in place to restore member to original design strength.
- (c) Provide holes for attachment of other work only after obtaining Contract Administrator's approval.

E35.7.4 Welding

- (a) Shop Qualifications: The Contractor shall be fully approved by the Canadian Welding Bureau (CWB) as per CSA-W47.1. Welding procedures shall be submitted for each type of weld used in the structure. The procedures shall bear the approval of the Canadian Welding Bureau and must also be approved by the Contract Administrator prior to use on the structure.
- (b) Welder Qualifications: Only welders, welding operators and tackers approved by the Canadian Welding Bureau in the particular category may be permitted to perform weldments. Their qualifications must be current and be available for examination by the Contract Administrator.
- (c) Welding Code: Except as otherwise noted on the drawings, all welding, cutting and preparation shall be in accordance with the CSA-W59.
- (d) Cleaning: All weld areas must be clean and free of mill scale, dirt, grease, paint, etc., prior to welding.
- (e) Preheat material and enclose heated enclosures as required for all field welding or cutting to maintain the steel at temperatures above 10°C.
- (f) Filler Metals: Low hydrogen filler, fluxes and low hydrogen welding practices are to be used throughout. The low hydrogen covering and flux shall be protected and stored as specified by CSA-W59.
- (g) Tack and Temporary Welds: Tack and temporary welds are not allowed unless they are to be incorporated in the final weld.
- (h) Methods of Weld Repair: Repair procedures for unsatisfactory welds must be submitted for approval by the Contract Administrator prior to work commencing.
- (i) Arc Strikes: Arc strikes shall not be permitted. In the event of accidental arc strikes, the Contractor shall submit to the Contract Administrator for approval his/her proposed repair procedure. The repair procedure shall include the complete grinding out of the crater produced by the arc strike. These areas shall be examined by the Contract Administrator to ensure complete removal of the metal in the affected area.

E35.7.5 Material Splices

- (a) Additional splices, other than those shown on the details, will require approval of the Contract Administrator. The Contractor shall bear the cost of inspection of these splices.

E35.7.6 Handling and Storage

- (a) All lifting and handling shall be done using devices that do not mark damage, or distort the assemblies or members in any way. Girders shall be stored upright, supported on sufficient skids and safely shored to maintain the proper section without buckling, twisting or in any damage or misalign the material.

E35.7.7 Approval of Erection Scheme

- (a) Erect to CSA-S16.1.

E36. SHEET METAL ROOFING

E36.1 Related Sections

- (a) Prefabricated Wood Trusses, E38.
- (b) Rough Carpentry, E39.

E36.2 References

- (a) American Society for Testing and Materials (ASTM)
 - (i) ASTM C79/C79M, Standard Specification for Treated Core and Nontreated Core Gypsum Sheathing Board
 - (ii) ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- (b) Canadian General Standards Board (CGSB)
 - (i) CGSB 37-GP-56, Membrane, Modified, Bituminous, Prefabricated, and Reinforced for Roofing.
 - (ii) CAN/CGSB-51.32, Sheathing, Membrane, Breather Type.
- (c) Underwriters Laboratory Canada (ULC).
 - (i) CAN/ULC-S701, Thermal Insulation, Polystyrene, Boards and Pipe Coverings.
- (d) Canadian Sheet Steel Building Institute (CSSBI)
 - (i) Manufacturers' Standard Gauge (MSG)

E36.3 Design Criteria

- (a) Design sheet metal roofing to provide for thermal movement of component materials caused by ambient temperature range of -35°C to 75°C without causing buckling, failure of joint seals, undue stress on fasteners or other detrimental effects.
- (b) Include expansion joints to accommodate movement in roofing system and between roofing system and building structure, caused by structural movements, without permanent distortion, damage to infill, racking of joints, breakage of seals, or water penetration.
- (c) Design members to withstand dead load, snow loads and build-up and wind loads including uplift, calculated in accordance with NBC and applicable local regulations [as indicated on drawings].
- (d) Deflection of roof system under live loads shall not exceed 1/180th of span.
- (e) Provide for positive drainage of condensation occurring behind roof panels and water entering at joints, to exterior face of panels.

E36.4 Shop Drawings

- (a) Submit shop drawings in accordance with E11- Submittals.
- (b) Indicate sizes and dimensions, components, materials and finish, metal gauges and thickness, fastening details, compliance with design criteria and requirements of related work.
- (c) Indicate arrangement of roof panels including joints, types and location of supports, fasteners and special shapes.
- (d) Include details of standing seams, supports, gutters and downspouts, and all other system components.

E36.5 Samples

- (a) Submit samples in accordance with E11-Submittals.

- (b) Submit duplicate samples of each sheet metal material with specified finish and colors on actual base metal.
- (c) Submit duplicate color samples of prefinished steel sheet in manufacturer's complete color range for color selection by the City.

E36.6 Mockup.

- (a) Fabricate 400 x 400 sample roofing panel using identical project materials and methods to include typical seam.

E36.7 Protection

- (a) Protect prefinished steel during fabrication, transportation, site storage and erections. Replace any scratched or otherwise damaged materials.
- (b) During storage stack panels tilted to provide water run off. Cover materials to protect from weathering.

E36.8 Products

E36.8.1 Sheet Metal Materials

- (a) Zinc coated steel sheet: to ASTM A 653/A 653M, commercial quality, with designation Z275 coating, regular spangle surface, prefinished as specified.

E36.8.2 Prefinished Steel Sheet

- (a) Zinc coated steel sheet prefinished with factory applied polyvinylidene fluoride. Stelco Stelcolor 10000 Series Coil Coating, 22 gauge color selected by Contract Administrator.
- (b) Zinc coated steel sheet prefinished with factory applied high molecular polyester coating. Colorite HMP, 22 gauge. Color selected by Contract Administrator.

E36.8.3 Accessories

- (a) Waterproof membrane: self-adhesive, modified bitumen sheet, minimum 1 mm (40 mils) thick, non-slip surface. Primers and mastic sealants as recommended by membrane manufacturer.
 - (i) Acceptable products: IKO Armour Gard Ice and Water Protector, W.R. Grace Ice and Water Shield; Domtar Eavesshield; Nordshield Water Stopper; Bakor Eave Guard; BPCO ProGard; EMCO Gripgard.
- (b) Roof panel support clips: fabricated of galvanized steel sheet to ASTM A653 with Z275 designation zinc coating. Concealed purpose made thermal clips, designed to allow full thermal expansion and contraction of roof panels.
- (c) Slip sheet: reinforced sisal paper or a heavy felt kraft paper.
- (d) Fasteners:
 - (i) Roof system components: as recommended by roof system manufacturer, head color to match materials being fastened, corrosion resistant.
- (e) Sealants: as specified in E 43 -Joint Sealers. colors selected by Contract Administrator.
- (f) Rubber-asphalt sealing compound: to CAN/CGSB-37.29.
- (g) Touch-up paint: as recommended by sheet metal roofing manufacture.
- (h) Isolation coating: alkali resistant bituminous paint.

E36.8.4 Fabrication

- (a) Fabricate aluminum sheet metal in accordance with Aluminum Association "Aluminum Sheet Metal Work in Building Construction".
- (b) Form individual pieces in maximum lengths to reduce number of joints. Make allowances for expansion at joints.
- (c) Hem exposed edges on underside 12 mm, miter and seal.
- (d) Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- (e) Apply minimum 0.2 mm dry film thickness coat of plastic cement to both faces of dissimilar metals in contact.

E36.9 Execution

E36.9.1 Installation Self-Adhesive Membrane

- (a) Waterproof Membrane

E36.9.2 Installation

- (a) Use concealed fastenings except where approved by Contract Administrator before installation.
- (b) Provide underlay under sheet metal roofing. Secure in place and lap joints minimum 100 mm.
- (c) Apply slip sheet over waterproof membrane to prevent bonding between sheet metal and felt. Secure with minimum anchorage and lap joints 50 mm minimum in direction of water flow.
- (d) Install sheet metal roof panels using cleats spaced at manufacturer's recommended spacing.
- (e) Secure cleats with two fasteners each and cover with cleat tabs.
- (f) Transverse seams not permitted.
- (g) Flash roof penetrations with material matching roof panels, and make watertight.
- (h) Form seams in direction of water-flow and make watertight.
- (i) Separate sheet metal cut-offs and damaged material from non-recyclable waste and dispose of at proper recycling facility.

E36.9.3 Standing Seam Roofing

- (a) Use prefinished steel continuous sheets to make standing seams 400 on centre without straight run of standing seam exceeding 10 m.
- (b) Fold lower end of each pan under 20 mm. Slit fold 25 mm away from corner to form tab where pan turns up to make standing seam. Fold upper end of each pan over 50 mm. Hook 20 mm fold on lower end of upper pan into 50 mm fold on upper end of underlying pan.
- (c) Apply sheet metal roofing beginning at eaves. Loose lock pans to valley flashing and edge strips at eaves and gable rakes.
- (d) Finish standing seams 25 mm high on flat surfaces. Bend up one side edge 40 mm and other 45 mm. Make first fold 6 mm wide single fold and second fold 12 mm wide, providing locked portion of standing seam with 5 plies in thickness. Fold lower ends of seams at eaves over at 45° angle. Terminate standing seams at ridge and hips by turning down in tapered fold.
- (e) Meet or exceed Roofing MRC system snap on cap.

- (f) Vertical Application: Sub-girts and alignment bars: galvanized steel sheet to ASTM A 653/A 653M with Z275 zinc coating, profile to accept preformed panels with structural attachment to building frame. Base metal thickness as recommended by manufacturer to meet design requirements.

E37. MISCELLANEOUS METAL

E37.1 Description

- (a) This section specifies requirements for the supply, fabrication and installation of miscellaneous metals.

E37.2 Related Work

- (a) Structural Concrete, E26.
- (b) Structural Steel, E35.
- (c) High Build Glaze Coatings, E48.

E37.3 Reference Standards

- (a) Materials shall be in accordance with CSA, CGSB and ASTM Standards.
- (b) Submit certificates for the materials supplied, as requested by the Contract Administrator.

E37.4 Quality Assurance

- (a) Employ tradesmen skilled in this trade and proficient in the use of various materials specified.
- (b) Perform work in accordance with material manufacturer's instructions.

E37.5 Submittals

- (a) Submit detailed shop drawings for all miscellaneous metals, showing fabrication and erection details. Design of all connections and stairs to be carried out and stamped by a Professional Engineer registered in the Province of Manitoba.
- (b) Submit details and shop drawings for review by the Contract Administrator, at least 10 days in advance of fabrication.

E37.6 Product Delivery, Storage, Handling

- (a) Deliver items to the Site in a safe manner.
- (b) Deliver items in sufficient quantity to allow continuity of work.
- (c) Deliver products to the Site in the largest practical sections. Tag and mark items for identification.

E37.7 Deliver items to be built in adjoining construction at proper time.

- (a) Store items on Site under cover in positions to ensure that no bending, warping or marring takes place.
- (b) Prevent staining by concrete, mortar, plaster, oil, grease or other foreign substances.
- (c) Do not paint or place crayon or other markings on exposed surfaces.

E37.8 Job Conditions

- (a) Give timely and accurate instructions to other trades for locations, levels, holes, connections of anchors, sleeves and frames.
- (b) Examine Site conditions and take Site measurements to ensure accurate and proper fitting, clear of obstructions.

E37.9 Materials

- (a) Steel - conform to CSA-G40.21, Grade 350W for wide flange and HSS sections and 300W for all other sections and plates
- (b) Aluminium – as specified on the drawings.
- (c) Galvanizing - conform to CSA-G164.
- (d) Stainless Steel - ASTM A167 and A276 or Type 316 as shown on the drawings.
- (e) Fastenings and Anchor Bolts
- (f) Nuts, bolts, washers, rivets and screws to ASTM-A325M.
- (g) Anchor bolts to ASTM-A307, unless specified otherwise.
- (h) For fastenings in stainless steel (S.S.) and aluminum use stainless steel Type 316 ELC ASTM-A167.
- (i) For structural steel use high strength bolts to ASTM-A325M.
- (j) All fasteners submerged in sewage or water - Stainless Steel Type 316 ELC ASTM A167-86.
- (k) For anchors or fastening required to fix equipment after concrete has been poured, use anchorage in accordance with the equipment manufacturers recommendations.
- (l) Provide angles, brackets, inserts, bolts, frames and all other items required to fasten metalwork to concrete, to metal framing or other parts of the structure.

E37.10 Grout

- (a) Refer to Structural Concrete, E26.

E37.11 Access Ladders and Stairs

- (a) Aluminium access ladders and cases welded construction to CSA-S157 and shall be as detailed on the drawings.
- (b) Ladder Rungs – Clear anodized aluminum to CSA “HA” Series.
- (c) Stairs to be hot dipped galvanized.

E37.12 Aluminum

- (a) Aluminum handrail system as noted on the drawings.
- (b) Handrailing shall meet the National Building Code of Canada – 1980, Section 4.1.10.1.
- (c) Circular pipe handrailing – as shown on the drawings, SCH 40.
- (d) Plug ends of horizontal bars exposed posts with tapered spun aluminum end gaps.
- (e) Finish for all aluminum shall be clear anodized.

E37.13 Steel Grating and treadplates

- (a) Grating and treadplates to be as detailed on the drawings.
- (b) To be removable in sections as shown on the drawings.
- (c) Treadplate – raised diamond pattern.
- (d) Band around grating openings with 25 mm clearance all around. All edges to be banded.
- (e) Submit shop drawings of grating and treadplate.
- (f) Submit fastening details including sizes, gauges and centres.
- (g) Steel grating and treadplate to be hot dipped galvanized.

E37.14 Safety Chains

- (a) Removable 5 mm proof chain 13 mm x 29 mm c/c oval shaped 316 SS stainless steel links, snaphooks and eyes unless noted otherwise.

E37.15 All Other Miscellaneous

- (a) All other miscellaneous items as shown on the drawings shall be hot dipped galvanized unless otherwise specified or shown on the drawings.

E37.16 Inspection

- (a) Notify the Contract Administrator to allow inspection of fit, welding, bolting and other items.
- (b) Take field measurements as necessary to ensure proper fit of miscellaneous metal items into structures.

E37.17 Fabrication

- (a) Perform steel welding according to CSA-W59.
- (b) Trim and bevel ends and other items to enable satisfactory welding.
- (c) Keep painting back from areas requiring welding after fabrication.

E37.18 Finishing

- (a) Apply touch up paint for galvanized metal.
- (b) Clean and touch up shop primer after installation.

E37.19 Fastening, Anchoring

- (a) Cast anchor bolts in concrete as shown on the drawings.
- (b) Do not use self-drilling anchors where cast-in anchor bolts are specified.

E37.20 Installation

- (a) Aluminum plates cast into concrete shall be coated with bitumastic to prevent contact between aluminum and concrete.

E37.21 Installation of Handrail

- (a) Fix aluminum handrailing to the locations shown on the drawings.
- (b) Anchor post base plates to concrete floor with self drilling galvanized anchor bolts. Adjust the alignment and the elevation of the posts and grout in bases with specified grout.
- (c) Provide handrailing as detailed on drawings, and provide handrail posts at every change in direction.
- (d) Removable posts and handrail sections as detailed on drawings.
- (e) Set posts vertical and in line, one with others, both in line of the railings and structure. Erect rails horizontal without wave or bend in any direction to the configuration exactly fitting supporting structures.

E37.22 Installation of Grating

- (a) Clip panels together with sufficient clips to prevent differential movement panel to panel when subjected to moving loads.
- (b) Where appropriate, support gratings on framing angles set into concrete.
- (c) Where a number of panels are laid side by side line up the carrier or spacer bars to preserve a continuous appearance.

- (d) Provide cut outs required for pipes, conduits, valves and other equipment and band with bars having the same thickness as the bearing bars. Arrange cut outs to allow any grating section to be removed without disturbing the item passing through or adjacent to grating sections.

E37.23 Treadplate

- (a) Provide treadplate covers and frames where shown on the drawings.
- (b) Frames to consist of angle mitred at corners, complete with anchors and packing bars. Covers to be detailed as per the project drawings.

E37.24 Access Ladders

- (a) Position access ladders as shown on the drawings.
- (b) Access ladders to be in accordance with details on drawings.

E37.25 Removable Safety Chains

- (a) Removable safety chains shall be complete with approved snap hooks fastened at each end to posts, all in 316 A SS.
- (b) Provide 20 mm diameter eyes fixed on posts.

E37.26 Ladder Rungs

- (a) Position ladder rungs as indicated on drawings.

E37.27 Sump Covers

- (a) Install sump covers in the location shown and as detailed on the drawings.

DIVISION 6 – WOOD & PLASTICS

E38. PREFABRICATED WOOD TRUSSES

E38.1 Related Work

- (a) Rough carpentry: E39.

E38.2 References

- (a) Canadian Standards Association (CSA)
 - (i) CAN/CSA-O80-Series - Wood Preservation.
 - (ii) CAN/CSA-O86.1 - Contract Administratoring Design in Wood (Limit States Design).
 - (iii) CAN/CSA-O141 - Softwood Lumber.
 - (iv) CSA S307 - Load Test Procedure for Wood Roof Trusses for Houses and Small Buildings.
 - (v) CSA S347 - Method of Test for Evaluation of Truss Plates Used in Lumber Joints.
 - (vi) CSA W47.1 - Certification of Companies for Fusion Welding of Steel Structures.
- (b) National Lumber Grades Authority (NLGA)
 - (i) NLGA - Standard Grading Rules for Canadian Lumber.

E38.3 Design Criteria

- (a) Design trusses, bridging in accordance with CAN/CSA-O86.1 for loads indicated and minimum uniform and minimum concentrated loadings stipulated in NBC commentary.
- (b) Limit live load deflection to $1/360^{\text{th}}$ of span where gypsum boardceilings are hung directly from trusses.

- (c) Limit live load deflections to $1/180^{\text{th}}$ of span unless otherwise specified or indicated. See Structural.
- (d) Provide camber for trusses as indicated.

E38.4 Source Quality Control

- (a) Identify lumber by grade stamp of an agency certified by Canadian Lumber Standards Administration Board.

E38.5 Qualification of Manufacturers

- (a) Fabricator for welded steel connections to be certified in accordance with CSA W47.1.

E38.6 Shop Drawings

- (a) Submit shop drawings in accordance with Section E12 – Shop Drawings.
- (b) Each shop drawing submission showing connection details shall bear signature and stamp of professional engineer registered or licensed in Province of Manitoba, Canada.
- (c) Indicate species, sizes, and stress grades of lumber used as truss members. Show pitch, span, camber, configuration and spacing of trusses. Indicate connector types, thicknesses, sizes, locations and design value. Show bearing details. Indicate design load for each member.
- (d) Submit stress diagram or print-out of computer design indicating design load for each truss member. Indicate allowable load and stress increase.
- (e) Indicate arrangement of webs or other members to accommodate ducts and other specialties.
- (f) Show lifting points for storage, handling and erection.
- (g) Show location of lateral bracing for compression members.
- (h) Submit a truss layout.

E38.7 Delivery and Storage

- (a) Deliver, handle, store and protect materials in accordance with Section E14 - Materials and Installation.
- (b) Store trusses on Site in accordance with manufacturer's instructions. Provide bearing supports and bracings. Prevent bending, warping and overturning of trusses.

E38.8 Products

E38.8.1 Materials

- (a) Lumber: SPF species, No. 2 or better grade, softwood, with maximum moisture content of 19% at time of fabrication and to following standards:
 - (i) CAN/CSA-O141.
 - (ii) NLGA (National Lumber Grading Association), Standard Grading Rules for Canadian Lumber.
- (b) Fastenings: to CAN/CSA-O86.1.

E38.8.2 Fabrication

- (a) Fabricate wood trusses in accordance with reviewed shop drawings.
- (b) Provide for design camber and roof slopes when positioning truss members.
- (c) Connect members using metal connector plates.

E38.9 Execution

E38.9.1 Erection

- (a) Erect wood trusses in accordance with reviewed erection drawings.
- (b) Indicated lifting points to be used to hoist trusses into position.
- (c) Make adequate provisions for handling and erection stresses.
- (d) Exercise care to prevent out-of-plane bending of trusses.
- (e) Install temporary horizontal and cross bracing to hold trusses plumb and in safe condition until permanent bracing and decking is installed.
- (f) Install permanent bracing in accordance with reviewed shop drawings, prior to application of loads to trusses.
- (g) Do not cut or remove any truss material without approval of Contract Administrator.
- (h) Remove chemical and other surface deposits on treated wood, in preparation for applied finishes.

E39. ROUGH CARPENTRY

E39.1 References

E39.1.1 Canadian General Standards Board (CGSB)

- (a) CAN/CGSB-11.3, Hardboard.

E39.1.2 Canadian Standards Association (CSA)

- (a) CSA B111 - Wire Nails, spikes and Staples.
- (b) CSA O80 - Wood Preservation.
- (c) CAN/CSA O141 - Softwood Lumber.
- (d) CSA O151 - Canadian Softwood Plywood.

E39.1.3 National Lumber Grades Authority (NLGA)

- (a) Standard Grading Rules for Canadian Lumber.

E39.2 Quality Assurance

- (a) Lumber identification: by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.
- (b) Plywood, particleboard, OSB and wood based composite panels in accordance with CSA and ANSI standards.

E39.3 Materials

- (a) Lumber: unless specified otherwise, softwood, S4S, moisture content 19% (S-dry) or less in accordance with CAN/CSA-O141, Spruce, Pine or Fir NLGA No. 2 or better grade. Glued end-jointed (finger-jointed) lumber is not acceptable
- (b) Canadian softwood plywood (CSP): to CSA 0151, standard construction, square edge. Standard sheathing grade.
- (c) Hardboard paneling: to CAN/CGSB-11.3, smooth, tempered, 1219 x 2438 x 3 mm thick panels.
- (d) Nails, spikes and staples: to CSA B111 and NBC requirements. Galvanized.
- (e) Bolts: steel, of sizes required, complete with nuts and washers. Galvanized.

- (f) Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead plugs, recommended for purpose by manufacturer.
- (g) Surface-applied wood preservative: copper naphthenate or pentachlorophenol base water repellent preservative. Use clear for materials exposed in final assembly, coloured elsewhere.
- (h) Soffit board: James Hardie Hardisoffit Vented Smooth.

E39.3.1 Pressure Preservative Treated Wood

- (a) Provide lumber materials pressure preservative treated for:
 - (i) Rough bucks at openings.
 - (ii) Wood strapping.
 - (iii) Lumber used on exterior of building, above or below grade.
- (b) Treat material to CAN/CSA-O80 using Type-C (copper chromate arsenate) preservative to obtain a minimum net retention level of 6.4 kg/m³ of wood.
- (c) Materials shall be dried after treatment to a moisture content of 19% or less.
- (d) Each piece of treated material shall be identified with a tag or ink mark bearing the Canadian Wood Preservers' Bureau quality mark.
- (e) Apply surface applied wood preservative to heartwood exposed from ripping, end cutting or boring.

E39.4 Execution

E39.4.1 Installation

- (a) Comply with requirements of NBC, Part 9 supplemented by following paragraphs.
- (b) Install members true to line, levels and elevations. Space uniformly.
- (c) Construct continuous members from pieces of longest practical length.
- (d) Install spanning members with "crown-edge" up.
- (e) Frame, anchor, fasten, tie and brace members to provide necessary strength and rigidity.
- (f) Countersink bolts where necessary to provide clearance for other work.
- (g) Use fastenings of following types, except where specific type is indicated or specified:
 - (i) To hollow masonry, plaster and panel surfaces use toggle bolt.
 - (ii) To solid masonry and concrete use expansion shield with lag screw, lead plug with wood screw.
 - (iii) To structural steel use bolts through drilled hole, or welded stud-bolts or power driven self-drilling screws, or welded stud-bolts or explosive actuated stud-bolts.
 - (iv) Install furring and blocking as required to space-out and support surface wall and ceiling finishes, facings, fascia, soffit, siding and other work as indicated. Align and plumb faces of furring and blocking to tolerance of 1:600.
 - (v) Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work. Except where indicated otherwise, use material at least 38 mm thick.
 - (vi) Install fascia backing, nailers and other wood supports as required and secure using galvanized fasteners.
 - (vii) Install soffit panels in accordance with manufacturers instructions .

DIVISION 7 – THERMAL & MOISTURE PROTECTION

E40. BOARD INSULATION

E40.1 Related Work

- (a) Air Barrier Membrane, E44.
- (b) Sheet Vapour Barriers: E42.

E40.2 References

- (a) Canadian Standards Association (CSA)
 - (i) CAN/CSA-A247, Insulating Fibreboard.
- (b) Canadian General Standards Board (CGSB)
 - (i) CGSB 71-GP-24, Adhesive, Flexible, for Bonding Cellular Polystyrene Insulation.
- (c) Laboratories of Canada (ULC)
- (d) CAN/ULC-S604, Type A Chimneys.
- (e) CAN/ULC-S701, Thermal Insulation, Polystyrene, Boards and Pipe Coverings.

E40.3 Products

E40.3.1 Insulation

- (a) Rigid cellular polystyrene:
- (b) To CAN/ULC-S701, type 3 above grade, Type 4 below grade.
- (c) Compressive strength 140 kPa (Type 3) 210 kPa (Type 4)
- (d) Thickness 3".
- (e) Board size 24" x 96"
- (f) Edges: shiplapped
- (g) VOC content: CFC free and HCFC free.
- (h) EcoLogo certified.

E40.3.2 Mineral fibre board: to CAN/ULC-S702

- (a) Type 1 no facing.
- (b) Density 56 kg/m³.
- (c) Flame spread classification 0, smoke developed .
- (d) Thermal resistance: RSI 0.76 per 25 mm.
- (e) Thickness: 75mm
- (f) Acceptable material: Roxul CavityRock.

E40.3.3 Protection Board

- (a) Insulating fibreboard: to CAN/CSA-A247, Type II, thickness 9.5 mm.

E40.3.4 Insulation Clips

- (a) Insulation clips: impale type, perforated 50 x 50 mm cold rolled carbon steel, 20 gauge plate, adhesive back, spindle of 12 gauge diameter annealed steel, length to suit insulation. Self-locking washers, 25 mm diameter.
- (b) Insulation clip adhesive: high solids rubberized adhesive suitable for bonding clip plates to substrate.

E40.3.5 System

- (a) Steel channels, 0.6 mm (26 gauge) steel core thickness, galvanized to ASTM A525 with Z725 zinc coating. Size 41 mm x 12.5 mm legs x 2390 mm long.
 - (i) Acceptable products: Insuloc Thermo-Studs.
- (b) Pregroove insulation boards at 400 mm on centre to receive metal channel fastening system.
- (c) Mechanical fasteners:
 - (i) For concrete or masonry backup: hot dipped galvanized concrete/masonry anchors. Gripcon Concrete Masonry Fastening System or equal.

E40.4 Execution

E40.4.1 Examination

- (a) Examine substrates and immediately inform Contract Administrator in writing of defects.
- (b) Prior to commencement of work, ensure substrates are firm, straight, smooth, dry, free of snow, ice or frost, and clean of dust, debris, oil, grease, or foreign materials.

E40.4.2 Installation

- (a) Install insulation after building substrate materials are cured and dry.
- (b) Install insulation to maintain continuity of thermal protection to building elements and spaces.
- (c) Coordinate installation with work of other trades.
- (d) Fit insulation tight around electrical boxes, plumbing and heating pipes and ducts, around exterior doors and windows and other protrusions.
- (e) Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from sidewalls of CAN/ULC-S604 type A chimneys and CAN/CGA-B149.1 and CAN/CGA-B149.2 type B and L vents.
- (f) Cut and trim insulation neatly to fit spaces.
- (g) Install insulation boards in parallel rows. Butt joints tightly, offset vertical joints.
- (h) Offset both vertical and horizontal joints in multiple layer applications.
- (i) Interlock boards at corners.
- (j) Use only insulation boards free from chipped or broken edges. Use largest possible dimensions to reduce number of joints.
- (k) Leave insulation board joints unbonded over line of expansion and control joints. Bond a continuous 150 mm wide 0.15 mm strip of air barrier membrane over expansion and control joints using compatible adhesive before application of insulation.

E40.4.3 Insulation Clips

- (a) Install insulation clips to dry, sound substrates free of substances that will inhibit bond.
- (b) Provide minimum five clips per 600 x 1200 mm of insulation board.
- (c) Provide additional clips spaced at 300 mm on centre around perimeter of openings, corners and abutments.
- (d) Ensure all clips are sufficiently bonded to substrates. Replace any inadequately bonded clips.
- (e) Impale insulation boards on spindles and secure with self-locking washer to hold insulation firmly against backing without voids.

- (f) Cut off fastener spindle 3 mm beyond disk.

E40.4.4 Metal Channel Fastening System

- (a) Install metal channel fastening system in accordance with manufacturer's instructions. Space and install fasteners to carry intended dead loads of covering materials and anticipated wind loads in accordance with local building codes.
- (b) Position first insulation board at corner. Plumb or square to building elements. Install first metal channel starting at corner. Butt succeeding insulation boards tight and insert metal channel in two grooves adjacent to edges of abutting insulation boards. Fasten in place and continue in same sequence to provide continuous insulation to building elements.
- (c) Ensure channels maintain 400 mm centres. Provide additional channels around openings, corners, abutments and as required to provide firm attachment of covering materials.
- (d) Install fasteners through metal channel and insulation boards to secure system rigidly in place. Provide fasteners spaced at 400 mm on centre along channel. Provide additional fasteners 150 mm from ends of channels terminating at openings, corners and abutments.
- (e) Ensure metal channels are pressed flat against insulation boards when fasteners secured.
- (f) Install insulation boards and metal channels over stud framing or furring so that metal channels are perpendicular to studs or furring members. Ensure all screw fasteners are secure. Do not overturn. Replace loose or stripped fasteners
- (g) Install masonry anchors in accordance with manufacturer's instructions. Position insulation boards and metal channels and drill pilot holes through channel and insulation into substrate. Pilot holes shall be 6 mm deeper into substrate than specified embedment depth of fastener. Use approved and properly sizes drill bit only, no substitutes. Insert fastener through metal channel and insulation board and into pilot hole. Tap with hammer until securely seated. Replace loose fasteners or provide additional fastener adjacent to loose fasteners.

E40.4.5 Masonry Anchors

- (a) Refer to E32.

E40.4.6 Masonry Cavity Wall Insulation

- (a) Install insulation boards on outer surface of inner wythe of wall cavity over impale clips or with plastic insulation clips.
- (b) Install boards horizontally between masonry ties, with horizontal joints centred on ties.
- (c) Install plastic insulation clips over masonry ties to hold insulation tight to backup wall.

E40.4.7 Exterior Wall Insulation

- (a) Install insulation boards on exterior walls with insulation clips or insulation adhesive.

E40.4.8 Perimeter Foundation Insulation

- (a) Install insulation boards with insulation clips or insulation adhesive.
- (b) Install frost barrier where indicated using same insulation as applied to foundation. Set straight and level with joints butted tight. Ensure insulation is not displaced during backfilling.

E40.4.9 Protection Board

- (a) Install protection board against insulation below grade to protect from backfilling operations.

- (b) Do not use adhesives or fasteners to attach protection board. Install protection board during backfilling operations to allow backfill to hold boards against insulation.

E41. BATT AND BLANKET

E41.1 Related Work

- (a) Sheet vapour barrier, E42.
- (b) Board insulation, E40.

E41.2 References

- (a) Canadian Standards Association (CSA)
 - (i) CSA B111, Wire Nails, Spikes and Staples.
- (b) Canadian Gas Association (CGA)
 - (i) CAN/CGA-B149.1, Natural Gas Installation Code.
 - (ii) CAN/CGA-B149.2, Propane Installation Code.
- (c) Underwriters Laboratories of Canada (ULC)
 - (i) CAN/ULC-S604, Factory-Built, Type A Chimneys.
 - (ii) CAN/ULC-S702, Standard for Mineral Fibre Thermal Insulation for Building.

E41.3 Products

E41.3.1 Materials

- (a) Batt and blanket mineral fibre insulation: to CAN/ULC-S702, Type 1. Thickness to provide total thermal resistance values as indicated].

E41.4 Execution

E41.4.1 Installation

- (a) Install insulation to maintain continuity of thermal protection to building elements and spaces.
- (b) In attic space install two layers of batt insulation. First layer between bottom cords of trusses/joists; second layer perpendicular to first.
- (c) Fit insulation closely around electrical boxes, pipes, ducts, frames and other objects in or passing through insulation.
- (d) Fill all voids completely. Cut and trim insulation neatly to fill voids; leave no gaps.
- (e) Do not compress insulation to fit into spaces.
- (f) Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from side walls of CAN4-S604 type A chimneys and CAN/CGA-B149.1 and CAN/CGA-B149.2 type B and L vents.
- (g) Do not enclose insulation until installation has been reviewed by Contract Administrator.

E42. SHEET VAPOUR BARRIERS

E42.1 Related Work

- (a) Batt and blanket insulation, E41.
- (b) Gypsum board, E47.

E42.2 References

- (a) Canadian General Standards Board (CGSB)
 - (i) CAN/CGSB-51.33, Vapour Barrier Sheet, Excluding Polyethylene, for Use in Building Construction
 - (ii) CAN/CGSB-51.34, Vapour Barrier, Polyethylene Sheet, for Use in Building Construction.
- (b) Canadian Construction Materials Centre (CCMC)

E42.3 Pre-Installation Meeting

- (a) Prior to start of vapour barrier installation, convene a pre-installation meeting with the applicators, Contract Administrator and other affected Subcontractors to review and confirm installation procedures, detailing.
- (b) Select date, time and location and notify parties in advance of meeting to attend.

E42.4 Products

E42.4.1 Materials

- (a) Sheet vapour barrier: polyethylene film to CAN/CGSB 51.34, 0.15 mm thick, CCMC listed.
- (b) Joint sealing tape: air resistant pressure sensitive adhesive tape, type recommended by vapour barrier manufacturer, 50 mm wide for lap joints and perimeter seals, 25 mm wide elsewhere.
- (c) Sealing adhesive: acoustical sealant Tremco Tremflex 834 or equal.
- (d) Staples: minimum 6 mm leg.

E42.5 Execution

E42.5.1 Installation

- (a) Ensure services are installed and inspected prior to installation of barrier.
- (b) Coordinate delivery and installation of vapour barrier with installation of covering materials to minimize exposure of membrane to elements or damage.
- (c) Coordinate installation of sheet vapour barrier with work of other trades. Overlap and seal vapour barrier with air barriers and vapour barrier membranes installed by other trades to ensure continuity of air barrier and vapour barrier systems over entire building.
- (d) Install sheet vapour barrier on warm side of exterior wall assemblies prior to installation of gypsum board or paneling to form continuous barrier.
- (e) Use sheets of largest possible size to minimize joints.
- (f) Inspect sheets for continuity. Repair punctures and tears with patch material and sealant before work is concealed.
- (g) Bond sheets to solid substrates such as steel and concrete using continuous bead of sealant.
- (h) Install foil with reflective surface facing the air space of assembly.

E42.5.2 Exterior Surface Openings

- (a) Cut sheet vapour barrier to form openings and ensure material is lapped and sealed to frame.

E42.5.3 Perimeter Seals

- (a) Seal perimeter of sheet vapour barrier as follows:
 - (i) Apply continuous bead of sealant to substrate at perimeter of sheets.
 - (ii) Lap sheet over sealant and press into sealant bead.
 - (iii) At wood substrates install staples through lapped sheets at sealant bead into wood substrate.
 - (iv) Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.

E42.5.4 Lap Joint Seals

- (a) Seal lap joints of sheet vapour barrier as follows:
 - (i) Attach first sheet to substrate.
 - (ii) Apply continuous bead of sealant over solid backing at joint.
 - (iii) Lap adjoining sheet minimum 150 mm and press into sealant bead.
 - (iv) At wood substrates install staples through lapped sheets at sealant bead into wood substrate.
 - (v) Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.

E42.5.5 Patching and Repairing

- (a) Inspect sheet vapour barriers for defects and poor workmanship before covering and make corrections immediately.
- (b) Patch and repair misaligned or inadequately lapped seams, tears, punctures or fishmouths to the satisfaction of the Contract Administrator.
- (c) Patch cuts, tears and punctures with sealing tape. For large holes replace entire sheet or patch with an additional layer of sheet vapour barrier fully sealed at all edges and stapled or bonded to solid backing. Extend minimum one stud width from fault.

E43. JOINT SEALERS

E43.1 General

E43.1.1 References

- (a) Canadian General Standards Board (CGSB).
 - (i) CAN/CGSB-19.13, Sealing Compound, One-component, Elastomeric, Chemical Curing.

E43.1.2 Environmental and Safety Requirements

- (a) Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labeling and provision of material safety data sheets acceptable to Labour Canada.
- (b) Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.

E43.2 Products

E43.2.1 Sealant Materials

- (a) Urethanes, One Part, Self-Leveling.
 - (i) To CAN/CGSB-19.13, Type 1.

- (b) Acceptable material: Sikaflex 1cSL, Bostik Chem-Calk 950.
 - (i) Urethanes, One Part, Non-Sag.
- (c) To CAN/CGSB-19.13, Type 2.
 - (i) Acceptable products: Sikaflex 1a, Tremco DyMonic, Bostik Chem-Calk 900.
- (d) Sealant colours: selected by Contract Administrator from manufacturer's standard colour selection.
- (e) Foam backer rods: extruded polyethylene foam, compressible, oversized 30 to 50%.
 - (i) Acceptable material: Tremco Tundra Foam.
- (f) Bond breaker tape: polyethylene bond breaker tape that will not bond to sealants.
- (g) Expanding foam sealant: high-density open cell polyurethane foam, pre-compressed, impregnated with water-based, stabilized acrylic, self-adhesive. Secondary seal requiring primary seal of wet sealant.
 - (i) Acceptable material: Emseal Greyflex.
- (h) Adhesives: type recommended by expanding foam sealant manufacturer.
- (i) Primers: type recommended by sealant manufacturer, for appropriate sealant and corresponding substrate.
- (j) Joint cleaner: non-corrosive and non-staining type, compatible with joint forming materials and sealant recommended by sealant manufacturer.

E43.2.2 Sealant Selection

- (a) Perimeters of exterior openings where frames meet exterior facade of building: Urethanes One Part, Non-Sag.
- (b) Expansion and control joints in exterior surfaces of architectural wall panels: Urethanes One Part, Non-Sag.
- (c) Expansion and control joints in exterior surfaces of unit masonry walls: Urethanes One Part, Non-Sag.
- (d) Coping joints and coping-to-facade joints: Sealant type: Urethanes One Part, Non-Sag.
- (e) Cornice and wash (or horizontal surface joints): Sealant type: Urethanes One Part, Self-leveling.
- (f) Exterior joints in horizontal wearing surfaces (as itemized): Sealant type: Urethanes One Part, Self-leveling.
- (g) Perimeters of interior frames where frames meet interior finishes: Urethanes One Part, Non-Sag.
- (h) Interior masonry vertical control joints (block-to-block, block-to-concrete, and intersecting masonry walls): Sealant type: Urethanes One Part, Non-Sag.
- (i) Under thresholds at exterior doors. Sealant type: Urethanes, One Part, Non-Sag.
- (j) As itemized in other sections.

E43.3 Execution

E43.3.1 Protection

- (a) Protect installed work of other trades from staining or contamination.
- (b) Preparation of Joint Surfaces
- (c) Before commencing application of sealants test materials for indications of staining or poor adhesion.

- (d) Ascertain that sealers and coatings applied to sealant substrates are compatible with sealant used and that full bond between the sealant and substrate is attained. Request samples of the sealed or coated substrate from their fabricators for testing of compatibility and bond, if necessary.
- (e) Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.
- (f) Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter that may impair the Work.
- (g) Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.
- (h) Ensure joint surfaces are dry and frost free.
- (i) Prepare surfaces in accordance with manufacturer's directions.

E43.3.2 Priming

- (a) Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.
- (b) Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.

E43.3.3 Backup Material

- (a) Apply bond breaker tape where required to manufacturer's instructions.
- (b) Install foam backer rod to achieve correct joint depth and shape, with approximately 30% compression.

E43.3.4 Expanding Foam Sealants

- (a) Install expanding foam sealants in accordance with manufacturer's instructions.
- (b) Coordinate installation with work of other trades to ensure foam sealants are installed before building joints are covered.
- (c) For expansion and control joints above grade in exterior walls install as secondary seal with wet caulking as primary seal.
- (d) Where used as a secondary seal together with field applied wet caulking provide bond breaker tape or backer rod between foam sealant and caulking.
- (e) Size preformed foam sealant to suit joint depth and width allowing for proper compression of the material.
- (f) Use adhesives recommended by manufacturer, suitable for substrate and application.
- (g) Install in longest possible lengths. Keep number of joints to a minimum. Join individual strips by means of scarf joint, cut at approximately 30°.

E43.3.5 Application

- (a) Sealant:
 - (i) Apply sealant in accordance with manufacturer's written instructions.
 - (ii) Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.
 - (iii) Apply sealant in continuous beads.
 - (iv) Apply sealant using gun with proper size nozzle.
 - (v) Use sufficient pressure to fill voids and joints solid.

- (vi) Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.
 - (vii) Tool exposed surfaces before skinning begins to give slightly concave shape.
 - (viii) Remove excess compound promptly as work progresses and upon completion.
- (b) Curing:
- (i) Cure sealants in accordance with sealant manufacturer's instructions.
 - (ii) Do not cover up sealants until proper curing has taken place.
 - (iii) Cleanup:
 - (iv) Clean adjacent surfaces immediately and leave work neat and clean.
 - (v) Remove excess and droppings, using recommended cleaners as work progresses.
 - (vi) Remove masking tape after initial set of sealant.

E44. AIR BARRIER

E44.1 General

E44.1.1 Quality Assurance

- (a) Coordinate installation of air barrier materials with work of other trades to minimize exposure of membrane to elements or damage and to coordinate proper sealing of all protrusions.
- (b) Overlap and seal air barrier with air and vapour barrier membranes installed by other trades to ensure continuity of building air/vapour barrier system over entire building.
- (c) Environmental Conditions
- (d) Apply primers and membranes in dry weather and only when air and surface temperature are within manufacturer's recommended limits.
- (e) For applications below recommended temperature consult manufacturer and do not proceed until approved by manufacturer or his representative.

E44.2 Products

E44.2.1 Materials

- (a) Self-adhesive air barrier membrane: modified bitumen on high-density polyethylene film, with silicone release paper on adhesive side, minimum 1.0 mm thick.
- (b) Acceptable material – exterior walls: Soprema Sopraseal Stick 1100, Bakor Blueskin SA, WR Grace Perm-A-Barrier, IKO Aquabarrier AVB.
- (c) Acceptable material – roof deck: IKO Armour Gard Ice and Water Protector, W.R. Grace Ice and Water Shield; Domtar Eavesshield; Nordshield Water Stopper; Bakor Eave Guard; BPCO ProGard; EMCO Grippgard.
- (d) Primers: as recommended by manufacturer and suitable for substrate.
- (e) Mastics and sealants: as recommended by manufacturer, suitable for substrate.
- (f) Flashing and stripping membranes: as recommended by air barrier membrane manufacturer.

E44.3 Execution

E44.3.1 Examination

- (a) Verify that surfaces and conditions are cured, dry and acceptable for installation of air barrier membranes.

- (b) Notify Contract Administrator in writing of unsuitable surfaces or working conditions and await remedial measures. Commencement of work shall imply acceptance of surfaces and working conditions.

E44.3.2 Preparation

- (a) Clean substrates of all snow, ice, loose particles, oil, grease, dirt, curing compounds, or other foreign matter detrimental to installation and bonding of air barrier membrane.
- (b) Repair defects in concrete and masonry surfaces such as mortar droppings spalled or poorly consolidated areas, honeycombing. Patch rough areas with a well-adhered parge coat to provide smooth surface. Allow to fully cure and dry.
- (c) Remove sharp protrusions, form lines and rough edges.

E44.3.3 Priming

- (a) Prime all surfaces and substrates to receive self-adhesive air barrier membranes.
- (b) Apply primers in accordance with manufacturer's instructions, at recommended rate of application.
- (c) Do not apply to frozen or damp surfaces. Apply in dry weather when air and surface temperatures are within manufacturer's recommended limits.
- (d) Avoid pooling of primer and allow to cure until tack-free.
- (e) Prime only an area that can be covered in a working day. Re-prime areas which over dry or become soiled or dusty.

E44.3.4 Workmanship

- (a) Install materials in accordance with manufacturer's instructions using only materials approved for use with their products.
- (b) Apply with good construction practice to maintain continuity of air barrier membrane over building elements.
- (c) Do not commence work until all other work penetrating substrates has been completed, and reviewed by Contract Administrator.
- (d) Use largest lengths possible to minimize joints. Overlap side and end laps minimum 50 mm. Stagger end laps minimum 300 mm in adjacent rows.
- (e) Locate end joints minimum 300 mm from internal and external corners.
- (f) Masonry cavity walls:
 - (i) Install sheets horizontally between masonry ties penetrating membrane.
 - (ii) Overlap horizontal joints minimum 50 mm. Slit membrane at each tie and seal making air tight.
- (g) Roof deck:
 - (i) Install sheets starting at low point parallel to roof eave. Overlap succeeding sheets minimum 50 mm to shed water.
- (h) Place membrane in position without stretching, taking care to avoid trapped air, creases or fishmouths. As installation progresses roll membrane with hand roller to ensure full contact and bond to substrates.
- (i) Flash and seal around all penetrations and protrusions such as pipes, conduits, steel angle supports, masonry ties, anchors. Cut and fit membrane neatly and snug fitting, leave no gaps. Seal and make airtight.
- (j) Seal with mastic all difficult detail areas that do not allow easy installation of membrane. Make airtight.

- (k) At rough openings cut air barrier membrane to form opening. Return membrane into opening and seal to rough bucks. Reinforce corners with additional piece of membrane cut and formed to seal corners.
- (l) Overlap and seal air barrier membrane to air and vapour barriers installed by other trades. Maintain continuity of building air/vapour barrier system over entire building.

E44.3.5 Installation Self-Adhesive Air Barrier

- (a) Apply membrane in accordance with manufacturer's instructions.
- (b) Roll out sheets and press firmly to substrate. As installation progresses roll with hand roller to ensure positive bond.
- (c) At all internal corners, both vertical and horizontal, provide a fillet strip formed of liquid mastic. Do not use fibre or wood cants.
- (d) Flash and seal around all penetrations and protrusions such as pipes, conduits, steel angle supports, masonry ties and anchors. Cut and fit membrane neatly and snug fitting, leave no gaps. Seal around all protrusions with mastic sealant. Make airtight.
- (e) Patching and Repairing
- (f) Inspect membrane for defects and poor workmanship before covering and make corrections immediately.
- (g) Ensure full contact and bond to substrates. Patch and repair loose or poorly bonded areas.
- (h) Patch and repair misaligned or inadequately lapped seams, tears, punctures or fishmouths to the satisfaction of the Contract Administrator.
- (i) Patch cuts, tears, and punctures by bonding an additional layer of air barrier membrane over damaged area. Patch shall extend minimum 150 mm in all directions from fault. Seal and make airtight.

DIVISION 8 – DOORS & WINDOWS

E45. STEEL DOORS AND FRAMES

E45.1.1 Related Work

- (a) Building in and grouting frames in masonry, E31.
- (b) Joint sealants, E43.
- (c) Door hardware, E45.3 and E45.4.

E45.1.2 References

- (a) American Society for Testing and Materials (ASTM)
 - (i) ASTM A 653/A 653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - (ii) ASTM E 152, Methods for Fire Tests of Door Assemblies.
- (b) Canadian General Standards Board (CGSB).
 - (i) CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.
 - (ii) CGSB 41-GP-19, Rigid Vinyl Extrusions for Windows and Doors.
- (c) Canadian Standards Association (CSA)
 - (i) CAN/CSA-G40.21, Structural Quality Steels.
 - (ii) CSA W59, Welded Steel Construction (Metal Arc Welding).
- (d) Canadian Steel Door and Frame Manufacturers' Association, (CSDFMA):

- (i) CSDFMS, Specifications for Commercial Steel Doors and Frames.
- (ii) CSDFMA, Recommended Selection and Usage Guide for Commercial Steel Doors.
- (e) National Fire Protection Association (NFPA)
 - (i) NFPA 80, Fire Doors and Windows.
 - (ii) NFPA 252, Door Assemblies, Fire Tests of.
- (f) Underwriters' Laboratories of Canada (ULC)
 - (i) CAN4-S104M, Fire Tests of Door Assemblies.
 - (ii) CAN4-S105M, Fire Door Frames.
 - (iii) CAN/ULC-S702, Standard for Mineral Fibre Thermal Insulation for Buildings.

E45.1.3 Shop Drawings

- (a) Submit shop drawings in accordance with E11 - Submittals.
- (b) Indicate each type door and frame, materials, core thickness, mortises, reinforcements, glazed and louver opening, glazing stops, arrangement of hardware, location and methods of anchors, exposed fastenings and reinforcing, fire ratings, and finishes.
- (c) Indicate details of jamb and head, frame types, meeting and stiles on pairs of doors, field splices.
- (d) Indicate special features, junction boxes and conduit for electrical and electronic door hardware.
- (e) Include schedule identifying each unit, with door marks and numbers relating to numbering on drawings and door schedule.

E45.1.4 Requirements of Regulatory Agencies

- (a) Steel fire rated doors and frames: labeled and listed by an organization accredited by Standards Council of Canada in conformance with CAN4-S104 and NFPA 252 for ratings specified or indicated.
- (b) Provide fire labeled frame products for those openings requiring fire protection ratings, as scheduled. Test products in strict conformance with CAN4-S104, ASTM E152 or NFPA 252 and list by nationally recognized agency having factory inspection service and construct as detailed in Follow-Up Service Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.

E45.1.5 Delivery, Storage and Handling

- (a) Store frames in dry location, above ground to prevent corrosion.
- (b) Protect by suitable means until installation. Brace and stack to prevent warping, bending, twisting and other damage.
- (c) Replace or make good materials that become damaged or defective as directed by Contract Administrator.

E45.2 Products

E45.2.1 Materials

- (a) Hot dipped galvanized steel sheet: to ASTM A 653/A 653M coating designation for locations as follows.
 - (i) Interior doors and frames: ZF75 (A25).
 - (ii) Interior doors and frames for: Z275 (G9] with factory applied primer as specified in this Section.

- (iii) Exterior doors and frames: Z275 (G90) with factory applied primer as specified in this Section].
- (b) Minimum base steel thickness (gauge) in accordance with CSDFMA Table 1, except as follows:
 - (i) Door face sheets: 1.2 mm (18 gauge).
 - (ii) Frames: 1.6 mm (16 gauge).
 - (iii) Astragals: 1.9 mm (14 gauge).
 - (iv) Floor anchors: 1.6 mm (16 gauge).
 - (v) Jamb anchors:
 - ◆ T" strap type: 1.6 mm (16 gauge).
 - ◆ "L" type: 1.2 mm (18 gauge).
 - ◆ Stirrup-strap type: 15 x 250 x 1.6 mm (16 gauge)
 - ◆ Stud type: 1.2 mm (18 gauge).
 - ◆ Wire type: 4.0 mm (9 gauge).
 - (vi) Reinforcing steel:
 - ◆ Locks, strikes: 1.6 mm (16 gauge).
 - ◆ Butts, hinges: 3.4 mm (10 gauge).
 - ◆ Surface mounted hardware: 2.7 mm (12 gauge).
 - (vii) Flush bolts: 3.4 mm (10 gauge).
 - (viii) Glazing stops: 0.9 mm (20 gauge). ULC approved for fire rated doors and frames.
 - (ix) Channel reinforcement for glazed and louvre openings: 0.9 mm (20 gauge).
 - (x) Mortar guard boxes: 0.8 mm (22 gauge).
 - (xi) Jamb spreaders: 1.2 mm (18 gauge).
- (c) Reinforcement channel: to CAN/CSA-G40.21, Type 44W, coating designation to ASTM A 653M, ZF75.
- (d) Stiffened: face sheets welded, insulated core.

E45.2.2

Adhesives

- (a) Select Adhesives which:
 - (i) do not contain volatile organic compounds in excess of 5 % by weight as measured by as demonstrated through calculation from records of the amounts of constituents used to make the product;
 - (ii) are accompanied by detailed instructions for proper application so as to minimize health concerns and maximize performance;
 - (iii) are accompanied by information describing proper disposal methods for containers.
- (b) Honeycomb cores and steel components: heat resistant, spray grade, resin reinforced neoprene/rubber (polychloroprene) based, low viscosity, contact cement.

E45.2.3

Accessories

- (a) Primer: to CAN/CGSB-1.181.
- (b) Top and bottom caps:
- (c) Interior doors: steel.
- (d) Sealant (caulking): as specified in Section 07900 – Joint Sealers.

- (e) Spray foam sealant: spray-applied polyurethane foam sealant, CFC and urea formaldehyde free, non-shrinking after cure. Ener-Foam, Insta-Seal or equal.
- (f) Metallic paste filler: to manufacturer's standard.
- (g) Fire labels: metal riveted.

E45.2.4 Frames Fabrication General

- (a) Fabricate frames in accordance with CSDFMA specifications.
- (b) Fabricate frames to profiles and maximum face sizes as indicated.
- (c) Exterior frames: thermally broken type construction.
- (d) Interior frames: welded] type construction.
- (e) Blank, mortise, reinforce, drill and tap frames and reinforcements to receive hardware and electronic hardware using templates provided by door hardware supplier. Reinforce internally for surface mounted hardware.
- (f) Top hinge reinforcement: weld in top hinge reinforcement with 20 mm leg to hinge reinforcement, 25 mm leg to frame.
- (g) Reinforce head of frames wider than 1200 mm.
- (h) Protect mortised cutouts with steel guard boxes for frames installed in masonry and concrete walls.
- (i) Prepare frame for door silencers, three for single door, and two at head for double doors.
- (j) Manufacturer's nameplates on frames and screens are not permitted.
- (k) Conceal fastenings except where exposed fastenings are indicated.
- (l) Insulate exterior frame components with fibreglass batt insulation.

E45.2.5 Frame Anchorage

- (a) Provide appropriate anchorage to floor and wall construction.
- (b) Locate each wall anchor immediately above or below each hinge reinforcement on hinge jamb and directly opposite on strike jamb.
- (c) Provide two anchors for rebate opening heights up to 1520 mm and one additional anchor for each additional 760 mm of height or fraction thereof.

E45.2.6 Frames: Welded Type

- (a) Welding in accordance with CSA W59.
- (b) Accurately mitre or mechanically joint frame product and securely weld on inside of profile. Spot welding not acceptable.
- (c) Cope accurately and securely weld butt joints of mullions, transom bars, centre rails and sills.
- (d) Grind welded joints and corners to a flat plane, fill with metallic paste and sand to uniform smooth finish.
- (e) Securely attach floor anchors to inside of each jamb profile.
- (f) Fabrication frame assemblies in largest sections possible. Where field splices are required, weld and grind smooth. Make field splices and joints inconspicuous after assembly. Exposed fasteners not permitted.
- (g) Weld in two temporary jamb spreaders per frame to maintain proper alignment during shipment.

E45.2.7 Frames: Thermally Broken Type

- (a) Fabricate thermally broken frames using insulated core and separating exterior parts from interior parts with continuous interlocking thermal break.
- (b) Thermal break: rigid polyvinylchloride (PVC) extrusion conforming to CGSB 41-GP-19Ma.
- (c) Do not fix together frame sections with screws or other fastening devices. Manufacture frames in a manner to provide adequate integral strength to ensure trouble free operation.
- (d) Fill closed frame sections with fibreglass insulation.

E45.2.8 Door Fabrication General

- (a) Exterior doors: hollow steel construction.
- (b) Interior doors: hollow steel construction.
- (c) Fabricate doors with longitudinal edges welded. Seams: grind welded joints to a flat plane, fill with metallic paste filler and sand to a uniform smooth finish].
- (d) Construct rail and stile doors, and matching panels in same manner as flush doors.
- (e) Provide astragals for pairs of doors in accordance with ULC requirements but only where specified in Door Schedule and Section 08710 – Door Hardware.
- (f) Where pairs of doors are fitted with top and bottom rod exit devices, doors are to be ULC approved without the use of an astragal.
- (g) Provide flush steel top caps to exterior doors. Provide inverted, recessed, spot welded channels to top and bottom of interior doors.
- (h) Provide fire labelled doors for those openings requiring fire protection ratings, as scheduled. Test such products in strict conformance with CAN4-S104, ASTM E 152 or NFPA 252 and list by nationally recognized agency having factory inspection service and construct as detailed in Follow-Up Service Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.
- (i) Manufacturer's nameplates on doors permitted on hinge side of door concealed from view.

E45.2.9 Doors: Hollow Steel Construction

- (a) Form each face sheet for exterior doors from 1.2 mm sheet steel.
- (b) Form each face sheet for interior doors from 1.2 mm sheet steel.
- (c) Reinforce doors with vertical stiffeners, securely welded to each face sheet at 150 mm on centre maximum.
- (d) Fill voids between stiffeners of exterior doors with fibreglass core.
- (e) Fill voids between stiffeners of interior doors with fibreglass core.

E45.2.10 Shop Priming

- (a) For doors and frames fabricated of steel sheet with Z275 (G90) designation galvanized coating apply in factory one coat of zinc-rich primer CAN/CGSB-1.181 to all exposed surfaces. Properly pre-treat and prepare surfaces before application of primer to ensure good primer adhesion.

E45.3 Execution

E45.3.1 Installation General

- (a) Install labeled steel fire rated doors and frames to NFPA 80 except where specified otherwise.

(b) Install doors and frames to CSDFMA Installation Guide.

E45.3.2 Frame Installation

- (a) Set frames plumb, square, level and at correct elevation.
- (b) Secure anchorages and connections to adjacent construction.
- (c) Brace frames rigidly in position while building-in. Install temporary horizontal wood spreader at third points of door opening to maintain frame width. Provide vertical support at centre of head for openings over 1200 mm wide. Remove temporary spreaders after frames are built-in.
- (d) Make allowances for deflection of structure to ensure structural loads are not transmitted to frames.
- (e) Maintain continuity of air barrier.
- (f) Coordinate installation with Division 16 for installation of junction boxes and conduit for electric hardware, wiring and controls.

E45.3.3 Door Installation

- (a) Install doors and hardware in accordance with hardware templates and manufacturer's instructions.
- (b) Provide even margins between doors and jambs and doors and finished floor and thresholds as follows.
 - (i) Hinge side: 1.0 mm.
 - (ii) Latch side and head: 1.5 mm.
 - (iii) Finished flooring and thresholds: 13 mm, except where doors are fitted with exit rod devices margin shall be 6 mm.
 - (iv) Adjust operable parts for correct function.
- (c) Provide deadbolt and exit device with Medeco cylinder keyed to City of Winnipeg requirements. The City will provide lock number before keying.
- (d) Provide keys in triplicate for each lock.

E45.4 Hardware Schedule

1) HW SET: 1						
QTY	UNIT	DESCRIPTION	MANUFACTURER	QTY	UNIT	DESCRIPTION
6	EA	HINGE	3CB1 4.5 X 4 NRP	630		IVE
2	EA	DEADBOLT	B660P	626		SCH
2	SB360	SURFACE BOLTS	626	626		IVE
2	EA	PUSH PLATE	8200 6" X 16"	630		IVE
2	EA	PULL PLATE	8303-0 4" X 16"	630		LCN
1	EA	SURFACE CLOSER	4111 H CUSH	689		IVE
2	EA	KICK PLATE	8400	630		IVE
1	W-50	WEATHERSTRIP	628	628		KNC
1	EA	ASTRAGAL	W-9	628		KNC
2	EA	DOOR SWEEP	W-13S	628		KNC
1	EA	THRESHOLD	CT-10	627		KNC

2) HW SET: 2						
QTY	UNIT	DESCRIPTION	MANUFACTURER	QTY	UNIT	DESCRIPTION
3	EA	HINGE	3CB1 4.5 X 4 NRP	630		IVE
1	EA	PANIC HARDWARE	98EO	626		VON
1	EA	SURFACE CLOSER	4111 EDA	689		LCN
1	EA	OVERHEAD STOP	100S	630		GLY

1	EA	WEATHERSTRIP	W-50		628	KNC
1	EA	DOOR SWEEP	W-13S		628	KNC
1	EA	THRESHOLD	CT-10		627	KNC
1	EA					

3) HW SET: 3						
3	EA	HINGE	3CB1 4.5 X 4		652	IVE
1	EA	SURFACE CLOSER	1461		630	LCN
1	EA	KICK PLATE	8400		630	IVE
1	EA	WALL STOP	WS406		630	IVE
1	EA	PASSAGE SET	ALIOS NEP		626	SCH

4) HW SET: 4						
3	EA	HINGE	3CB1 4.5 X 4		652	IVE
1	EA	PANIC HARDWARE	98EO		626	VON
1	EA	SURFACE CLOSER	1461		689	LCN
1	EA	KICK PLATE	8400		630	IVE
1	EA	WALL STOP	WS406		630	IVE

5) Doors						
	Door D01	Hardware group 1	HMI			
	Door D02	Hardware group 2	HMI			
	Door D03	Hardware group 3	HMI	45 min. f.r.		
	Door D04	Hardware group 4	HMI	45 min. f.r.		

E45.4.1 Caulking and Sealing

- (a) At exterior openings, fill head and jamb frame sections with foam sealant. Fill shim space around perimeter of frames with foam sealant.
- (b) For both interior and exterior frames seal joint between frames and adjacent construction with sealant (caulking). Apply sealant around full perimeter of frames, on both sides of opening.
- (c) For frames at exterior openings provide foam backer rod or bond breaker tape behind sealant.
- (d) Apply sealants in accordance with Section 07900 – Joint Sealers. Provide smooth, neat bead, tooled to slight concave profile.

E45.4.2 Finish Repairs

- (a) Touch up with primer finishes damaged during installation.
- (b) Fill exposed frame anchors and surfaces with imperfections with metallic paste filler and sand to a uniform smooth finish. Apply primer on sanded surfaces.

DIVISION 9 – FINISHES

E46. PORTLAND CEMENT STUCCO (PARGING)

E46.1 General

E46.1.1 Section Includes

- (a) New stucco work where indicated.

E46.1.2 Related Work

- (a) Rough Carpentry, E39.
- (b) Board insulation, E40.

E46.1.3 References

- (a) American Society for Testing and Materials (ASTM)
 - (i) ASTM C 206, Standard Specification for Finishing Hydrated Lime.
 - (ii) ASTM C 897, Standard Specification for Aggregate for Job-Mixed Portland Cement-Based Plaster
- (b) Canadian Standards Association (CSA)
 - (i) CAN/CSA-A3000, Cementitious Materials Compendium (Consists of A5, A8, A23.5, A362, A363, A456.1, A456.2, A456.3).
 - (ii) CSA-B111, Wire Nails, Spikes and Staples.
 - (iii) CAN/CGSB-51.32, Sheathing, Membrane, Breather Type.
 - (iv) CSA-A123.2, Asphalt Coated Roofing Sheets.

E46.2 Products

E46.2.1 Stucco Cement Materials

- (a) Portland cement: Type 10 to CAN/CSA-A5.
- (b) White cement: proprietary brand as commercially available conforming to CAN/CSA A5.
- (c) Hydrated finishing lime: to ASTM C 206, Type S.

E46.2.2 Aggregates

- (a) Sand: clean, well graded fresh water sand to ASTM C 897.
- (b) White sand: clean, well screened to ASTM C 897, or proprietary white sand as commercially available.

E46.2.3 Other Materials

- (a) Water: clean, potable and free from deleterious matter, acids or alkalis.
- (b) Admixtures: for bonding, pumping or curing to be manufactured specifically for use in stucco mixes and to be used in strict conformance with manufacturer's recommendations. Detergent or soap is not permitted.
- (c) Stucco finish coat: factory prepared, cement stucco finish coat, water/weather resistant and requiring only addition of water. Acceptable products: Imasco Premixed Finish Coat Stucco, color base white.
- (d) Coloring pigment: dry powder pigment for job mix in finish coat. Imasco Custom Colors.
- (e) Liquid bonding agent: acrylic polymerization type capable of bonding cementitious material immediately upon application.

E46.2.4 Metal Lath

- (a) Stucco wire: welded wire, 50 x 50 mm mesh, minimum 1.6 mm (16 gauge) wire diameter, galvanized, self-furring type.
- (b) Metal lath: diamond mesh, 1.65 kg/m² galvanized for exterior work, rust inhibitive coating for interior work.
- (c) Tie wire: zinc coated annealed steel wire, minimum 1.6 mm (16 gauge) diameter.
- (d) Hangers: 4.8 mm diameter steel rods, zinc coated.

- (e) Inserts for suspended soffits: capable of developing full strength of hangers they support, strength in tension at 16,000 lbs./in² for diameter rods.
- (f) Cross furring (ceiling/soffits): cold rolled steel channels, galvanized, minimum size 19 mm x 15 mm x 1.62 mm.
- (g) Main runners (carrying channels) for ceilings/soffits: cold rolled steel channels, galvanized, minimum size 38 mm x 15 mm x 1.62 mm .
- (h) Cornerite: expanded 0.45 mm (26 gauge) thick sheet steel, 64 mm legs, galvanized finish.
- (i) Striplath: expanded 0.45 mm (26 gauge) thick sheet steel, 150 mm wide, galvanized finish.
- (j) Stucco stops: square, 0.62 mm (24 gauge) galvanized sheet steel or pure zinc, perforated or expanded flanges.
- (k) Base screed: purpose made base screed of rigid vinyl, perforated to allow drainage.
 - (i) Acceptable material: Fry Reglet Foundation Weep Screed FWS-875.
- (l) Corner beads: standard 0.45 mm (26 gauge) galvanized sheet steel or pure zinc, perforated or expanded flanges.
- (m) Concrete/masonry fasteners: purpose made wedge type anchors, carbon steel, corrosion resistant finish. Fastener length equal to thickness of materials to be fastened plus [25 mm] [1"] embedded depth into substrate.
- (n) Acceptable material: Gripcon Perma-Grip, Rawl Spike.
- (o) Exterior wall sheathing paper: to CAN/CGSB-51.32, single ply type as indicated. Tyvek Stucco Wrap.
- (p) Sealing tape for sheathing paper: Dupont Contractor Sheathing Tape 50 mm or 75 mm wide.
- (q) Building paper: No.15 asphalt saturated felt to CSA A123.3.
- (r) Fasteners for attaching sheathing paper: nails with plastic washer heads, or staples with minimum [25 mm] [1"] crown.

E46.2.5 Mixing

- (a) Detergent, soap, or other additives in stucco mixes not permitted without prior written approval of the Contract Administrator.
- (b) Proportion parts by volume. Accurately measure ingredients, including water. Proportion successive batches alike.
- (c) Adjust cement and lime content by volume based on strength, workability and finishing requirements.
- (d) Use clean mixers for colored and white stucco coats.
- (e) Scratch coat: 1 part cement; 3/4 to 1½ parts lime; 2½ to 4 parts sand (volume of sand per sum of cementitious material).
- (f) Brown coat: 1 part cement; 3/4 to 1½ parts lime; 3 to 5 parts sand (volume of sand per sum of cementitious material).
- (g) Base coat for stone dash: 1 part white cement, 3/4 to 1½ parts lime, 3 to 5 parts white sand (volume of sand per sum of cementitious material). Add latex additive full strength.
- (h) Stucco finish coat: proportion and mix materials in strict conformance with material manufacturer's instructions.

E46.3 Execution

E46.3.1 Sheathing Paper

- (a) Install sheathing paper horizontally, overlapping upper sheet over lower to shed water.
- (b) Seal seams with seaming tape.

E46.3.2 Metal Lath

- (a) Install metal lath with long dimension of sheets at right angles to supports. Offset end laps in adjacent rows.
- (b) Secure at 150 mm on centre along vertical lines running 400 mm apart.
- (c) Lap sheets 12 mm at sides and 25 mm at ends. Side laps shall be secured at 400 mm on centre.
- (d) At external corners, wrap metal lath around corner minimum of 400 mm. Reinforce with cornerite.
- (e) At internal corners, fold wire through corner minimum 400 mm. Reinforce internal corners with cornerite.
- (f) Reinforce at all openings with 460 mm long piece of strip lath diagonally over corners.
- (g) Do not install metal lath behind stucco control joints or metal reveals. Install metal lath over nailing flanges and butt tight to control joint or reveal allowing installation of control joint or reveal directly to backup wall.
- (h) Install diamond mesh lath over foundation insulation using concrete anchors. Secure through foundation insulation into concrete substrate minimum 25 mm.

E46.3.3 Accessories

- (a) Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces wherever possible. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges.
- (b) Provide metal corner beads at all external angles.
- (c) Provide casing beads wherever stucco terminates and abuts other surfaces and where specifically called for on drawings.
- (d) Provide continuous base screed at bottom of stucco panels where panels terminate.
- (e) Provide stucco control joints where indicated. Install control joints over exterior wall sheathing paper. Screw or nail directly to backup surfaces. Do not install over metal lath.
- (f) Provide metal reveals where indicated. Install metal reveals over exterior wall sheathing paper. Screw or nail directly to backup surfaces. Do not install over metal lath.

E46.3.4 Preparation of Concrete and Masonry Surfaces

- (a) Prepare concrete and masonry surfaces to receive cement stucco.
- (b) Clean surfaces of dust, laitance, efflorescence, loose particles, oil, grease, form release agent, or other foreign matter.
- (c) Remove laitance, efflorescence with wire brush and/or 10 percent solution of muriatic acid.
- (d) If using acid solutions, solvents or detergents to clean concrete, wet concrete prior to application to prevent excessive absorption. Completely remove cleaning solutions and agents by washing surfaces with clean water.

- (e) Roughen surface to ensure mechanical key by sand blasting, wire brushing, acid wash, or chipping.
- (f) Bonding agent suitable for exterior surfaces may be used to bond cement plaster to solid base. Apply in accordance with manufacturer's instructions.
 - (i) Scratch coat:
 - ◆ Apply full scratch coat in sufficient thickness with sufficient pressure to form positive bond. Cross scratch and allow to set.
 - ◆ Damp cure for not less than 48 hours. Permit to dry.
 - (ii) Brown coat:
 - ◆ Apply brown coat no sooner than 48 hours after installation of scratch coat.
 - ◆ Apply over dampened scratch coat with sufficient pressure to form positive bond.
 - ◆ Bring out to grounds, straighten to true surface, float, compact and leave sufficiently rough to ensure adequate bond for finish coat.
 - ◆ Damp cure for not less than 48 hours.
 - (iii) Parging coat:
 - ◆ Apply parging coat on scratch coat no sooner than 48 hours after installation of scratch coat.
 - ◆ Apply over dampened scratch coat with sufficient pressure to form positive bond.
 - ◆ Bring out to grounds, straighten to true surface, and provide fine brush dash finish.
 - ◆ Damp cure for not less than 48 hours.

E46.3.5 Stucco Thickness

- (a) Cement parging (two coat system) on vertical surfaces on metal reinforcement on solid base:
- (b) Scratch coat: 12 mm
- (c) Finish coat: 6 mm
- (d) Total: 18 mm

E47. GYPSUM BOARD

E47.1 Section Includes.

- (a) New gypsum board work as indicated and as specified.

E47.2 Related Work

- (a) Sheet vapour barrier, E42.
- (b) Batt and blanket insulation, E41.
- (c) Steel doors and frames, E45.
- (d) Painting, E49.

E47.3 References

- (a) American Society for Testing and Materials (ASTM)
 - (i) ASTM B29, Specification for Pig Lead.
 - (ii) ASTM B749, Specification for Lead and Lead Alloy Strip, Sheet and Plate Products.

- (iii) ASTM C475, Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
- (iv) ASTM C514, Specification for Nails for the Application of Gypsum Board.
- (v) ASTM C840, Specification for Application and Finishing of Gypsum Board.
- (vi) ASTM C1002, Specification for Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases.
- (vii) ASTM C1047, Accessories for Gypsum Wallboard and Gypsum Veneer.
- (viii) ASTM C1177, Specification for Glass Mat Gypsum Substrate for Use as a Sheathing.
- (ix) ASTM C1178, Specification for Glass Mat Water-Resistant Gypsum Backing Panel.
- (x) ASTM C1278, Standard Specification for Fiber-Reinforced Gypsum Panels.
- (xi) ASTM C1280, Specification for Application of Gypsum Sheathing Board.
- (xii) ASTM C1396, Standard Specification for Gypsum Board.
- (b) Canadian General Standards Board (CGSB)
 - (i) CAN/CGSB-71.25, Adhesives, for Bonding Drywall to Wood Framing and Metal Studs.
 - (ii) CAN/CGSB-51.34, Vapour Barrier, Polyethylene Sheet, for Use in Building Construction.
- (c) Underwriters Laboratories of Canada (ULC)
 - (a) CAN/ULC-S702, Standard for Mineral Fibre Thermal Insulation for Buildings.

E47.4 Products

E47.4.1 Gypsum Board

- (a) Standard board: to ASTM C1396, regular and Type X, thickness indicated, 1200 mm wide x maximum length, ends square cut, edges beveled.
- (b) Water resistant board: to ASTM C1396, regular and fire-rated, thickness indicated, 1200 mm wide x maximum practical length.
- (c) Exterior sheathing: to ASTM C1177, [1200 mm] [4'-0"] wide x maximum practical length x thickness indicated.
 - (i) Acceptable material: GP Gypsum DensGlass Gold, BPB GlasRoc.

E47.4.2 Fastenings and Adhesives

- (a) Nails and staples: to ASTM C514.
- (b) Screws: to ASTM C1002. Use corrosion resistant, rust proof fasteners.

E47.4.3 Accessories

- (a) Casing beads, corner beads fill type: to ASTM C1047, 25 gauge commercial grade sheet steel with zinc finish, perforated flanges; longest practical lengths, one piece wherever possible. Plastic casing bead, corner beads are not permitted.
- (b) Vinyl mouldings: vinyl mouldings for joint treatment of vinyl-faced gypsum board as supplied by gypsum board manufacturer.
- (c) Acoustical sealant: Tremco Tremflex 834 or equal.
- (d) Polyethylene: to CAN/CGSB-51.34, 0.15 mm.
- (e) Joint compound and paper joint tape: to ASTM C475, asbestos free.

E47.5 Execution

E47.5.1 Gypsum Board Application

- (a) Apply gypsum board in accordance with ASTM C840, except where indicated otherwise.
- (b) Apply gypsum sheathing board in accordance with ASTM C1280, except where indicated otherwise.
- (c) Do not apply gypsum board until bucks, anchors, blocking, electrical and mechanical equipment and other work which may be concealed behind gypsum board has been installed and inspected by Contract Administrator.
- (d) Apply gypsum board to [concrete] [and] [concrete block] surfaces using laminating adhesive.
- (e) Where gypsum board is installed above finished ceilings, fit work tight to all items penetrating through gypsum board. Seal around full perimeter of items with sealant. For fire rated assemblies and smoke barriers use fire stopping in accordance with Section 07840 – Fire Stopping, and acoustical sealant elsewhere.

E47.5.2 Fire Rated Assemblies

- (a) Construct fire rated assemblies where indicated.
- (b) Apply Type X (fire rated) gypsum board where indicated, to obtain fire ratings as indicated or required.
 - (i) For fire rated partitions and ceilings apply first and second layers with screw fasteners. No adhesives permitted. Screw spacing as follows:
 - (ii) Ceilings: 150 mm on centre around perimeter and 300 mm on centre in field of sheet.
- (c) Walls: 200 mm on centre around perimeter and 300 mm on centre in field of sheet.
- (d) At door and window openings in fire rated walls and partitions install gypsum board filler full

E47.5.3 Water Resistant Gypsum Board

- (a) Apply water resistant gypsum board where indicated, and in following locations:
 - (i) Where indicated on drawings and in Room Finish Schedule.
 - (ii) On ceiling in pump room.
- (b) Use corrosion resistant fasteners and accessories for installation of water resistant gypsum board.
- (c) Apply water-resistant sealant to edges, ends, cutouts that expose gypsum core and to fastener heads.

E47.5.4 Accessories

- (a) Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces wherever possible. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges.
- (b) Secure casing beads, corner beads and trim with screws. Staples and crimping not permitted. Secure at 300 mm on centre.
- (c) Install casing beads around perimeter of suspended ceilings and bulkheads, around openings and where gypsum board abuts a dissimilar material.
- (d) Install casing beads where gypsum board butts against surfaces having no trim concealing junction and elsewhere indicated.
- (e) Seal joints with acoustic sealant.

- (f) Install insulating strips continuously at edges of gypsum board and casing beads abutting metal window and exterior door frames, to provide thermal break.

E47.5.5 Control Joints

- (a) Construct control joints of two back-to-back casing beads set in gypsum board facing and supported independently on both sides of joint.
- (b) Install continuous 6 mil polyethylene dust barrier behind and across control joints.
- (c) Install control joints, plumb, straight and true with not more than 1 mm gap.
- (d) Use gypsum board with tapered edges on both sides of control joint. Tape, fill and sand casing beads flush with adjacent surface.
- (e) Locate control joints where indicated, and at the following locations:
 - (i) where partitions or furring abuts a structural element or dissimilar wall or ceiling.
 - (ii) where a ceiling or bulkhead abuts a structural element or dissimilar wall or other vertical penetration.
 - (iii) construction changes within plane of the partition or ceiling.
 - (iv) partition or furring runs exceed 9 m.
 - (v) ceiling dimensions exceed 15 m for gypsum board in either direction
 - (vi) wings of "L", "U" and "T" shaped ceiling areas are joined.
 - (vii) expansion or control joints occur in structural elements of the building.
- (f) On walls locate control joints over door and window openings wherever possible. Align control joint with corner of frames.

E47.5.6 Expansion Joints

- (a) Construct expansion joints as indicated, at building expansion joints and construction joints. Provide continuous polyethylene dust barrier.
- (b) Install expansion joints straight and true.

E47.5.7 Gypsum Board Finishing

- (a) Do taping and filling to ASTM C840, except where indicated otherwise.
- (b) Finish face panel joints and internal angles with joint system consisting of joint compound, joint tape and taping compound installed according to manufacturer's directions and feathered out onto panel faces.
- (c) Finish corner beads, control joints and trim as required with two coats of joint compound and one coat of taping compound, feathered out onto panel faces.
- (d) Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of gypsum board so as to be invisible after painting is completed.
- (e) Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.
- (f) Sanding not require behind solid finishes and above finished ceilings.
- (g) Completed installation to be smooth, level or plumb, free from waves and other defects and ready for painting or other thin finish coating including fabric wall coverings.

E47.5.8 Gypsum Board Finish Levels

- (a) Finish gypsum board in accordance with the following levels of finish for specific areas indicated.

- (b) Where a fire resistance rating is required for the gypsum board assembly, details of construction and finishing shall be in accordance with reports of fire tests of assemblies that have met the fire-rating requirement, regardless of the finish level specified below.
- (c) Level 1:
 - (i) All joints and interior angles shall have tape embedded in joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable.
 - (ii) Location: gypsum board above finished ceilings, attics.

E48. HIGH BUILD GLAZED COATINGS

E48.1 Related Work

- (a) Masonry - General, E30.
- (b) Gypsum Board, E47.

E48.2 Performance Requirements

- (a) Installed high building glazed coatings shall meet or exceed the following properties.
 - (i) Dry film thickness (with reinforcing cloth): 30 - 40 mils.
 - (ii) Solids by volume: 100%
 - (iii) Hardness, Shore D ASTM D2240: 65/60
 - (iv) Tensile strength ASTM D638: 9000 psi.
 - (v) Adhesion: ASTM D4541: 350 psi. 100% concrete failure.
 - (vi) Flammability ASTM D635: self extinguishing over concrete.

E48.3 Samples

- (a) Submit samples in accordance with E11- Submittals.
- (b) Submit 300 x 300 mm size samples of each color and finish coating applied to smooth hardboard, gypsum dry-wall wallboard, porous concrete block, steel pipe.
- (c) Mock-up
- (d) Apply coating of each finish to approximately 10 m² area of surface to be treated.
- (e) Allow 24 hours for review of mock-up by Contract Administrator before proceeding with coating work.
- (f) Refer to Section 01400 - Quality Control for other requirements regarding mock-up.

E48.4 Maintenance Data

- (a) Provide maintenance data for coatings for incorporation into manual specified in E11- Submittals.
- (b) Provide list of suitable cleaning agents.
- (c) Provide list of solvents and other chemicals that may cause fading of color or damage to texture and finish of coating system.

E48.5 Qualifications

- (a) High build glazed coatings shall be applied only by the manufacturer's fully trained and approved applicators. Submit proof of qualifications upon request by Contract Administrator.

E48.6 Environmental Requirements

- (a) Do not apply emulsion systems unless uniform minimum 10°C air temperature at installation area for 24 hours prior to and after application.
- (b) Provide adequate ventilation or isolation measures to protect against toxic fumes.

E48.7 Products

E48.7.1 Materials

- (a) Interior high build glazed coating system, consisting of
 - (i) High-performance epoxy coating for base, saturant, and intermediate coats
 - (ii) Finish coat: 100% solids polyurethane enamel, chemical resistant epoxy coating.
 - (iii) Acceptable material: General Polymers Saniglas with 3548P High Performance Epoxy Coating, [FC38-5.8 oz. Fibreglass Cloth,] [4685P Poly-Cote 100% Solids Polyurethane Enamel] [3744P Novo-Flo Chemical Resistant Epoxy Coating].
- (b) Fillers and patching compounds: for surface preparation, of type recommended by coating manufacturer, applicable for substrate. Use filler coat over porous surfaces such as concrete and masonry.
- (c) Pipe Coatings:
 - (i) Exterior Coating System:
 - ◆ Carboline Carboguard 890 Epoxy-2 coats-4.0 to 6.0 mils DFT/coat.
 - ◆ International Paints Interseal 670HS Epoxy-2 coats- 5.0 to 7.0 mils DFT/coat.
 - ◆ Devoe – Bar-Rust 235 Epoxy- 2 coats- 5.0 to 7.0 mils DFT/coat.
 - (ii) Interior Lining System:
 - ◆ Carboline Carboguard 561 Epoxy-12.0 to 16.0 mils Total DFT.
 - ◆ International Paints Interzone 954 Epoxy-12.0 to 20.0 mils Total DFT.

E48.7.2 Colors

- (a) Refer to Color Code.
- (b) Selected by Contract Administrator from manufacturer's full color selection range.
- (c) Allow for several different colors.

E48.8 Execution

E48.8.1 Preparation

- (a) As a minimum, the following surface preparation is required universally for coating and lining systems in immersion services:
 - ◆ Solvent Clean – SSPC SP1.
 - ◆ Near White Metal Blast – SSPC SP10 / Nace No. 2
- (b) The blast profile should be 2.0 to 3.0 mils with an angular anchor pattern (the manufacturer's recommendations for each product must always be consulted – some high performance materials may require a deeper blast profile range, or a higher cleanliness standard).

E48.8.2 Examination

- (a) Examine surfaces to receive coatings for defects and/or Site conditions detrimental to proper application and performance of high building glazed coatings.
- (b) Work penetrating substrate to be completed before installing coating.

- (c) Report unsuitable conditions to Contract Administrator and await remedial measures.
- (d) Commencement of work shall imply acceptance of surfaces and conditions.

E48.8.3 Protection

- (a) Mask surrounding surfaces to provide neat, clean juncture lines.
- (b) Protect adjacent surfaces and equipment from damage by over spray.
- (c) Preparation of Surfaces
- (d) Prepare surfaces in accordance with coating manufacturer's instructions.
- (e) Apply filler coats to porous surfaces such as concrete and concrete block.
- (f) Coating Application
- (g) Apply each component in compliance with product manufacturer's written installation instructions.
- (h) Strictly adhere to mixing and installation methods, recoat windows, cure times and environmental restrictions.
- (i) Apply coating system to produce smooth surface, uniform in sheen, color and finish, free from marks, dirt, particles, runs, crawls, curling, holes, airpockets and other defects.
- (j) Structural steel elements requiring coatings are indicated on the structural drawings.

E48.8.4 Testing

- (a) Provide test instruments and equipment to perform tests on Site to determine compliance with performance requirements, if requested by Contract Administrator.
- (b) Remove and replace non-conforming areas.

E49. PAINTING

E49.1 General

E49.1.1 Related Work

- (a) Structural steel, steel joists, metal fabrications.
- (b) Steel doors and frames, E45.
- (c) Graffiti resistant coatings, E50.
- (d) Masonry – General, E30.

E49.1.2 References

- (a) Master Painters Institute (MPI)
 - (i) Architectural Painting Specifications Manual.
- (b) Society for Protective Coatings (SSPC)
 - (i) Systems and Specifications Manual, SSPC Painting Manual, Volume Two.
- (c) National Fire Code of Canada

E49.1.3 Quality Assurance

- (a) Conform to latest MPI requirements for painting work including preparation and priming.

E49.1.4 Delivery, Handling and Storage

- (a) Deliver, store materials in original containers with labels intact. Observe manufacturer's recommendations for storage and handling.

- (b) Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling storage, and disposal of hazardous materials.

E49.1.5 Site Requirements

- (a) Unless specifically pre-approved by product manufacturer, perform no painting work when:
 - (i) substrate and ambient air temperatures are expected to fall outside MPI or paint manufacturer's prescribed limits.
 - (ii) Rain or snow is forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at Site.
 - (iii) The maximum moisture content of the substrate exceeds MPI or paint manufacturer's prescribed limits
- (b) Apply paint finish only:
 - (i) In areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.
 - (ii) Apply paint only to adequately prepared surfaces and to surfaces within moisture limits noted herein.
 - (iii) Apply paint only when previous coat of paint is dry or adequately cured.

E49.2 Products

E49.2.1 Materials

- (a) Only paint materials listed in the MPI Approved Products List (APL) are acceptable for use on this project.
- (b) Paint materials for paint systems shall be products of a single manufacturer.
- (c) Contract Administrator will select colours and determine total number of colours to be used on project and their locations.

E49.2.2 Gloss/Sheen Ratings

- (a) Paint gloss shall be as defined in MPI Architectural Painting Specifications Manual.
- (b) Gloss level ratings of painted surfaces shall be as specified herein.

E49.2.3 Painting Systems

- (a) Shop primed steel:
 - (i) EXT 5.1D - Alkyd semi-gloss finish premium grade.
- (b) Galvanized metal:
 - (i) EXT 5.3B - Alkyd semi-gloss finish premium grade.
- (c) Concrete Block
 - (i) INT 3.1D – Alkyd Semi-Gloss Finish Premium Grade

E49.3 Execution

E49.3.1 General

- (a) Perform preparation and operations for painting in accordance with MPI Painting Specifications Manual except where specified otherwise.
- (b) Do repainting of previously painted surfaces in accordance with MPI Maintenance Repainting Manual, except where specified otherwise.
- (c) Apply paint materials in accordance with paint manufacturers' written application instructions.

- (d) Paint all new work, except prefinished items or where indicated otherwise.
- (e) Do not paint structural steel and roof decking, mechanical and electrical equipment.

E49.3.2 Existing Conditions

- (a) Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report damages, defects, unsatisfactory or unfavourable conditions to Contract Administrator before proceeding with Work.
- (b) Conduct moisture testing of surfaces to be painted using a properly calibrated electronic moisture meter and report findings to Contract Administrator. Do not proceed with Work until conditions fall within acceptable range as recommended by manufacturer.

E49.3.3 Protection

- (a) Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore such surfaces as directed by Contract Administrator.
- (b) Protect items that are permanently attached such as Fire Labels on doors and frames.
- (c) Protect factory finished products and equipment.
- (d) Protect passing pedestrians and general public in and about the building.
- (e) Remove electrical cover plates, light fixtures, surface hardware on doors, and other surface mounted equipment, fittings and fastenings prior to undertaking any painting operations. Store securely store items and re-installed after painting is completed.

E49.3.4 Cleaning and Preparation

- (a) Clean and prepare surfaces in accordance with MPI Painting Specification Manual requirements. Refer to MPI Manual in regard to specific requirements.
- (b) Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.
- (c) Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements. Remove traces of blast products from surfaces, pockets and corners to be painted.
- (d) Touch up of shop primers with primer as specified in applicable section. Major touch-up including cleaning and painting of field connections, welds, rivets, nuts, washers, bolts, and damaged or defective paint and rusted areas, shall be by supplier of fabricated material.
- (e) Lift gate mechanism:
 - (i) Degrease lift gate mechanism by steam cleaning or pressure washing and solvent cleaning to remove oil and grease soiling from gear mechanism.
 - (ii) Remove flaked paint and rust by wire brushing and power tool cleaning.

E49.3.5 Application

- (a) Apply paint by brush, roller, airless sprayer. Conform to manufacturer's application instructions unless specified otherwise.
- (b) Apply coats of paint as a continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.
- (c) Painting coats specified are intended to cover surface completely. If necessary apply additional coats until satisfactory coverage is obtained. Provide additional coats at not additional cost to Contract.
- (d) Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.

- (e) Sand and dust between coats to remove visible defects.
- (f) Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.
- (g) Do not paint door and miscellaneous hardware, unless indicated otherwise.
- (h) Do not paint nameplates, signage, fire labels, or other markers or signs indicated to remain.
- (i) Do not paint copper, bronze, chromium plate, nickel, stainless steel, aluminum, lead and other bright metals, unless specified otherwise.
- (j) Clean shop applied paint surfaces that become marked. Touch up with primer and paint as required.

E49.3.6 Mechanical / Electrical Equipment

- (a) Do not paint conduits, piping, hangers, ductwork and other mechanical and electrical equipment. Leave in original finish.

E49.3.7 Restoration

- (a) Clean and re-install all hardware items removed before undertaken painting operations.
- (b) Remove protective coverings and warning signs as soon as practical after operations cease.
- (c) Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.
- (d) Protect freshly completed surfaces from paint droppings and dust. Avoid scuffing newly applied paint.
- (e) Restore areas used for storage, cleaning, mixing and handling of paint to clean condition.

E50. GRAFFITI-RESISTANT COATINGS

E50.1.1 General

- (a) Product Data
 - (i) Submit manufacturer's printed product literature, specifications and application instructions to Contract Administrator before commencing application.
- (b) Environmental Conditions
 - (i) Maintain ambient and structural base temperature at installation area within limits specified by coating manufacturer. Apply coating during dry weather. Do not apply coating to wet or damp surfaces.
- (c) Protection
 - (i) Protect plants and vegetation that might be damaged by coating. Protect surfaces not intended to have application of 1 coating. Provide adequate ventilation or isolation measures to protect against toxic fumes.

E50.1.2 Products

- (a) Materials
 - (i) Graffiti-resistant coating: one component, water based, non-sacrificial, clear penetrating sealer and liquid repellent.
 - (ii) Acceptable products: Fabrikem Fabrishield Paint Repellent PR-60 for precast concrete and PR-61 for clay brick.

- E50.1.3 Execution
- (a) Preparation
 - (i) Prepare and clean substrate surfaces in accordance with coating manufacturer's instructions.
 - (ii) Mix and prepare coatings to manufacturer's instructions.
 - (iii) Take moisture tests on substrates to receive coating to ensure moisture levels are within limits specified by coating manufacturer.
 - (b) Application
 - (i) Apply coating using low pressure spraying apparatus, at recommended coverage rate for product and substrate.
 - (ii) Apply in uniform, even coat to fully wet substrate, without flooding or rundowns.
 - (iii) Allow area to dry completely before applying additional coats.
 - (c) Schedule
 - (i) Apply graffiti-resistant coating to clay brick and architectural precast concrete units.

DIVISION 11 – PROCESS MECHANICAL

E51. PROCESS MECHANICAL GENERAL PROVISIONS

E51.1 Description

- E51.1.1 E51 – General Provisions specifies general clauses applicable to the supply and installation of all process and domestic mechanical systems (excluding HVAC) located in E51 to E56, inclusive.
- E51.1.2 The process mechanical systems include all of the systems handling process fluid and those directly related to the process system. The domestic mechanical systems include all domestic water and wastewater plumbing lines.
- E51.1.3 The Work under this section shall include the supply, installation, testing and start-up of the Process Mechanical and Domestic Mechanical Material and Products to provide a complete and workable installation in accordance with the contract drawings and specifications and all applicable codes, standards and ordinances. The Contractor shall furnish any work and/or other necessary materials not specifically mentioned in the specifications or shown on the drawings, but necessary to complete the installation, as if specifically mentioned herein and detailed.

E51.2 Related Work

- E51.2.1 The process mechanical and domestic plumbing drawings do not show structural details and any information involving accurate measurements of buildings. Refer to architectural and structural drawings as well as all other parts of this specification.
- E51.2.2 Piping and mechanical work shall be painted in accordance with the painting specifications in E49 - Painting and in accordance with this specification with regard to pipe identification.

E51.3 Permits, Certificates, Fees

- E51.3.1 The Contractor shall give all notices, obtain all permits and pay all fees so that the work specified herein may be carried out.
- E51.3.2 The Contractor shall make all necessary arrangements with utilities companies for services and meters as required and pay for all the costs involved.

E51.3.3 Arrange for inspection of all work by the authorities having jurisdiction over the Work including local building, plumbing and Manitoba Hydro representatives. On completion of the Work, present to the Contract Administrator the final unconditional certificate of approval of the inspecting authorities.

E51.3.4 Before starting any work, submit the required number of copies of drawings and specifications to the authorities for their approval and comments. Comply with any changes requested as part of the Contract, but notify the Contract Administrator. Prepare and furnish any additional drawings, details or information as may be required. Change orders for extra work will be considered for items with the exception of those related to code conformance (National Building Code; National Plumbing Code; Electrical Code).

E51.4 Codes and Standards

E51.4.1 Comply with the requirements of the latest edition of the applicable CSA standards, the requirement of Federal, Provincial and Municipal Codes, the applicable standards of the Underwriters Association and all other authorities having jurisdiction. Comply with the guidelines of the Ministry of Natural Resources in the undertaking of the Work. These codes and regulations constitute an integral part of these specifications.

E51.4.2 Welding shall conform to the ANSI/ASME Power Piping Code and the ASME Boiler and Pressure Vessel Code.

E51.4.3 Welders shall be qualified and licensed in Manitoba, and welder qualifications shall be in accordance with CSA-Z662.

E51.4.4 Welding safety requirements shall be in accordance with CSA-W117.2 - Code for Safety in Welding and Cutting.

E51.4.5 Work shall be performed in accordance with the regulations of the Manitoba Workplace Health and Safety.

E51.4.6 Installation shall be in accordance with the National Building Code and all regulations and codes of the Province of Manitoba and City of Winnipeg.

E51.4.7 In case of conflict, the codes shall be taken as the minimum acceptable criteria where they exceed those in the Contract. In no instance reduce the standard or scope of work, or intent established by the Contract by applying any of the codes referred to herein. Where the Contract indicate a standard exceeding code requirements, the Contract shall take precedence.

E51.5 Approved Alternatives

E51.5.1 Equipment shown on the drawings and specified is the recommended equipment and is to be used unless permission for an approved equivalent alternative is obtained.

E51.6 Product Delivery, Storage Handling

E51.6.1 All materials and equipment shall be delivered, handled and stored subject to the provisions contained herein and according to the manufacturer's recommendations.

E51.6.2 Provide temporary storage facilities and heated storage where required for sensitive items such as motors.

E51.6.3 Equipment, including pumps and motors, shall not be placed in temporary or final locations in the new structures before a date approved by the Contract Administrator. The date of delivery into the structure shall be commensurate with the construction progress and the suitability, with respect to temperature, humidity, etc. of the building.

- E51.6.4 Take precautions to maintain equipment in good condition and to avoid corrosion or other damage, which may affect the equipment's performance. Provide temporary coatings as required to prevent corrosion.
- E51.6.5 Leave factory covers in place and prevent entry of foreign materials into working parts of equipment.
- E51.6.6 Protect members and bearings with plastic covers.
- E51.6.7 Grease all shafts and sheaves to prevent corrosion.
- E51.6.8 The Contractor shall recognize the time interval required for complete construction before the structure is suitable for equipment installation. If equipment is manufactured before it is required at the Site, the Contractor shall provide suitable heated dry storage space for the equipment, to the approval of the Contract Administrator. All equipment and motors shall be rotated at least weekly during the storage period, and after installation, until the equipment is placed in normal use.
- E51.6.9 All material damaged or otherwise harmfully affected during delivery, storage, handling or installation shall be replaced by the Contractor at his/her own expense.
- E51.7 Equipment Supports, Anchors, Bases
- E51.7.1 The Contractor shall provide all structural work required for foundation and support of units, foundation bolts, sleeves, washers, nuts, shims and templates to locate bolts.
- E51.7.2 Anchor bolts shall be set in concrete with one end of the bolt hooked as detailed; or sleeved anchor bolts as detailed may be set in concrete. Expansion type bolts drilled into concrete may not be used in lieu of cast-in-place anchor bolts.
- E51.7.3 Provide a minimum of 25 mm non-metallic grout between bedplates and concrete foundation, fill voids, finish and remove wedges after grout is set. Grout shall be Embecco or approved equivalent alternative, non metallic type.
- E51.7.4 Where grouting is required for bedplates and equipment bases on concrete foundations, the surface of the concrete foundation shall be roughened to provide a bond.
- E51.7.5 All bases shall be finished to match the floor.
- E51.8 Installations
- E51.8.1 Coordinate all work with the work of other trades to avoid conflict.
- E51.8.2 Follow the recommend installation details and procedures for all equipment as found in the supplier's technical data, supplemental by the shop drawings, the contract drawings, the specifications, and the directions of the Contract Administrator.
- E51.8.3 Install mechanical sleeve work in advance of concrete pouring.
- E51.8.4 For equipment or material of the same type or classification, install only products of one manufacturer.
- E51.8.5 Install all equipment with adequate access for inspection and servicing and to provide minimum interference. Conserve headroom and leave maximum usable space.
- E51.8.6 Employ only skilled tradesmen properly licensed by the Province of Manitoba, for all work requiring tradesmen with special skill.
- E51.8.7 Set equipment in place and install piping, fittings, valves and other items. Make final adjustments in alignment and elevation before securely fastening equipment and other items in place.

- E51.8.8 Control alignment so that excess forces are not imposed on equipment when piping connections are tightened.
- E51.8.9 Do not tighten pipes until grout is set.
- E51.8.10 Tighten so that there are no excessive stresses set up in flanges.
- E51.9 Vibration Isolation
- E51.9.1 Provide vibration isolators for all non-submergable mechanical motor driven equipment throughout the project, unless specifically noted otherwise. This shall include but not be limited to HVAC equipment, and all piping connected to vibration isolated equipment.
- E51.9.2 Provide vibration isolators as manufactured by Vibro-Acoustics, Vibron or Air Master.
- E51.9.3 Provide all sound and vibration elimination material by one supplier unless otherwise specified. Provide shop drawings showing isolator location, load forces, anchor positions, etc. and installation instructions.
- E51.9.4 Statically and dynamically balance rotating equipment for minimum vibration and low operating noise level.
- E51.9.5 Provide flexible connectors for pipes to all equipment supported by vibration isolators.
- E51.9.6 Provide flame proof flexible connectors between fans, heaters, equipment and ducts.
- E51.9.7 Equipment installed by the Contractor shall operate smoothly without excessive wear, adjustment and attention. Vibration shall not exceed the manufacturer's specified limits for individual products. Vibrations in pumps shall be within acceptable field vibration limits as outlined in the Standards of the Hydraulics Institute.
- E51.10 Guards
- E51.10.1 Provide vibration free guards on all exposed drives and rotating parts, to meet safety requirements.
- E51.10.2 Provide means to permit lubrication, use of test instruments and movements of motors to adjust belt tension.
- E51.11 Minor Deviations
- E51.11.1 The Contractor shall allow for additional material such as pipe and ducts for modifications that may be required to correct minor conflicts or deviations.
- E51.12 Shop Drawings
- E51.12.1 Shop drawings shall be submitted in accordance with E11-Submittals, E12-Shop Drawings and in accordance with the requirements of the various mechanical sections.
- E51.12.2 The Contractor shall submit shop drawings and data for all mechanical products, components and control systems provided.
- E51.12.3 The Contractor shall submit a schedule of shop drawings within 2 weeks following the contract award.
- E51.12.4 Valves, pumps and other equipment installed prior to the submission and review of shop drawings shall be removed and replaced entirely at the Contractor's expense.
- E51.13 Operation and Maintenance Manuals
- E51.13.1 Submit operation and maintenance manuals in accordance with E17 - Contract Close Out, and this Section.

- E51.13.2 Operation and Maintenance Manuals Specific to Process Mechanical shall include and be arranged as follows:
- (a) Tab 1.0 Title Page (in clear plastic Cover).
 - (b) Tab 1.1 List of Process Drawings
 - (c) Tab 1.2 Description of Systems: Provide a complete description of each mechanical system within the building. Include an explanation of each component comprising the system and a description of how each component interfaces with others within the system. Indicate the location of mode of energization, switches and controls and sequence of operation.
 - (d) At the end of each system list the manufacturer, type and location of each mechanical component.
 - (e) Tab 1.3 Operation Division: Provide a comprehensive explanation of operation for each mechanical component. Include start up procedures, remote set point adjustments, condition indicators, alarms, how the mechanical component interfaces with other components, control sequences, operational changes for summer and winter operation and how to accomplish changeover, and safeguards to check if equipment goes off line.
 - (f) Tab 1.4 Maintenance and Lubrication Division: Provide a preventive maintenance schedule for each of the major components to include daily, weekly, monthly, semi-annual and yearly checks and tasks. Include this information as a separate preventive maintenance schedule. Provide lubrication information and instructions that will explain the various bearings and lubrication procedures.
 - (g) Tab 1.5 List of equipment suppliers and Contractors: Provide a complete list of equipment suppliers and Contractors, including address and telephone number.
 - (h) Tab 2.0, 2.1, etc. Certification: Include copy of test data, hydrostatic or air tests performed on piping systems, equipment alignment certificates, copy of valve tag identification and pipe color code.
 - (i) Tab 3.0, 3.1 , etc. Manufacturer's Shop Drawings and Maintenance Bulletins: include materials submitted as Shop Drawings including all product data.
- E51.13.3 Provide two complete manuals including system description two weeks prior to start-up. These are for the City's and Contract Administrator's review.
- E51.13.4 Upon completion of performance tests and debugging, provide corrected system description and correct differences in manuals noted by the City and Contract Administrator.
- E51.13.5 Individual check sheets shall be prepared for all mechanical equipment. Each check sheet will contain specified design, shop drawing and actual on Site information as follows:
- (a) designation
 - (b) location
 - (c) manufacturer
 - (d) model number
 - (e) serial number
 - (f) voltage
 - (g) current
 - (h) phase
 - (i) power
 - (j) peak load performance

- (k) control set points
- (l) safety limit set points
- (m) equipment interlocked by controls
- (n) control sequence

E51.13.6 Operation and Maintenance Manuals shall be completed by a firm specializing in this type of work. Acceptable supplier: Dynacom Communications Inc.

E51.14 Painting

E51.14.1 Piping and valves shall be painted in accordance with paint specifications in E49 – Painting.

E51.14.2 All unpainted equipment and appurtenances shall be given shop prime paint suitable for field painting as specified in E49 – Painting.

E51.14.3 Hangers, supports and fabricated equipment shall be primed and painted as specified in E49.

E51.14.4 Equipment having a finished shop coat shall be touched up.

E51.14.5 Do not paint over nameplates.

E51.15 Identification of Equipment

E51.15.1 Provide metal manufacturer's nameplate on each piece of equipment, mechanically fastened with raised or recessed letters. Provide the following information on nameplate:

- (a) Underwriter's Laboratories of Canada and CSA registration plates as required respective agency.
- (b) Indicate size, equipment model, manufacturer's name, serial number, voltage cycle, phase and power of motors.
- (c) Locate nameplates so that they are easily read. Do not insulate or paint over plates.

E51.15.2 Provide system nameplates on each piece of mechanical equipment as follows:

- (a) Minimum size 75 mm x 35 mm x 2.5 mm thick laminated plastic with black face and white centre. Letters to be 6 mm high.

E51.15.3 Identify each piece of equipment by type and number.

E51.16 Identification of Piping

E51.16.1 Unless otherwise specified, piping and fittings for water supply and waste systems shall be painted in accordance with the following color Code:

<u>Pipe</u>	<u>Color</u>
Process	Color by City of Winnipeg
Domestic Water	Color by City of Winnipeg
Plumbing (Waste)	Color by City of Winnipeg
Natural Gas	Yellow
Pipe Supports	Black

E51.16.2 Colors will be primary colors, numbered in accordance with CGSB Standard Paint Colors.

E51.16.3 The entire length of each pipe (except stainless steel pipe) will be painted in the basic color, with bands to indicate the specific fluid and an arrow to indicate flow direction.

E51.16.4 Stainless steel pipes will not be painted. Stencil arrows indicating flow direction only.

- E51.16.5 Bands shall be 25 mm wide, painted in 5 meters intervals or wherever a pipe enters or leaves a room.
- E51.16.6 Use standard plastic color bands and marker tags on small piping.
- E51.16.7 Direction arrows shall be black 150 mm x 25 mm.
- E51.16.8 Arrows shall be painted at each branch and termination point.
- E51.16.9 Locate markers from usual operating areas and identify piping runs at least once in each room and where piping enters or leaves a room.
- E51.16.10 Use stencil painted or glue on lettering for pipe identification letters.
- E51.16.11 Painting specifications in E49 – Painting shall apply.
- E51.17 Valve Directories
- E51.17.1 Tag all valves and floor stands to the corresponding valve number.
- E51.17.2 Tags shall be 75 mm x 35 mm x 2.5 mm laminated plastic with black face and white lettering secured to the valve stem with a key chain.
- E51.17.3 Prepare a schematic diagram of the various piping systems in the building and on each diagram show the valve number and the purpose of the valve. Frame one copy of each under glass for wall mounting as directed.
- E51.17.4 All branch and main valves shall be consecutively numbered and identified on the schematic and on the list.
- E51.17.5 Tag automatic controls, instruments and relays and key to control shop drawing identification numbers. Tag all equipment excluding pipes and ducts.
- E51.18 Electric Starting Switch Identification
- E51.18.1 Identify electric starting switches, remote push button stations and equipment supplied under this division with lamacoid plates having 6 mm minimum letter size. Identification to state equipment controlled.
- E51.19 Cleanup and Disinfection
- E51.19.1 All piping and equipment shall be thoroughly cleaned of dirt, cuttings and other foreign substances.
- E51.19.2 Disconnect, clean and reconnect whenever necessary for purposes of locating and removing obstructions.
- E51.19.3 Flush and chlorinate all potable water systems as specified in plumbing codes and where applicable, in accordance with AWWA standards for Disinfection of Facilities.
- E51.20 Lubrication
- E51.20.1 For all equipment furnish all lubricants used during testing and trial runs.
- E51.20.2 For equipment supplied by the Contractor, furnish lubricants in sufficient quantity for 12 months operation by the City.
- E51.20.3 Identify lubricants furnished by brand, grade and item of equipment for which it is intended.
- E51.20.4 Operate, drain and flush out bearings and refill with a new change of oil before completion.
- E51.21 Drawings of Record
- E51.21.1 Refer to E13 – Drawings of Record.

E51.21.2 Drawings of Record are required for process mechanical revisions.

E51.21.3 The Contractor shall maintain, at the Site, a separate set of "red line" process mechanical drawings on which he/she shall record all changes and deviations from the original contract plans and specifications.

E51.22 Motors

E51.22.1 Motors supplied for Process Mechanical equipment shall be suitable for hard, continuous service according to EEMAC and CSA Standards and shall operate free of vibration.

E51.23 Cutting and Patching

E51.23.1 The Contractor shall locate and provide holes and sleeves for all process mechanical work in accordance with the contract drawings and specifications.

E51.24 Patents

E51.24.1 Pay all royalties and license fees, and defend all suits or claims for infringement of any patent rights, and save the City of Winnipeg and the Contract Administrator harmless of loss or annoyance on account of suit, or claims of any kind for violation or infringement of any letters patent or patent rights, by this Subcontractor or anyone directly or indirectly employed by him or by reason of the use by him or them of any part, machine, manufacture, or composition of matter on the work, in violation or infringement of such letters patent or rights.

E51.25 Trial Usage and Test

E51.25.1 The City has the privilege of trial usage of mechanical systems or parts thereof for the purpose of testing and learning operational procedures.

E51.25.2 Assist in trial usage for a one-day period following commissioning, at no extra cost and do not waive any responsibility because of trial usage.

E51.25.3 Trial usage shall not be construed as acceptance by the Contract Administrator.

E51.25.4 Provide and pay for all testing required on the system components where, in the opinion of the Contract Administrator, manufacturer's ratings or specified performance is not being achieved.

E51.26 Instruction to City of Winnipeg

E51.26.1 Supply tools, equipment and personnel to demonstrate and provide training to the City operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment.

E51.26.2 Where specified elsewhere, manufacturers to provide demonstrations and instructions.

E51.26.3 Provide instruction to operating staff during regular work hours prior to acceptance and turn-over.

E51.26.4 Availability of approved operation and maintenance manuals to the City operators are mandatory during all training sessions.

E51.26.5 Use as-built drawings, audio visual aids, etc. as part of instruction manual.

E51.26.6 Where deemed necessary, the City may record these demonstrations on videotape for future reference. Coordinate operational demonstrations with availability of videographer.

E51.26.7 Additional sections of the specifications may define and describe training and number of days for start up of each type of equipment. Utilize the most stringent.

E51.27 Documentation and Systems Acceptance

E51.27.1 Meet requirements stated in E17 – Contract Close Out.

E51.27.2 Ensure the following on completion of the Work:

- (a) As constructed reproducible mark-ups.
- (b) Operating and maintenance manuals.
- (c) Valve charts and process schematics as identified herein (one set in each manual plus one set in framed plexiglass) mounted as directed by the City in the pump house Superstructure.
- (d) Contractor shall obtain suitable document signed by the Contract Administrator and the City or his representative, confirming:
 - (i) The City has received satisfactory instruction in operation and maintenance of all equipment and systems.
 - (ii) Operation and maintenance manuals have been provided to the City.
 - (iii) Specified spare parts of components, keys, removables, handles, tools and the like, have been accepted by the City.

E52. MECHANICAL TESTING

E52.1 General

E52.1.1 Description

- (a) This section refers to testing of process mechanical piping and equipment.

E52.1.2 Quality Assurance

- (a) Coordinate with equipment manufacturer and submit manufacturer's check sheets for starting the following specialty equipment:

- Submersible Pumps	- Process Instruments
- Control components	- Control Valves
- Air Makeup Unit	
- Exhaust Fan	
- (b) Prior to starting, testing, adjusting, and cleaning processes, verify with Contract Administrator any tests required to be witnessed. Provide sufficient notice to Contract Administrator prior to commencement of procedures.
- (c) Contract Administrator shall be allowed to witness any testing, adjusting, starting, and cleaning procedures.
- (d) Assume all costs associated with starting and testing, including the supply of testing or cleaning medium.
- (e) Prior to starting equipment or systems, secure and review manufacturer's installation, operation, and starting instructions. Read in conjunction with procedures defined herein.
- (f) Use manufacturer's or supplier's starting personnel where required.
- (g) Ensure integrity of manufacturer's warranty during all starting and testing.
- (h) Compare installations to published manufacturer's data and record discrepancies. Items proving detrimental to equipment performance shall be corrected prior to equipment starting.

- (i) Some processes involved in starting procedures defined in this section may be duplications of authorities verification. To facilitate expedient completion of project, arrange for authorities to assist or witness these procedures.
- (j) All starting, testing, procedures shall be in accordance with applicable portions of ASME, ASHRAE, AABC, CSA, NFPA, SMACNA, ASTM, and ASPE.
- (k) Personnel involved in starting, testing and adjusting procedures shall be experienced in the design and operation of mechanical equipment and systems being checked and shall be able to interpret results of the readings and tests.
- (l) Assume all liabilities associated with starting and testing procedures.

E52.2 Execution

E52.2.1 General Testing

- (a) Test all equipment and material where required by contract specification or authority having jurisdiction to demonstrate its proper operation. All tests shall be witnessed by the Contract Administrator.
- (b) Provide all equipment, materials and labour for tests and pay all expenses for conducting same. All instruments shall be tested by an approved laboratory and test results and certificates showing degree of accuracy shall be furnished to the Contract Administrator. If permanent gauges, thermometers, etc. are used for tests these shall not be installed until just prior to the tests to avoid possible changes in calibration.
- (c) Meet with relevant electrical manufacturers, supplies, and other specialists as required to ensure all phases of the Work are properly coordinated prior to commencement of each particular testing procedure. Establish all necessary manpower requirements.
- (d) Should tests indicate defective work or performance at variance with specified requirements, make all changes immediately to correct the defects.
- (e) The Contractor shall be in charge of the Work during tests. He/she shall assume responsibility for damages in the event of injury to the personnel, building or equipment and shall bear all costs for liability, repairs and restoration.
- (f) Operate and test motors and speed switches for correct wiring and sequences and direction of rotation. Check and record overload heaters in motor starters.
- (g) Confirm voltages and operating amperages at full load.
- (h) Perform tests as specified and upon completion of mechanical installation, provide certification of tests with detailed data as required. Itemize each test as to time performed and personnel responsible. Obtain certificates of approval, acceptance and compliance with rules and regulations from authorities having jurisdiction. Include these certificates in the Operation and Maintenance manuals. This work will not be considered complete until such certificates have been delivered to the Contract Administrator.

E52.2.2 Procedures

- (a) Procedure shall be identified in the following three (3) distinct phases:
 - (i) Pre-Starting: Visual inspection.
 - (ii) Starting: Actual starting procedure.
 - (iii) Post-Starting: Operational testing, adjusting or balancing, and equipment run-in phase.
- (b) Check the installation is as defined by contract documents and as per manufacturer's recommendations including manufacturer's installation check sheets.

E52.2.3 Pressure and Leakage Testing

- (a) Hydraulic tests shall be carried out for a period of 8 hours and pressure maintained with no appreciable pressure drop. Where leakage occurs, repairs shall be made and the entire system shall be retested.
 - (i) Process piping shall be tested at normal operating pressure plus 300 kPa (45 psi) or 550 kPa (80 psi) water pressure, whichever is greater, measured at the low point in the system or as specified otherwise.
- (b) Lines that will be normally open-ended on completion of the Work shall be initially plugged for testing purposes. A cap shall be temporarily installed just prior to the pipe exit from the building for the Kenaston Pump Station project to permit process pipe pressure testing.
- (c) Air shall not be used as a test medium for systems not using air.
- (d) Leaks in screwed fittings shall be corrected by remaking joints; leaks in PVC joints shall be cut out and re-glued; leaks in welded joints shall be cut out and rewelded. Caulking will not be permitted.
- (e) Leaks in valves shall be rectified by replacement of the valve.

E52.2.4 Contractor Testing Responsibilities

- (a) The Contractor shall be required to provide the following tests as part of his construction contract. For each test, a test form is to be filled out, witnessed, kept on Site for the Contract Administrator to verify at any time during construction and then they are to be included in the final submission of the Contractor O&M manuals.
 - (i) Submersible Solids Handling
 - ◆ Prior to operation, check that all electrical connections are correctly made
 - ◆ Check pump operation and rotation
 - ◆ Undertake draw down testing for each pump (minimum of 2 tests per pump and minimum of 2 tests for the 3 pumps operating at once).
 - ◆ Provide factory certified performance curves for each pump
 - (ii) Process Valves
 - ◆ Test operation of all manually actuated valves
 - ◆ Test operation of all electrically actuated valves through both system operation and manual override.
 - (iii) Pumping Systems
 - ◆ Domestic Cold Water
 - Piping to be tested to 1035 kPa for three (3) hours
 - Conduct pipe flushing and cleaning program with all fixtures in place
 - Conduct a water analysis after shock treatment of piping system
 - ◆ Drainage System
 - Conduct a standing water test (75 kPa) over eight (8) hour period.

E52.2.5 Performance Testing

- (a) After the mechanical installations are completed and pressure tested, conduct performance tests to demonstrate that the equipment and systems actually meet the specified requirements. Conduct tests, as soon as conditions permit. Make changes, repairs, and adjustments required prior to operating testing.
- (b) Lubricate all bearings, adjust and/or replace and set all direct drives and "V" belt drives for proper alignment and tension; calibrate and adjust all thermostats,

thermometers, operate and test all motors and speed switches for correct wiring, sequences, check all heaters in motor starters; replace and clean all filters, flush out lines and equipment, remove and clean all strainers; fill all water systems and purge all air; clean fan wheels, heating and cooling coils; fasten all loose and rattling pieces of equipment. Equipment and other apparatus must operate quietly and develop specified capacities; control valves must operate freely.

- (c) Operating tests shall be made on all systems and items of equipment. For testing, vary conditions to simulate operating conditions to test start up, operation sequence, normal shutdown, safety shutdown and all automatic and manual functions.
- (d) Furnish written test reports to the Contract Administrator noting the tests made and any adjustments made.
- (e) Furnish disinfection tests by an independent laboratory on domestic water plumbing.

E53. PROCESS PIPING MATERIALS AND METHODS

E53.1 General

E53.1.1 Description

- (a) This section specifies the general requirements for supply and installation of all process mechanical piping systems and is supplemented by other specific details shown or specified in the respective piping system section.

E53.1.2 Related Work

- (a) E49 - Painting
- (b) E51 to E56, Process Mechanical Sections
- (c) E88 - Process Control and Instrumentation

E53.1.3 Piping Material

- (a) Unless otherwise specified the pipe material to be used at different areas of the process piping system shall be as follows:
 - (i) Process Piping – Steel (Epoxy coated)
 - (ii) Process water piping sleeves - Stainless steel.
 - (iii) Potable service domestic water piping - PVC.
 - (iv) Non-potable service water piping – PVC or Steel as indicated on the drawings.

E53.1.4 Quality Assurances

- (a) Welding materials, fabrication standards and labour qualifications must conform to ANSI/ASME B31.1, ANSI/ASME B16.25, ASME Section IX, and the Provincial Board of Labour Regulations. For steam systems operating over 690 kPa, conform to ANSI/ASME B31.3.
- (b) Use welders fully qualified and licensed by Provincial authorities.
- (c) Domestic Water, Drainage and Vent Piping: comply with Provincial and Municipal codes.

E53.1.5 References

- (a) ASTM D2564-88, Specification for Solvent Cements for Poly (Vinyl-Chloride).
- (b) CAN/CSA-B181.2-M87, PVC Drain, Waste and Vent Pipe and Pipe Fittings.
- (c) CAN/CSA-B182.1-M87, Plastic Drain and Sewer Pipe and Pipe Fittings.
- (d) CSA B181.12-1967 – Recommended Practice for the Installation of PVC Drain, Waste, and Vent Pipe and Pipe Fitting.

E53.2 Products

E53.2.1 Pipe for Buried Service

- (a) As per E21 – Pressure Mains
- (b) As per E22 – Land Drainage Sewers

E53.2.2 Pipe For Non-Buried Service

- (a) Steel Pipe (65 diameter and smaller)
 - (i) To ASTM-A120
 - (ii) Galvanized, standard wall, finish painted
 - (iii) Black standard wall for gas
 - (iv) Screwed joints Class 150
- (b) Steel Pipe (75 diameter to 150 diameter) - (Process Water Pipe and Emergency Generator Exhaust)
 - (i) To ASTM-A53 - Grade B
 - (ii) Standard wall thickness
 - (iii) Flanged joints
 - (iv) Epoxy coated interior and exterior for Process Water Piping. (Shop applied).
 - (v) Paint gen-set exhaust, exterior only.
- (c) Steel Pipe (450 diameter and larger) – (Process Water Pipe)
 - (i) ASTM-A139 - Grade B
 - (ii) Wall thickness - standard wall
 - (iii) Welded or seamless pipe
 - (iv) Flanged joints for valve, equipment or sleeve connections
 - (v) Flanged joints for fitting and pipe connection joints.
 - (vi) Provide flanges to assist in future removal on all straight runs of pipe, placed at a minimum spacing of 3.05 m.
 - (vii) Epoxy coated interior and exterior (to be shop applied).
- (d) Stainless Steel Pipe – (Wall Sleeves)
 - (i) ASTM-A240 Type 316
 - (ii) Minimum Wall Thickness:
 - 1.98 mm to 150 mm diameter
 - 4.75 mm for 500 mm and 600 mm
 - (iii) Operating pressure rating: 1035 kPa
 - (iv) Vacuum rating: 100 kPa
 - (v) Longitudinally welded by Tungsten Inert Gas (TIG) or Metal Inert Gas (MIT) method
 - (vi) Ends prepared to suit connections as shown on drawings
 - (vii) Provide flanges to connect to valves and equipment
- (e) Polyvinyl Chloride (Domestic Water Pressure Service)
 - (i) CSA-B137.3
 - (ii) Class 12454B PVC compound
 - (iii) Schedule 80
 - (iv) Solvent weld joints
- (f) Polyvinyl Chloride (Sanitary Drainage and Vent)
 - (i) CSA-B181.2

- (ii) SCH 40 PVC – DWV
- (iii) Solvent weld joints
- (iv) To CSA – B181-2

E53.2.3 Pipe Fittings

- (a) Steel Fittings – (Process Water Pipe and Gen-set Exhaust)
 - (i) Includes elbows, tees, caps, reducers and other fittings as shown on drawings
 - (ii) To ASTM-A234 seamless or seam welded
 - (iii) Standard weight
 - (iv) Physical properties to match pipe
 - (v) Dimensions to ANSI-B16.9
 - (vi) Lined and coated to match pipe
- (b) Steel - Threaded
 - (i) ANSI-B16.3 - standard malleable
 - (ii) Pressure rate to match pipe
 - (iii) Lined and coated to match pipe
 - (iv) Standard straight thread ANSI-B1.20.1
- (c) PVC
 - (i) For pressure service to CSA3-B137.3
 - (ii) For non-pressure service to CSA-181.2
 - (iii) Schedule 80 for all pressure fittings
 - (iv) Schedule 40 for all non-pressure fittings
 - (v) Solvent joint fittings to match pipe
 - (vi) To AWWA-C111 - rubber gasket type where required
 - (vii) Flanges, reducing bushings and other fittings to be compatible with line pipe material

E53.2.4 Flanges

- (a) Flanges for use in cold water service with steel pipe shall be welding neck or slip-on type as shown on the drawings.
- (b) Slip-on flanges shall be in accordance with AWWA-C207.
- (c) Slip-on flanges to be Class D for pressures as follows:
 - (i) Pipe size greater than 300 mm: 1035 kPa
- (d) Slip-on flanges shall be flat face.
- (e) Screw-on flanges to be Class D for pressures as follows:
 - (i) Pipe size 50 to 100: 1200 kPa
- (f) Welding neck flanges shall be steel to ASTM-A181, Grade 60, fabricated to ANSI B16.5, rated for 1035 kPa or 2070 kPa as shown on the drawings.
- (g) Use flat face flanges to connect to cast iron flanges, and raised face flanges to connect to raised face flanges.
- (h) Flange class shall be plainly marked on all flanges.
- (i) All flanges shall be finished as specified for the pipe system.

E53.2.5 Bolts and Nuts

- (a) Bolts and nuts shall be to AWWA C207.

- (b) Bolts and nuts shall be stainless steel, Type 304 hexagonal heads.
- (c) Size and length to match flanges and valves.

E53.2.6 Flange Gaskets

- (a) For flanges, 1.6 mm cloth inserted rubber SBR, Garlock Style 22 or approved alternate for temperatures below 100°C.
- (b) Use flat ring gaskets with raised face flanges.
- (c) Use full faced gaskets with flat face flanges.

E53.2.7 Welding Outlets

- (a) Fabricate to the requirements of ANSI-B16.9, ANSI-B16.11 and ANSI-B31.1.
- (b) Welded outlets include weldolets, sockolets and thredolets.

E53.2.8 Pipe Sleeves

- (a) Pipe sleeves shall be Schedule 40 stainless steel pipe and shall be, unless detailed otherwise, one size larger than the penetrating pipe for 100 mm and larger pipe, and two sizes larger for pipe smaller than 100 mm.
- (b) Pipe sleeve forming on integral part of the pipe system are detailed on the drawings.
- (c) All pipe sleeves shall have a 50 mm by 10 mm thick steel ring continuously welded all around the middle of the pipe length.
- (d) Special sleeves shall be as shown on the drawings.

E53.2.9 Supports and Hangers - General

- (a) Hangers and supports shall conform to ANSI Code for Pressure Piping B31.1.
- (b) Materials, design and manufacture for Pipe Hangers and Support shall be in accordance with ANSI/MSS SP-58.
- (c) Hot dip galvanize all supports, hangers, guides, sway braces, restraints, dampeners, bolts, washers and nuts after fabrication and before installation.
- (d) Hangers and supports shall be sized to suit the pipe sizes as shown on drawings and as recommended by the manufacturer.

E53.2.10 Pipe Supports

- (a) Wall supports - use Grinnell Fig. 194, Fig. 195, or Fig. 199 welded steel brackets hot dipped galvanized, or as shown on the drawings.
- (b) Floor Supports - use concrete supports as detailed on drawings.
- (c) Pipe saddle supports - use Grinnell Fig. 264 adjustable pipe saddle support complete with riser pipe and floor flange.
- (d) Strap supports - use Grinnell Fig. 262 for 100 mm and smaller pipe. Provide straps for larger pipe as detailed on drawings.
- (e) Wall supports for PVC plumbing piping - up to 50 mm diameter shall be Grinnell tube strap or approved alternate.

E53.2.11 Pipe Hangers

- (a) For non-insulated steel pipe of 150 mm and smaller use Grinnell Figure CT97C coated adjustable pipe ring complete with hanger rod and expansion case or insert for mounting on concrete surface.
- (b) For non-insulated steel pipes to 600 mm use Grinnell Fig. 260 adjustable clevis galvanized.
- (c) For PVC to 50 mm use Grinnell CT99C.

- (d) For concrete inserts use Grinnell Fig. 152, Fig. 117 and Fig. 285 to suit service conditions and pipe size.
- (e) For ceiling flanges, use Grinnell Fig. 153.
- (f) Hanger rods shall be machine threaded both ends and shall be hot dipped galvanized after fabrication.
- (g) Spring hangers shall be Grinnell Fig. 80-V or 81-H constant support spring hangers.
- (h) Any part of a hanger or other pipe support in direct contact with stainless steel shall be nylon coated with NCA-1477 nylon thermoplastic 0.5 mm thick or shall be of 304 stainless steel. Provide felt paper between pipe and concrete pipe supports to prevent bonding.

E53.3 Execution

E53.3.1 Nuts and Bolts

- (a) Install nuts and bolts so that bolts have a minimum of two exposed threads projecting after tightening; with a maximum of 8 threads projecting.
- (b) Apply Denso paste to exposed threads, flanges and coupling bolts.

E53.3.2 Installation of Pipe and Fittings

- (a) Protect all steel pipes when stored on Site from external conditions and ensure protective coating remains intact. If in the opinion of the Contract Administrator, deterioration of the protective coating has instigated corrosion, all rust must be removed down to bare metal and prime coated with red oxide paint.
- (b) Install piping to lines and elevations shown on the drawings.
- (c) Install all piping parallel or perpendicular to building walls.
- (d) Prior to commencing piping work, examine route for conflicts and notify the Contract Administrator of any conflicts. Obtain approval of the Contract Administrator for any relocations.
- (e) Install piping to lines and elevations shown on the drawings. Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.
- (f) Install all piping parallel to building walls.
- (g) Determine exact location of each pipe in the field with respect to adjacent and interconnecting piping and equipment.
- (h) Install all piping systems in accordance with the ANSI code for pressure piping, B31.1.
- (i) Provide flanged joints intermittently in all process piping systems to facilitate removal of every section of the piping systems by two men and without cutting any pipe or joint.
- (j) Provide unions intermittently in all screwed piping systems to facilitate removal of valves and every section of the piping system without cutting any pipe or joint.
- (k) Provide temporary bracing and supports to adequately support pipes and fittings during installation.
- (l) Where the required piping is not shown on drawings or is shown diagrammatically, the pipes shall be installed in such a way as to conserve head room and interfere as little as possible with the spaces through which they pass.
- (m) Maintain grade on all draining pipes. Horizontal water piping shall be run with a grade of 2% to drain.

- (n) Where piping is to connect to equipment, dimensions shown on the drawings are based on catalogue information of first named supplier.
- (o) Modify work to suit final dimensions shown on shop drawings for equipment.
- (p) Make reductions in water pipes with eccentric reducing fittings installed to provide drainage and venting. Top flat for water, bottom flat for steam.
- (q) Pipe the discharge from all relief valves, safety valves, vents, drains, equipment blowdowns, water columns, and overflows to the nearest building drain.
- (r) Ascertain the correct equipment dimensions before ordering piping closure lengths and fittings. Review of drawings by the Contract Administrator will not relieve the Contractor of his/her obligation in this respect.

E53.3.3 Jointing Pipes – General

- (a) Clean off scale and dirt, inside and outside, before assembling. Remove welding slag or other foreign material from piping.
- (b) Ream pipes and tubes.
- (c) Make screwed joints using approved compound or teflon tape applied to male threads. Use thread tape on P.V.C. pipe.
- (d) Connect pipes to equipment as shown or specified, without springing the pipes.
- (e) Provide complete isolation of dissimilar metals. Do not connect copper to any ferrous metal.
- (f) Use standard fittings for direction changes.
- (g) Follow the recommendations of the manufacturer for jointing pipes and installing couplings and fittings.

E53.3.4 Welding Steel Pipe Joints

- (a) Jointing of steel pipe by field welding, shall be in accordance with CSA-Z662.
- (b) Each operator shall be currently qualified for the P number covering the material on which he/she will be engaged as prescribed in the Welding Qualification Code, latest revision. Each operator certificate of qualification and experience record shall be on file at the Site and shall be made available to the Contract Administrator on request.
- (c) Prior to the start of production welding, a detailed procedure specification shall be established and qualified in accordance with CSA-Z662, by the Contractor to demonstrate that welds have suitable mechanical properties and soundness.
- (d) Welders shall qualify by demonstrating ability to produce acceptable welds using the qualified welding procedure. CSA Standard Z662 shall apply to this section.
- (e) The Contract Administrator reserves the right to specifically test, at no cost to the City, the qualification of individual welders employed by the Contractor.
- (f) Welding equipment shall be of a size and type suitable for the work and shall be maintained in such a condition as to ensure acceptable welds, continuity of operation and safety of personnel.
- (g) Filler metals shall be approved by the Canadian Welding Bureau and shall conform to CSA W 48.1 or CSA Standard W48.3.
- (h) All welding shall be done by the shielded metal-arc welding process. Three beads or more shall be required and the size and type of rods used shall be suitable for the pipe being welded.
- (i) Any welder who does not perform satisfactorily in the Contractor Administrator's test shall be removed from the job at no cost to the City.

- (j) Welded pipe joints shall be single-V butt joint, using a root gap of 1.6 mm. Welds shall be full penetration welds. Care shall be exercised to keep the interior pipe lining free from damage during welding. Longitudinal weld seams shall be on opposite sides of the pipe at the joint. Welding shall not be carried on when weather conditions, in the opinion of Contract Administrator, are unsatisfactory and would impair the quality of the welds.
- (k) Quality of full penetration welds and partial penetration welds shall be determined by testing in conformance with CSA-Z662.
- (l) The minimum distance between the edges to adjacent circumferential welds shall be 50 mm. If this requirement cannot be satisfied, stress relieving of the welds must be undertaken.
- (m) The Contract Administrator shall have the right to inspect all welds by non-destructive means or by removing welds and testing by mechanical means. Prepare sections for destructive testing in accordance with CSA-Z662.
- (n) Repair damage to linings, and reline joints after welding is complete. Reline joints using materials and procedures recommended by the supplier of the lining material.
- (o) For further details on welding steel pipe joints refer to Section 02713, Pressure Pipe.

E53.3.5 Welding Stainless Steel Pipe Sleeves

- (a) Welds shall be made by a certified welder, skilled in stainless steel welding. Submit certifications for all welders and submit details of proposed methods.
- (b) Prepare pipe ends by grinding and bevelling; then clean using stainless steel brushes and acetone.
- (c) Select filler rods and electrodes to conform with the pipe composition.
- (d) Make tack welds employing gas tungsten arc methods and remove while making the root pass.
- (e) Use gas tungsten arc welding for materials to 3 mm thick; and for root pass for heavier thicknesses, using Gas Metal Arc Welding or Shielded Metal Arc Welding.
- (f) Use argon as arc shielding gas.
- (g) All welds shall have full penetration without shrinkage or porosity. Welds shall be smooth and shall not have undue protrusions on the pipe interior.

E53.3.6 Rubber Gasket Joints

- (a) Make rubber gaskets in carbon steel pipe, or other pipes in accordance with the manufacturer's instructions. Use appropriate tools to pull joints, to field cut joints and to prepare pipes for joining. After assembly check the gasket position.

E53.3.7 Flanged Joints

- (a) Welded flanges shall be welded inside an outside.
- (b) Fit flanged joints so that gaskets are bearing uniformly and joints are even. Apply an anti-seize compound to bolt threads and tighten bolts evenly.

E53.3.8 Valve and Operators

- (a) Install all valves and operators in strict accordance with manufacturer's shop drawings and instructions.
- (b) Valve floor stand and operators shall be oriented as shown on the drawings.
- (c) Install extension stems, stem supports and other accessories as required and as shown on drawings for the connection of valve operators to floor stand units.

- (d) If pipe sleeves through concrete slabs for floor stands are not in vertical line with gear operators other than as shown on the drawings, provide universal joints on the extension operating stem for the correction of alignment.

E53.3.9 Installation of Support and Hangers

- (a) Support all piping after alignment and before tightening joints.
- (b) Do not move pipe after tightening joints.
- (c) Provide all hangers, supports, anchor bolts, washers and nuts to support pipes at the lines and elevations indicated and/or as detailed on the drawings.
- (d) Provide inserts in concrete, concrete piers and anchor bolts as required. Provide reinforcing bars in concrete for inserts carrying pipe over 100 mm in diameter.
- (e) Bolt base flanges to the floors or to concrete.
- (f) Provide all necessary sway braces, dampeners, flexible hoses and restraints to eliminate all movements of piping due to vibration. Install additional braces and anchors as necessary to eliminate vibrations.
- (g) Provide hangers, supports, anchors, guides, dampeners, flexible hoses, restraints and sway braces that will cope with the loads and thrust forces from all directions so that all pipe joints will function and thrust is not transferred to the equipment to which the pipe is connected.
- (h) Maximum hanger spacing and minimum rod size shall be in accordance with the following:

<u>Pipe Size</u>	<u>Rod Size</u>	<u>Maximum Spacing Steel</u>	<u>Maximum Spacing P.V.C.</u>
up to 25 mm	10 mm	1200 mm	1200 mm
25 - 50 mm	10 mm	1800 mm	1800 mm
65 - 90 mm	12 mm	2400 mm	2100 mm
100 - 125 mm	16 mm	2400 mm	2100 mm
150 mm	20 mm	3600 mm	2400 mm
200 - 300 mm	22 mm	5500 mm	2400 mm
350 and up	25 mm	6500 mm	2800 mm

- (i) A pipe hanger, support or brace shall be provided at each fitting which changes the direction of flow, and at each proposed valve.
- (j) Install sufficient hangers and supports to provide an adequate safety factor as outlined in ANS1-B31.1.
- (k) Drilling into concrete, and using expansion type inserts will be permitted only on approval of the Contract Administrator.

E53.3.10 Pipes Through Floors and Walls

- (a) Provide SCH40 stainless steel pipe sleeves where pipes pass through floors and walls.
- (b) Install sleeves flush at walls and projecting at floors as detailed or 50 mm above floor surfaces and flush with bottom.
- (c) Provide continuously welded rings on pipes passing through walls below grade or where walls are watertight. The thrust/seepage rings shall be as detailed on the drawings.
- (d) Remove coating from pipes to be cast in concrete to permit a good bond.
- (e) Where electrical insulation from concrete rebar is required, use link seals with pipe sleeves where shown on drawings.

- (f) Where thrust restraint is required design according to AWWA Manual M11 or as detailed.
- (g) There shall be no direct contact between structural steel and stainless steel.
- (h) Seal space between sleeves and pipes with non-hardening mastic -Daraseal-A or approved alternative.

E53.3.11 Backflow Preventors

- (a) Install backflow preventors on domestic plumbing treated water lines where indicated. This includes but is not limited to connections to:
 - (i) Domestic water service/building connection.
 - (ii) Hose bibb or wash down facilities within untreated water facilities.
- (b) Provide with an air gap, a suitably sized collector funnel beneath the valve drain to contain the drain discharge. Pipe the collector funnel to the nearest drain.

E53.3.12 Connection of PVC Pipe

- (a) PVC pipe and socket fittings shall be jointed by use of solvent based cements manufactured in accordance with ASTM D2564.
- (b) American National Taper pipe thread must be used for all screwed connections. Remove burrs and chips and ream or file the pipe ends out to size or bore. Not more than two (2) imperfect threads exposed when joint make-up.
- (c) Make screw joints metal to metal. Do not use lampwick or other packaging material in making up screwed joints.
- (d) Use Telfon tape, red lead and linseed oil or other approved non-toxic joint compound applied to male threads only.
- (e) Thread chromium plated piping and make up carefully. Do not expose more than one full turn of thread beyond any fitting.

E53.3.13 Route and Grades

- (a) Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.
- (b) Slope water piping 0.2% and provide hose bibb drains at low points.
- (c) On closed systems, equip low points with 20mm drain valves and hose nipples.
- (d) Make reductions in water and steam pipes with eccentric reducing fittings installed to provide drainage and venting. Top flat for water, bottom flat for steam.
- (e) Grade horizontal drainage and vent piping 2% minimum.
- (f) Pipe the discharge from all relief valves, safety valves, vents, drains, equipment blowdowns, water columns, and overflows to the nearest building drain. Average overflow drains so that drips may be readily seen.
- (g) Provide at high points of closed systems, collecting chambers and high capacity float operated automatic air vents.

E53.3.14 Installation of PVC Pipe

- (a) Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.
- (b) Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.

- (c) Install piping parallel and close to walls and ceilings to conserve head room and space, and to grade as indicated.
- (d) Install piping material specified as inside the building to 2500mm outside of building.

E53.3.15 Cleaning

- (a) Clean all pipes, fittings and miscellaneous items after installation.
- (b) Remove all materials from pipes, whatever their origin, by flushing with water, blowing with air and dismantling and manually cleaning.
- (c) Prevent entrance of foreign materials from pipes to equipment or pumps.
- (d) Pickle stainless steel lines and wash to remove stains. Pickle all welds and brush with stainless steel brushes; then wash with hot water.

E53.3.16 Shop Finishes

- (a) Shop priming and epoxy coating of the equipment shall be as specified in Painting.

E53.3.17 Field Painting

- (a) Field painting shall be in accordance with Painting.

E54. PROCESS VALVES

E54.1 General

E54.1.1 Description

- (a) This section specifies the supply and installation of all process and domestic plumbing valves applicable to the process and domestic piping systems.
- (b) Valves shall be tested in accordance with Clause E52 – Mechanical Testing.

E54.1.2 Submittals

- (a) The Contractor shall submit shop drawings and product data as follows:
 - (i) Assembly drawings and material list.
 - (ii) Details of all parts and principal dimensions.
 - (iii) Submit installation manuals before shipment of any equipment.
 - (iv) Submit operation and maintenance manuals 10 working days prior to start up.
 - (v) Indicate compliance of valves, which are specified to conform to AWWA specifications.
 - (vi) Submit in accordance with E12 – Shop Drawings.

E54.1.3 Manufacturer

- (a) Provide valves of the same type by the same manufacture throughout.
- (b) Provide valves with manufacturer's name and pressure rating clearly marked outside of body.

E54.2 Products

E54.2.1 Ball Valves

- (a) Ball Valves up to 50-mm for Steel Pipe:
 - (i) Two piece bronze body
 - (ii) Full standard port
 - (iii) Chrome plated
 - (iv) Solid bronze ball

- (v) TFE seat and packing
 - (vi) Lever handle
 - (vii) Threaded ends
 - (viii) Kitz 68 and 69, Flowtek 759, Matco, Jenkins 910J, or approved equal.
- (b) For PVC Pipe:
- (i) PVC body
 - (ii) EDPM Seat
 - (iii) 12-mm to 25-mm sizes to 1564 kPa working pressure and larger sizes to 1020 kPa working pressure
 - (iv) All valves shall have double stem blow out stem o-rings
 - (v) Socket ends to be Schedule 80 conforming to ASTM D-2427
 - (vi) PVC compound shall have an ASTM cell classification 23567-A with a minimum suffix "A" chemical resistance
 - (vii) Chemline type 21 True union ball valve (EPDM and socket), George Fisher, or approved equal.
- (c) All lubricants in valves shall be edible and suitable for use in potable water.

E54.2.2

Gate Valves

- (a) Valves 80 mm and smaller
- (i) Bronze body
 - (ii) Solid wedge
 - (iii) Non-rising stem
 - (iv) 1380 kPa WOG rating
 - (v) Threaded end Jenkins Fig. 310, Crane 1320 or approved alternative
 - (vi) Soldered ends Jenkins Fig. 313, Crane 1320C or approved alternative
- (b) 100 mm and larger - flanged (Pump Insulation Valves)
- (i) 1300 kPa rated hydrostatic working pressure, factory tested to 1600 kPa.
 - (ii) Flanged each end.
 - (iii) Rising stem c/w OS&Y configuration
 - (iv) NRS stuffing box to contain 2 field replaceable o-ring seals.
 - (v) To AWWA C509 for resilient seated gate valves.
 - (vi) Bronze trimmed.
 - (vii) Rubber to iron bond on wedge as per ASTM D 429-73.
 - (viii) Fully encapsulated rubber, resilient wedge disc.
 - (ix) Clockwise turns to open.
 - (x) Bubble tight shut-off
 - (xi) Hydrostatically tested to 2.5 times the rated pressure
 - (xii) Interior Coating to meet AWWA C-550.
 - (xiii) Provide exterior polymeric coating.
 - (xiv) Clow Figure F-6136, Crane or approved alternative.

E54.2.3

Butterfly Valves (Air Release/Vacuum Valve Insolation)

- (a) Valves 50 mm to 100 mm shall be water style body. Valves over 100 mm shall be lug style body. Valves shall be complete with:
- (i) Cast iron, wafer body c/w flange locating holes, factory coated for use in potable water immersion.

- (ii) For installation between 1000 kPa ANSI drilled flanges.
- (iii) Single piece shaft – 304 stainless steel – consistent diameter throughout body.
- (iv) Valve seat – peroxide cured EPDM NSF61 approved (Sulphur cured seats are not acceptable).
- (v) Flange gaskets not required.
- (vi) For operating temperature range -40°C to +121°C
- (vii) For valves 150 mm and smaller – lever operated cast iron c/w 10 position plated steel notch plate and stainless steel spring.
- (viii) Valve size 50-250 mm
 - ◆ Aluminium Bronze disc (Nylon coated ductile iron is acceptable)
 - ◆ Cast iron body
 - ◆ Operating pressure 1400 kPa
 - ◆ Bray Series 30/31, Keystone AR1/AR2 or approved equal

E54.2.4 Swing-Flex Check Valve

- (a) Full body flanged type with full size domed access cover
- (b) Flanges to ANSI B1-6.1 Class 125
- (c) Valve shall provide full flow
- (d) Capable of passing a 75 mm sphere
- (e) Valve to be complete with a manual backflow actuator
- (f) Disc shall be field accessible and replaceable without removal of valve body
- (g) Disc shall contain steel and be one-piece precision moulded, c/w a 25-year warranty.
- (h) Valve body to ASTM A126 Class B Cast Iron
- (i) Disc shall be precision moulded Buna-N to ASTM D2000-BG
- (j) Valve shall be hydrostatically tested to 15 times the rated working pressure
- (k) Acceptable product: Val Matic Swing Flex model VM-518 BF for approved alternative.

E54.2.5 Combination Air Valve

- (a) Water Service
 - (i) For pressures to 2000 kPa
 - (ii) Cast iron body, cover, lever frame
 - (iii) Stainless steel float
 - (iv) Buna N seat
 - (v) Inlet 150 to 200 mm dia. – flanged
 - (vi) Outlet to be flanged as shown
 - (vii) Large orifice: dia. 150 mm.
 - (viii) Small orifice: dia. Minimum 3 mm.
 - (ix) APCO Series 150 CAV, Cla-Val model 366-CAV038, or approved alternative.

E54.2.6 Drain Valves

- (a) Up to 50 mm forged brass body, brass cap, stem and ball. Teflon stem seals and Teflon seat. Hose thread end full port. Working pressure 1725 kPa at 120⁰ C. Dahl 50.430, Jenkins Fig. 901CJ, Toyo 5046, Kitz 58CC, Matco 759, or approved equal.
- (b) Drain valves 65 mm and over: bronzed body, bronze ball, threaded ends, twin seal Teflon seats and Viton seals, O-ring, lever handle, rating 2070 kPa at 120⁰ C water. Matco 759, or approved equal.

- (c) Terminal unit brass T-body drain valve, wheel handle, ground body-bonnet joint, renewable disc, brass chain, forged brass gasketed cap. Working pressure 1725 kPa at 120⁰ C. Dahl 21.616, or approved equal.

E54.2.7 Sampling Valve

- (a) Type 316 stainless steel wetted parts
- (b) Viton stem seal
- (c) 410 kPa pressure rating
- (d) c/w lever actuator
- (e) Fabri-Valve Figure 151 sampling valve or approved alternative

E54.2.8 Shop Finishes

- (a) All unfinished iron and steel work on the valves shall be thoroughly cleaned and painted with approved shop coat, refer to E49 - Painting. All finished parts shall be coated with heavy grease or a mixture of white lead and tallow to prevent corrosion during shipment and installation. Bronze work shall be left bright.

E54.2.9 Pressure Gauges

- (a) Provide 114 mm diameter, cast aluminum pressure gauges – black finish – stainless steel internals – liquid filled – dial type to CGSB 91-GP-1 – glass window, white dial, black lettering – ½ of 1% accuracy unless otherwise stated.
 - (i) Pressure range: 0-700 kPa (Domestic water piping system).
 - (ii) Pressure range: 0-1500 kPa as detailed (Blower discharge headers).
 - (iii) Provide brass gauge cock
 - (iv) Use materials compatible with system requirements.
 - (v) Acceptable Gauge Manufacturers: Trerice, Taylor, Weiss, Weksler, Winters, Marshall Town, or approved equal.

E54.2.10 Pressure Gauge Isolators

- (a) All pressure gauges shall be supplied complete with a gauge isolator. A diaphragm shall separate the gauge from the process liquid. The upper chamber shall be filled with glycerine.
- (b) Provide a 12 mm gauge connection.
- (c) Acceptable product: Chemline SI series gauge isolator.

E54.2.11 Valves and Operators

- (a) Install all valves and operators in strict accordance with manufacturer's shop drawings and instructions.
- (b) Valve floor stands and operators shall be oriented as show on the drawings.
- (c) Install extension stems, stem supports and other accessories are required and as shown on the drawings for the connection of valve operators to floor stand units.
- (d) If pipe sleeves through concrete slab for floor stands are not in vertical line with gear operators other than as shown on the drawings, provide universal joints on the extension operating stem for the correction of alignment.

E54.2.12 Field Painting

- (a) All exposed surfaces of valves shall be finish painted after installation in accordance with E49 - Painting.

E54.3 Execution

E54.3.1 Valves and Operators

- (a) Install all valves, operators and control items in strict accordance with manufacturer's shop drawings and instructions.
- (b) Valve floor stands and operators shall be oriented as shown on the drawings.

E55. SLUICE GATES

E55.1 General

E55.1.1 Description

- (a) This section specifies the supply and installation of sluice gates indicated on the drawings and as specified hereinafter.
- (b) Each gate shall have a clear waterway, shall consist of a slide, frame, guides, yoke, stem, manual and electric gate operator and accessories for a complete sluice gate assembly as specified.

E55.1.2 Submittals

- (a) The Contractor shall submit shop drawings of the gate as follows:
 - (i) General layout of sluice gate and drive with anchor bolt locations.
 - (ii) Details of gate operator assembly and parts list.
 - (iii) Details of gate assembly, accessories and parts list.
 - (iv) Details of stem support assemblies.
 - (v) Submit installation manuals before shipment of gates.

E55.1.3 Stainless Steel Sluice Gate Acceptable Manufacturers

- (a) H. Fontaine Ltd., Series 20, CWX
- (b) Waterman Industries
- (c) Hydro Gate Company
- (d) or approved equal

E55.1.4 Electric Actuator Acceptable Manufacturers

- (a) Rotork Model MKII
- (b) Limitorque
- (c) or approved equal.

E55.2 Products

E55.2.1 Design

- (a) Provide new material only.
- (b) Confirm with Contract Administration all elevations prior to manufacturing.
- (c) Each sluice gate shall be designed for a 9 m seating and unseating head and shall be of the highest quality both as to materials and workmanship. The sluice gate shall exceed the requirements of AWWA-C501 - latest edition by 50% and meet the leakage requirements as specified herein.
- (d) The sluice gates shall be fully stainless steel and all parts shall be amply proportioned for all stresses, which may occur during installation and operation.

- (e) The stainless steel gate frame shall be constructed of structural members or formed plate welded to form a rigid one-piece frame.
- (f) Where applicable, the frame shall be flanged back and suitable for mounting on a wall.
- (g) The frame configuration shall allow the replacement of the top and side seals without removing the gate frame from the wall.
- (h) Each sluice gate shall be substantially watertight, when closed. Leakage shall not exceed 74 litres per hour per metre perimeter for seating and unseating slides under a rated head of 9 m.
- (i) The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to 1/720 of the gate's span under the design head of 9 m.
- (j) The sluice gate shall close by rotation of the stems, in a clockwise direction.
- (k) Provide all actuator mounting hardware and accessories mounted on the device prior to shipment.
- (l) Provide electric actuators of National Electrical Manufacturers Association (NEMA) 4x construction, suitable for use in an industrial environment.
- (m) Provide device and actuator as a matched set from the same manufacturer wherever possible.
- (n) For electrical actuated gates, actuators shall be provided with Modbus/TCP communications capability.
- (o) Tag the control devices, accessories and actuators to indicate operating characteristics. Tag the actuator inlet and outlet ports for electric or pneumatic services. Electric actuators must be Canadian Standards Association (CSA) approved.
- (p) The sluice gate shall have heavy self-supporting or self-contained frames as noted in the specifications, machined and drilled for bolting to the flat concrete wet well wall. Gates shall be bolted to the concrete wall as shown on the drawings. All holes for bolts and studs shall be drilled. Coring of the holes will not be permitted.
- (q) All anchor bolts and fasteners shall be Type 316 stainless steel.

E55.2.2 Replacements

- (a) Make interchangeable such individual pieces of the equipment herein specified which are furnished alike in each unit. Like pieces shall conform to exact dimensions on the working drawings made by the manufacturer, so that no fitting or adjustment will be necessary in setting up the entire equipment, other than such as is usually done in high grade standard designed apparatus.
- (b) It is essential that any defective piece of equipment be easily replaced by a new piece made in accordance with the drawings.

E55.2.3 Frames and Guides

- (a) Provide sluice gate frames and guides of type 304 Stainless Steel.
- (b) Side guides shall be of suitable design to keep the slide in true alignment and shall be securely bolted to the frame with stud bolts and nuts. The guides shall be of sufficient length so that not less than one-half of the slide is within the guides when the sluice gate is fully open. Guides shall be machined on all sides.
- (c) Thrust bearings at yokes shall be grease lubricated and provided with manganese bronze fittings.

E55.2.4 Slides

- (a) Provide slides of stainless steel type 304 suitably ribbed or strengthened to prevent distortion.
- (b) Slides shall have tongues on each side extending the full height of the slide and the tongues shall be accurately machined all over to fit the guides. Side seals shall be UHMW polyethylene to ASTM D-4020.

E55.2.5 Seats

- (a) The gate guide liner shall be made of "True" ultra high molecular weight polyethylene (UHMWPE) to ASTM D-4020 and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.
- (b) Side and top seats shall, be made of "True" UHMWPE of the self-adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and allow the water to flow only below the slide plate.
- (c) The compression cord shall be nitrile to ASTM D-2000.
- (d) The bottom seal shall be Neoprene grade 2 to ASTM D-2000.
- (e) The flush bottom seal shall be set and mechanically fastened into the bottom member of the frame.

E55.2.6 Floor Stand Operator

- (a) Floor stand operator shall be of the enclosed gear pedestal type with side mounted hand wheel and shall be sized for the allowable maximum torques for the specified operating pressure across the sluice gate.
- (b) The lift mechanism shall be complete with floor stand, ball thrust bearings, grease fittings, bronze nuts, mounting pedestal and accessories as required.
- (c) Standard pedestal floor stand shall be used unless otherwise specified.
- (d) Provide rising stem floorstand for sluice gates.

E55.2.7 Lifting Mechanism

- (a) Operator shall be electric, with manual override.
- (b) Manual operation shall be designed to operator the gate under the maximum specified seating and unseating heads by using a maximum effort of 178 Newton on the crank or hand wheel and shall be able to withstand, without damage, an effort of 356 Newton.
- (c) Gearboxes shall be provided when required to maintain the operating force below 178 Newton. All bearings and gears shall be totally enclosed in a weather tight housing. The pinion shaft of hand wheel mechanisms shall be constructed of stainless steel and supported by roller or needle bearings. The operating shaft shall be fitted with a 50 millimeters square operating nut and hand wheel. The maximum hand wheel diameter shall be 600 millimeters.
- (d) Motor operated gate control shall include motor, operator unit gearing, limit switch gearing, limit switches, torque switches, bored and key wayed drive sleeve, declutch level, and auxiliary hand wheel as self contained unit.
- (e) Motor shall be 575 Volt, 3 ph, 50 Hertz, suitable for typical high humidity indoor conditions.
- (f) Limit and Torque Switches: Engage limit switches to drive mechanism at all times whether unit operated electrically or manually. Set switches to trip at fully open and fully closed gate positions. Factory wire electrical interconnections between limit switches and torque switches, ready for operation. Factory wire gearing used in

connection with limit switches. Provide open and close limit switches. Mount limit switches on gate operator or stem above gate operator. Equip each gate control with double torque switch adjustable and responsive to load encountered in either direction of travel.

- (g) Operate during complete cycle without auxiliary relays or devices for protection should excessive load be caused by obstruction in either direction of travel.
- (h) Controller: Provide integral reversing controller for each operator. Controller consists of reversing combination magnetic starters, control transformer, three (3) overloads, and cover mounted pilot devices specified.
- (i) Gear case, base plates and input housings shall be cast iron. Range gears shall be alloy steel. Fasteners shall be zinc-plated steel.
- (j) Hand wheel shall not rotate during electric operation.
- (k) Do not rotate motor during hand operation, nor shall fused motor prevent manual operation. When in manual operating position, unit shall remain in this position until motor is energized at which time gate operator shall automatically return to electric operation and shall remain in motor position until hand wheel operation desired.
- (l) Movement from motor operation to hand wheel operation accomplished by positive declutching lever, which shall disengage motor gearing mechanically but not electrically. Ensure that the unit cannot be placed in manual operation when motor is running.
- (m) Hammer Blow Device: Gate control with built in lost motion device that travels a minimum of 135 degrees before imparting hammer blow to start gate in motion in closing or operating direction. Permit motor to attain full speed before load is encountered. Share load equally by 2 lugs cast integrally on drive sleeve.

E55.2.8

Extension Stems

- (a) Provide the rising type stems of ASTM-A276, Type 316 stainless steel complete with stainless steel stem block and stainless steel stem splices and guides, and stainless steel wall brackets.
- (b) The operating stem shall be designed to transmit in compression at least two (2) times the rated output of the operating manual mechanism with a 178 Newton effort on the hand wheel.
- (c) The stem shall have a slenderness ratio (Length/Radius) of less than two hundred (200). The threaded portion of the stem shall have machine cut threads of the Acme type.
- (d) The stems shall be designed to withstand, without buckling, the maximum thrust developed by the operating power mechanism or the manually operated handwheel.
- (e) For stems in more than one piece and with a diameter of 45 millimetres and larger, the different sections shall be joined together by solid couplings. The couplings shall be threaded and keyed or threaded and bolted and shall be of greater strength than the stem. Stems with a diameter smaller than 45 millimetres shall be pinned to an extension tube.
- (f) Stem guides shall be adjustable and spaced in accordance with the manufacturer's recommendation. The Length/Radius ratio shall not be greater than two hundred (200).
- (g) Rising stem gates shall be provided with a clear stem cover. The stem cover shall have a cap and condensation vents, and a clear Mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

- (h) Stem guards shall have the words "Open", "Closed", and the numerals engraved at appropriate locations thereon. Vent holes shall be provided to prevent condensation.
- (i) Provide a threaded cast iron stop nut on all geared and ball bearing lifts.

E55.2.9

Electric Liner Actuators, Open/Close Type (EMLO) and Modulating Type (EMLM)

- (a) Electric actuators for gates to be comprised of an electric motor and one or two gear boxes, depending on the gate design.
- (b) Provide a sufficiently sized motor to seal and unseat gates and, if necessary, for control to transverse from full open to full closed position in response to control signals. Operator shall develop 1.5 times the torque required to operate the valve at design pressure.
- (c) The actuator will impart a travel speed of 18.0 m/h to open/close gate. The actuator speed shall be field adjustable.
- (d) The actuator shall be fully compatible with the gate. Mount at operating height on the frame.
- (e) Electric motors shall be CSA approved, totally enclosed, non-ventilated with Class B insulation and windings specially impregnated to prevent moisture absorption.
- (f) The actuators to accept 575 V, 3 phase, 60 Hz power. Protect motors against reverse phase rotation.
- (g) The drive train to be rated for heavy duty, continuous service. Connect the actuator drive shaft to gear box shaft(s) through a removable flexible mechanical coupling. Where the actuator is fitted to two stems, ensure that the gearing in each gearbox allows both stems to move identically.
- (h) House the internal components of actuators and related gear boxes in weatherproof, corrosion proof metal enclosures. Electrical components shall be contained in Electrical and Electronic Manufacturer's Association of Canada (EEMAC) six enclosures. All electrical and mechanical components shall be capable of continuous operation in an ambient temperature range of -40°C to plus 40°C.
- (i) Fit actuators with a capstan hand wheel operator. Fit hand wheel assemblies with a clutching mechanism, which prevents hand wheel operation during normal motor operation. Provide a 1:1 gearing ratio with respect to the main drive shaft for the hand wheel.
- (j) Fit removable safety guards over all moving drive train components between the actuator and each gearbox.
- (k) Provide adjustable limit switches on each actuator to define the upper and lower limits of the stroke (open-close position).
- (l) High torque switches will protect the equipment and the structure against excessive gate travel. Provide high torque protection at the lower and upper ends of the stroke.
- (m) Provide a controller enclosure to contain a motor contactor complete with overload protection. Provide line, load, and external control terminal strips.
- (n) Fit each actuator with an electronic positioner to control gate elevation in response to continuous 4 to 20 mA DC input signal.
- (o) Provide a local operating station with an automatic Off-Hand switch and an Open-Close switch.
- (p) Actuator position switches shall include two (2) form C2 amp contacts in an EEMAC four (4) (minimum) rated enclosure.
- (q) Cams shall be fastened to a splined shaft and adjustable without setscrews.

- (r) Provide a visual indicator with beacon type display showing red when the controlled device is open and green when the device is closed.
- (s) Supply all required hardware for mounting of the position monitor in accordance with the specified valve/actuator orientation.
- (t) Diaphragm actuated valves shall have external position monitor actuated through linkages.
- (u) Minimum monitoring and control signal requirements:
 - (i) Open-Close actuators:
 - ◆ Momentary Open Command (Remote dry contact)
 - ◆ Momentary Close Command (Remote dry contact)
 - ◆ Open Status (Dry contact for remote indication)
 - ◆ Closed Status (Dry contact for remote indication)
 - ◆ Computer (Remote) Mode (Dry contact for remote indication)
 - ◆ Remote dry contacts will be rated 2 Amps at 120 VAC minimum.

E55.2.10 Materials

- (a) Stainless Steel Grates shall be as per the following:

PART	MATERIAL
Frame	Stainless steel American Society for Testing and Materials (ASTM) A-240 316L
Slide	Stainless steel ASTM A-240 316L
Guides	Stainless steel ASTM A-240 316L
Stem Guides	Stainless steel ASTM A240 316L
Threaded stem	Stainless steel ASTM A-276, Type 316
Seats	UHMWPE, ASTM D-4020-96
Steam Guide Bushings	Stainless Steel ASTM A276 316
Anchor Bolts and Fasteners	Stainless Steel ASTM F593 or F594 GR2 316
Wedges and Pressure Pads	Stainless Steel ASTM A276 316 or ASTM A743
Gate Operator Lift Nut	Bronze ASTM B584 or ASTM BH505
Operator and Lift	Enclosed gear lift with pedestal suitable for operating an electric portable drill and manual opening.
Stem Couplings	Stainless Steel ASTM A276, 316
Stem Cover	Galvanized steel pipe with acrylic window with graduations
Thrust Nut	Stainless Steel ASTM A276, 316
Pedestal	SS 316 Stainless Steel
Gears	Steel AISI 8620, 4140 or 1117
Gear Housing	Stainless Steel ASTM A276 316, or ASTM A312, or ASTM A376
Flush Bottom Sill	Extruded or molded neoprene
Flush Bottom Sill Retainer	Stainless Steel ASTM A276 316

- (b) Surface Treatment and Finishes
 - (i) Carbon and alloyed steel surfaces require coatings. Stainless steel does not require coatings.
 - (ii) Stainless steel to be cleaned to such that all surfaces are free of dirt and grease.
 - (iii) All surfaces requiring coatings to be cleaned to National Association of Corrosion Engineers (NACE) SSPC-SP6.

- (iv) Submerged or surface subjected to splashing require two (2) or more layers (5 mils minimum each coat) of Polyamide Epoxy, Amerlock 400, Tremec Series 140F Pota-Pox Pillus or approved equal. Application as per Manufacture's recommendations.
- (v) Above ground surface requires one (1) layer (5 mils minimum) of high solids epoxy coating. Coating is required to be suitable for potable water application.
- (vi) Coatings shall be holiday free as defined in Section 5.1 of AWWA Standard C550.
- (vii) After coated surfaces are dry, a protective grease shall be applied to all machined or bearing surfaces and holes to prevent corrosion prior to installation.

E55.3 Execution

E55.3.1 Shop Finishes

- (a) Thoroughly clean all unfinished iron and steel work of the gate assembly, including guide brackets and collars and paint as specified in E49 - Painting.
- (b) All stainless steel components shall not be painted.
- (c) Coat finished parts with heavy grease or a mixture of white lead and allow to prevent corrosion during shipment and installation.

E55.3.2 Installation

- (a) Install gates on wall free from distortion and undue strain and truly plum and level.
- (b) Test gates to the seating and unseating pressures specified.
- (c) Reduce leakage as required to comply with specified leakage limits.
- (d) Protect all exposed apparatus and equipment from mortar drippings, wet concrete or other adhering substances.
- (e) After installation, clean gates and operators of all foreign matter.

E55.3.3 Testing and Performance Verification

- (a) Operating equipment and systems shall be performance tested by the Contractor in the presence of the Contract Administrator to demonstrate compliance with the specified operating requirements. Functional testing shall be conducted under the specified design operating conditions in this document or under simulated operating conditions as recommended or approved by the Contract Administrator.
- (b) Operate each gate with and without liquid on both sides to show that each gate can be operated with applied torques within design limits.
- (c) In the event any sluice gate field leakage test is not successful, retesting shall be required.
- (d) Depending upon the cause of the test failure, the Contract Administrator shall determine the responsible party or the re-testing cost.
- (e) The Contractor shall coordinate the testing with the Contract Administrator. As a minimum, the Contractor shall allow for seven (7) working days for testing in at least five (5) separate trips to the Site.
- (f) In addition to the field leakage testing, the Contractor shall have proof of long-term operational testing. The gate shall meet AWWA C-561-04 Standard for allowable leakage after run through 25,000 cycles in testing. Contractor to supply test report to Contract Administrator.
- (g) The Contractor shall shop test each wall mounted slide gate for both operation and leakage prior to shipping. The Contractor shall supply certificate that the testing has

been carried out. The Contract Administrator reserves the right to witness this shop testing at the factory.

- (h) Coordinate with the Contract Administrator and Installer such that the Contractor shall be in attendance during performance verification of the sluice gates to ensure that each gate functions as intended.

E55.3.4 Training

- (a) The Contractor shall provide training to City staff by a factory trained representative on the Operation and Maintenance of the equipment.
- (b) Training for the equipment shall be conducted before the operation period as described in the Project Master Schedule. The training seminar shall be conducted on Site. If necessary, instruction can be held in the City office. The Contractor shall provide a qualified instructor as well as the necessary course material.
- (c) Training shall be provided in a single session of one-half (1/2) day. Time for training shall be in addition to the other requirements specified.
- (d) The manufacturer's representative shall provide five (5) sets of training seminar manuals in similar format to the O&M manuals prior to the training session. In addition, the manufacturer's representative shall document each training session with detailed sets of minutes.
- (e) The training shall cover Operation and Maintenance.

E56. SUBMERSIBLE SOLIDS HANDLING PUMPS

E56.1 General

E56.1.1 Description

- (a) This section specifies the supply, delivery and installation of submersible solids handling pumps with accessories for pumping.

E56.1.2 Related Work

- (a) Refer to mechanical, electrical and controls sections for supplemental information.

E56.1.3 Submittals

- (a) Submittals shall be in accordance with E11 – Submittals and E12 – Shop Drawings.
- (b) Submit six (6) copies of drawings and data.
- (c) Submittals shall include:
 - (i) Type, manufacturer and general description,
 - (ii) General outline drawings showing clearly all general and essential dimensions,
 - (iii) Descriptions and specifications of various components including:
 - ◆ Pump impeller
 - ◆ Pump casting
 - ◆ Wearing rings
 - ◆ Discharge fittings
 - ◆ Cast-in-place pump base support frames
 - ◆ Accessories
 - (iv) Pump characteristics curves showing efficiency, power requirements, pump capacities of various heads, curve number, impeller diameter, rated speed.
 - (v) Data as follows:

- ◆ Power requirements, voltage, motor power outlet
 - ◆ Maximum solids size
 - ◆ Total mass of pump and motor
 - ◆ Level controls
 - ◆ Pump controls
- (d) Submit operation and maintenance data in accordance with E17 – Contract Close Out.
- (e) Submit certified shop test results including non-witnessed performance test curves for all pumps.
- (f) Submit installation manuals 10 working days prior to start-up and in accordance with E16 – Commissioning.

E56.1.4 Standards

- (a) Products provided under the Specification must comply with all regulations and codes in effect in Manitoba.
- (b) Electrical work shall be in accordance with the Canadian Electrical Code and with applicable standards of the Electrical and Electronic Manufacturers Association of Canada (EEMAC) and the Canadian Standards Association (CSA).
- (c) Hydraulic Efficiency and Pump Impeller tolerances shall conform to the Standards of the Hydraulic Institute.

E56.1.5 Quality Assurance

- (a) The pump manufacturer shall check the pump system and the intended pump conditions for conformance to their recommended installation guidelines.
- (b) If the pump manufacturer has concerns regarding the satisfactory operation of this equipment under the required conditions, the concerns shall be submitted in writing to the Contract Administrator.

E56.1.6 Product Delivery, Storage and Handling

- (a) Deliver products to the Site, and handle and store them to avoid damage to any components.
- (b) Provide dry storage areas and follow the manufacture's recommendations for storage and handling. Rotate moving parts monthly during storage.

E56.2 Products

E56.2.1 Pump Systems

- (a) The pump system includes three (3) submersible solids handling pumps complete with the following accessories.
- (i) Cast iron discharge elbows
 - (ii) Discharge elbow support frames
 - (iii) Lifting guide rails
 - (iv) Guide rail supports
 - (v) Anchor bolts
 - (vi) Pump lifting chains
 - (vii) Chain hangers
 - (viii) Level regulators
 - (ix) Level control supports
 - (x) Pump Power Cables

- (xi) Other accessories as detailed on the design drawings.
- (b) The pump system shall be as manufactured by ITT Flygt Canada or approved alternate.

E56.2.2 Service Conditions

- (a) Submersible solids handling pumps shall meet the following service conditions:

<u>Service Condition</u>	<u>Kenaston Pump Station</u>
No. Pumps Required	3
Individual Pump Design Point (L/s at m)	357 L/s @ 16.4 m
Minimum Pump Efficiency (%)	75
Minimum Solid Size (mm)	100
Maximum acceptable Minimum Submergence level (mm)	840
Maximum Motorspeed (rpm)	880
Minimum Pump Motor Efficiency (%)	90
Acceptable Product or Approved Alternate	Flygt CP 3356/665 (Curve 63-810) c/w 475 mm Impeller

E56.2.3 Pumps

- (a) Pump Construction
 - (i) The pump shall be a submersible water tight, corrosion resistant non-clog, solids handling type with cast-iron vane impeller conforming to ASTM A-278.
 - (ii) Pump volute, motor and seal housing to be high quality cast-iron confirming to ASTM A-278.
 - (iii) All external-mating parts to be machined and sealed with O-rings.
 - (iv) All fasteners or hardware including the motor nameplate exposed to the pumped liquid shall be stainless steel. Pump and motor shaft shall be stainless steel, one piece.
 - (v) Pump shall have two mechanical seals, mounted in tandem with an oil chamber between the seals. The rotating seal surfaces to be carbon and stationary seal faces to be ceramic. The outboard seal next to the impeller shall be provided with tungsten carbide faces. Provide removable inspection plugs.
 - (vi) Replaceable case wearing ring to be bronze with 304 stainless steel fasteners.
 - (vii) All rotating components of the pump shall be statically and dynamically balanced as an assembled unit.
- (b) Pump Accessories
 - (i) The pump base plate assembly and the pump discharge elbow shall support pump guide rail system.
 - (ii) The discharge elbow shall be cast-iron conforming to ASTM A-278.
 - (iii) Pump volute, motor and seal housing to be high quality cast-iron conforming to ASTM A-278.
 - (iv) Anchor bolts – 316 stainless steel.
 - (v) Discharge elbow support frame shall be galvanized steel c/w stainless steel anchor lugs.
 - (vi) Pump lifting /guide rail system shall be designed to allow removal of the pump without disturbing the discharge piping and shall be complete with galvanized lifting chains.

- (vii) Guide rails, guide bar hangers, level regulator hangers, chains hangers, etc. shall be galvanized.
- (viii) The pump discharge flange and the discharge elbow surface shall be machined and/or provided with seals to minimize leakage during pumping cycle.

E56.2.4 Motors

(a) General

- (i) Motors shall be in accordance with EEMAC. Design Letter B, EEMAC Code Letter G and CSA Standards.
- (ii) Motors shall be provided in accordance with motor data listed below, and shall be capable of satisfactory operation at voltage of 10% above or below the rated value without harmful effects.
- (iii) Motor shall be sized to always exceed the kilowatt requirements of the pump at any point on the pump curve by at least 10%.
- (iv) Motors shall be constant speed, with maximum speed as identified in the service conditions.
- (v) Motor winding, rotor and bearings to be in a sealed submersible type housing, with moisture sensing probe. Motors shall be capable of operating with motor only partially submerged.
- (vi) Motors shall be identified by a manufacturer's rating nameplate in permanently inscribed material attached to the unit.
- (vii) Motors shall be designed for continuous duty, submerged or not fully submerged and shall be capable of 10 starts per hour.
- (viii) Motors shall be fully overload protected.

(b) Motor Data:

Rated Power	75 kW
Rated Voltage	600 Volt
Primary Power Supply	3 phase
Insulation	CEMA Class F - 155° C
Power Factor	Overall motor power factor at full load 0.9 or higher
Temperature rise	CEMA – Class B

(c) Motor Construction

- (i) Bearings to be factory prelubricated for low maintenance and bearing life shall not be less than AFBMA B-10 life – 70,000 hours.
- (ii) Provide lifting lugs for full weight of pump and motor.
- (iii) Rotating components shall be statically and dynamically balanced to provide a minimum of vibration under service conditions.

(d) Motor Protection

- (i) Provide six (6) embedded resistance type temperature detectors for winding temperature alarm with two (2) detectors in each phase of the starter windings for use with winding temperature relay in pump control panels. Resistance temperature detectors to be 100 ohm platinum type.

(e) Cables

- (i) Power cable shall be sized to match the pump supplied, and shall be provided with fully waterproof cable and connections.

- (ii) The power cables shall be of sufficient length so that no splicing is required between the lock-off/stop push button on the mechanical level and the pump in the wet well. Allow for slack in the cable.
- (iii) The outer jacket of the cable shall be oil resistant chloroprene rubber.

E56.2.5 Liquid Level Control

- (a) Sealed, float level regulators shall to be used to provide level alarm signals and emergency operation.

E56.2.6 Pump Control

- (a) Refer to specification Sections E84, E85, E86 and E88 for pump requirements.

E56.2.7 Finishes

- (a) The submersible pumps shall be shop primed and shop finished on all exterior surfaces.

E56.2.8 Spare Parts

- (a) Provide 1 set of O-rings and 1 set of mechanical seals for each pump.
- (b) Provide 1 spare pump impeller.

E56.2.9 Shop Testing

- (a) Performance and Certified Test Curves for Pumps
 - (i) Each pump shall be given a certified non-witness performance test under the simulated submerged conditions, to establish head, capacity and efficiency along the pump curve. Test shall be conducted in accordance with Hydraulic Institute Standards. Certified test curves shall be furnished to the Contract Administrator prior to shipping. If the efficiency of the pump supplied is more than 2% below that specified, the Contract Administrator reserves the right to reject the equipment.
 - (ii) Each pump shall be given a certified non-witness operating test at shut-off head for at least 3 minutes without harmful effect on the pump. This test result shall be specifically noted on the non-witness performance test certificate.
- (b) Motor Tests
 - (i) Each motor shall be given the following non-witness tests at the factory and results shall be plotted to show full and part load motor characteristics in accordance with I.E.E.E. Standards.
 - ◆ Winding Resistance
 - ◆ Running High Current
 - ◆ Locked Rotor Current
 - ◆ High Potential
 - ◆ Efficiencies and Power Factors at $\frac{1}{2}$, $\frac{3}{4}$ and Full Loads
 - ◆ Temperature rise with full load test run
 - ◆ Leak detection
- (c) Test Results
 - (i) Submit four (4) certified copies of the test reports for the above prior to shipping. The Contract Administrator and the City reserve the right to reject pumps and equipment shipped prior to receipt of factory tests.

E56.3 Execution

E56.3.1 Installation

- (a) Follow the manufacturer's recommended installation details and procedures supplemented by details on the drawings.
- (b) Install in a neat, workmanlike manner so that connections and disconnections can be easily made with parts accessible for inspections, maintenance and repairs.
- (c) Install at correct elevations, true, square, plumb, and level and provide all shims required.
- (d) Apply protection so that all shims and miscellaneous metals are fully corrosion protected.

E56.3.2 Clean Up

- (a) Clean up and remove all waste prior to start up.

E56.3.3 Factory Finishes

- (a) Touch up of all surfaces as required so that all finishes are in an unmarred factory condition.

E56.3.4 Start Up and On-Site Testing

- (a) Check the final installation and the operation of each component. Check the interconnection of wiring for alarms and controls.
- (b) Coordinate an inspection and supervision of start up by the manufacturer's representative and provide to the Contract Administrator a written certification by the supplier that the equipment is installed and operating in accordance with the manufacturer's standards and that the warranty is in effect until the date of Final Acceptance.
- (c) Field-test all pumps in presence of the Contract Administrator to demonstrate the installation is correctly completed and all pumps are operating satisfactorily without vibration.
- (d) The manufacturer's representative shall undertake draw down tests.
- (e) Field-testing shall be used to confirm each pump curve. Each pump shall be tested a minimum of two (2) times to confirm results.
- (f) Provide written notice to the Contract Administrator of the date when tests will be made at least two (2) weeks in advance of the test.
- (g) The Contractor shall be responsible for supplying water to the pump station to complete all testing.

E56.4 Plumbing Specialties and Accessories

E56.5 General

E56.5.1 Description

- (a) The Contractor shall furnish all labour, materials, tools, equipment and incidentals required to provide, install and place in satisfactory operation the following:
 - (i) Floor drains
 - (ii) Cleanouts
 - (iii) Corporation stops
 - (iv) Backflow Preventer
 - (v) Hose Bibb & Hoses

- (vi) Hose Assembly
- (vii) Turbine Flow Meter
- (viii) Accessories as shown, specified or required

(b) Review installation procedures under other Sections and coordinate work that is related to this Section.

E56.5.2 References

- (a) ANSI/AWWA C700-77, Cold Water Meters – Displacement Type.
- (b) CAN3-B79-M79, Floor Drains.

E56.5.3 Quality Assurance

(a) Qualifications: Execute work of this section only by skilled tradesmen regularly employed in the installation of mechanical systems.

E56.5.4 Submittals

- (a) Submit shop drawings in accordance with E12 – Shop Drawings.
- (b) Indicate dimensions, construction details and materials for the following: floor drains, cleanouts, backflow preventers, backwater valves, hose bibs, traps, etc.
- (c) Submit O & M manuals in accordance with E17– Contract Close Out
- (d) Data to include:
 - (i) Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.

E56.6 Products

E56.6.1 Floor Drains

- (a) Floor drains: to CAN3-B79.
- (b) Type II: heavy duty, cast iron body, heavy duty non-tilting or hinged lacquered cast iron grate, integral seepage pan and clamping collar.
- (c) Floor Drains:
 - (i) Zurn ZN-415B all epoxy coated cast body with reversible clamp device and adjustable 127 mm diameter nickel bronze 6.35 mm thick “Type B” strainer, secured with SS screws and 100 mm throat on strainer, or approved equal.

E56.6.2 Cleanouts

- (a) Line Cleanout
 - (i) Line cleanouts in PVC pipe shall be Emco Line Cleanout SXSX with polyurethane gasketed plug secured to body with full size opening or approved equal.

E56.6.3 Corporation Stops

- (a) Brass ball valve
- (b) Buna-N rubber seal
- (c) 1035 kPa working pressure
- (d) AWWA Standard inlet thread
- (e) Outlet with compression fittings
- (f) Corporation stop to be City of Winnipeg approved product.

E56.6.4 Backflow Preventer

- (a) Bronze main body to ASTM-B61.
- (b) Double check valve assembly c/w two independently operated, spring loaded, centre guided check valves.
- (c) Two resilient seated ball valves for shut-off.
- (d) Four test cocks
- (e) Threaded ends.
- (f) Replaceable seats.
- (g) Minimum working pressure 1035 kPa.
- (h) Entire unit to be serviceable in line.
- (i) Watts model 709 or approved alternative.

E56.6.5 Hose Valve

- (a) Bronze globe
- (b) Threaded inlet
- (c) Hose end to iron pipe standard thread
- (d) 1068 kPa pressure rating
- (e) c/w cap and chain, Jenkins Figure 658 or approved alternative
- (f) Valve to be 19 mm Jenkins Figure 1112-A or approved alternative

E56.6.6 Hose Bibb

- (a) Bronze body globe valve.
- (b) Threaded inlet
- (c) "garden hose" threaded outlet.
- (d) Self-draining style.
- (e) 1055 kPa pressure rating
- (f) Replacement composition disc
- (g) Shall include Watts 8A vacuum breaker
- (h) Jenkins Figure 658 or Crane C504619 diameter hose bibb with hose thread spout.

E56.6.7 Washdown Hose Assembly

- (a) Flexible PVC covered hose
- (b) Light weight
- (c) 1000 kPa pressure rating
- (d) 20 metres long
- (e) 19 mm aluminum female expansion ring coupling at inlet end suitable for hose valve connection
- (f) Hard-coated, 19 mm aluminum ball valve c/w pistol hand grip at outlet end of hose
- (g) Hose to be 19 mm Goodall Limelite Mill Hose or approved alternate
- (h) Valve to be 19 mm Goodall Super Flo Ball Valve or approved alternate

E56.6.8 Turbine Flow Meter

- (a) Provide 25 mm Ø residential water meter.

- (b) Meter to be displaced type.
- (c) Bronze body meeting, AUSI/NSF61.
- (d) Make arrangements with the City, water services, to provide a water meter.

E56.7 Execution

E56.7.1 Installation

- (a) Install in accordance with The Plumbing Code, Manitoba Reg. except where specified.
- (b) Install in accordance with manufacturer's instructions as specified.

E56.7.2 Piping Installation

- (a) Run piping with uniform grade. Trap and vent fixtures as required in accordance to the Manitoba Plumbing Code.
- (b) Install pipe within concrete walls and floors as shown on the drawings.
- (c) Plug or cap pipe fittings to keep out debris during construction.
- (d) Jointing of pipe: compatible with type of pipe used. Use 45° bends for direction changes on all drain lines.
- (e) Test piping and equipment prior to encasement into concrete.
- (f) Install cleanouts where required.

E56.7.3 Cleanouts

- (a) In addition to those required by code, and as indicated, install at base of all soil and waste stacks, and rainwater leaders and where indicated.
- (b) Bring cleanouts to wall or furnished floor unless serviceable from below floor.
- (c) Building drain cleanout and stack base cleanouts: line size to maximum NPS 4.

E56.7.4 Commissioning

- (a) After start-up, test, adjust and prove operation as indicated, to suit site conditions such as:
 - (i) Clean out and prime all floor drain traps using trap seal primers or other means acceptable to the Canadian Plumbing Code.
 - (ii) Prove freedom of movement of cleanouts.

DIVISION 14 - SPECIALTIES

E57. FIRE STOPPING

E57.1 Related Work

- (a) Fire stopping and smoke seals within mechanical assemblies (i.e. inside ducts, dampers) and electrical assemblies (i.e. inside cable trays) are specified in herein.

E57.2 References

- (a) Underwriter's Laboratories of Canada (ULC)
 - (i) ULC-S115, Fire Tests of Firestop Systems.

E57.3 Submittals

- (a) Submit shop drawings, product data, samples in accordance with E-11 – Submittals.

- (b) Submit manufacturer's product data for materials and prefabricated devices, providing descriptions are sufficient for identification at Site. Include manufacturer's printed instructions for installation.
- (c) Submit shop drawings to show proposed material, reinforcement, anchorage, fastenings and method of installation. Construction details should accurately reflect actual job conditions.
- (d) Submit duplicate 300 x 300 mm samples showing actual fire stop material proposed for project.

E57.4 Products

E57.4.1 Materials

- (a) Fire stopping and smoke seal systems: in accordance with ULC S115.
 - (i) Asbestos-free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of ULC-S115 and not to exceed opening sizes for which they are intended and conforming to special requirements specified.
 - (ii) Firestop system rating: meeting requirements in ULC-S115.
- (b) Service penetration assemblies: certified by ULC in accordance with ULC S115 and listed in ULC Guide No. 40 U19.
- (c) Service penetration fire stop components: certified by ULC in accordance with ULC-S115 and listed in ULC Guide No. 40 U19.13 and ULC Guide No. 40 U19.15 under the Label Service of ULC.
- (d) Fire-resistance rating of installed fire stopping assembly in accordance with NBC.
- (e) Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal.
- (f) Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal.
- (g) Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- (h) Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- (i) Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
- (j) Sealants for vertical joints: non-sagging.
 - (i) Identification plate: warning plate or self-adhesive sticker, containing the following information:
 - (ii) The words "Fire Rated Assembly" or similar warning that the opening has been firestopped.
 - (iii) Fire stop system used (ULC or cUL).
 - (iv) Fire stop system rating.
 - (v) Product(s) used.
 - (vi) Name and phone number of initial installer.
 - (vii) Date of initial installation.
 - (viii) Date, name and phone number of person or company responsible for repenetration of assembly (allow several lines).

E57.5 Execution

E57.5.1 Preparation

- (a) Examine sizes and conditions of voids to be filled to establish correct thickness and installation of materials. Ensure that substrates and surfaces are clean, dry and frost free.
- (b) Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.
- (c) Maintain insulation around pipes and ducts penetrating fire separation without interruption to vapour barrier.
- (d) Mask where necessary to avoid spillage and over coating onto adjoining surfaces. Remove stains on adjacent surfaces.

E57.5.2 Installation

- (a) Install fire stopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions.
- (b) Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
- (c) Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
- (d) Tool or trowel exposed surfaces to a neat finish.
- (e) Remove excess compound promptly as work progresses and upon completion.
- (f) Install identification plate or sticker adjacent to each fire stop system assembly. Complete all information using non-erasable ink.

E57.5.3 Schedule

- (a) Fire stop and smoke seal at:
 - (i) Penetrations through fire-resistance rated masonry, concrete, and gypsum board partitions and walls.
 - (ii) Top of fire-resistance rated masonry and gypsum board partitions.
 - (iii) Intersection of fire-resistance rated masonry and gypsum board partitions.
 - (iv) Control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.
 - (v) Penetrations through fire-resistance rated floor slabs, ceilings and roofs.
 - (vi) Openings and sleeves installed for future use through fire separations.
 - (vii) Around mechanical and electrical assemblies penetrating fire separations.
 - (viii) Rigid ducts: greater than 129 cm² (20 in²): fire stopping to consist of bead of fire stopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.
- (b) Prior to Substantial Performance of the Work inspect fire stopping work, prepare a deficiency list and submit to Contract Administrator. Repair deficiencies and request Contract Administrator's review of the Work.
- (c) Notify Contract Administrator when ready for review and prior to concealing or enclosing fire stopping materials and service penetration assemblies.
- (d) Exploratory investigations:
 - (i) The Contract Administrator's may request random exploratory investigations of designated fire stopping installation during course of the Work.

- (ii) Allow for 1 exploratory review.
 - (iii) Cut or open up designated assemblies to allow Contract Administrator's review.
 - (iv) Once the investigation is complete and is acceptable to Contract Administrator, replace the fire stop system with new materials that meet specification requirements.
 - (v) If an installation is deemed unacceptable to the Contract Administrator, the Contract Administrator may request additional investigations on similar installations.
 - (vi) If additional investigations are found deficient Contract Administrator will determine the degree of remedial measures allowed by Contractor to correct similar installations. Remedial work may include complete removal and replacement of fire stopping at similar installations.
- (e) Include costs for initial exploratory investigations in Contract, including cutting, removal and replacement of materials.
 - (f) Additional investigations and remedial work, if required, are to be borne by the Contractor at no additional cost to the Contract.

E57.5.4 Clean Up

- (a) Remove excess materials and debris and clean adjacent surfaces immediately after application.
- (b) Remove temporary dams after initial set of fire stopping and smoke seal materials.

E58. PORTABLE FIRE EXTINGUISHERS (AND BLANKETS)

E58.1 References

- (a) NFPA 10 - Portable Fire Extinguishers.
- (b) CAN/ULC-S508 - Rating and Fire Testing of Fire Extinguishers and Class "D " Extinguishing Media.

E58.2 Shop Drawings and Product Data

- (a) Submit shop drawings and product data in accordance with E11 – Submittals.

E58.3 Closeout Submittals

- (a) Provide maintenance data for incorporation into manual specified in E11 – Submittals.

E58.4 Products

- (a) Multi-Purpose Dry Chemical Extinguishers
- (b) Stored pressure rechargeable type with hose and shut-off nozzle, ULC labeled for A, B and C class protection. Size 4.5.

E58.5 Extinguisher Brackets

- (a) Type recommended by extinguisher manufacturer.

E58.6 Identification

- (a) Identify extinguishers in accordance with recommendations of ANSI/NFPA 10 or CAN/ULC-S508.
- (b) Attach bilingual tag or label to extinguishers, indicating month and year of installation. Provide space for service dates.

E58.7 Execution

E58.7.1 Installation

- (a) Install or mount extinguishers in cabinets or on brackets as indicated on the drawings.

DIVISION 15 – BUILDING MECHANICAL

E59. MECHANICAL –GENERAL PROVISIONS

E59.1.1 General Requirements

- (a) This section applies to and is part of all sections of related to building mechanical.
- (b) Provide fully tested and operational mechanical systems in complete accordance with applicable codes and ordinances.
- (c) Connect to equipment specified in other sections and to equipment supplied and installed by other Contractors or by the City.
- (d) The Subcontractor shall be wholly responsible to the “Contractor” for all work of this Division.

E59.1.2 Definitions

- (a) Wherever the terms install or supply are used in the drawings and specifications, it means install and connect complete and operational.
- (b) Wherever the terms "Provide" or "Provision of" are used in relationship to equipment, piping and other materials specified for the Work, it means, "Supply, Install and Connect". Wherever the terms “Provide” or “Provision of” are used in connection with services such as testing, balancing, start-up, preparation of drawings and commissioning for any part of the Work, it means procure, prepare, supervise, take responsibility for and pay for these services.
- (c) Wherever the terms "authorities" or "authorities having jurisdiction" are used in the building mechanical drawings and specifications it means any and all agencies that enforce the applicable laws, ordinances, rules, regulations or codes for the place of work.
- (d) Wherever the term "Performance" is used in the building mechanical drawings and specifications In relation to specified equipment, it means the specified capacity of that equipment as it applies to this project within the specified conditions of operation.
- (e) Wherever the term “Acceptable” is used in the drawings and specifications it means acceptable to the Contract Administrator.

E59.1.3 Materials

- (a) All materials and equipment installed under this contract shall be new unless otherwise noted.

E59.1.4 Work Included

- (a) Sections of these specifications are not intended to delegate functions nor to delegate work and supply to any specific trade, and the work shall include all labour, materials, equipment, and tools required for a complete and working installation.

E59.1.5 Permits, Fees and Inspection

- (a) Apply for, obtain, and pay for all permits, licences, inspections, examinations and fees required for the Work. Also submit, if required by the authorities, information such as heat loss calculations, and other data that may be obtained from the Contract Administrator. Should the authorities require the information on specific forms, fill in

these forms by transcribing thereto the information as provided by the Contract Administrator.

- (b) Arrange for inspection of all work by the authorities having jurisdiction over the Work. On completion of the Work, present to the Contract Administrator the final unconditional certificate of acceptance of the inspecting authorities.
- (c) In case of conflict, codes and regulations take precedence over the Contract. In no instance reduce the standard or scope of work or intent established by the drawings and Specifications by applying only minimum code standards.
- (d) Before commencing work, submit the required number of copies of drawings and Specifications to the authorities for their approval and comments. Comply with any changes requested as part of the contract, but notify the Contract Administrator immediately of such changes. Prepare and submit any additional drawings, details or information as may be required.
- (e) Comply with the requirements of the latest edition of the applicable C.S.A. standards, the requirements of the authorities, Federal, Provincial and Municipal Codes, the applicable standards of the Underwriters' Association and all other authorities having jurisdiction. These codes and regulations constitute an integral part of these specifications.

E59.1.6

Contract

- (a) The drawings for building mechanical work are performance drawings, diagrammatic, intended to convey the scope of work and indicate general arrangement and approximate location of apparatus, fixtures and pipe runs. The drawings do not intend to show architectural and structural details.
- (b) Do not scale drawings. Obtain information involving accurate dimensions from architectural and structural drawings, and by Site measurement. Visit and inspect the Site to verify location and elevation of existing services, which may affect the work of this Division (water, electrical, sanitary, ductwork etc.) before Bid Submission.
- (c) Make, at no additional cost, any changes or additions to materials, and/or equipment necessary to accommodate structural conditions (pipes or ducts around beams, columns etc.)
- (d) Install ceiling mounted or exposed components (e.g. diffusers, sprinkler heads, grilles) in accordance with reflected ceiling drawings or floor plans.
- (e) Drawings and specifications are complementary each to the other, what is called for by one shall be binding as if called for by both.
- (f) Examine all contract documents, including all drawings and specifications and work of other trades to ensure that work is co-ordinated and satisfactorily carried out without changes to the building or contract value.
- (g) Fire dampers must be provided in new ductwork at all fire separations whether indicated on the mechanical drawings or not. For clarification refer to the architectural drawings.
- (h) Where interconnecting piping or ductwork is not indicated or not indicated with a size, the Contractor shall provide the pipe and or ducts sized in accordance with industry standards.
- (i) The Contractor shall review the architectural and mechanical drawings for plumbing fixtures and shall provide a complete working system as per both sets of documents.
- (j) If there is any doubt on the part of the Contractor, clarification shall be obtained as indicated above. Failure of the Contractor to obtain a clarification does not absolve the Contractor of the responsibility to provide a working, fully functional system, nor the

responsibility to provide all equipment and fixtures indicated in the contract documents.

E59.1.7 Examination of the Project Site and Documentation

- (a) Prior to undertaking work, verify that materials and equipment can be delivered to the Place of the Work and that sufficient space and access is available to permit installation thereof in locations shown on the drawings.
- (b) Where specific codes are noted in the specifications the latest edition shall apply.

E59.1.8 Coordination Drawings

- (a) Prepare drawings in conjunction with all trades concerned, showing sleeves and openings for passage through structure, and all inserts, equipment bases, sumps, pits and supports, and relate these to suitable grid lines and elevation datum.
- (b) Prepare interference and co-ordination drawings for all areas where the work of this division could conflict with and/or obstruct the work of other trades and/or other sections of this division. Submit drawings for acceptance by the Contract Administrator.

E59.1.9 Contract Administrator's Site Review

- (a) The City, Contract Administrator, or their representatives, solely for purpose of determining general quality of work, will review the Contractor's work periodically. Guidance will be offered to Contractor in interpretation of plans and specifications to assist him to carry out work. Inspection and directives given to Contractor does not relieve Contractor and his agents, servants and employees of their responsibility to provide work in all its parts in a safe and workmanlike manner, and in accordance with plans and specifications, nor impose upon the City, and/or Contract Administrator or their representatives, any responsibility to supervise or oversee erection or installation of any work.
- (b) Co-operate with the City and Contract Administrator; provide access to all areas of building and equipment as requested.
- (c) The Contract Administrator may request disassembly of components for review of installation practices assist as directed, at no additional cost to the contract.
- (d) Remove components or devices as directed for off-site testing when requested to do so by the Contract Administrator at no additional cost to the contract.

E59.1.10 Shop Drawings

- (a) Submit shop drawings for items and equipment related to building mechanical systems including heating, ventilation, and gas piping. For equipment, provide performance, physical and operating data as described in the Specifications and listed in equipment schedules. Provide performance data and curves. Include sound power data for any equipment.
- (b) Shop drawings shall be submitted in accordance with E12 – Shop Drawings.
- (c) All equipment shop drawings shall be referenced by specification section and sub-section numbers, system name and number. (eg. S-1, second floor, air supply)
- (d) Clearly mark submittal to indicate all differences from the specified material. The Contract Administrator will require all options and material indicated on the shop drawing to be provided and installed. Specifically note on the submittal specified features and options provided.
- (e) Installed materials and equipment shall meet specified requirements regardless of whether or not the shop drawings were reviewed by the Contract Administrator

- (f) Where equipment is specified with control panels or electrical control components, provide wiring diagrams and component descriptions that are specific to the item.
- (g) Do not order equipment until the Contract Administrator has reviewed and returned the shop drawings.

E59.1.11 Record Drawings

- (a) Obtain one set of white bond prints and electronic disc copy, as the job progresses mark these prints to accurately indicate installed work. Have the white bond prints available for inspection at the Site at all times, and present for scrutiny at each job meeting. Submit this set of record drawings to the Contract Administrator on completion of the Work.
- (b) Take special care to indicate underground piping equipment, routing and locations from fixed points of structure. Record inverts from fixed points of the structure. In addition to all mechanical changes indicate architectural changes made to the building.
- (c) Reviewed drawings will be returned to the Contractor with comments so that Contractor can incorporate changes in AutoCAD 2000 format. Final cadd drawings shall be submitted to the Contract Administrator with one complete CD ROM and three (3) sets of vellum prints.
- (d) Each print, vellum and/or electronic drawing shall bear the following statements in 2mm high text:
- (e) The original drawings were stamped and sealed by (insert Contract Administrator's name)
- (f) (Contractors Name) certify that these drawings are an accurate record of the construction.
- (g) A minimum of \$500.00 per drawing holdback shall be retained until all drawings are submitted to the Contract Administrator for review verified and modified by the Contractor as necessary.
- (h) For all drawings produced by CAD, pay for all services required such as recreating, plotting and printing to produce "As-constructed" drawings.

E59.1.12 Rights Reserved

- (a) Rights are reserved to furnish any additional detail drawings, which, in the judgement of the Contract Administrator, may be necessary to clarify the Work, and such drawings shall form a part of this contract.

E59.1.13 Standard of Material

- (a) Provide new material and equipment, delivered, erected, connected and complete in every detail. Assume responsibility for ensuring that equipment provided performs as specified.
- (b) Where a manufacturer's name is mentioned, it is for the purpose of setting a standard of quality, performance, capacity, appearance and serviceability. Acceptable equals will be shown, where deemed necessary by the Contract Administrator, and can be used in the preparation of the Bid Submission. Where no equals are indicated, provide the exact make specified.
- (c) The Contractor shall assume full responsibility for ensuring that, accepted alternatives meet all space, weight, connections, power and wiring requirements. Alternative equipment requiring greater than specified energy requirements or unduly limiting service space requirements shall not be used.

E59.1.14 Temporary Services

- (a) Refer to Division 1 regarding temporary services, Contractor's shop, storage and other such facilities.
- (b) Do not use any of the permanent mechanical systems during construction except as may be specified in Division 1, or unless specific written approval is obtained from the Contract Administrator.
- (c) The use of permanent facilities for temporary construction service will not affect, in any way, the commencement date of the warranty period.

E59.1.15 Patents

- (a) Pay all royalties and license fees, and defend all suits or claims for infringement of any patent rights, and save the City and Contract Administrator harmless of loss or annoyance on account of suit, or claims of any kind for violation or infringement of any letters patent or patent rights, by this Subcontractor or anyone directly or indirectly employed by him or by reason of the use by him or them of any part, machine, manufacture or composition of matter on the work, in violation or infringement or such letters patent or rights.

E59.1.16 Substantial Completion

- (a) All heating and air conditioning systems shall be operational with alarms, interlocks and control functions.
- (b) Obtain all certificates of approval from the authorities having jurisdiction.
- (c) All manufacturer start-ups shall be complete.
- (d) Balance all systems and certify all fire dampers.
- (e) Lubricate all equipment as per manufacturers instructions.
- (f) Mail all warranty forms to manufacturer; provide copy of original warranty of equipment with a warranty period of longer than 1 year.
- (g) Submit O & M Manuals and operator training schedule.
- (h) Provide all manufacturers reports required by specifications.
- (i) Complete all previously identified deficiencies.
- (j) Clean all equipment, surfaces and the like, remove temporary filters and install permanent ones.
- (k) Clean equipment both inside and out. Clean plumbing fixtures and brass.
- (l) Provide as constructed record drawings.
- (m) All life safety systems and interlocks shall be complete in all respects.

E59.1.17 Identification of Equipment by Manufacturer

- (a) Provide apparatus (including electric motors) with proper nameplates affixed thereto, showing the size, name of equipment, serial number and all information usually provided, which also includes voltage, cycle, phase and horsepower of motors and the name of the manufacturer and his address.

E59.1.18 Expediting and Deliveries

- (a) Continuously check and expedite delivery of equipment and materials. If necessary, inspect at the source of manufacture.
- (b) Ensure that materials and equipment are delivered to the Site at the proper time and in such assemblies and sizes so as to enter into the building and to be moved into the spaces where they are to be located without difficulty.

- (c) Immediately inform the Contract Administrator of any difficulties in delivery of equipment.

E59.1.19 Superintendence

- (a) Maintain at the Site qualified personnel consisting of licensed tradesmen and registered apprentices with proven experience in erecting, supervising, testing and adjusting projects of comparable nature and complexity.
- (b) Supervision personnel and their qualifications are subject to the approval of the Contract Administrator.
- (c) Present trade certification and documentation of such immediately when requested to do so.

E59.1.20 Trial Usage and Tests

- (a) The City has the privilege of trial usage of mechanical systems or parts thereof for the purpose of testing and learning operational procedures.
- (b) Assist in trial usage over a length of time, as deemed reasonable by the Contract Administrator, at no extra cost and do not waive any responsibility because of trial usage.
- (c) Trial usage shall not be construed as acceptance by the City or as Substantial Completion of the Work.
- (d) Provide and pay for all testing required on the system components where, in the opinion of the Contract Administrator, manufacturer's ratings or specified performance is not being achieved.

E59.1.21 Special Cleaning

- (a) Vacuum clean and remove debris from the inside of all air handling systems.
- (b) Clean exposed surfaces of mechanical equipment, ductwork, piping, etc., and polish plated work.

E59.1.22 Completion

- (a) Leave mechanical work in specified working order.

E59.1.23 Warranties

- (a) Comply with requirements of Division 1. Provide warranties on specified products, equipment and components as well as on the installation of these items. Include for all costs for cutting and patching, removals and restoration materials and work and repairs to other equipment affected in performance of warranty work.
- (b) Provide warranty certificates, wherever given or required, that are in excess of the normal warranty period showing the names of the firm giving the warranty, dated and acknowledged, on specific equipment and systems.

E59.1.24 Instructions to City of Winnipeg

- (a) Instruct the City's representatives on all aspects of the operation of systems and equipment. Schedule all instruction sessions to enable the Contract Administrator to be present.
- (b) Arrange and pay for services of manufacturers' representatives required for instruction on specialized portions of the installation.
- (c) Demonstrate the specific starting, stopping, controlling and general maintenance requirements for each major piece of equipment and system.
- (d) Answer all questions raised by the City at demonstrations. Provide a written response to any question within 3 days when requested to do so.

- (e) Provide 14 days written notice of operator training to the City and the Contract Administrator. The Contractor shall take attendance at the training and include a typewritten list of attendees under Tab 6 in the O & M manuals.
- (f) Submit to the Contract Administrator at the time of final inspection a complete list of systems stating for each system:
 - (i) Date instructions were given to the City's staff.
 - (ii) Duration of instruction.
 - (iii) Name of persons instructed.
 - (iv) Other parties present (manufacturer's representative, Contract Administrators, etc.).
 - (v) O & M Manuals have been reviewed with the City.
 - (vi) Specified spare parts and the City has accepted components.
- (g) Signatures of the City's staff stating that they properly understood the system installation, operation and maintenance requirements.

E59.1.25 Safety Device Testing

- (a) Make complete inspection of all safety devices.
- (b) On completion of the inspections, provide letters and/or certificates, confirming that inspections have been completed; insert in each O & M Manual.

E59.1.26 Operating and Maintenance Manuals

- (a) Comply with requirements of Division 1.
- (b) Provide O & M Manuals to the Contract Administrator for review (thirty) 30 days prior to final inspection.
- (c) Provide 3 manuals in separate 3 ring binders, with the project name clearly indicated on the spine.
- (d) Organize the manuals as follows:
- (e) Cover page indicating project name, City, Contract Administrator, Contractors complete with contact names and addresses.
- (f) TAB 1- List of subcontractors complete with contact names, addresses and phone numbers.
- (g) TAB 2- List of all equipment suppliers, complete with addresses and phone numbers.
- (h) TAB 3- List of mechanical drawings.
- (i) TAB 4- Systems description, sequence of operations, recommended setpoints etc..
- (j) TAB 5- Operating division; provide complete and detailed operation of major components and systems. Indicate how components interface with each other. Operation of controls including operation sequence and operational changes for seasonal usage.
- (k) TAB 6- Maintenance and Lubrication; provide schedule and instructions for maintenance and lubrication of all pieces of equipment.
- (l) TAB 7- Certificates, provide all test and inspection certificates as well as warranty information.
- (m) TAB 8- Shop Drawings; provide one copy of each reviewed shop drawing.

E59.1.27 Municipal and Utility Services

- (a) Co-ordinate, arrange, and pay for all municipal and utility relocation, termination and connections as required and shown on the drawings, complete with all required

metering. Install all metering equipment in accordance with municipal or utility requirements.

E59.1.28 Cutting and Patching

- (a) The cutting of openings not requiring lintels or other structural support will be the responsibility of the trade requiring the opening, the opening size will be the minimum required, and that patching will be the responsibility of the trades normally engaged in working with the finishing materials required to restore the opening to the original or specified conditions.
- (b) Where openings require lintels or other structural support, or roofing work, such openings shall be co-ordinated by the Contractor between trades.

E59.1.29 Commissioning

- (a) Systems commissioning will be conducted prior to turnover to the City. The purpose of the Commissioning is to ensure all systems are functioning as designed prior to building turnover to the City.
- (b) Commissioning will require the presence of knowledgeable representatives of the equipment and systems installed. The Contractor shall include all necessary costs for systems commissioning. The Contract Administrator will participate to the extent deemed necessary.
- (c) All aspects of mechanical systems operations will be operated, checked and verified. If any portion of the Work fails to meet design requirements, the Commissioning procedure will be halted and only resumed when all necessary repairs are completed. All extra costs including costs for the Contract Administrator to revisit the Site resulting from this postponement will be borne by this Contractor.

E59.1.30 Mechanical List of Sub-Trades & Prices

- (a) Submit to the Contract Administrator within 48 hours of award the List of Manufacturers, Subtrades and their prices.
- (b) Substitution of listed manufacturers or Subtrades after close of Bid Opportunity will not be accepted.
- (c) No progress billing will be reviewed unless this document has been received.

E59.1.31 List of Sub-Trades & Prices

<u>ITEM</u>	<u>Contractor</u>	<u>COST</u>
Insulation:		
Heating:		
Air Distribution:		
Controls:		
Air & Water Balancing		

E60. AIR BALANCING

E60.1 Description

- (a) Balance, adjust and test air systems and equipment.
- (b) Balance all fans, ducts, grilles, outlets, and diffusers.
- (c) Test all fire dampers, fire/smoke dampers, and fire stop flaps.
- (d) Fire/Smoke Dampers
- (e) Fire Stop Flaps
- (f) Provide reports as described in this section.

E60.2 Products

- (a) Provide and install all additional belts, pulleys and sheaves required to complete the balancing.
- (b) Provide one copy of the final report to the Contract Administrator prior to Substantial Performance inspection.
- (c) Attend the Substantial Performance inspection, with equipment, to verify findings randomly selected by the Contract Administrator.
- (d) Provide copies of the balancing reports and fire barrier device certification, for inclusion in the Operations and Maintenance Manuals.
- (e) Provide the Contract Administrator with a sealed letter with a report certifying the proper operation of every fire damper
- (f) Ensure damper operation has been verified prior to Substantial Performance inspection. Have the Contractor repair all dampers that do not operate freely and retest until units operate without binding.

E60.3 Balance Reports

- (a) As a minimum, the following information shall be provided in the balancing reports:
- (b) Cover page containing the name of the project and the air balancing agencies name, address, phone number and seal. Enclose the page in a protective plastic cover.
- (c) Measuring instrument makes models and calibration histories including dates.

E60.3.1 Air Moving Equipment

- (a) Installed make and model
- (b) Location of equipment
- (c) Drive Type
- (d) Design and installed motor sizes (H.P.)
- (e) Motor nameplate and operating amperages
- (f) Design and actual static pressures
- (g) Design and actual fan speeds (RPM)
- (h) Design and actual air volumes.

E60.3.2 Ductwork and Air Outlets

- (a) Design and actual air volumes in ducts containing more than 20% of the fan air volume.
- (b) Design and actual air volumes at each air inlet and outlet.
- (c) A schematic layout of the distribution and collection systems

E60.4 Execution

E60.4.1 Testing of Fire Dampers

- (a) General
 - (i) This section of work to be performed by an independent testing firm experienced with this type of installation.
 - (ii) Written test report to be provided with the following information.
 - ◆ Verify the unit is fully accessible
 - ◆ Unit has been successfully tested
 - ◆ Unit has been re-set.

- ◆ Name of tester, date unit was tested.
 - ◆ Location schedule of all devices, each device must be labeled by the testing firm.
 - ◆ Provide one (1) copy of initial report to Contract Administrator, once copy has been reviewed make available sufficient copies for insertion into O & M manuals.
- (iii) Test and verify operation of all dampers and ceiling fire flaps in this project.
 - (iv) Test shall include manually releasing fusible link; allowing damper or flap to close to ensure that it has tight-fit closing operation without binding.
 - (v) Repair all dampers that have been identified as being faulty.
- (b) Identification
- (i) At all dampers and ceiling fire flaps, supply and install tags as approved by the Contract Administrator.
 - (ii) Tags shall be mechanically fastened to duct damper access door, or onto of on structure near dampers or ceiling fire flaps which have no connecting ductwork.
 - (iii) After each damper has been tested and has been proven to operate satisfactorily as noted in previous clause, label unit number and mark date and signature on tag. Tag shall have space for minimum size further dates and signatures for future checking of damper operation by the City's staff.

E60.4.2 Testing of Fire Dampers

- (a) Provide all testing. Tagging and test report for all dampers and flaps. Follow instruction noted in previous clause.
- (b) Ensure damper closes/opens against associated fan operating static pressure.
- (c) Testing Accuracy
 - (i) Minimum balancing accuracy's
 - (ii) Air Handling Equipment plus or minus 5%
 - (iii) Air Outlets plus or minus 10%
 - (iv) Branch Ductwork plus or minus 10%
- (d) Building Pressure
 - (i) Balance to achieve a positive pressure in the building of between 10 and 20 Pa. when there is a negligible wind. Provide negative pressure in wet well of 10-20 Pa relative to the rest of the building.
- (e) Damper Marking
 - (i) Position and clearly mark all balancing dampers.

E61. BASIC MATERIAL & METHODS

E61.1 Description

- (a) Comply with requirements of all documents referred to therein.

E61.2 Submittals

- (a) Submit shop drawings on vibration isolators and motor starters.

E61.3 Quality Assurance

- (a) Welding materials, fabrication standards and labour qualifications to Provincial Labour Board Regulations. All welders must be licensed by the provincial authorities.

- (b) Natural Gas Systems: CAN1-B149.1 (latest edition), installation code for Natural Gas Burning Appliances and Equipment.

E61.4 Pipe and Fittings

- (a) Stand-by generator exhaust:
 - (i) Schedule 40 ASTM specification A53 (Sch. 80 for condensate) wrought steel black pipe with standard black steel welding fittings for pipe sizes 65mm (2 ½") and over.
- (b) Natural gas and Propane piping: Provide as required by the authorities having jurisdiction as follows:
 - (i) ASTM A53 Schedule 40 seamless wrought steel with standard threaded malleable fittings to ANSI standard B16.3; welded in concealed areas and X-rayed if required by authorities having jurisdiction.
 - (ii) ASTM A53 Schedule 40 wrought steel seamless with standard wrought steel butt welding fittings to ANSI B16.9. Welding procedures to comply with standards as required by the authorities having jurisdiction.

E61.5 Valves

E61.5.1 Gas valves:

- (a) Gas Service Plug Cocks: Class 125, cast iron body and plug with parallel valve, CGA approved.
- (b) 12 to 50 mm (1/2" to 2"): Newman Hattersley 70M.

E61.6 Hangars and Supports

E61.6.1 Supports welded directly to pipes and equipment are not acceptable.

E61.6.2 Hangers:

- (a) Provide adjustable Clevis type equal to Grinnell Fig. 65 for pipe sizes up to and including 65mm (2½").

E61.7 Inserts

- (a) Use only factory made, threaded or toggle type inserts or expansion shields as required for supports, and anchors, properly sized for the load to be carried.

E61.8 Sleeves

- (a) Provide and install sleeves at mechanical penetrations of all separations. Size to allow for insulation to pass through sleeve.
 - (i) Piping: Machine cut Schedule 40 steel pipe, medium cast iron or 18 gauge galvanized steel; refer to detail drawings.
 - (ii) Ductwork: At fire dampers refer to detail drawings: Other locations - formed to accommodate duct size or access opening as required.

E61.9 Wiring

- (a) Electrically operated equipment: to CSA Standard and bear certification label.
- (b) Provide motor control wiring (at any required voltage) between starter panels and control components to all requirements specified.
- (c) Provide wiring of items supplied by equipment manufacturers such as flow switches, remote and local thermostats for unitary heating equipment and control wiring between starters and control panels. Also provide wiring for communications interface panels, sensors.

E61.10 Electric Motors

- (a) Confirm and co-ordinate all motors with electrical portions of these documents. Refer to drawings and equipment schedules for exact details. Motors to meet NEMA standards for maximum sound level ratings under full load. All motors shall be TEFC. Exhaust fans shall be AMCA rated.
- (b) Motor bearings: to be permanently lubricated ball type for motors up to and including 3725 W (5 hp). Bearings for all motors over 3725 W to be self aligning greaseable ball bearings sized to provide life of at least 50,000 hours under belt driven service.
- (c) Single Phase Motors: Provide permanent split capacitor type. Motors 14.9 kW (20 hp) and greater: Provide thermistor over temperature protection for each winding, wire in series, with leads terminated in the motor junction box.
- (d) Acceptable electric motor manufacturers: Westinghouse, CGE, Reliance, Brook-Crompton, Marathon, US Motors, WEG and Siemens.
- (e) For motors used with variable speed drives, provide Class H motor winding insulation and be inverter duty type manufactured to NEMA Standard MG-1 part 31 "Definite purpose inverter-fed motors". Ensure that drive manufacturer reviews motor shop drawings prior to releasing order.

E61.11 Fire Stopping

- (a) Fire stop all pipe and duct penetrations through all rated separations.
- (b) Fire stopping materials to meet ULC CAN 2S115.

E61.12 Installation

- (a) Install equipment, ductwork, conduit and piping in a workmanlike manner to present a neat appearance and to function properly to the acceptance of the Contract Administrator. Install ducts and pipes parallel and perpendicular to building planes. Install piping and ductwork concealed in chases, behind furring or above ceiling. Comply with manufacturer's installation instructions.
- (b) Install all equipment and apparatus with adequate space allowance and with regard to wiring, maintenance, adjustment or eventual replacement with due allowances therefore.
- (c) Install control devices to guarantee proper sensing. Shield elements from direct radiation and avoid placing them behind obstructions.
- (d) Include in the Work all requirements of manufacturers shown on the shop drawings.
- (e) Replace all work unsatisfactory to the Contract Administrator without extra cost.
- (f) Leave space clear and install all work to accommodate future materials and/or equipment as indicated and to accommodate equipment and/or materials supplied by other trades. Verify spaces in which work is to be installed. Install pipe runs etc., to maintain maximum headroom and clearances and to conserve space in shaft and ceiling spaces.
- (g) Miscellaneous metals provided by the Contractor shall be primed and ready for painting prior to installation.

E61.13 Piping System Installation

- (a) Keep all openings in pipe or fittings plugged or capped during installation.
- (b) Install piping to avoid any interference with the installation or removal of equipment, other piping, ducts, equipment and access doors.
- (c) During welding or soldering procedures, provide a fire retardant cloth, mat or blanket to protect the structure, and adequate fire protection equipment at all locations where work is being done. Close off shaft or confined areas with a fire retardant mat or cloth to prevent sparks or pieces of hot metal from falling down the shaft or areaway.

- (d) Where it is necessary to offset piping to avoid obstructions, use 45 degree rather than 90 degree elbows.
- (e) Provide sufficient space between piping to install valves arranged in straight rows or equally spaced steps. Valve wheels, handles and operators to be easily accessible and operable.
- (f) Do not install horizontal piping within masonry walls. Any piping installed in this manner will not be accepted.
- (g) Use only non-ferrous metals in high humidity areas.
- (h) Do not suspend any equipment, piping, ducting or any other mechanical components from formed hollow steel decking.

E61.14 Welding

- (a) Only persons who have passed welding tests to the satisfaction of the authorities having jurisdiction and who are certified by them to be qualified welders, shall be permitted to do any welding on this contract.

E61.15 Hangars

- (a) Hanger rods may be attached to beam or joist clamps, brackets, or concrete inserts. Explosive actuated tools are not permitted. Do not weld to structural steel.
- (b) The following table will determine support points for all piping on this installation.

STEEL PIPE	
Nominal Pipe Size	Distance Between Supports
Up to & including 1¼"	1,800 mm (6 ft.)
1½" - 2½"	2,700 mm (9 ft.)
3" and over	3,600 mm (12 ft.)

E61.16 Protection

- (a) Cover openings in equipment and cover equipment where damage may occur from weather. Cover temporary openings in ducts and pipes with polyethylene sheets, until final connection is made.
- (b) Cover and seal, with polyethylene sheeting, all equipment, coils and motors in place during construction to prevent entry of dust, paint and debris.

E61.17 Rigging of Equipment

- (a) Provide all rigging, hoisting and handling of equipment as necessary in order to place the equipment in designated area in the building.
- (b) Direct this work by qualified people normally engaged in rigging, hoisting and handling of equipment.

E61.18 Concrete

- (a) Except as specifically indicated on the drawings as provided by other Sections, provide all concrete work required for mechanical work (bases, curbs, anchors, thrust blocks, manholes, catch basins) in accordance with requirements of Division 1. Provide housekeeping pads (equipment bases) at least 100 mm (4") high under all floor mounted equipment. Provide 150 mm (6") high bases under equipment with cooling coils to provide sufficient clearance for deep seal condensate traps.
- (b) Provide all inserts, sump frames, anchors etc., required to be built into forming for mechanical services.

E61.19 Metals

- (a) Steel construction required solely for the work of mechanical trades and not shown on architectural or structural drawings: Provided by this Sub-contractor to the acceptance of the Contract Administrator.
- (b) These metals shall be primed and ready for finish painting prior to installation.

E61.20 Cutting and Patching

- (a) Give timely notice concerning required openings.
- (b) Provide all cutting and patching for mechanical services penetrating walls, floors and roofs as shown on the drawings. Cut only to suit dimensions required and for minimum clearances.
- (c) Seal around services passing through cut openings with materials commensurate with the fire rating of the wall, floor or roof. Ensure sealing is weatherproof for openings through exterior walls and roofs. Before sealing, provide prime coat of paint on all repaired surfaces.

E61.21 Lintels

- (a) Lintels for openings in masonry to conform to requirements given on structural drawings and as required by By-laws.
- (b) Pay all costs for lintels over openings required solely by the mechanical trades.

E61.22 Identification

- (a) Identify all automatic control devices, fans etc., with 3 mm ($\frac{1}{8}$ ") Lamacoid plastic plates of approved size with bevelled edges having engraved white letter on black background giving the name of the equipment or equipment service and its number, i.e. "Washroom Exhaust E-1", "Condenser Pump P-1", etc. Fix to equipment using pip rivets or sheet metal screws. Also provide:
 - (i) 12mm ($\frac{1}{2}$ ") lettering for motor starters and 25mm (1") lettering for equipment.
 - (ii) Where equipment is locally switched (e.g. Room exhaust fans) provide identification plate at switch.
- (b) Co-ordinate with Electrical and obtain list of automatically operated equipment and provide warning identification on Lamacoid plate for each item as follows:
- (c) "Warning: This equipment may start at any time. Do not service without disconnecting power."
- (d) Identify the following piping as to service and direction of flow using stencils and black lettering behind each access door, in each room, and/or every 12m (40 ft.)
 - (i) Gas (identify to code requirements)
 - (ii) Any other special service or mechanical system piping.

E61.23 Flashing

- (a) Flash all mechanical parts passing through or built into an outside wall, or a waterproof floor.
- (b) Provide copper flashing for sleeves passing through exterior walls or waterproof floors.
- (c) Provide counter flashing on stacks, ducts and pipes passing through roofs to fit over flashing or curb.
- (d) Co-ordinate installation of flashings with roofing trade as required.

E61.24 Painting

- (a) Provide all exposed ferrous metal work on equipment with at least one factory prime coat, or paint one prime coat on job. This Division is not required to prime coat or paint ductwork or piping.
- (b) For factory applied finishes, repaint or refinish surfaces damaged during shipment, erection or construction work.

E61.25 Exposed Work

- (a) Wherever any mechanical work (ductwork, and associated thermal insulation) is exposed in finished areas, co-ordinate work with the Contract Administrator prior to installation. If unsatisfactory installation results due to not following this procedure, perform remedial work to the Contract Administrator's acceptance.

E61.26 Piping System Tests

- (a) Should leaks develop in any part of the piping system, remove and replace defective sections, fittings and equipment.
- (b) Test piping system in sections as required by the progress of the Work.
- (c) Test all natural gas piping as required by codes and authorities.
- (d) All tests must be recorded and witnessed by the City's representative. Submit recorded data to the Contract Administrator.

E61.27 Vibration Isolation

- (a) Provide Vibration Isolators as manufactured by Vibro-Acoustics, Vibron or Air Master.
- (b) It is a requirement of this Specification that the Mechanical equipment be designed and installed so that the average noise criteria curves as outlined in the latest edition of the ASHRAE guide for this type of project are not exceeded. Where objectionable noise or vibration is encountered due to faulty equipment or inefficient noise and vibration reduction devices, as determined by the Contract Administrator, make necessary tests, change and provide additional equipment as may be required and approved, without extra charge.
- (c) Provide all sound and vibration elimination materials by one supplier unless otherwise specified. Provide shop drawings showing isolator location, load forces, anchor positions etc., and installation instructions.
- (d) Provide vibration isolators for all mechanical motor driven equipment throughout the project.
- (e) Support all piping connected to isolated equipment by spring hangers on the first three support points. Bolt all anchors and guides on elastorib pads with neoprene washers on each side of the fastening. Use of 3 Style 77 Victaulic flexible couplings to absorb noise/vibration is acceptable alternative.
- (f) Give consideration to side loading of equipment and inertia pads when calculating maximum loads on isolators; provide pairs of side snubbers and/or restraining springs where side torque or thrust may develop. When properly adjusted, the equipment shall be level when operating.
- (g) Provide all spring isolators with height and levelling adjustment and set on neoprene antisound pads 6 mm (¼") or thicker. Do not use sponge rubber for side snubbers.
- (h) Provide spring isolation for ceiling mounted equipment with box-frames and anti-sound spring seats. All hardware to be corrosion resistant.

E62. INSULATION

E62.1 Work Performed by This Section

- (a) Supply and installation of piping, ductwork and equipment insulation.

E62.2 Quality Assurance

- (a) Qualifications: Execute work of this section only by skilled tradesmen regularly employed in the application of insulation to piping, ductwork, ventilating and heating systems.
- (b) Insulation, self adhesive tape, adhesives and any insulation finishes to be ULC labelled and listed for flame spread rating of less than 25 and smoke development classification of less than 50.
- (c) Acceptable Manufacturers:
 - (i) Insulation: Fiberglas Canada Inc., Knauf Fiber Glass, Manson, Roxul.
 - (ii) Tape: Avery Dennison, Mactac, Tuck, Compac.
 - (iii) Canvas: Fattal Thermocanvas, Alpa-Maritex 3451-RW, Clairmont Diplag 60.
 - (iv) Lagging adhesive: Childers CP.50A-HV2, Fosters 30-36 asbestos free.

E62.3 Definitions

- (a) The word "exposed" where used in this Section means any work, which is not concealed in wall, shaft, or ceiling cavities or spaces. Work behind doors in closets or cupboards or under counters is considered exposed.

E62.4 Products

E62.4.1 Premolded Insulation

- (a) Provide ULC Listed sectional fibreglass pipe insulation in compliance with ASTM C335-84 in pre-moulded sections 900 mm (36") long, split and ready for application with a minimum Thermal Conductivity of 0.033 W/m deg C at 24°C (75°F) mean temperature and be capable of use on service from -40°C to 260°C (-40°F to 500°F) and with factory applied vapour seal jacket of vinyl coated foil Kraft laminate with reinforcing of open mesh glass fibre.
- (b) Rigid board: 72 kg/m³ (4.5 lbs/ft³) density ULC listed glass fibre board with glass fibre reinforced aluminium foil vapour seal facing and minimum thermal conductivity of 0.035 W/m deg C at 24 deg C mean temperature.

E62.4.2 Low Temperature Insulation

- (a) Low temperature: 20 mm (3/4 ") fire retardant closed cell elastomer insulation in sheet form or pre-formed for piping.

E62.5 Finishes and Protective Coverings

- (a) Canvas: 170 g/m² with lagging adhesive, ULC labelled.
- (b) Protective covering (aluminium): .020 corrugated aluminium pre-formed covering complete with strapping and seals.
- (c) Blue Coat coating: Bakor 110-14 asphalt mastic vapour barrier coating.

E62.6 Equipment and Miscellaneous Applications

- (a) Stand-by generator exhaust piping and boiler breechings: calcium silicate pre-formed pipe insulation or Roxul 1200 mineral fibre. Stand-by generator exhaust: from 150mm (6") of manifold connection including muffler and to 150mm (6") beyond roof or exterior wall surface; Secure with 12mm x 0.38 mm (1/2" x 0.015") galvanized steel bands at 300mm (12") OC. Flash over portions protruding through roof or wall with copper sheet. Provide schedule 40 steel pipe sleeves at wall or roof. Cover all insulation with pre-formed aluminium. Secure breeching insulation in place with 20mm x 0.38mm (1/2" x 0.015") steel bands 400mm (16") on centre.

E62.7 Ductwork

E62.7.1 Installation

- (a) Exposed ductwork shall be finished with canvass coating as described previously:
- (i) Rectangular ductwork: Impale rigid board on weld pins and speed washers 300mm (12") OC with a minimum of two rows per side on any side greater than 300mm (12"). Cut pins flush with surface of insulation and cover with foil faced type. Cover all joints with foil faced self-adhesive tape. Finish with canvas.

E62.7.2 Concealed ductwork:

- (a) Apply flexible blanket insulation with an approved adhesive brushed on in 100mm (4") wide strips 300mm (12") OC and at all joints. Seal all joints and perforations with foil faced self-adhesive tape.
- (b) Ductwork exposed to outdoors: Impale rigid board on weld pins and speed washers 300mm (12") OC with a minimum of two rows per side on any side greater than 300mm (12"). Cut pins flush with surface of insulation and cover pins and joints with foil faced self-adhesive tape. Finish with two applications of weather protective coating.
- (c) Where ductwork is symbolized as external acoustic: apply over rigid board two coats of hard plaster at 9.53mm (3/8") thick each, trowel smooth and finish with canvas.

E62.7.3 Application: Provide external ductwork insulation in thickness as listed below:

- (a) All supply air ductwork from fan discharge or unit outlet to termination space. Where specifically noted on drawings, there can be an exception to the foregoing.

E62.8 Application Schedule

E62.8.1 Ductwork:

- | | | |
|--|------------|------------------|
| (a) Supply ductwork throughout | 25 mm (1") | all |
| (b) Fresh air intake ducts to air unit, mix plenums or heat exchangers | 50 mm (2") | all |
| (c) Ducts penetrating an exterior building surface | 25 mm (1") | for the last 3 M |

E62.8.2 Piping:

- | | | |
|-----------------------|------------|-----|
| (a) Generator exhaust | 75 mm (3") | all |
|-----------------------|------------|-----|

E63. HEATING & COOLING

E63.1 Description

- (a) Comply with requirements of Mechanical General Provisions and Section 15050 and Basic Materials and Methods.

E63.2 Work Performed in This Section

- (a) Heating
- (b) Supply and installation of unit heaters for complete and fully operative systems.

E63.3 Quality Assurance

- (a) Qualifications: execute work of this section only be licensed tradesmen regularly employed in the installation of heating equipment.
- (b) Submittals: Submit shop drawings on unit heaters.

- (c) Equipment mounted controls must be fully compatible with building DDC system (if any).

E63.4 Unit Heaters

- (a) Provide unit heaters complete with speed switches, 16 gauge steel enclosure, copper aluminum construction of coils, TEFC motors and permanently lubricated bearings.
- (b) Provide a thermostat with each and unit heater.
 - (i) Provide an integral thermostat

E63.5 Execution

E63.5.1 Equipment and Terminals

- (a) Comply with manufacturer's requirements for the installation of any equipment.
- (b) Locate equipment to provide the best possible connection arrangement and accessibility for servicing.
- (c) Install items of equipment, such as convectors, etc., with due regard for architectural finishes and ensure all items are level and finished in keeping with good workmanship practices.

E63.5.2 Equipment Start-Up

- (a) Follow manufacturer's instructions an/or have manufacturer's representative present.
- (b) Check each item of equipment to ensure proper electrical connections, etc., and to verify proper operations.

E64. AIR DISTRIBUTION

E64.1 Description

- (a) Comply with Requirements and all documents referred to therein.

E64.2 Work Performed by This Section

- (a) Provide a complete installation of ventilation systems as shown of the drawings and including ductwork, grilles and diffusers, fire dampers, fans, dampers, hoods and provision of personnel and materials to assist in air balancing i.e., scaffolds and ladders.
- (b) Install all automatic dampers.

E64.3 Quality Assurance

- (a) Execute work of this Section only by skilled tradesmen regularly employed in the manufacture and installation of sheetmetal ductwork and air handling equipment.

E64.4 Submittals

- (a) Submit shop drawings on grilles, diffusers, fans, filters, fire dampers, automatic dampers, prefabricated plenums. Provide fan curves for all fans 200 l/s (400 CFM) and greater capacity.

E64.5 Access Doors

- (a) Ductwork: Provide latched and gasketed access doors where required constructed of No. 22 gauge materials with flat iron or angle iron stiffening frame so constructed that the door can be operated without twisting or distortion.
- (b) Doors in insulated ductwork: double panel construction with a 25mm (1") insulating filler. Refer to the drawings.

- (c) Acceptable alternative: for non-hinged type, provide cam-latched insulated access doors Model 08 as manufactured by Nailor Industries Inc.

E64.6 Fire Dampers

- (a) Provide ULC labelled and listed units as manufactured by Controlled Air Manufacturing Ltd. type "B" or "C" gravity or spring type. Use type "A" only where mounted directly behind supply or return grilles.
- (b) Provide Fire Dampers in sizes and in arrangements to suit openings shown on the drawings to ULC requirements as they relate to maximum sizes permissible in the applicable fire separation construction.
- (c) Do not use asbestos in any form in the construction of fire dampers or ceiling dampers.
- (d) Other acceptable manufacturers: Ruskin, Kerr-Hunt, Nailor Industries, Air Balance of Canada Ltd.

E64.7 Splitter and Quadrant Dampers

- (a) Provide splitter dampers as described in the detail drawings.
- (b) Construct quadrant dampers of not less than 22 gauge material. Where installed in ducts up to 300mm (12") deep, provide single blade, and in ducts greater than 300mm (12") provide multi-blade with linkages, each blade being not wider than 228mm (9").

E64.8 Ductwork

- (a) Provide rectangular and round ductwork constructed of galvanized steel sheets as follows as a minimum but not less than required by SMACNA HVAC Duct Construction Standards - Metal and Flexible 1985:

TYPE	MAXIMUM DIMENSION	GAUGE	JOINTS
Round spiral 4 ply seam	450 mm (18")	26	Slip joint with 3#8 screws evenly spaced.
	457 to 750 mm (19" to 30")	24	Slip joint held with 3#8 screws evenly spaced.
Rectangular with Pittsburgh	Up to 300 mm (12")	26	S & drive
Longitudinal seam	325 to 750 mm (13" to 30")	24	S & drive
	775 to 1275 mm (31" to 50")	22	25 mm (1") bar slip or standing T @ 1500 mm (60") o/c. maximum.
	1300 to 1500 mm (51" to 60")	20	As above with 40 mm (1½") bar slip or standing T.
	1525 to 2250 mm (61" to 88")	18	As above except provide 40 mm x 40 mm x 5 mm (1½" x 1½" x 3/16") angle reinforcement at 750 mm (30") o/c.

Note:

- (a) Cross break all ductwork greater than 300mm (12").
- (b) Button lock longitudinal seam may be used [provided seam is sealed or caulked with high velocity duct sealer.]

- (c) In place of previously specified duct joints, "Nexus" or "Ductmate" gasketed flanges may be used provided gasketing meets approval of ULC and installation is to SMACNA Standards.

E64.9 Registers, Grilles & Diffusers

- (a) Provide for as indicated and referenced on the drawings and as specified below based on E.H. Price models. Nailor, Carnes, Hart and Cooley & Titus will be considered equal.
- (b) Provide fire dampers where required or indicated. Fire dampers behind side wall and floor grilles and registers to be VCS4/C, U.L.C./W.H. rated for 1½ hours with screwdriver balance adjustment. Such dampers to replace standard balance dampers where specified.
- (c) Borders and/or frames to have countersunk screw holes where indicated. Slot or Phillips head countersunk #8 sheet metal screws with finish to match border.
- (d) Supply, Return, Transfer, and Exhaust, grilles, registers and diffusers to be as follows:
 - (i) All supply diffusers to be equipped with balancing dampers type VCR-7 or VCS9 where branch duct line dampers are not shown.
 - (ii) Sidewall supply registers.
 - (i) C22S3AB15, ¾" double deflecting with short vanes in front, balance dampers, screw mounted and aluminum finish.

E64.10 Louvres

- (a) Supply and install louvres of aluminum (steel where specified on the drawings to be prime or finish coated). Louvres shall be 100 mm (4") deep with 30 degree blades at 75 mm (3") o/c. and constructed of 12 gauge material with 16 gauge frame and 12 mm (½") square 16 ga. aluminium removable bird screen 50% minimum free area.
- (b) Provide sill or frame as required. Louvres shall be Aerolite model CB 666, Penn, Airmaster.
- (c) Other acceptable manufacturers: Ruskin, Construction Specialities.

E64.11 Centrifugal Fans

- (a) Provide as indicated on the drawings and in the equipment schedules, statically and dynamically balanced, constructed in conformance with AMCA 2408-69 and carrying the AMCA seal.
- (b) Bearings: Roof and sidewall domed type small utility fans etc.: Sealed permanently lubricated ball bearing. Belted ventilating sets and Class I and Class II. Fans: Heavy-duty ball bearings, 200,000 hour bearings with grease extensions where applicable, grease lubricated self-aligning pillow block. On arrangement III single inlet fans with ducted inlets, provide extended lubrication fittings.
- (c) Provide electric motors, disconnect switches (on roof mounted units), vibration isolators, variable pitch drives, inlet screen, belts, belt guards, weatherhoods where mounted outdoors and back draft dampers on exhaust fans. Provide integral bases on floor mounted Class I and Class II fans.
- (d) Provide fixed pitch drive sheaves on fans greater than 5.6 kW (7.5 HP). Provide two sets of sheaves; one set to provide specified RPM and another set as specified by the air balance firm should field testing make this necessary.
- (e) Belt Guards: Provide expanded metal type with 25mm (1") dia. tachometer openings at both fan and motor shaft locations. Provide one opening with adjustable plate to compensate for motor position adjustment.
- (f) Acceptable Manufacturers:
 - (i) Greenheck, Chicago Blower, Sheldons, Barry Blower, Trane, Joy, Woods, SF, New York Blower, Twin City, Northern Blower and Acme for all Belted Vent Sets, Class I, Class II, in line and propeller applications;

- (ii) Cook, Jenn Fan, Delhi, Lau, Greenheck, Aerovent, Acme, Penn and Carnes for Light Duty Roof and Sidewall Mounted Exhaust propeller, belted vent sets and Air Transfer.

E64.12 Utility Fans

- (a) Fans shall be AMCA B rated.
- (b) Provide spring mounts and support fans at 4 points from structure.
- (c) Provide belt guards. Field fabricate if necessary.
- (d) Standard of Acceptance: Delhi 400 Series, Greenheck, Penn, Phillips-Lau.

E64.13 Gas Vents and Stacks

- (a) Gas vents for stand-by generator exhaust and Metalbestos Model PS Insulated 316 stainless steel lined and clad all fuels type complete with all supports, flashings, rain caps, thimbles, etc., in size as shown complete to meet requirements of authorities having jurisdiction.
- (b) Acceptable Alternative Manufacture: Vanpacker.

E64.14 Flexible Connections

- (a) General HVAC System: provide at connections to fans and at air handling units, neoprene coated glass fabric, factory fabricated, flexible connections, as approved by authorities.
- (b) Except where noted, otherwise connections up to 750 mm (30") in the largest dimension shall be 100 mm (4"). Connections larger than 750 mm to be 150 mm (6").

E64.15 Air Balancing

- (a) Refer to Section 15050. Provide in quantities and as directed by the air balancing firm Dial 1000 or Dial 2000 duct pitot tube test opening enclosures as manufactured by Air Power Equipment Co. Ltd. (416-233-7389).

E64.16 Execution

E64.16.1 Duct Installation

- (a) Install ductwork in accordance with SMACNA Duct Construction Standards - Metal and Flexible 1985 for 2 in. wc) static pressure.
- (b) Leakage testing is required for ductwork subject to static pressures in excess of 0.75 kPa (3 in.) w.c. Refer to E60 - Air Balancing.
- (c) Ground across flexible connector with No. 2/0 braided copper strap.
- (d) Install balancing dampers at branch ducts and additionally.
- (e) Seal all transverse joints in supply, return and exhaust ductwork with Bakelite 530-09 high velocity duct sealer or equivalent meeting requirements of authorities having jurisdiction and SMACNA Seal Class C - maximum leakage 5%. Above sealer not required in Nexus type joints except as may be specified in manufacturers installation instructions.
- (f) Where interior of duct is visible through grilles, registers or diffusers, paint interior of duct with flat black Tremco paint formulated for galvanized surfaces.
- (g) Seal all exposed edges, perforations and joints in acoustic duct lining with Bakelite 110-26 compound or high velocity duct sealer meeting requirements of authorities having jurisdiction.
- (h) Use Bakelite 230-38 adhesive, full coverage, for internal insulation.

- (i) Ductwork installed outdoors (not externally insulated): Seal all joints with paintable Silicon caulking compound.
- (j) Hangers: Galvanized steel strap and steel angle with support rods, locking nuts and washers to the following table:

	Circular Duct Size (mm)*	Angle Size (mm)
.1	Up to 600 (24") galvanized steel strap	25 x 20 ga. (1" x 20 ga.)
.2	625 to 1000 (25" to 40")	40 x 40 x 3 (1½" x 1½" x 1/8")
.3	1005 to 1500 (41" to 60")	40 x 40 x 3 (1½" x 1½" x 1/8")
.4	1505 to 2000 (61" to 80")	50 x 50 x 3 (2" x 2" x 1/8")

	Rod Size (mm)	Spacing (mm)
.1	6 (1/4")	3000 (10')
.2	6 (1/4")	3000 (10')
.3	10 (3/8")	3000 (10')
.4	10 (3/8")	2300 (7' 6")

*Equivalent Rectangular Maximum Dimension

E64.17 Fire Dampers

- (a) Install to ULC requirements. Locate in fire walls, floors and where indicated.
- (b) Seal around fire damper assembly.
- (c) After completion, have installation approved prior to concealment.

E64.18 Fresh Air and Exhaust Louvres

- (a) [Install flush and true with exterior wall surfaces. Thoroughly caulk entire perimeter of louvre with material acceptable to the Contract Administrator.
- (b) Caulk all joints at louvre connection and make duct connection watertight.

E64.19 Flashing

- (a) Provide flashings to suit installation.
- (b) Follow drawings for vents and pipes penetrating roofs.

E64.20 Grilles, Registers and Diffusers

- (a) Fit frame with gasket to prevent leakage, and smudging.
- (b) Install with oval head plated screws in countersunk holes where fastenings are visible.
- (c) Set squarely in place parallel to adjacent building lines.
- (d) Ensure unit is compatible with ceiling or wall construction.
- (e) Ensure devices are set rigidly in place and properly secured.

E64.21 Filter Gauges

- (a) Sensing Points: Locate as directed by the manufacturer and carefully clip tubing to avoid damage and interference with filter removal or servicing. Mount gauges on the unit for convenient observation as directed by the Contract Administrator.

E64.22 Motorized Dampers

- (a) Install all automatic dampers free from distortion and binding of linkages. Thoroughly caulk around frames.

E64.23 Sheet Metal Installation

- (a) During installation, protect open ends of ducts to prevent debris and dirt from entering.

- (b) Where ducts are shown along side of partitions, place tight to the surface.

E64.24 Fans

- (a) Comply with manufacturers' requirements. Ensure vibration free installation. Leave access for servicing. Install belt guards and weatherproof covers as required.
- (b) On all vane axial fans, (mounted vertically or horizontally), provide steel support brackets from floor or overhead with vibration isolators at centreline supports on fan - Do not place isolators on floor or at overhead attachment point.
- (c) Secure snubbers to be parallel with the fan horizontal longitudinal axis.
- (d) All fans to be AMCA B rated.

E64.25 Vibration and Objectionable Noise

- (a) Install ductwork free from pulsation, chatter, vibration or objectionable noises. Should any of these defects appear after the system is in operation, correct same by either removing, replacing or reinforcing the work as directed by the Contract Administrator.

E64.26 Air Balancing

- (a) Provide personnel and materials to assist and work under direction of air balancing firm for removal and replacement of ceiling tiles, installation of pilot tube test opening enclosures, installation of dampers and baffles as required for specified air balance and elimination of stratification, provision of access openings and covers, provision of ladders and scaffolds, removal and replacement of guards, removal and replacement and provision of required sheave and belt sizes as directed and other items as necessary for complete and acceptable air balancing procedures.

E65. SOUND VIBRATION

E65.1 General Description

- (a) Comply with requirements of all documents referred to herein.

E65.2 Description of System

- (a) The work under the section shall include furnishing all labor, materials, tools, appliances and equipment, and forming all operations necessary for the complete execution of the installation of noise and vibration isolation devices and system as shown, detailed, and/or scheduled on the drawing and/or specified in this section of the specifications to provide sound, vibration and seismic control for all motor driven equipment.
- (b) This work in general shall include but not necessarily be limited to the following:
 - (i) All mechanical and electrical equipment shall be isolated from the building structure by means of noise and vibration isolators.
 - (ii) All piping over 1" outside diameter located in mechanical equipment rooms, and for a minimum of fifty (50) feet or 100 pipe diameters, whichever is greater, from any connection to vibration isolated mechanical or electrical equipment, shall be isolated from the building structure by means of noise and vibration isolation hangers. All piping in the building, which is connected to vibration, isolated equipment shall be isolated at connections to the building structure.
 - (iii) All ductwork located in mechanical equipment room, and for a minimum of fifty (50) feet from any connection to vibration isolated air moving equipment shall be isolated from the building structure by means of noise and vibration isolation hangers.
 - (iv) All piping and ductwork vertical risers shall be isolated from the building structure by means of noise and vibration isolation guides and supports.

- (v) All piping and ductwork to be isolated according to this section of the specification shall freely pass through walls and floors without rigid connections. Penetration points shall be sleeved or otherwise formed to allow passage of piping or ductwork, and maintain a minimum of $\frac{3}{4}$ " and maximum of $1\frac{1}{4}$ " clearance around the outside surfaces. This clearance space shall be tightly packed with 1.58 P.C.F. glass fiber and shall be caulked airtight after installation of the piping or ductwork.

E65.3 Quality Assurance

- (a) Execute work of this section in accordance with the manufacturer's instructions by workman only experienced in the installation of vibration isolation systems and equipment.
- (b) Ensure isolators and restraining devices which are factory supplied with equipment meet the requirements of this Section.
- (c) Provide all equipment to control noise and vibration such that the average noise criteria curves for the conditioned occupied space, do not exceed **NC35** and vibration is below the level of perception for these.
- (d) Provide the inspection and supervision services of the vibration and noise control equipment manufacturer to ensure that during construction all equipment is installed as required to achieve specified performance.

E65.4 Submittals

E65.4.1 Samples:

- (a) The Contractor shall submit samples in triplicate of all vibration isolation devices offered as substitutions to those specified. The Contractor shall also submit samples of specified isolation devices upon request to the Contract Administrator for approval.

E65.4.2 Shop Drawings:

- (a) The Contractor shall have prepared by the isolation materials manufacturer, and shall submit to the Contract Administrator for approval, drawings showing the construction of the isolation devices to be used, including specific selection of isolators for the equipment to be furnished for this project, and shall include the complete design of supplementary bases; a tabulation of the design data for each isolator, including spring OD, free operating, and solid heights, and ratio of horizontal to vertical stiffness, and other required data to clearly indicate that the specified isolator types and minimum static deflections are provided by the system submitted.

E65.5 Products

E65.5.1 General

- (a) Installation of all vibration isolation materials and supplemental equipment bases specified in this section shall be accomplished as per manufacturer's written instructions.
- (b) On completion of installation of all isolation materials and before start-up of isolated equipment all debris shall be cleared from areas surrounding and from beneath all isolated equipment, leaving equipment free to move on the isolation supports.
- (c) No rigid connections between equipment and building structure shall be made that degrades the noise and vibration isolation system herein specified. Electrical conduit connections to isolated equipment shall be looped to allow free motion of isolated equipment.

E65.5.2 Vibration Isolators

- (a) Provide all vibration isolation equipment as manufactured by one approved supplier.

- (b) Type 4 spring hangers: Open spring type within zinc chromate plated frame with neoprene grommet (1.25 mm deflection) mounted over the retaining washer for placement under the support rod adjustment nut; to have a single stable position when loaded; to allow a ± 150 angular misalignment.

E65.5.3 Vibration Isolation - General

- (a) Provide vibration isolation on all motor driven equipment with electric motors of 0.37 kW (0.5 HP) and greater power output and on piping and ductwork as specified herein. For equipment less than 0.37 kW, provide neoprene grommets at the support points.
- (b) Ensure isolation systems have a natural frequency no higher than 1/3 of the lowest forcing frequency unless otherwise specified.
- (c) Provide horizontal limit springs or snubbers on all spring isolated fans (except vertical discharge) in excess of 1 kPa (4" water gauge) static pressure, and on hanger supported horizontally mounted axial fans.
- (d) Provide, for equipment as designated in the equipment schedules or shown on the drawings, concrete inertia bases or structural steel frames located between all vibrating equipment and vibration isolation elements. Structural steel frames will not be required if the equipment manufacturer certifies direct attachment capabilities. Provide inertia bases on centrifugal fans with static pressure in excess of 876 Pa (3.5") and/or motor in excess of 30 kW (40 HP) and on base mounted pumps over 8 kW (10 HP).
- (e) On fans, as designated in the equipment schedules or on the drawings, provide stabilizing springs to eliminate movement at flexible connections to 25% of fabric width under steady state conditions and 40% at start-up. Flexible duct connectors between all isolated fans and non-isolated ductwork are specified in Section 15800.
- (f) Provide weatherproof coating (Rustoleum or Neoprene paint) on springs and frames on all isolation equipment exposed to outdoors.

E65.5.4 General Vibration Isolation Schedule

Item	Isolator Type	Deflection (mm)	Comments
In-line Pumps	Type 4	25	Refer to Detail Drawing
Vertical In-line Pumps	Type 2	2.5	See Detail Drawing
Chillers	Type 3 & Type 1	25 2.5	[Mount on Pads through Floating Floor]
Boilers	Type 1	2.5	
Cooling Towers	Type 3	25 min.	Refer to [2.02.8]
Base Mount Centrifugal Fans	Type 3	25	
Suspended Centrifugal Fans	Type 4	25	
Vane Axial Fans	Type 3 or 4	25	

E65.6 Installation

- (a) Obtain all relevant equipment information and provide shop and installation drawings for all vibration isolation elements and steel bases. Include details of attachment to both the equipment and the structure to meet the specified forces involved. Do not perform any work or order any materials or equipment prior to review of shop and installation drawings by the Contract Administrator.
- (b) For all equipment mounted on vibration isolators, provide a minimum clearance of 50 mm (2") to other structures, piping, equipment, etc.
- (c) Space isolators under equipment so that the minimum distance between adjacent corner isolators is at least equal to the height of the centre of gravity of the equipment or

specifically designed for increased forces on the supports. If improved supports are proposed, include design calculations with shop drawings, for approval.

- (d) Isolate all floor or pier mounted equipment on Type 3 isolators unless otherwise specified.
- (e) Use the lowest RPM scheduled for 2 speed equipment.
- (f) Under equipment mounted on Type 3 mounts, provide neoprene/steel/neoprene (Type 1) pads, adjacent to the springs selected for the manufacturer's optimum loading, and shimmed to be just clear of the base of the equipment under operating conditions. Bolt these pads to the floor slab, maintaining the top of the bolt below the top of the pads. These pads are to minimizing rocking of the equipment in the event of an earthquake and can be deleted if other provision is designed into the isolator to control rocking.
- (g) For equipment mounted on slab on grade including chillers and pumps, mount on Type 1 neoprene/steel/neoprene sandwich pads unless otherwise specified.
- (h) Use Type 4 spring hangers for a minimum static deflection of 25 mm (1") for all ceiling hung fans, air handling units and emergency generator exhaust silencers.
- (i) Provide Type 4 resilient hangers on all piping connected to a vibrating source if the piping is supported from walls or ceiling slabs adjoining occupied spaces, and if the piping is in excess of 40 mm (1.5") diameter. Provide the hangers for a distance of 4 m plus $0.03 \times$ (pipe diameter mm) from the vibrating source - e.g. for 250 mm pipe, required distance is 4 m plus $0.03 \times 250 = 11.5$ m. Use Type 1 pads under pipe pedestals on slab on grade. Bolt down equipment mounted on neoprene pad isolators using neoprene grommets.

E65.7 Inspection

- (a) The Contractor shall notify the local representative of the vibration isolation materials manufacturer prior to installing any vibration isolation devices. The Contractor shall seek the representative's guidance in any installation procedures with which he is unfamiliar.
- (b) The local representative of the vibration isolation materials manufacturer shall conduct periodic inspections of the installation of materials herein specified, and shall report in writing to the Contractor any deviations from good installation practice observed.
- (c) On completion of installation of all noise and vibration isolation devices herein specified, the local representative of the isolation materials manufacturer shall inspect the completed system and report in writing any installation errors, improperly selected isolation devices, or other fault in the system that could affect the performance of the system.
- (d) The Contractor shall submit a report to the Contract Administrator, including the manufacturer representative's final report, indicating all isolation material is properly installed or steps to be taken by Contractor to properly complete the isolation work as per specification.

E65.8 Housekeeping Pads

- (a) Refer to Section 15050 for the provision of housekeeping pads.

E66. HVAC CONTROLS

E66.1 Work Performed by This Section

- (a) Provide a electronic and control system with all thermostats, controllers, dampers, operators, switches and other accessory equipment, in accordance with the drawings which shall include, but not be limited to:
- (b) Air supply, return, exhaust and Generator Ventilation Systems.

E66.2 Quality Assurance

- (a) Qualifications: Execute work of this Section by a recognized contractor regularly employed in the manufacturing and installation of temperature control equipment.

E66.3 Submittals

- (a) Submit control working drawings and wiring diagrams with written sequences of operation and components description.

E66.4 Guarantee

- (a) Guarantee the control system designated on drawings and plans, and specified therein, free from original defects in materials and workmanship for a period of one year of normal use and service from the date of final acceptance except damage from other causes.

E66.5 Instruction, Adjustment and "As-Built" drawings

- (a) On completion of the job, calibrate all thermostats, damper motors and relays provided under this contract. Provide three complete instruction manuals with "as constructed" control drawings and instruct the City's operating personnel in the operation and function of the system.

E66.6 Products

E66.6.1 Dampers

- (a) Low-leakage type dampers manufactured and supplied by the automatic control Manufacturer. Tamco 9000 Series.

E66.6.2 Actuators

- (a) Sized to provide adequate power for opening, closing and modulating dampers or valves in specified time. Size according to damper manufacturers recommendations.
- (b) Provide each motor with a bracket for attaching to ductwork, building structure, or equipment. Do not install operators in ducts or fresh air intakes. Direct mount actuators. Crank arms and swivels are not acceptable.
- (c) Install as per damper manufacturers recommendations.

E66.6.3 Thermostats

- (a) Room thermostats: concealed adjustment with vandal proof covers unit heaters shall have built in thermostats.

E66.6.4 Control Wiring

- (a) Provide all electrical wiring required within the temperature control system including wiring between control system components such as low limit protection, thermostats, alarms, motor starters and motor interlocks, etc., as required to achieve the control function specified in the schematic drawings and sequences of operation. All control wiring shall be in conduit suitable for environment in which it is installed.

E66.6.5 Local Control Panels

- (a) Provide cubicle type lockable panels with hinged doors constructed of 14 gauge steel with enamel finish suitable for either wall mounting or leg mounting as required, with sufficient space on cover for mounting labelled switches, gauges, etc. Control panels to be suitable for environments for which it is installed.

E66.7 Execution

E66.7.1 Components

- (a) Mount all controllers and relays within control panel cubicles. Mount exposed components for easy access and protect from damage. Control panels shall be suitable for environments in which they are installed.
- (b) Identify all equipment mounted on the control panel front with 50 mm x 75 mm (2" x 3") lamacoid nameplates. Identify instruments inside the cabinet with Dymo tape labels.
- (c) Locate all local control panels as shown on the drawings or as directed by the Contract Administrator.
- (d) Sensor elements for remote thermometers: where installed to sense a common temperature condition with a controller, strap both elements together. Protect from mechanical injury. Duct mounted sensors shall be installed securely within air stream.

E66.7.2 Wiring

- (a) Install all control wiring in conduit and conform to C.S.A., U.L.C. and local Code requirements as well as requirements as specified in Division 16. All wiring shall be in conduit suitable for environments in which installed.

E66.7.3 EF-1

- (a) Shall be complete with two speed motor. Fan shall be off normally and cycle on under two conditions. Fan shall operate on low speed when space occupied. Provide manual switch by entrance door on main floor. Interlock low speed operation with lights in wet well to ensure operation when wet well is occupied. High hydrocarbon levels shall initiate high speed operation. Interlock s/a motorized damper for operation with EF-1. Provide status for high speed operation. Coordinate integration of status into building PLC.

E66.7.4 AHU-1

- (a) Shall be complete with built in thermostat. Provide all safety devices, control transformers, etc. for complete and functional installation. Unit shall cycle on with a call for heat based on built in thermostat setting.

E66.7.5 Genset Ventillation

- (a) Provide a complete and functional system of dampers actuators and control devices as follows. On Genset start-up, provide combustion air to Generator Room (2400 cfm). Co-ordinate combustion air requirements with Genset supplier. Ventilation dampers shall modulate to maintain temperature setpoints of 85°F (adjustable) in Genset Room. Dampers shall revert to resting position upon Genset shutdown. Refer to drawings. Dampers shall be Tamco 1000 Series. Co-ordinate 120V emergency power requirements. Control panel shall be suitable for environment in which it is installed. All wiring shall be in conduit, suitable for environment in which it is installed.

E66.7.6 Ancillary Devices

- (a) Provide 1000 OHM Balco Type resistor for the following monitor points: Building Low Temp and Building High Temp. Locate as per drawings. Co-ordinate install with integration with PLC control. Protect sensor bulb from mechanical injury.

DIVISION 16 – ELECTRICAL

E67. ELECTRICAL SCOPE OF WORK

E67.1 Description

- (a) A brief but not necessarily all inclusive list of electrical work to be performed under this contract is given herein.
- (b) The Contractor shall supply all labour, material, equipment, transportation, services and facilities necessary to make, test and place into operation a complete electrical installation as shown on the drawings and/or as specified herein.
- (c) Where the term "provide" is used herein, it shall mean "supply, install, adjust, test and place into operation".
- (d) All systems shall be completely assembled, adjusted, tested and demonstrated to be ready for operation to the satisfaction of the Contract Administrator.
- (e) The Contractor shall satisfy himself as to working space, storage space, access facilities and all other conditions pertaining to the Site, relating to the conduct of his operations, by the inspection of the Site and examination of the drawings.

E67.2 Extent of Work

- (a) This work shall consist of furnishing of all labour, material, equipment and all incidentals required for the new Kenaston Underpass Pumping Station and all associated works.
- (b) Work shall include, but not be limited to:
 - (i) Provision of new electrical system as required.
 - (ii) Wire to and make connections to, all electrical power and control items required, including motors, controls, etc.

E67.3 General

- (a) All work to be carried out by qualified journeymen of the related trades.

E67.4 Installation

- (a) Install to make a complete and working system.

E68. GENERAL ELECTRICAL PROVISIONS

E68.1 Scope

- (a) Refer to E-67 - Electrical Scope of Work for general description of electrical work to be carried out under this Contract.

E68.2 Examination of Drawings

- (a) The electrical drawings do not show all architectural, mechanical and structural details. All electrical schematics are shown diagrammatically unless otherwise noted. The Contractor shall review the mechanical and structural drawings to obtain building dimensions and details. Verify dimensions accurately by measurements.
- (b) To change the location of electrical equipment, submit a request in writing to the Contract Administrator for approval. If approved, such changes are to be made at no additional cost to the City.
- (c) No extra will be allowed for any additional labour or materials required for relocation of equipment due to interference with equipment of other trades, beams, joists, walls, etc.

E68.3 Approved Design and Installation

- (a) Equipment and material to be of approved design and manufactured in accordance with all governing regulations such as "Canadian Standards Association", "Canadian Electrical Code", "Provincial Department of Labour", "Underwriters Laboratory", etc. Equipment and material must bear applicable acceptance labels of all associations and governing bodies recognized by the municipal, provincial and federal authorities.
- (b) Install equipment in strict accordance with manufacturer's recommendations and governing rules, regulations and codes.
- (c) Where requirement conflict occurs, install all materials in accordance with the most severe requirements.
- (d) Material installed under this Division to be new and of uniform construction.
- (e) All installation to ensure maximum headroom, minimum interference with free use of surrounding areas, and best access to equipment.
- (f) To deviate major service runs from the location shown on the drawings, submit to the Contract Administrator suitable drawings showing such deviations together with reasons for deviations and obtain approval from the Contract Administrator before proceeding with the installation.

E68.4 Codes and Standards

- (a) Install all equipment in accordance with current editions of CSA 22.1 and 22.2, including all local amendments unless otherwise specified.
- (b) Perform all work in accordance with drawings, specifications, applicable municipal and provincial regulations, and any pertinent inspection bulletins issued by the electrical inspection authority having jurisdiction over the installation. In no instance shall the standard established by the drawings and specifications be reduced.
- (c) Provide a copy of all standards referred to in this Section for use on Site.

E68.5 Permits, Inspections and Fees

- (a) Deliver to the Contract Administrator all necessary interim and final certificates of inspection and approval which may be required by all inspection authorities having jurisdiction over the Work, as evidence that the Work installed conforms with the laws and regulations of all governing authorities.
- (b) Submit copies of all plans and specifications to the authority having jurisdiction for inspections as may be required prior to commencement of work to comply with the above.
- (c) Notify the inspection authorities in sufficient time for them to arrange to inspect the Work.
- (d) Pay all associated fees.

E68.6 Abbreviations

- (a) Abbreviations for electrical terms shall be to CSA Z85-1983.
- (b) Names used throughout these specifications are:

EEMAC	Electrical & Electronic Manufacturers Association of Canada (formerly CEMA)
CSA	Canadian Standards Association
FM	Factory Mutual
NEMA	National Electrical Manufacturers Association (U.S.)
JIC	Joint Industry Conference
IPCEA	Insulated Power Cable Contract Administrators Association

ISA	Instrument Society of America
CEC	Canadian Electrical Code
IEEE	Institute of Electrical and Electronic Contract Administrators
IES	Illuminating Contract Administrating Society
NBC	National Building Code
ANSI	American National Standards Institute

E68.7 Record Drawings

- (a) Submit record drawings in accordance with General Requirements.
- (b) The Contractor shall record all changes made during construction and provide record drawings to the City upon completion of the Work.
- (c) At the completion of the project, the Contractor shall submit one (1) set of record drawings on disk, accurately recording all changes, deviations and relocations necessitated by job conditions and equipment approved shop drawings all done on CADD using AutoCad Release 2000 or later to the satisfaction of the Contract Administrator.
- (d) Include with the record drawings a list for each motor indicating motor or equipment number and name, nameplate voltage, horsepower and current, the size of overload and breaker or fuse protection provided.

E68.8 Definitions

- (a) The following are definitions of terms and expressions used in the specification:
 - (i) "Inspection Authority" means agent of any authority having jurisdiction over construction and safety standards associated with any part of electrical work on Site.
 - (ii) "Supply Authority" means electrical power company or commission responsible for delivery of electrical power to project.
 - (iii) "Electrical Code" means Canadian Electrical Code C22.1 or code in force at project location.
 - (iv) "Indicated" means as shown on contract drawings or noted in contract documents.
- (b) Refer to CSA C22.2 No.0 for "Definitions and General Requirements".

E68.9 Cooperation and Coordination

- (a) Schedule expediting of all materials and execution of the Work.
- (b) Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete shall be schedule 40 galvanized steel pipe, sized for free passage of conduit, and protruding 50 mm (2").
- (c) Cables, conduits and fittings to be embedded or plastered over neatly and close to building structure so furring can be kept to a minimum.
- (d) Arrange for holes through exterior walls and roof to be flashed and made weatherproof.

E68.10 Source Quality Control

- (a) Arrange for a plant inspection by Contract Administrator where specified.
- (b) Inform Contract Administrator of manufacturing progress and arrange inspections at appropriate times.
- (c) Action required by factory inspection shall not be construed as final acceptance.

- (d) Obtain a Certificate of Acceptance from the inspection authority on completion of the Work and provide it to the Contract Administrator.
- (e) The Contract Administrator may carry out inspections and prepare deficiency lists for action by the Contractor, during and on completion of project.

E68.11 Guarantee

- (a) Guarantee all work of the specification against all defects and labour and materials.

E68.12 Care, Operation and Start-Up

- (a) Instruct the City's operating personnel in the operation, care and maintenance of equipment.
- (b) Arrange and pay for services of manufacturer's factory service representative to supervise start-up of installation, check, test, adjust, balance and calibrate components.
- (c) Provide these services for such period, and for as many visits as necessary, to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

E68.13 General

- (a) All materials shall be fully approved by the Canadian Standards Association (CSA) for use as installed and meet the requirements of this specification in all respects.
- (b) Where there is no alternative to supplying equipment which does not have CSA approval, submit such equipment to Provincial Hydro inspection authorities for special inspection and obtain approval. Pay all associated fees.
- (c) Materials and equipment shall be of Canadian manufacture except where specified otherwise or where Canadian made materials or equipment do not exist.
- (d) Where two or more units of the same class or type of equipment are required, the units shall be the product of a single manufacturer, although components of equipment need not be products of the same manufacturer.
- (e) Use material and equipment available from regular production of manufacturer.
- (f) Control panels and component assemblies to be shop manufactured.

E68.14 Finish

- (a) Finish metal enclosure surfaces by removing rust and scale, cleaning, and applying rust resistant primer inside and outside with at least two coats of finish enamel.
- (b) Paint all outdoor electrical equipment "equipment green" finish to EEMAC-Y1.
- (c) Paint all indoor switchgear and distribution enclosure "light grey" to ASA 61 grey.
- (d) Clean, prime and paint exposed hangers, racks, fastenings, etc., to prevent rusting.

E68.15 Voltage Ratings

- (a) Operating voltages to be within those defined in CSA Standard C235-1969.
- (b) All motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment must be able to operate in extreme operating conditions established in above standard without damage to equipment.

E68.16 Wiring Terminations

- (a) Lugs, terminals, screws used for termination of wiring must be suitable for copper conductors.

E68.17 Enclosures

- (a) Minimum enclosure type to be used is EEMAC 12 unless otherwise specified.

E68.18 Manufacturers and CSA Labels

- (a) Manufacturers' nameplates and CSA labels are to be visible and legible after equipment is installed.

E68.19 Warning Signs

- (a) Provide warning signs with suitable background color and lettering as required to meet requirements of inspection authorities and Contract Administrator. Use decal signs, minimum size 178 mm x 250 mm.

E68.20 Plywood Mounting Boards

- (a) Surface wall mounted panelboards and other electrical equipment shall be installed on plywood mounting boards. Boards shall be provided under this section of the specifications, sized to suit equipment indicated and/or implied.
- (b) Plywood mounting boards shall consist of 20 mm fir plywood fastened securely to wall.
- (c) Plywood mounting boards, strapping and trim shall be treated with wood preservative prior to installation and painted with one coat of primer and two coats of grey enamel ASA61. Painting shall be completed before any electrical equipment is mounted on the plywood.
- (d) Service entrance equipment shall be spaced from the plywood mounting boards to the satisfaction of the inspection authorities.

E68.21 Workmanship

- (a) Where sheet metal enclosures are not provided with knockouts, Greenlee punches shall be used in all cases. Cutting torches shall not be used for making holes.

E68.22 Installation

- (a) Determine manufacturers' recommendations regarding storage and installation of equipment and adhere to these recommendations.
- (b) Check all factory joints and tighten where necessary to ensure continuity.

E68.23 Mounting Heights

- (a) Mounting height of equipment is given from finished floor to top of equipment.
- (b) Exact mounting height of unnoted equipment must be verified with Contract Administrator before proceeding with installation.
- (c) Install electrical equipment at heights listed below unless otherwise indicated. (All heights in millimetres from finished floor unless indicated):
 - (i) Local Switches: 1420
 - (ii) Wall Receptacles: 450
 - (iii) Lighting Panels: 1800
 - (iv) Cabinets: 1800
 - (v) Emergency Lights: 2400 (minimum)
- (d) All dimensions indicated are to the top above finished floor elevations.

E68.24 Special Protection

- (a) Accept the responsibility to protect those working on the project from any physical danger due to exposed electrically energized equipment such as panel mains, outlet wiring, etc. Shield and mark all live parts "LIVE - 600 VOLTS" or with the appropriate voltage.
- (b) Arrange for the installation of temporary doors, barriers, etc., for all electrical equipment. Keep these doors locked at all times except when under direct supervision.

E68.25 Fireproofing

- (a) Where sleeves or openings are installed in walls, floors, roof or partitions to accommodate raceways, cables or bus duct, provide all necessary seals, fittings, barriers and fire-resistant materials to restore the installation to its original fire rating to the satisfaction of the Contract Administrator and the City's insurance underwriters.

E68.26 Equipment Identification

- (a) Supply and install identification nameplates on all equipment such as motor starters, safety switches, panelboards, pushbutton stations, etc. and any equipment not so supplied. All nameplates shall be securely fastened to equipment with galvanized steel screws.
- (b) All identification nameplates, except for motors, shall be laminated phenolic with minimum 6 mm (1/4 inch) black letters on white background, the wording of which shall be identical to that on the single line diagrams and the title of the equipment controlled. Motor nameplates to be of non-corroding metal stamped or engraved with black lettering on light background.
- (c) Warning nameplates shall be laminated phenolic with minimum 6 mm (1/4 inch) white letters on red background, the wording to be reviewed by the Contract Administrator. All warning nameplates to be screwed to equipment.
- (d) Warning nameplates required by inspection authorities shall be provided for all electrical switchgear and equipment and on access doors to electrical rooms, vaults, switchyards, etc. in accordance with the applicable Code regulations. Obtain all necessary details from the inspection authorities.
- (e) Where wording not specified on the drawings, obtain exact wording from the Contract Administrator.
- (f) Identify pull boxes, terminal cabinets and junction boxes enclosing cables or connections with nameplates indicating voltage, box number and circuit number.
- (g) Provide junction boxes, relay panels and miscellaneous equipment energized from two or more sources with a warning nameplate prominently displayed, noting number and location of sources and their voltage.
- (h) Provide a typewritten circuit directory with a clear plastic cover for each panelboard in a suitable holder on the inside of each panel door. Unless otherwise noted, the directory shall indicate breaker or switch circuit number, rating, load description and associated load data.
- (i) Manufacturer's nameplates and CSA labels to be visible and legible after equipment is installed.
- (j) Welding receptacle shall be 60A, 600V, 3 pole, 3 wire with threaded cap. Acceptable manufacturer is Crouse-Hinds No. AR337.

E68.27 Wiring Identification

- (a) Provide permanent indelible identifying markings, either numbered or colored plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring. Maintain phase sequence and identification throughout system, i.e. panelboards, starters, terminal blocks, disconnect switches.
- (b) Maintain identification system at all junction boxes, splitters, cabinets and outlet boxes.
- (c) Use color coded wires in communication cables, matched throughout system. All color coding must adhere to CSA C22.1.

E68.28 Touch-Up Painting

- (a) Be responsible for field touch-up painting of all shop painted electrical equipment installed in this Contract.
- (b) All surfaces to be painted shall be dry, clean, free from dust, dirt, grease, frost, rust, loose crystals or extraneous matter, tool and machine marks. Feather out edges of scratch marks to make patch inconspicuous.
- (c) Apply one or more coats of paint until the damaged surface has been restored to original finish condition. Do not apply succeeding coats until preceding coat is dry and hard. Sand lightly between coats with No. 00 sandpaper.
- (d) Be responsible for obtaining the necessary touch-up paint of the original type and quality from the equipment manufacturer.
- (e) Supervise priming and finish painting of all electrical equipment and material not shop painted.

E68.29 Sleeves and Openings

- (a) Provide sleeves and openings for exposed conduits, busways, and wireways, where they pass through walls or floors conforming to relevant fire codes where applicable.
- (b) Sleeves for individual conduits shall be galvanized or stainless steel.
- (c) Pack or fill sleeves and openings after the completed work is in place. Filling shall provide a waterproof seal to prevent leakage of water or other liquids through the sleeve or opening.
- (d) Sleeves and openings shall not displace reinforcing steel, and shall receive approval of the Contract Administrator prior to placement.

E68.30 Cutting and Patching

- (a) Do all drilling, cutting, fitting and patching necessary for the running and securing of conduits, wireways, and other electrical equipment.
- (b) Provide supports necessary for same.
- (c) Provide bracing and anchorage of work subject to Contract Administrator's approval.
- (d) No cutting of the structural members or of the fireproofing shall be done without the written consent of the Contract Administrator.
- (e) Caulk and flash all conduits passing through walls, roofs or other surfaces exposed to weather or as indicated on the drawings to prevent the passage of water and/or sewer gases.

E68.31 Hangers and Supports

- (a) Provide hangers, angles, channels, and other supports necessitated by field conditions to install all items of electrical equipment. Design of supports and methods of fastening to building structures shall be subject to the Contract Administrator's approval.

- (b) All local motor control devices are to be grouped and mounted on a free-standing frame of galvanized steel construction easily accessible and as close to the motor as possible.
- (c) Provide weight-distribution facilities, where required, so as not to exceed the load-bearing capacities of floors or walls that bear the weight of, or support, electrical items.
- (d) Paint all exposed parts of hangers and supports with an anti rust inhibiting primer.
- (e) Equipment shall not be held in place by its own weight. Provide base anchor fasteners in each case.

E68.32 Protection of Equipment

- (a) Protect conduit and wireway openings against the entrance of foreign matter by means of plugs or caps.
- (b) Fixtures, materials, equipment, or devices damaged prior to final acceptance of the Work shall be restored to their original condition or replaced by the Contractor.

E68.33 Testing of Electrical Systems

E68.33.1 General

- (a) Prior to the Contract Administrator's acceptance, all electrical equipment, materials and systems installed shall be subject to an inspection and applicable performance tests supervised by the Contract Administrator to ensure that the operation of the system and components satisfy the requirements of the Specifications.
- (b) Ensure that the system and its components are ready prior to the inspection and test for acceptance.
- (c) All testing shall be conducted by fully qualified personnel only. Tests requiring initial power energization of a system shall not be made without notification of the Contract Administrator. Tests, checks and the like carried out by or on behalf of the Contractor shall be documented and certified at no additional cost to the City. Submit six copies of the test certificates to the Contract Administrator. Carefully check wiring for each system and/or part of a system to ensure that the system will function properly as indicated by wiring and schematic diagrams, description of operation, etc.
- (d) Carefully check wiring for each system and/or part of a system to ensure that the system will function properly as indicated by wiring and schematic diagrams, description of operation, etc.
- (e) Manually operate alarms and control devices to check whether their operation during normal and abnormal operating conditions causes the proper effect.
- (f) Supply the necessary labour and for all electrical systems equipment for operational tests required and make final adjustments to the electrical controls at no additional cost to the City.
- (g) Perform tests on auxiliary or specialized systems with the assistance of the manufacturer's representative. Upon successful conclusion of the tests, obtain a certificate from the manufacturer stating that the system has been installed to their satisfaction and that it is in good working order.
- (h) Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to values and settings as indicated.
- (i) Supply all instruments, meters and personnel required for the tests.

E68.34 Cable and Wire 1000 Volt and Below

- (a) Tests on cables in this voltage range shall be limited to insulation resistance measurements using a 500V megger for systems up to 350V and a 1000V megger for 351-600V systems.
- (b) Record all test results in a log book and submit to the Contract Administrator for reference. Replace or repair all circuits which do not meet minimum requirements specified in the CEC, Table 24. Insulation resistance of the following circuits shall be measured:
 - (i) Power, lighting and motor feeders (with equipment disconnected): phase-to-phase, phase-to-neutral and phase-to-ground.
 - (ii) Control circuits: measure to ground only.
 - (iii) Do not perform megger tests on control circuits containing transistorized or solid-state components.
 - (iv) Where power factor correction equipment is installed, it may be necessary to disconnect the capacitors from the system prior to testing to avoid overvoltage.

E68.35 Ground System

- (a) Test the grounding system efficacy for compliance with CSA Standard C22.1 and Supply Authority requirements. Verify that the ohmic resistance values specified therein are not exceeded.
- (b) Notify inspection and supply authorities that they may be present to witness Contractor testing and provide any assistance required by these authorities for their own testing procedures.

E68.36 Training

- (a) Provide for the training of the City's representatives in the operation, maintenance and testing of all systems and equipment including the provision of qualified manufacturer's technical representatives for specialized systems.
- (b) Provide these services for such period, and for as many visits as necessary to put installation in working order, and to ensure that operating personnel are conversant with all aspects of its care and operation.

E69. CONDUIT, CONDUIT FASTENINGS AND CONDUIT FITTINGS

E69.1 Scope

- (a) Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install a complete conduit raceway system. The raceway systems shall be comprised of the supply and installation of all conduits, fittings, supports, hangers and miscellaneous support materials and hardware required.

E69.2 Quality Assurance

- (a) Rigid PVC (Unplasticized) conduit to CSA C22.2 No. 211.2-M1984. Liquid-tight flexible metal conduit to CSA C22.2 No. 56-1977.

E69.3 Location of Conduit

- (a) The drawings do not show every specific conduit run. All wiring shall be surface or run in the slab unless otherwise indicated in the specifications and/or shown on the drawings. All devices shall be surface mounted type except as shown.

E69.4 Conduits

- (a) Conduit shall be Rigid PVC Minimum size to be 12 mm.

- (b) Liquid-tight flexible metal conduit for motor and equipment connections.
- (c) EMT conduit shall not be utilized anywhere in the installation.

E69.5 Conduit Fastenings

- (a) Two hole PVC straps to secure surface conduits.
- (b) Beam clamps to secure conduits to exposed steel work.

E69.6 Conduit Fittings

- (a) Couplings, terminal adapters, female adapters shall be of the IPEX type of equal. PVC fittings shall be installed in all areas.

E69.7 Expansion Fittings for PVC Conduit

- (a) All conduits entering outlet boxes and devices that are located in walls subject to movement shall be terminated by means of liquid-tight flexible conduit, approximately 450 mm in length between the PVC conduit and the outlet box or device which is being supplied. All conduits, bus duct, wireways, etc., passing through or across expansion joints of the building shall be installed with the use of approved expansion fittings.

E69.8 Fish Cord

- (a) Polypropylene

E69.9 General Installation Requirements

- (a) Install surface mounted conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- (b) Cut conduit ends square and ream to remove burrs and sharp edges. Ensure that conduits butt in couplings and other fittings.
- (c) Bends and offsets shall have a minimum radius of curvature not less than the minimum bending radius of the cable to be installed.
- (d) Temporarily plug all conduits terminating in cabinets and boxes where moisture and foreign matter may enter.
- (e) Blow all conduits through with clean compressed air to clear all foreign matter and moisture prior to the installation of wires or cables.
- (f) Install fish cord in all conduits.
- (g) Group exposed conduits together wherever possible and run parallel to building lines, supported from structural members and protected by the flanges of the structural member where practical.
- (h) Support horizontal and vertical runs of individual exposed conduits by one-hole or two-hole conduit straps and suitable fasteners or beam clamps for mounting to building structure or bracket. Make no holes in building structural members for supporting conduits without the permission of the Contract Administrator.
- (i) Securely fasten exposed conduits in place at regular intervals with hangers, supports or straps. Provide additional supports at each elbow and terminations at a box or cabinet.
- (j) Perforated metal straps used to support conduits are unacceptable.
- (k) Install conduits at least 150 mm (6") clear of all steam pipes and flues, and 1 m (39") clear of heaters. Do not bend over sharp objects or improperly form.
- (l) The maximum length of straight conduit run shall be 30 M (100 feet) between pull boxes or other terminations. This length shall be reduced by 10 M (32 feet) for each

90 degree bend or 5 M (12.5 feet) for each 45 degree bend or offset. Conduit runs shall not include more than the equivalent of two 90 degree bends between pull boxes except where indicated otherwise on the drawings.

- (m) Where conduits pass through roof, seal with flashing and make weatherproof. For conduits passing through exterior walls, above or below grade, seal with waterproof sealing compound.

E70. WIRE AND CABLE

E70.1 Scope

- (a) Furnish all labour, materials, supervision, equipment and services specified herein, indicated or requested to install the complete wiring system including but not limited to:
 - (i) Low voltage wire and cable (1000 V and below)
 - (ii) Control wiring
- (b) The wiring system shall include all wiring, terminations, wire markers, cable tags, cable ties, splice fittings, insulating tapes, connectors and miscellaneous materials necessary to complete the wiring system.

E70.2 Low Voltage Wire 1000 Volt and Below

- (a) All wire shall have stranded, annealed copper or compact stranded 8000 Series aluminium alloy conductors, 600 volt rating, cross-linked polyethylene (XLPE) insulation, minus 40°C, 90°C maximum conductor temperature, limited flame spread.
- (b) The wiring shall be suitable for installation in wet environment and rated RW-90.
- (c) For direct buried installations or for installation in direct buried polyethylene pipe, the cable shall be cross-linked polyethylene, rated RWU-90.
- (d) Minimum conductor size shall be #12 AWG unless otherwise specified. #14 AWG may be used for control wiring, #6 for aluminium.
- (e) Use GTF fixture wire, 600 volt, 125 C, flexible copper conductor for all connections between lighting fixtures and outlet boxes.
- (f) Color coding of insulated conductors shall conform to the following:

Single Phase Systems

Phase A	Red
Phase B	Black
Neutral	White
Ground	Green

Three Phase Four Wire Systems

Phase A	Red
Phase B	Black
Phase C	Blue
Neutral	White
Ground	Green

- (g) Insulated ground conductors forming part of a multi-conductor cable assembly shall have green color coding.
- (h) Cable and wire shall be as manufactured by Alcatel Canada Wire Inc., Phillips Cables Ltd., Pirelli Cables Inc., Alcan Cable Inc.

E70.3 Teck Cable/ACWU90

- (a) Conductors:
 - (i) Grounding Conductor: copper or 8000 series Aluminium
 - (ii) Circuit conductors: copper or 8000 series Aluminium, size as indicated
- (b) Insulation:
 - (i) Chemically cross-linked thermosetting polyethylene rated RW90, 600 volt.
- (c) Inner Jacket: polyvinyl chloride material (Teck cable)
- (d) Armor: interlocking aluminium
- (e) Overall covering PVC material, color black, flame retardant, FT4 rated, AG14.
- (f) Fastenings:
 - (i) One hole aluminum straps to secure surface cables 50 mm and smaller. Two hole straps for cables larger than 50 mm. All straps to have inert spacers between spacer and concrete.
 - (ii) Channel type supports for two or more cables.
 - (iii) 3/8" diameter threaded rods to support suspended channels.
- (g) Connectors:
 - (i) Watertight approved for Teck or ACWU90 cables.
- (h) Lugs:
 - (i) Dual rated AL7CU or AL9CU listed by CSA for use with Aluminum or Copper conductors and sized to accept aluminium conductors of the ampacity specified.

E70.4 Wiring Accessories

- (a) Wire markers, black letters on white background, shall be heat shrink type as manufactured by Critchley.
- (b) Cable markers for cables or conductors greater than 13 mm (1/2 inch) diameter, shall be strap-on type, rigid PVC, black letters on white background, with PVC covered aluminum straps, as manufactured by Electrovert Cat. No. 510.
- (c) Terminal blocks shall be minimum 600 volt rated, modular, sized to accommodate conductor size used, as manufactured by Weidmuller, Phoenix, Allen-Bradley.
- (d) Where screw-type terminals are provided on equipment, field wiring shall be terminated with insulated fork tongue terminals, as manufactured by Thomas & Betts, Sta-Kon.
- (e) Splice connectors for wire sizes #14-10 AWG inclusive, shall be of the compression spring type, as manufactured by Ideal Waterproof Type DP.
- (f) Splice connectors for wire sizes #8 AWG and larger shall be split-bolt type, sized to suit number and size of conductors, as manufactured by Burndy Servit Type KS.
- (g) Cable ties shall be nylon, one-piece, self-locking type, as manufactured by Thomas & Betts, Burndy, Electrovert.
- (h) Electrical insulating tape as manufactured by 3M Scotch 88.
- (i) Cable grips shall be provided for all vertical and catenary cable suspension installations to reduce cable tension at connectors or at cable bends. The cable grips shall be selected to accommodate the type and geometry of cable supported and shall be of the single wave, variable mesh design, as manufactured by Kellems, Arrow-Hart.

- (j) Cable pulling lubricant shall be compatible with cable covering and shall not cause damage and corrosion to conduits or ducts.

E70.5 Installation

- (a) Install all wire according to the drawings with a minimum size of #12 AWG unless indicated otherwise.
- (b) Pull wire into ducts and conduits in accordance with the manufacturer's recommendations, using patented wire grips suitable for the type of wire or using pulling eyes to be installed directly onto the conductors.
- (c) Limit pulling tensions to those recommended by the manufacturer to avoid overstressing wire.
- (d) Utilize adequate lubricant when pulling wires through ducts and conduits to minimize wear on cable jackets.
- (e) Make connections to equipment "pig-tails" with mechanical, insulated, screw-on connectors for wire sizes #14-10 AWG. For wire sizes #8 AWG and larger utilize split-bolt connectors, taped with three layers minimum of insulating tape. For both copper and aluminium terminations, wire through the conductor, apply joint compound anti-oxidant, and torque to lug manufacturer's recommended torque levels.
- (f) No splices shall be permitted in cable or wiring runs without the written permission of the Contract Administrator, and shall only be permitted in junction boxes.
- (g) Neutral conductors shall be identified. Paint or other means of coloring the insulation shall not be used.
- (h) Unless otherwise specified, make all wiring taps, splices and terminations with identified compression screw type terminal blocks, securely fastened to avoid loosening under vibration or normal strain. Make connections for interior and exterior lighting circuits and 120 volt, 15 amp convenience receptacle circuits using screw-on or split-bolt connectors and insulating tape.
- (i) Determine the exact length of cable required to avoid splices.
- (j) Identify each conductor by specified markers at each termination indicating the circuit designation or wire number.
- (k) Identify each cable by attaching a suitable marker, stamped or indelibly marked with the cable number, at each end of the cable and in all junction boxes and pull boxes.

E71. WIRE AND BOX CONNECTORS

E71.1 Scope

- (a) This section covers the supply and installation of all wire and box connectors.

E71.2 Quality Assurance

- (a) Solder lugs to CSA C22.2 No. 19-1935 (R1981).
- (b) Wire connectors to CSA C22.2 No. 65-M1988.
- (c) Connectors shall be copper or copper alloy.
- (d) Bushing stud connectors to EEMAC 1Y-2-1961 and shall be suited for conductor type.
- (e) Clamps or connectors for cable to CSA-C22.2 No. 18, 1972.

E71.3 Materials

- (a) All lugs, terminals and screws used for termination of wiring must be suitable for copper conductors.

- (b) Pressure type wire connectors: with current carrying parts of copper sized to fit copper conductors as required.
- (c) Fixture type splicing connectors: with current carrying parts of copper sized to fit copper 10 AWG or less.
- (d) Clamps or connectors for flexible conduit, as required.
- (e) All cable terminations shall be with compression type connectors.

E71.4 Installation

- (a) Remove insulation carefully from ends of conductors.
- (b) Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No. 65-M1988.
- (c) Install fixture type connectors and tighten. Replace insulating cap.
- (d) Install crimp type connectors to the satisfaction of the Contract Administrator.
- (e) Install box connectors to CSA requirements.

E72. FASTENINGS AND SUPPORTS

E72.1 Scope

- (a) This section covers the supply and installation of all fastenings and supports for equipment mounted under the electrical contract.

E72.2 Materials

- (a) Expansive screw anchors, shields, or other fastening items containing lead or other material that might loosen or melt under fire conditions shall not be used. All fastenings used in the sewage lift station shall be corrosion resistant stainless steel.
- (b) Power-actuated fasteners and devices shall not be used.
- (c) Support channels, length as required, U shaped, size as required, of stainless steel.
- (d) Support equipment, conduit or cable clips, spring loaded bolts, cable clamps etc., to be purpose-built accessories to basic channel members.
- (e) Two-hole PVC straps to secure surface conduits 50 mm and smaller.
- (f) Beam clamps to secure conduit to exposed steel work.
- (g) Support individual cable or conduit runs with 6.0 mm diameter galvanized steel threaded rods and spring clips.
- (h) Support two or more cables or conduits on channels supported by 6.0 mm diameter stainless steel threaded rod hangers where direct fastening to building construction is impractical.

E72.3 Installation

- (a) Install fastenings and supports as required for each type of equipment, cables and conduit to manufacturer's installation recommendations.
- (b) Provide metal brackets, frames, hangers, clamps and related support structures where indicated or as required to support conduit and cable runs.
- (c) Do not use wire lashing or perforated strap to support or secure raceways or cables.
- (d) Provide adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

- (e) Do not use supports of other equipment installed for conduit or cable support except with permission and approval of the Contract Administrator.
- (f) Any aluminum support bracket or channel that is in direct contact with concrete is required to have inert spacers to reduce chemical reaction between support and concrete.

E73. OUTLET PULL, SPLITTER AND JUNCTION BOXES

E73.1 Scope

- (a) Furnish all labour, materials, equipment and services specified, indicated or requested to install the electrical boxes specified herein and on the drawings.

E73.2 Outlet Boxes

- (a) Size boxes in accordance with CSA C22.1-1986.
- (b) 100 mm square or larger outlet boxes as required for special devices.
- (c) Gang boxes where wiring devices are grouped.
- (d) Blank cover plates for boxes without wiring devices.
- (e) Outlet boxes to be PVC.
- (f) All outlet boxes shall be supplied with ground stud.
- (g) Outlet boxes to be Series FS or FD as manufactured by Ipex.
- (h) Surface mounted outlet boxes shall be EEMAC 12 unless otherwise indicated.
- (i) All outlet boxes to CSA C22.2 No. 18-M1987.

E73.3 Installation

- (a) Install boxes to clear all building and mechanical services equipment. Where two or more devices are shown at one location, utilize multi-gang boxes. Supply all outlet boxes with covers as required.
- (b) Size all boxes to accommodate the number of conduits, conductors and terminal blocks. Provide junction boxes with 20% spare terminal blocks.
- (c) Securely fasten surface-mounted boxes to the building or mounting structure and support independently of the conduits entering the box.
- (d) Install junction and pull boxes mounted on brick, concrete or block walls with 3 mm (1/8 inch) thick lead or nylon washers between box and wall face.
- (e) Provide pull boxes sized to CEC requirements, in all conduit raceway systems to limit length of straight conduit runs to 30 m (100 ft). Reduce this length by 7.5 m (25 ft) for each 90 degrees bend or 4 m (12 ft) for each 45 degree bend or offset.
- (f) Mark location and size of all pull boxes on the record drawings.

E73.4 Application

- (a) Location of outlets indicated may be changed by the Contract Administrator at no extra cost or credit, providing distance moved does not exceed 3000 mm, and notice is given before installation is completed.

E73.5 Mounting Heights

- (a) Refer to General Electrical Provision.
- (b) Exact mounting height of unnoted equipment must be verified with the Contract Administrator before proceeding with installation.

E74. WIRING DEVICES

E74.1 Scope

- (a) This section covers the supply and installation of all receptacles, toggle switches, and cover plates.
- (b) All wiring devices shall be at the same manufacturer throughout the Contract.

E74.2 Receptacles

- (a) This specification applies to single and duplex receptacles and receptacles of other voltage and ampacity as indicated on the drawings.
- (b) Type EEMAC 5-15R, 125V, 15A, U-ground, heavy duty specification grade to CSA C22.2 No. 42-M1984.
- (c) Receptacle shall have heavy duty nylon face with steel reinforcing plate in centre.
- (d) Receptacle shall have spring loaded back wiring.
- (e) Receptacle shall have raised ground for safety.
- (f) Receptacle contacts shall have spring steel clips to reduce contact fatigue.
- (g) Receptacle shall be suitable for No. 10 AWG back and side wiring.
- (h) All screws shall be combination slotted socket head design to accept #6 socket head screwdriver on all screws.
- (i) Acceptable manufacturer is Bryant, Arrow Hart, Levton No. 5262 duplex receptacle.

E74.3 Switches

- (a) Switches shall be 15A, 120V, single pole, double pole, or three way as indicated on the drawings.
 - (i) Must adhere to CSA 22.2 No. 111-M1986.
 - (ii) Switches to be manually-operated heavy duty with the following features:
 - (iii) Heavy duty mounting strap
 - (iv) One piece Lexan toggle, lever, and cam
 - (v) Silver alloy contacts
 - (vi) Spring loaded back wired
 - (vii) Green hex head grounding terminal
 - (viii) All screws socket/slotted head suited to accommodate #6 socket head screwdriver
 - (ix) Switches to be fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
 - (x) Acceptable manufacturer is Bryant, Arrow Hart, Leviton No. 1201 (number to suit application and amperage).

E74.4 Cover Plate

- (a) Cover plates from one manufacturer throughout project to match switches and receptacles.
- (b) Cover plates to be PVC.
- (c) For wiring devices mounted in flush-mounted outlet boxes, thickness to be 2.5 mm.
- (d) Cover plates shall be suitable for Ipex FS/FD boxes.
- (e) Acceptable manufacturer is Ipex.

E74.5 Weatherproof Cover Plates

- (a) Weatherproof covers for duplex receptacles shall be self closing, two spring loaded independent doors, PVC complete with non-corrosion stainless steel springs and stainless steel mounting screws.
- (b) Weatherproof covers for light switches shall be plunger style, PVC complete with non-corrosive stainless steel mounting screws.
- (c) Covers shall be complete with EPDM gasketry material suitable for -45°C to 85°C.
- (d) Acceptable manufacturers are IPEX, Leviton.

E74.6 Installation

- (a) Switches:
 - (i) Install single throw switches with handle in "UP" position when switch is closed.
 - (ii) Utilize gang type outlet box where more than one switch is required in one location.
- (b) Receptacles:
 - (i) Install all 15A receptacles with "U" ground slot up.
 - (ii) Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - (iii) Mount receptacles at height specified in Section 16010 or as indicated.
 - (iv) The location of all outlets as shown on the electrical plans is approximately correct at the time of planning, but as these drawings do not shall all structural details, measure any work requiring accurate dimensions either on the project or from the architectural details.
 - (v) The location of outlets shown on the drawings may be changed by the Contract Administrator at no extra cost to the City, providing the distance does not exceed 3000 mm and the information is given before installation.
- (c) Cover Plates:
 - (i) Install all cover plants prior to energization.
 - (ii) Cover plates shall be straight and true.
 - (iii) Flush-mounted cover plants shall be flush with the wall.
 - (iv) Do not use cover plants meant for flush-mounted outlet boxes on surface-mounted boxes.

E75. DISCONNECT SWITCHES

E75.1 Scope

- (a) This section covers the supply and installation of all motor and equipment disconnect switches.

E75.2 Submittals

- (a) Submit shop drawings in accordance with the general provisions including the following information:
 - (i) Scale drawing of switch and enclosure
 - (ii) Switch voltage rating

E75.3 Unfused Disconnect Switches

- (a) Provide unfused disconnect switches, voltage and amperage rated to suit loads.

- (b) Disconnect shall be front-operational, heavy duty, industrial grade, quick-make, quick-break type.
- (c) Make provision for padlocking in the "OFF" position.
- (d) Mechanically interlocked door to prevent opening when handle in "ON" position.
- (e) "ON/OFF" switch position indication on switch enclosure cover.
- (f) Disconnect enclosures shall be EEMAC 12 unless otherwise indicated.

E75.4 Manufacturers

- (a) Disconnects for all equipment specified shall be as manufactured by Cooper Crouse-Hinds GHG series, Arrow Hart AH series, Cutler-Hammer HD series, Schneider Canada Square "D"CHU series.

E75.5 Installation

- (a) Install disconnect switches as per manufacturer's recommendations.
- (b) Mount switches at 1400 mm above finished floor to the underside of the switch enclosure.

E75.6 Identification

- (a) Provide lamacoid nameplates on front face of switch identifying equipment.

E76. GROUNDING

E76.1 Scope

- (a) Furnish all labour, materials, equipment and services specified, indicated or requested to install a complete grounding system. The grounding system shall include ground rods, all wiring, ground bus, thermit welds, mechanical fittings, connectors, links and miscellaneous materials necessary to complete a grounding system acceptable to the inspection authorities.

E76.2 Quality Assurance

- (a) Grounding equipment to CSA C22.2 No. 41-M1987.
- (b) Copper grounding conductors to ASA A7.1 1964.

E76.3 Ground Conductors

- (a) Ground conductors shall be concentric stranded, soft drawn copper. Insulated conductors, where required by inspection authorities or specified, shall be type TW, 600 volt rating, green color.
- (b) Where direct buried bare ground conductor comes into contact with corrosive material, the conductor shall be tinned.

E76.4 Ground Clamps

- (a) Ground clamps for connecting ground conductors to metal water piping not suitable for thermit weld connections shall be sized to accommodate the system ground conductor and the water pipe, as manufactured by T & B, Burndy.

E76.5 Compression Connections

- (a) Compression devices shall be of pure wrought copper material, factory fitted with oxide inhibiting compound and shall meet latest IEEE 80 Standard, as manufactured by T & B, Burndy.

E76.6 Mechanical Connections

- (a) Mechanical connectors shall be of bronze , copper or brass construction with stainless steel hardware selected and sized specifically for the particular application and shall meet latest IEEE standard.

E76.7 Ground Rods

- (a) Ground rods shall be 19 mm (3/4") diameter, 3 m (10 feet) long, copper clad steel construction with the copper exterior coating permanently bonded to the steel core.

E76.8 Installation

- (a) Make all conductor joints, splices and connections with permanent type thermit welds or mechanical compression connectors utilizing hydraulic tools.
- (b) Make ground connections to building steel or flat metallic surfaces with thermit welds. Locate connections where they will not be subject to mechanical damage and, where possible, be accessible for inspection.
- (c) Protect grounding conductors or bus subject to mechanical damage by rigid steel conduit or steel guards which shall be effectively grounded at both ends to the ground conductor they are protecting, regardless of their length.
- (d) Make connections to ground bus using mechanical clamp type connectors.
- (e) Securely bond metal enclosures, motor frames, steel supports for starters, panels, switches, etc., which are not rigidly secured to and in contact with grounded structural steel of a building or conduit system, or which are subject to excessive vibration, to building steel or conduit system with stranded copper conductors.
- (f) Install ground conductors passing through masonry walls, floors, foundations, etc. in 25 mm (1") rigid PVC conduit sleeves. Where sleeves are installed in walls or floors below grade, seal the sleeves watertight after installation of ground conductor.

E76.9 Equipment Grounding

- (a) Install grounding connections to typical equipment included in, but not necessarily limited to the following list: service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steelwork, distribution panels, outdoor lighting, telephone backboard.

E76.10 Tests

- (a) Perform tests in accordance with general provisions.
- (b) Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of the Contract Administrator and inspection authority having jurisdiction.
- (c) Perform tests before energizing electrical system.
- (d) Disconnect ground fault indicator during tests.
- (e) Perform tests in presence of the Contract Administrator.
- (f) Submit written test results to the Contract Administrator.

E77. DRY TYPE TRANSFORMERS

E77.1 Scope

- (a) This section covers the supply and installation of all dry type transformers.

E77.2 Quality Assurance

- (a) To CSA C22.2 No. 47-1961 and C9-1966
- (b) To C.E.C. Section 26-260 "Marking of Transformers"

E77.3 Submittals

- (a) Shop drawings in accordance with the general provisions.
 - (i) Voltage ranges and taps
 - (ii) KVA rating
 - (iii) Mounting configurations
 - (iv) Weight
 - (v) Cable terminal sizes
 - (vi) Nameplate data.

E77.4 Transformers

- (a) Use transformers of one manufacturer throughout project.
- (b) Transformers to have the following characteristics:
 - (i) Type: Epoxy encapsulated
 - (ii) Three phase, 600V delta connected primary, 120/208V wye connected secondary
 - (iii) kVA rating as indicated on drawings
 - (iv) Operating frequency of 60 Hz
 - (v) Winding insulation of 1000 V class, 115 degree temperature rise
 - (vi) Maximum impedance of 5%
 - (vii) Sound rating of 40 dB
 - (viii) Basic Impulse Level (BIL) is standard
 - (ix) Hipot is standard
 - (x) Taps 4 – 2 1/2 percent FCAN, FCBN
 - (xi) Air ventilated via louvres
 - (xii) Termination at bottom of transformer
 - (xiii) Finish shall be ASA 61 grey

E77.5 Manufacturers

- (a) Acceptable manufacturer is Hammond, Square "D", Bemag.

E77.6 Mounting

- (a) Installation to C.E.C. Section 26-248.
- (b) Units shall be floor or wall mounted as indicated on drawings.
- (c) Mount transformers in level upright position.
- (d) Units shall be clear of air obstructions on five sides by minimum of 75 mm to ensure adequate ventilation.
- (e) Remove shipping supports only after transformer is installed and just before putting into service.
- (f) Loosen isolation pad bolts until no compression is visible.

E77.7 Connections

- (a) Make primary and secondary connections
- (b) Energize transformers immediately after installation is completed, where practicable.

E77.8 Equipment Identification

- (a) Provide equipment identification in accordance with the general provisions.

E78. PANELBOARDS

E78.1 Scope

- (a) This section covers the supply and installation of all distribution and power panelboards, including mounting hardware and breakers or fuses.

E78.2 Quality Assurance

- (a) All equipment to CSA Standard C22.2 No. 29-M1989.
- (b) Fault current ratings to be indicated on nameplates.

E78.3 Submittals

- (a) Submit shop drawings in accordance with the general provisions.

E78.4 Panelboards

- (a) Panelboards shall be supplied by one manufacturer.
- (b) 120/208V, 3 phase, 4 wire power panelboard bus and breakers to be rated 10,000 amps (symmetrical) interrupting capacity.
- (c) 347/1600V, 3 phase, 4 wire power panelboard bus and breakers to be rated 18,000 amps (symmetrical) interrupting capacity.
- (d) Panelboard mains, number of circuits, and number and size of branch circuit breakers shall be as indicated on the drawings.
- (e) The main bus bars shall be copper and shall be equipped with solderless lugs for incoming cables. Neutral to be of same ampere rating as mains.
- (f) Distribution section to accommodate circuit breakers. Breakers shall be the interchangeable trip type.
- (g) Doors shall have spring latches and cylinder locks, and all locks shall be keyed alike with two keys per panelboard.
- (h) EEMAC 12 rated enclosure.
- (i) Distribution panelboard acceptable manufacturer shall be Schneider Canada Square "D" type NQOD, Cutler-Hammer Pow-R-Line Series.
- (j) Power panelboard acceptable manufacturer shall be Schneider Canada Square "D" In-Line, Cutler-Hammer Pow-R-Line series, Siemens type NDP.

E78.5 Circuit Breakers

- (a) Refer to Circuit Breakers for breaker specification.
- (b) Breakers shall be numbered with odd numbers on left and even numbers on right sides of the panel.
- (c) Breakers shall be the bolt-on type and shall provide instantaneous trip on over-currents and time-delay trip on overloads.
- (d) Breakers shall be compatible with fault current rating of the panel.
- (e) Breakers shall be of the thermal magnetic tripping type.
- (f) Main breaker shall be separately mounted on top or bottom of panel to suit cable entry as required. When mounted vertically, down position should open breaker.

E78.6 Plant Assembly

- (a) Install circuit breakers in panelboards before shipment.

E78.7 Installation

- (a) Locate panelboards as indicated on the drawings and mount securely, plumb true and square.
- (b) Install each panelboard 1980 mm above finished floor measured to the top of the enclosure.
- (c) Install panelboards mounted on brick, concrete or block walls on plywood backboards or use 3 mm thick lead washers between enclosure and wall face. Where practical, group panels on common backboard.
- (d) Make all field wiring connections and terminations. Connect loads to circuits as indicated and connect neutral conductors to common neutral bus with respective neutral identified.

E78.8 Equipment Identification

- (a) Provide nameplate for each panelboard engraved as directed.
- (b) Provide complete circuit directly with typewritten legend showing location and load of each circuit.

E79. CIRCUIT BREAKERS

E79.1 Scope

- (a) This section covers the supply and installation of all magnetic and thermal magnetic circuit breakers.
- (b) Specific circuit breaker voltage, phase, ampacity, pole numbers, interrupting capacity, breaker type and setting are indicated elsewhere in the specifications or on the drawings.

E79.2 Quality Assurance

- (a) All equipment to CSA Standard 22.2, No. 5-M1986.

E79.3 Submittals

- (a) Submit shop drawings in accordance with these provisions, including:
 - (i) Component function, make and model no.
 - (ii) Breaker voltage and amperage.
 - (iii) Breaker phase, number of poles & number of wires.
 - (iv) Indication of solid neutral if required.
- (b) Submit time-current characteristic curves for breakers with ampacity of 15 A and over or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

E79.4 Breakers – General

- (a) Bolt-on moulded case circuit breakers, quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.
- (b) Common-trip breakers with single handle for multipole applications.
- (c) Magnetic instantaneous trip elements in circuit breakers, to operate only when the value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3-10 times current rating.

- (d) Circuit breakers with interchangeable trips as indicated.

E79.5 Thermal Magnetic Breakers

- (a) Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping.

E79.6 Magnetic Breakers

- (a) Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping.

E79.7 Enclosures

- (a) All breakers shall be housed in an EEMAC 12 rated panelboard or in an MCC cubicle.

E79.8 Manufacturers

- (a) For circuit breakers protecting fans, heating elements, transformers and panelboards, acceptable manufacturer is Schneider Canada Federal Pioneer FHL, Cutler-Hammer Series C, Siemens type SB.
- (b) For circuit breakers protecting electric motors, acceptable manufacturer is Schneider Canada Square "D" Mag-Guard MCP, Culter-Hammer Series C HMCP, Siemens.

E79.9 Installation

- (a) Install circuit breakers in panelboard and MCC as indicated.

E80. SURGE SUPPRESSORS

E80.1 Scope

- (a) This section covers the supply and installation of all transient voltage surge suppressors.

E80.2 Submittals

- (a) Submit shop drawings in accordance with General Electrical Requirements including:
 - (i) Unit dimensions, mass, installation instruction details and wiring configuration.
 - (ii) Clamping voltage test data, in a graph form, for a Category B3 ringwave and a Category B3 combination wave, as defined by ANSI/IEEE C62.41 and tested in accordance with ANSI/IEEE C62.45.
 - (iii) Insertion loss test data, in a graph form, over a frequency bandwidth from 0 to 100 MHz and tested in accordance with MIL-STD 220A.
 - (iv) A nameplate showing the electrical ratings, including UL 1449 surge suppression ratings and the UL and CSA monograms, shall be permanently affixed to the unit.

E80.3 General Product

- (a) The transient voltage surge suppressors (TVSS) described by this specification are to be installed in the various panels as indicated.
- (b) All TVSS devices shall be listed under UL 1449 and certified by CSA.

E80.4 Specific Product Requirements

- (a) TVSS device installed on the MCC shall be suitable for a Category C3 environment in accordance with ANSI/IEEE C62.41.
- (b) TVSS device shall be wired in parallel into the electrical system.

- (c) TVSS device shall feature full-cycle tracking clamping profiles that follow the AC sine wave contour for uniform transient voltage surge suppression regardless of phase angle.
- (d) TVSS device circuit shall be a MOV-based, hybrid design; surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform shall be rated and internally fused to a minimum of 100kA in relation to available interrupting capacity (AIC) per phase and provide equal impedance paths to each matched MOV bank. TVSS device design shall not be based on components such as gas tubes, which may crowbar the system.
- (e) The maximum continuous operating voltage (MCOV) shall be greater than 115% of the nominal system operating voltage.
- (f) TVSS devices shall protect against surges between phase and neutral (L-N) and neutral and ground (N-G) in wye configured systems (four-mode TVSS device). TVSS devices for branch panels shall protect against surges between phase and neutral (L-N), phase and ground (L-G) and neutral and ground (N-G) in wye configured systems (seven-mode TVSS device). All delta configured systems shall be protected between phases (L-L) and phase to ground (L-G).
- (g) TVSS devices shall be capable of sustaining a single pulse transient current (based on a single pulse 8 x 20µs waveform specified in IEEE C62.45) of 150 kA in the L-N mode for wye configured systems, or L-L and L-G for delta configured systems, and 50kA in the N-G mode. TVSS devices for branch panels shall be capable of sustaining a single pulse transient current (based on a single pulse 8 x 20µs waveform specified in IEEE C62.45) of 90 kA in the L-N and L-G modes, or L-L and L-G for delta configured systems, and 50kA in the N-G mode.
- (h) Maximum let through voltage shall not exceed the following UL 1449 Classification, for Category B3 ring and combination waves:

Max. Let Through Voltage per Mode	L-N, N-G; L-G (when present)	L-L
120/240 VAC, 1φ	500	-
120Y/208 VAC	500	-
220 VAC Delta	-	500
220Y/380 VAC	800	-
240 VAC Delta	-	800
277Y/480 VAC	1000	-
347Y/600 VAC	1200	-
480 VAC Delta	-	1500
600 VAC Delta	-	2000

- (i) MI/RFI rejection, measured in accordance with the 50 ohms insertion loss procedures outlined in MIL-STD 220A, shall reflect a minimum noise attenuation of 10 db over a frequency bandwidth from 20 kHz to 10 MHz.

- (j) TVSS device endurance shall meet the UL Category C3 as an adjunct to its TVSS UL listing, consisting in the application of 1000 surges at 30-second intervals with 20 kV full peak voltage values for IEEE Category C3.

E80.5 Safety and Diagnostic Monitoring

- (a) TVSS device shall have visual indicators and an audible alarm to advise that the system is active and functioning properly or that TVSS protection has been lost or damaged and that device maintenance or replacement is necessary.
- (b) TVSS device shall include a set of 1 N.O. and 1 N.C. contacts for remote monitoring of device status and be capable of incorporating an optically-coupled sensing circuit option, which will permit monitoring of the TVSS device from a remote site.
- (c) TVSS device shall include a test and diagnostic circuit to ensure proper functioning of the monitoring circuit.

E80.6 Acceptable Manufacturer

- (a) All TVSS devices shall be from the same manufacturer
- (b) TVSS device manufacturer shall provide a full 5 year warranty from the date of installation against any part failure when installed in compliance with the manufacturer's instructions and all applicable national and local electrical codes.
- (c) Acceptable manufacturer for the TVSS devices shall be Leviton No.57120-M3 or approved equal.

E80.7 Wiring Requirements

- (a) All TVSS devices shall be installed in accordance with the applicable sections of the C.E.C. Part I and following the manufacturer's recommended practice. Conductor lead lengths to the TVSS device shall be kept as short as possible, without unnecessary bends. Conductors shall be twisted and tightly bound together. Refer to manufacturer's instructions for required size of conductors.

E80.8 Externally Mounted TVSS

- (a) Provide a breaker sized in accordance with TVSS device manufacturer's instructions for connection of TVSS device into panel.
- (b) Maximum conductor lead length between breaker and TVSS device shall not exceed 500mm (18").

E80.9 Integrated Distribution Panel Installation

- (a) TVSS device shall be factory-installed into the MCC.

E81. LIGHTING FIXTURES

E81.1 Scope

- (a) This section covers the supply and installation of lighting fixtures and lamps.

E81.2 General Requirements

- (a) Supply and install where shown and as specified on the drawing, all lighting fixtures c/w suspension devices, lamps and other attachments as specified or required to give the best appearance and mechanical installation.
- (b) All fixtures shall carry the approval of the Canadian Standards Association and/or the approval of the Inspection Department having jurisdiction.

- (c) All fixtures, stem hangers, ballast compartments, canopies, reflectors, wireways, brackets, etc., used in conjunction with the fixtures shall be factory finished, baked white enamel, unless otherwise specified.
- (d) All fixtures which have minor scratches after installation shall be "touched up" with an approved enamel to match the fixture finish to the complete satisfaction of the Contract Administrator.

E81.3 Submittals

- (a) Submit shop drawings in accordance with these provisions showing information such as width, depth, finish, etc. of each fixture in addition to all pertinent lamp data.

E81.4 Lamps

- (a) Incandescent:
 - (i) Bulb Shapes "A" and "PS", medium base, inside frosted, extended service, minimum 2500 hours rated life, rated 130 volts, wattage as indicated.
- (b) Fluorescent:
 - (i) T8 lamps with minimum CRI85.
- (c) High Pressure Sodium:
 - (i) Rated as indicated medium or mogul screw base, initial lumens as follows:
 - (ii) 70 Watts: 6000
 - (iii) 100 Watts: 8800
 - (iv) 150 Watts: 15000
 - (v) 200 Watts: 22000
 - (vi) 250 Watts: 27500
 - (vii) Average rated life 24000 hrs.

E81.5 Fluorescent

- (a) Fluorescent ballasts shall be CSA and CBM certified electronics.
- (b) Designed for the operation of lamps in the lighting fixtures as specified, rated 120 volts, 60Hz integrated circuit design for use with one or two F32T8 lamps as indicated.
- (c) Designed to provide over 95% power factor with 95% of rated lamp lumen.
- (d) Non PCB, thermally protected capacitor.
- (e) Class P, automatic reset thermal protector.
- (f) Input:
 - (i) 1-lamp, maximum 32W
 - (ii) 2-lamp, maximum 65W
- (g) Class A sound rating.
- (h) Total harmonic distortion less than 10%.
- (i) Shall meet FCC limits on EM and RF interference.
- (j) Three year warranty from date of substantial completion.
- (k) Acceptable manufacturer is Advance System V or approved equal.

E81.6 High Pressure Sodium Ballasts

- (a) High pressure sodium ballasts to ANSI C82.4 - 1985.
- (b) Voltage rating as indicated, totally enclosed and designed for 40°C ambient temperature.

- (c) Designed to provide minimum 95% power factor with 95% of the rated lamp lumen.
- (d) Non PCB capacitor.
- (e) Plus 10% to minus 10% of nominal input voltage range.
- (f) Minimum starting temperature -34°C at 90% line voltage.
- (g) Mounting as indicated.

E81.7 Fixture Schedule

- (a) Type "A"
 - (i) Surface fluorescent fixture, fibreglass, enclosed and gasketed, suitable for damp environments complete with 4-32WT8 lamps.
LITHONIA # TFCD- 432-120-M5
CFI # VT-248T-120-SO
- (b) Type "B"
 - (i) Surface mounted fluorescent fixture, fibreglass, enclosed and gasketed, suitable for damp environments complete with 2-32WT8 lamps.
LITHONIA # FCD- 232-120-M5
CFI # VT-248-120-SO
- (c) Type "C"
 - (i) Outdoor wall mounted metal halide fixture c/w rugged die-cast single-piece housing, 150 W 120 V ceramic metal halide lamp, photocell control. Wall mount fixture 2.4 m from bottom of wall.
LITHONIA No. WST 150 m FT MDU5 120 PE DNA
- (d) Type "D"
 - (i) Wall mounted compact fluorescent fixture suitable for mounting in damp environments c/w 26w quad fluorescent lamp, polycarbonate lens and wire mesh guard.
IPEX No. LWPL
- (e) Type "E"
 - (i) Exit sign, baked white enamel, rugged steel housing, universal mounting, surface or T-bar ceiling as required. Letters shall be 150mm x 19mm red on white, universal knock-out directional arrows as required, long life 120 VAC lamp.
LITHONIA #LVS1R120 c/w WLCSA

E81.8 Installation

- (a) As per C.E.C. Section 22 and Section 30.
- (b) Unit shall conform to building lines being parallel or perpendicular.
- (c) Installation of all lighting equipment shall comply with the relevant Section of this Specification and the Canadian Electrical Code.
- (d) At the completion of construction and acceptance of the Work, all lighting fixtures shall be clean, complete with all necessary accessories and provided with the required operating lamp(s).

E82. EMERGENCY GENERATOR

E82.1 Scope

- (a) This section covers the supply and installation of the Pumping Station emergency standby natural gas electric generator set.

E82.2 Shop Drawings and Product Data

- (a) Submit shop drawings for review and approval. Include:
 - (i) Engine: make and model, with performance curves
 - (ii) Alternator: make and model
 - (iii) Voltage regulator: make, model and type
 - (iv) Automatic transfer switch: make, model and type
 - (v) Battery: make, type and capacity
 - (vi) Battery charger: make, type and model
 - (vii) Alternator control panel: make and type of meters and controls
 - (viii) Governor type and model
 - (ix) Flow diagrams for:
 - ◆ Natural Gas
 - ◆ Lubricating oil
 - ◆ Cooling air
- (b) Dimensioned drawing showing complete generating set mounted on steel base, including vibration isolators, exhaust system, drip trays, and total weight
- (c) Continuous full load output of set at 0.8 PF lagging
- (d) Description of set operation including:
 - (i) Automatic starting and transfer to load and back to normal power, including time in seconds from start of cranking until unit reaches rated voltage and frequency
 - (ii) Manual starting
 - (iii) Automatic shut down and alarm on:
 - ◆ Overcranking
 - ◆ Overspeed
 - ◆ High engine temperature
 - ◆ Low lube oil pressure
 - (iv) Over and under frequency protection.
 - (v) Over and under voltage protection.

E82.3 Source Quality Control

- (a) Conduct equipment inspection at manufacturer's plant.
- (b) Provide manufacturer's type test certificates.
- (c) The Contract Administrator to witness factory testing of the emergency Generator.
- (d) Submit written test results to the Contract Administrator.

E82.4 Genset Characteristics

- (a) The electric set shall be rated 280 KW continuous standby rating 350 KVA, 0.8% P.F., 347/600 volt, 3-phase, 4-wire, 60 hertz for standby power application at an ambient temperature of 85°F/29°C. Ratings must be substantiated with manufacturer's

standard published curves. The engine shall operate at 1800 RPM and suitable hydraulic governor shall be provided such that frequency regulations shall not exceed 5%. Ratings must reflect the net power available after deducting all engine driven accessories.

- (b) The generator output voltage shall be 347/600 volts, 3-phase, 4-wire. An automatic solid state voltage regulator shall be provided by the generator manufacturer to match the characteristics of the generator. Voltage regulations shall be (+-) 2% from no load to full load. An adjusting rheostat shall provide (+-) 5% regulation.
- (c) The engine shall be full compression ionization natural gas, four stroke cycle, single acting, solid injection, liquid cooled inline type with six cylinders, turbo charged.
- (d) The engine shall be equipped with a reliable fuel , lube oil, and intake air filters, lube oil cooler, fuel transfer pump, any attachments required for continued, dependable operation. Engine shall be complete with a fill of manufacturer's recommended lubrication and 60% ethylene glycol concentration in the cooling system.
- (e) Acceptable manufacturer shall be ONAN, Kohler, Spectrum.

E82.5 Alternator

- (a) Alternator shall be single bearing, self aligning, continuous standby duty, salient pole, synchronous type with amortisseur winding. It shall be of the drip proof type, entirely self-contained and with line leads brought out for load connections. Insulation shall be rated CEMA Class "F". Generator shall be so designed that with a minimum amount of labour all components will become completely accessible. Engine and generator shall be completely compatible and warranted by the same manufacturer, or his representative. Replacement parts shall be readily available.
- (b) Alternator to be of 105 degree rise design.

E82.6 Fuel System

- (a) The engine fuel system shall be equipped with a fuel filter having replaceable elements which may be easily removed from their housing for replacement without breaking any fuel line connections or disturbing the fuel pumps on any part of the engine. Fuel filters shall be located ahead of the injection pumps so that fuel will have been thoroughly filtered before it reaches the pumps.
- (b) Engine Fuel should be natural gas supplied from the utility natural gas service provided at the Pumping Station.

E82.7 Cooling System

- (a) Provide a unit mounted radiator for the standby generator set complete with all necessary connections. The coolant shall be supplied with a 60% ethylene glycol solution, capable of withstanding temperatures down to -60°F.

E82.8 Exhaust System

- (a) Provide a critical type horizontally mounted exhaust silencer, with condensate drain, properly sized according to the silencer manufacturer's recommendation for the engine used. A flexible exhaust fitting shall be provided for mounting between the engine exhaust and the exhaust pipe. The silencer size and pipe size shall be sufficient to ensure against loss of power due to excessive back pressure.

E82.9 Connections

- (a) Unit to be complete with flexible connections for fuel, exhaust and ventilation.
- (b) Provide all control wiring.

E82.10 Automatic Starting System

- (a) The emergency generator system shall be provided with a 24-volt d.c. direct electric starting system suitable for automatic start-stop operation.
- (b) A fully automatic engine start-stop control shall be installed in the generator control panel. Control shall provide for overcrank lockout, pilot lights for low oil pressure, high water temperature, overspeed, and overcrank, a 3-position selector switch marked "Auto"- "Off"- "Manual". Control shall be equipped with timers which provide for 15-second timed cycle cranking consisting of three timed crank periods each followed by a 10-second rest period.
- (c) The engine shall be furnished with an engine mounted thermal circulation type water heater to maintain engine jacket water at 90°F, in an ambient temperature of 50°F. A heater mounted thermostat shall be supplied.
- (d) Provide a heavy duty starting type lead acid storage battery set consisting of two (2) 12-volt, 4D heavy duty batteries. Battery cables, inter-connectors and steel rack shall also be provided. Batteries to be of VARTA manufacture. Battery rack to hold batteries minimum 150 mm (6") above floor surface.
- (e) Provide and install battery chargers which shall be a fully automatic type, VULCAN Model FA 2416, with 6-amp capacity when used on a 24-volt battery set or equal.
- (f) The necessary relays to provide the operation as described in clause "Operation" are to be included.

E82.11 Mounting

- (a) The units shall be complete with and mounted on structural steel sub-base, and shall be provided with spring vibration isolators.

E82.12 Generator Control Panel

- (a) Provide a control panel incorporating complete controls for all functions of the electrical set. The panel shall be a unit mounted type, complete AC voltmeter (0-750 volts) and selector switch, AC ammeter (0-400amps) and selector switch; frequency meter, and voltage regulator adjusting rheostat, running time meter, pilot lights, engine start selector switch, etc. Panel shall incorporate the engine automatic cranking panel. Generator line circuit breaker c/w neutral bar, shall be rated at 450 amps, 600 volts, 3-phase, 3-pole.
- (b) Provision shall be made to transmit "Generator Running", "Generator Trouble" and "Generator Loss of Control Power" signals.

E82.13 Engine Governor

- (a) The governor shall be electronic type, of current model and manufacture, to provide the specified "no load" to "full load" 5% maximum speed regulation.
- (b) Governor response shall be such that rated engine speed is established within three (3) seconds during a no-load to full-load condition and vice-versa.

E82.14 Guards

- (a) Provide guards to protect personnel from hot and moving parts. Locate guards so that normal daily maintenance inspections can be undertaken without their removal.\

E82.15 Drip Plans

- (a) Supply and install 25 mm deep galvanized metal drip pans under the engine.
- (b) These pans shall be sized to fit between the base channels and will be slid under the engine from the generator end when the unit is installed on Site.

- (c) The maximum panel length shall not exceed 1m and if more than one pan is required to cover the required floor space, there must be an overlap on the edge on the pan to prevent oil from dripping between the pans.

E82.16 Oil Drain

- (a) Extend oil drain valve to make it accessible alongside of the genset engine.

E82.17 Installation

- (a) Install the standby emergency generator set along with the following items:
 - (i) Generator control panel and generator breaker
 - (ii) Battery charger
 - (iii) Engine block heater
 - (iv) Engine silencer
 - (v) Flexible fuel and exhaust connections (mechanical)
 - (vi) Batteries, battery rack, and battery cables
 - (vii) Vibration isolators
 - (viii) Necessary power and control wiring for a complete and operational system
 - (ix) Radiator and cooling system
- (b) Control wiring from engine and generator devices to be installed in a separate conduit from all power wiring.
- (c) Generator ventilation system shall be interlocked with engine controls.
- (d) All wiring to the generator control panel shall be stranded extra flexible.

E82.18 Start Up

- (a) Standby set supplier to provide complete start-up service in the form of technical assistance for the Contractor.
- (b) Components requiring field adjustment such as fuel rack settings, governor settings, etc., to be performed specifically by this supplier in the presence of the Contractor. These services to be submitted along with the generator set operation instruction books to the Contract Administrator. Operating instructions (complete with spare parts lists) on the engine, generator, governor, exciter system, control panel, charger and batteries shall be contained in hard-backed binders and to be delivered to the Contract Administrator.
- (c) Emergency generator shall start on a signal from transfer switch, on loss of normal power and transfer the transfer switch.
- (d) Selector switch in Auto position and the normal supply voltage operating, the diesel electric unit is on "automatic service" and shall start and transfer automatically on power failure. Upon return of normal power supply voltage, the generator set will continue to run for a pre-set period for time (5 minutes) and will then automatically return the transfer switches to normal. The engine will continue running for a preset period of time and will then be automatically turned off.
- (e) Selector switch in "MANUAL" position, engine starts and runs up to output until shut off manually. (No transfer takes place).
- (f) Selector switch in "TEST" position, engine starts and system transfer switch, to emergency service. (Simulating power failure as described for Automatic Conditions).

E82.19 Testing

- (a) Prior to acceptance of the installation, the equipment shall be tested to the satisfaction of the Contract Administrator and subject to a full load test. Any defects which become evident during this test shall be corrected.
- (b) On the completion of the installation, the initial start-up shall be performed by a factory trained representative of the engine supplier. At the time of start-up operating instructions and maintenance procedures shall be thoroughly explained to the operating personnel.
- (c) Tests shall be conducted and certified written report of the tests submitted to the Contract Administrator, tests to include:
 - (i) "A" - Factory Test
 - ◆ Standard factory test shall be performed. Submit test information, including ambient temperature (exterior, interior). Test shall be run for minimum six (6) hours with continuous standby rating applied. The Contract Administrator to witness above tests. Notify the Contract Administrator 24-hours prior to conducting test.
 - (ii) "B" - On Site Test
 - ◆ A test run up test of the generating set with the generator control panel controlling its functions and include the simulated power failure conditions to ensure proper operation.
- (d) Running tests shall be conducted at full load (continuous standby rating) and operated for sufficient time for the engine temperature to stabilize plus additional two (2) hours.
- (e) With generator running on "no-load", a block load of not less than 80% of full load shall be applied and voltage and frequency dip recorded and the subsequent recovery time recorded. Voltage regulation shall be recorded.
- (f) With generator running on 80% (min.) of full load, the load shall be disconnected, voltage and frequency variations and subsequent recovery times recorded.
- (g) All safety features shall be tested by appropriately simulating the fail condition.
- (h) Insulation tests shall be conducted on all electrical equipment in accordance with the applicable standards.
- (i) Loading of generator shall be continuous. (Use all available Site loads).
- (j) All tests shall be performed on Site in the presence of the Contract Administrator or his appointed representative and the generator manufacturer's representative. NOTIFY the Contract Administrator ONE WEEK PRIOR TO CONDUCTING TESTS.
- (k) Record test results and submit to the Contract Administrator (record ambient temperatures, etc.).

E82.20 Spare Parts

- (a) Provide spare parts for each set. Include:
 - (i) 1 Air cleaner Element
 - (ii) 2 each of Lube Oil Filters
 - (iii) 2 each of Fuel Oil Filters
 - (iv) 2 Sets of Control Fuses
 - (v) Lubricant Oil for two Oil Changes
 - (vi) 2 sets pilot lights lamps
 - (vii) Special Tools for Unit servicing

E82.21 Commissioning and Training

- (a) The manufacturer's representative shall be present during commissioning by the Contract Administrator.
- (b) Instruct the City's staff in the proper operation, maintenance and repair procedures.
- (c) Training shall include operation, maintenance and repairs. (A minimum of 4 hours shall be included for training).

E83. TRANSFER SWITCH

E83.1 Scope

- (a) This section covers the supply and installation of the automatic transfer switches.

E83.2 Shop Drawings and Product Data

- (a) Submit shop drawings in accordance with these provisions. Include:
 - (i) Panel Layouts
 - (ii) Wiring Connections and Diagrams
 - (iii) Dimensions
 - (iv) Electrical Characteristics of Each Component
 - (v) Connection Requirements

E83.3 Automatic Transfer Switch

- (a) Automatic transfer switch shall be mounted in MCC as shown on the drawings, designed for 347/600 volts, 3 phase, 4 wire service and amperage rating as indicated. Include all the necessary control components to connect to genset controls to provide automatic utility-to-genset operation.
- (b) Transfer switch come c/w the following options:
 - (i) Engine start delay, set at 3 sec.
 - (ii) Transfer delay, set at 3 sec.
 - (iii) Re-transfer delay, set at 5 min.
 - (iv) Stop delay, set at 5 min.
 - (v) Load shredding feature
 - (vi) Programmed transition
 - (vii) Test switch
- (c) Acceptable manufacture shall be ONAN, Thompson Technology, Inc., Ascoelectric.

E83.4 Installation

- (a) Install transfer switches as per manufacturer's recommendations.
- (b) Provide and install all required power and control cables and cable hardware to complete transfer switch operation.

E83.5 Identification

- (a) Provide lamacoid nameplate on front face of switches identifying function.

E83.6 Operation

- (a) On loss of normal power emergency generator shall start on a signal from transfer switch. Switch shall transfer to emergency power feed from generator on confirmation of generator bus nominal voltage and frequency.

- (b) On return of normal power transfer switch shall transfer back to normal power feed on confirmation of normal power bus nominal voltage and frequency.

E83.7 Testing

- (a) On the completion of the installation, the initial start-up shall be performed by a factory trained representative who shall verify satisfactory operation of the transfer switch and generator. At the time of start-up operating instructions and maintenance procedures shall be thoroughly explained to the operating personnel.
- (b) Tests shall be conducted and certified written report of the tests submitted to the Contract Administrator.

E84. TELEPHONE SYSTEM INSTALLATION

E84.1 Scope

- (a) Provide a system of conduits, boxes, jacks, etc., for the telephone service in the building. Provide entrance conduit as required by the Telephone Utility. Provide a wall desk telephone set located as shown on the drawings. Extend the necessary wiring to the telephone sets, telephone dialler, telephone modems, etc.,. Make all connections and test system.
- (b) Co-ordinate the installation, testing and commissioning of the following one (1) telephone line with the Telephone Utility.
 - (i) RTU Panel modem

E84.2 Conduit System

- (a) Conduit shall be rigid PVC sized at 20 mm for one outlet, 25 mm for two outlets, 32 mm for three outlets, etc.

E84.3 Outlet Boxes

- (a) Outlet boxes PVC FS type, as required.

E84.4 Cover Plates

- (a) Cover plates for all outlets shall be PVC to suit the requirements.

E84.5 Wiring

- (a) Supply and install all inside wiring and jacks as indicated on the drawings, to the satisfaction of the Telephone Utility.

E84.6 Coordination

- (a) Prior to locating all outlets and installing conduit systems, coordinate with the Telephone Utility engineering department to confirm all construction details.

E84.7 Pullboxes

- (a) No conduit run shall be longer than 30 M without a pullbox being installed, regardless of the number of bends.
- (b) No conduit run shall contain more than 2 – 90° bends, or the equivalent, without having pullbox installed in the run.

E84.8 Fish Wires

- (a) Each empty conduit shall contain a fish wire, to facilitate wiring installation.

E84.9 Installation

- (a) Install raceway system, wiring, distribution system, pullboxes, conduit sleeves and clamps for a complete system.
- (b) Install 19 mm thick plywood backboard as indicated.
- (c) Install grounding facilities and make corrections.
- (d) Arrange for the installation of the Telephone Utility on behalf of the City.

E85. MOTOR STARTERS

E85.1 Scope

- (a) This section covers the supply and installation of the motor starters.

E85.2 Shop Drawings and Product Data

- (a) Submit shop drawings in accordance with these provisions. Indicate:
 - (i) Mounting method and dimensions
 - (ii) Starter size and type
 - (iii) Layout of identified internal and front panel components
 - (iv) Enclosure types
 - (v) Wiring diagram for each type of starter
 - (vi) Interconnection diagrams

E85.3 Standards

- (a) IEC Standards are acceptable for magnetic starter and contactors if application size doubled.
- (b) EEMAC North American Standards to apply.
- (c) Open wound starters or relay coils not allowed.
- (d) All coils to be epoxy potted.

E85.4 Operation and Maintenance Data

- (a) Provide operation and maintenance data as specified in general provisions.
- (b) Include operation and maintenance data for each type and style of starter.

E85.5 Maintenance Materials

- (a) Provide maintenance materials in accordance with the general provisions.
- (b) Provide listed spare parts for each different size and type of starter:
 - (i) 2 sets of contacts, stationary.
 - (ii) 2 sets of contacts, movable.
 - (iii) 1 set of contacts, auxiliary.
 - (iv) 1 control transformer for each VA rating supplied.
 - (v) 1 operating coil for each starter size supplied.
 - (vi) 2 fuses of each rating.
 - (vii) 4 indicating lamps, for each type supplied.
- (c) List local suppliers all above parts.

E85.6 Materials

- (a) Starters shall be EEMAC E140-1.

- (b) Half size starters not acceptable.
- (c) Smallest size starter to be size 1.

E85.7 Manual Motor Starters

- (a) Single or three phase manual motor starters of size, type and rating, with components as follows:
 - (i) Switching mechanism, quick make and break.
 - (ii) One or three overload heaters, manual reset, trip indicating handle as required.
 - (iii) Sprinkler Proof EEMAC 12 enclosure.
- (b) Accessories:
 - (i) Toggle switch: standard heavy duty oil tight labelled as indicated.
 - (ii) Indicating light: heavy duty oil tight type and color as indicated.
 - (iii) Locking tab to permit padlocking in "ON" or "OFF" position.
- (c) Acceptable manufacturer shall be Telemecanique C10/C11 series, Cutler- Hammer MS series, Siemens.

E85.8 Full Voltage Magnetic Starters

- (a) Magnetic and combination magnetic starters of size, type and rating, with components as follows:
 - (i) Contactor solenoid operated, rapid action type.
 - (ii) Motor overload protective device in each phase, manually reset from outside enclosure.
 - (iii) Power and control terminal blocks
 - (iv) Wiring and schematic diagram inside starter enclosure in visible location.
 - (v) Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
 - (vi) EEMAC 12 enclosure or MCC.
- (b) Combination type starters to include motor circuit protector with operating lever on outside of enclosure to control motor circuit protector and provision for:
 - (i) Locking in "OFF" position with up to 3 padlocks.
 - (ii) Locking in "ON" position.
 - (iii) Independent locking of enclosure door.
 - (iv) Provision for preventing switching to "ON" position while enclosure door open.
- (c) Accessories
 - (i) Pushbuttons and selector switches: standard heavy duty oil tight labelled as indicated.
 - (ii) Indicating lights: Push-to-test transformer heavy duty oil tight type and color as indicated.
 - (iii) 2-N/O and 2-N/C spare auxiliary contacts unless otherwise indicated.
- (d) Starter sizes shall be CEC suitable to applied HP as indicated on drawings.
- (e) Acceptable manufacturer is Telemecanique LE1 series, Cutler- Hammer Freedom series type AN16, Siemens.

E85.9 Two Speed Magnetic Starters

- (a) Two speed magnetic starters of size, type and rating indicated with components as follows:
 - (i) One-3-pole contactor for each winding for separate winding motors.

- (ii) 3 overload relays with three heater and manual reset for each speed.
 - (iii) Power and control terminal blocks
 - (iv) Wiring and schematic diagram inside starter enclosure in visible location.
 - (v) Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
 - (vi) EEMAC 12 panels.
- (b) Combination type starters to include motor circuit protector with operating lever on outside of enclosure to control motor circuit protector and provision for:
- (i) Locking in "OFF" position with up to 3 padlocks.
 - (ii) Locking in "ON" position.
 - (iii) Independent locking of enclosure door.
 - (iv) Provision for preventing switching to "ON" position while enclosure door open.
- (c) Accessories:
- (i) Pushbuttons and selector switches: standard heavy duty oil tight labelled as indicated.
 - (ii) Indicating lights: Push-to-test transformer heavy duty oil tight type and color as indicated.
 - (iii) 2-N/O and 2-N/C spare auxiliary contacts unless otherwise indicated.
- (d) Starter sizes shall be CEC suitable to applied HP as indicated on drawings.
- (e) Acceptable manufacturer is Telemecanique LE9 series, Culter-Hammer type W960.

E85.10 Soft Start Motor Starters

Solid-state "Soft Start" combination starters of size, type and rating, with components as follows:

- (a) Contactor solenoid operated, rapid action type
- (b) Motor overload protective device in each phase, manually reset from outside enclosure.
- (c) MCP circuit breaker with operating lever on outside of enclosure to control motor current protector and provision for:
 - (i) Locking in "OFF" position with up to 3 padlocks
 - (ii) Locking in "ON" position
 - (iii) Independent locking of enclosure door
 - (iv) Provision for preventing switching to "ON" with enclosure door open
- (d) Thermistors type protection relay, to match sensors provided in the motor windings, c/w alarm pilot light and manual reset.
- (e) Solid-state motor controller as manufactured by Benschaw No. RSD6-150-600-C or interphase option and the following features:
 - (i) Soft start adjustable 2 to 30 seconds
 - (ii) Soft stop adjustable 5 to 110 seconds
 - (iii) Current limit
- (f) Accessories:
 - (i) Pushbuttons and selector switches: Standard heavy duty oil tight labelled as indicated
 - (ii) Indicating lights: Push-to_test transformer heavy duty oil tight type and color as indicated
 - (iii) 2-N/O and 2-N/C spare auxiliary contact unless otherwise indicated.

- (g) Terminal blocks to be Weidmuller SAK Series or approved equal.
 - (i) Power and control terminals
 - (ii) Wiring and schematic diagram inside starter enclosure in a visible location
- (h) Acceptable manufacturer is Benshaw No. RSD6-100-600C.

E85.11 Control Transformers

- (a) Single phase, dry type, control transformer with 600 volt primary voltage and 120 V secondary, complete with secondary fuse, installed in with starter as indicated.
- (b) Size control transformer for control circuit load required plus 100% spare capacity.

E85.12 Finishes

- (a) Apply finishes to enclosure in accordance with these provisions.

E85.13 Equipment Identification

- (a) Provide equipment identification in accordance with these provisions.
- (b) Magnetic starter designation label, engraved as indicated in the motor equipment description column on the electrical motor schedule.

E85.14 Installation

- (a) Install starters, connect power and control circuits as indicated.
- (b) Install auxiliary contacts and connect wiring.
- (c) Ensure correct MCP settings and overload devices elements installed.
- (d) Manual motor starters shall be mounted 1500 mm above finished floor level to top of starter enclosure.

E85.15 Tests

- (a) Perform tests in accordance with these provisions and manufacturer's instructions.
- (b) Operate switches, contactors to verify correct functioning.
- (c) Perform starting and stopping sequences of contactors and relays.
- (d) Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

E86. MOTOR CONTROL CENTRE

E86.1 Scope

- (a) This section describes the supply and installation of the motor control centre.

E86.2 Quality Assurance

- (a) Conduct equipment inspection at manufacturer's plant.
- (b) Provide manufacturer's type test certificates.
- (c) The Contract Administrator reserves the right to witness standard factory testing of complete motor control centre including operation of switches, circuit breakers, starters and controls.
- (d) Submit written test results to the Contract Administrator.

E86.3 Shop Drawings

- (a) Submit shop drawings in accordance with these provisions. Indicate:

- (i) Outline dimensions.
- (ii) Configuration of identified compartments.
- (iii) Floor anchoring method and dimensioned foundation template.
- (iv) Cable entry and exit locations.
- (v) Dimensioned position and size of busbars and details of provision for future extension.
- (vi) Schematic and wiring diagrams

E86.4 Operations and Maintenance Data

- (a) Provide operation and maintenance data for motor control centre for incorporation into the Operation and Maintenance Manual as specified in these provisions.
- (b) Include data for each type and style of starter.

E86.5 Maintenance Materials

- (a) Provide maintenance materials in accordance with these provisions.
- (b) Provide listed spare parts for each different size and type of starter:
- (c) 2 sets of contacts, stationary
- (d) 2 sets of contacts, movable
- (e) 1 set of contact, auxiliary
- (f) 1 control transformer for each VA rating
- (g) 1 operating coil for each starter size supplied
- (h) 2 fuses of each rating
- (i) 4 indicating lamps for each type provided
- (j) 2 relays for each type provided

E86.6 Codes and Standards

- (a) Materials and workmanship shall comply with codes and standards of the Province in which the Work is located and local codes, regulation and standards.
 - (i) In addition, the Work shall conform to the latest editions and amendments of the applicable Codes and Standards of the following agencies:
 - (ii) EEMAC Standard ICS2-322.
 - (iii) CSA Standard C22.2 No. 14-M1987, "Industrial Control Equipment".
 - (iv) CSA Standard C22.1, Canadian Electrical Code, Part I plus Provincial supplements.
 - (v) Applicable sections of ANSI (American National Standards Institute) Standards.
 - (vi) All equipment to be CSA approved.

E86.7 Guarantee

- (a) The performance of the motor control centre equipment shall be guaranteed throughout to perform the duty stated herein in accordance with General Conditions.

E86.8 Supply Characteristics

- (a) Motor control centre rated 347/600V, 60 Hz, 3 phases, 4 wire, amperage rating as indicated.

E86.9 Motor Control Centre General Description

- (a) Compartmentalized vertical sections with common power busbars.

- (b) Floor mounting, free standing, enclosed dead front.
- (c) Accommodating incoming cable to enter at top as indicated.
- (d) Class 2, Type C.
- (e) Motor circuit protector combination starters
- (f) Sprinkler proof EEMAC 12 enclosure.

E86.10 Vertical Section Construction

- (a) Independent vertical sections fabricated from rolled flat steel sheets, bolted together to form rigid, completely enclosed assembly.
- (b) Each vertical section divided into compartment units, minimum 305 mm high.
- (c) Each unit to have complete top and bottom steel plate for isolation between units.
- (d) Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of motor control centre, isolated from busbars by steel barriers.
- (e) Vertical wireways for load and control conductors extending full height of vertical sections, and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place.
- (f) Openings, with removable cover plates, in side of vertical sections for horizontal wiring between sections.
- (g) Provision for outgoing cables to exit via top and bottom.
- (h) Removable lift means.
- (i) Divide assembly for shipment to Site, as indicated complete with hardware and instructions for re-assembly.

E86.11 Sills

- (a) Continuous 100 mm channel iron floor sills for mounting bases with 19 mm diameter holes for bolts.

E86.12 Bushbars

- (a) Main horizontal and branch vertical, three phase high conductivity tin plated copper busbars in separate compartment insulated self-cooled, extending entire width and height of motor control centre, supported on insulators and rated:
 - (i) Main horizontal busbars: 600 A.
 - (ii) Branch vertical busbars: 300 A.
- (b) Branch vertical busbars for distribution of power to units in vertical sections.
- (c) No other cables, wires, equipment in main and branch busbar compartments.
- (d) Brace bus-work to withstand effects of short-circuit current of 42 kA rms symmetrical.
- (e) Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.

E86.13 Ground Bus

- (a) Tin plated copper bus size 50mm x 6mm extending entire width of motor control centre, located at top. Ground motor control centre main bus as specified in herein.

E86.14 Starter Unit Compartments

- (a) Units EEMAC size 4 and smaller, circuit breaker units 225 A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive

contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.

- (b) Unit mounting:
 - (i) Engaged position - unit stabbed into vertical bus.
 - (ii) Withdrawn position - unit isolated from vertical bus but supported by structure. Terminal block accessible for electrical testing of starter.
 - (iii) Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.
 - (iv) Stab-on connectors free floating silver plated clips, self-aligning, backed up with steel springs.
- (c) External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for 3 padlocks to lock operating handle in "off" position and lock door closed.
- (d) Hinge unit doors on same side.
- (e) Overload relays manually reset from front with door closed.
- (f) Devices and components by one manufacturer to facilitate maintenance.
- (g) All starters and contactors to have two N.O. and two N.C. spare contacts wired to terminal block.

E86.15 Wiring and Terminal Blocks

- (a) The shop installed wiring arrangement shall be as indicated. For Type B wiring, all control connections to be brought to terminal blocks within each starter compartment. Provide a minimum of 10 spare terminal blocks for #12 AWG incoming control wiring.
- (b) Incoming and outgoing power cables and conduits shall enter the MCC's from the top as indicated.
- (c) Provide internal power wiring from the line side of each starter to the bus stabs with a minimum of #12 AWG wire rated for 600 volt duty. Size wiring to accommodate the largest horsepower that the line starter is capable of switching.
- (d) Control wiring shall be as 600 V rated, XLPE insulated, minimum #14 AWG size. Install wiring to panel doors utilizing extra flexible 49-strand conductors.
- (e) All internal wiring shall employ stranded copper conductors.
- (f) Identify all wiring by means of heat shrink type wire markers as manufactured by Critchley fixed to each conductor at both ends.
- (g) Wires shall be color coded as follows:
 - (i) Control circuits – Red
 - (ii) Power circuits - Black
- (h) Terminal blocks shall be of the compression type and shall be of modular pull-apart construction enabling unit wiring to be easily separated from the field wiring. Identify all terminal blocks with numbers identical to the wire numbers.
- (i) No more than two wires shall be placed under each terminal screw.

E86.16 Incoming Line Transmission

- (a) Provide pressure type cable lugs and bus adapters or extensions suitable for terminating the main incoming cable conductors. The lugs shall accommodate the number and size of cables as indicated. Cable entry shall be from the top of the MCC as indicated.

E86.17 Space for Future Units

- (a) Provide spaces for starters or switching units in the MCC's for equipment designated "Future". Fully equip these spaces with horizontal and vertical bus bars and all fittings necessary to accommodate the future equipment with a minimum of field alterations and additions. Provide bolted-on blank covers.

E86.18 Wiring Identification

- (a) Provide wiring identification in accordance with these provisions.

E86.19 Equipment Identification

- (a) Provide equipment identification in accordance with these provisions.
- (b) Motor control centre main nameplate as indicated.
- (c) Individual compartment nameplates engraved as indicated.

E86.20 MCC Layout

- (a) Section #1
 - (i) Service entrance rated at 600A, 347/600V, 3 phase, 4 wire complete with the following:
 - ◆ 600A, 3P main breaker
 - ◆ Compartment for hydro's metering CT's and PT's.
- (b) Section #2
 - (i) Power monitor as manufactured by Schneider Powerlogic CM3250 c/w display and Ethernet adapter, Allen-Bradley #1404-M4505A-ENT base unit and Ethernet adapter.
 - (ii) Automatic transfer switch ATS #1 rated 600 amps. Transfer switch supplied with generator, installed in MCC under this section.
- (c) Section #3
 - (i) 1- Softstart/Softstop, Submersible Pump SP-1, 100 HP.
- (d) Section #4
 - (i) 1-Softstart/Softstop, Submersible Pump SP-2, 100 HP.
- (e) Section #5
 - (i) 1-Softstart/Softstop, Submersible Pump SP-3, 100 HP.
- (f) Section #6
 - (i) Breakers and contactors for the following:
 - ◆ 1 – 40A 3P Breaker, Panel "A"
 - ◆ 1 – 125A 3P Breaker, Panel "H"
 - ◆ 1 – 60A, 3P Breaker, welding receptable
 - (ii) Starters for the following motors:
 - ◆ 1 – Spare size 1
 - (iii) 2 Spaces
- (g) Section #7
 - (i) Control section c/w all items indicated on the drawings including:
 - (ii) Terminal strips (identified) for all wiring
 - (iii) Identification nameplates on all components, interior and exterior
 - (iv) Extra flexible wire to door components

- (v) Control relays, OMRON MK3 PN-5S c/w PF-113A-E bases
- (vi) Time delay relays, OMRON H3CA series c/w bases
- (vii) Push-to-test LED type pilot lights, selector switches, push buttons.
- (viii) Ammeters, Crompton series
- (ix) Elapsed time meters
- (x) Alarm buzzer, Sonalert
- (xi) Transient voltage surge suppressor, Leviton # 51020-BM
- (xii) 2000 VA UPS, Prestige EXT series c/w full battery pack
- (xiii) DC power supply, Lambda 120VAC : 28VDC
- (xiv) LED digital indicators, 4-20mA input. LED displays to be of the signal retransmission type to accommodate analog field signal wiring requirements, Precision Digital # PD765-6R2-1.
- (xv) Programmable logic controller as specified in these provisions.

E86.21 Finishes

- (a) Apply finishes in accordance with these provisions.
- (b) Paint motor control centre exterior ASA 61 light grey enamel and interiors white.

E86.22 Manufacturers

- (a) Acceptable MCC manufacturer shall be Telemecanique, Cutler-Hammer, Allen-Bradley. Fabrication of custom built MCC shall be by acceptable panel manufacturer as specified in these provisions.

E86.23 Shop Assembly

- (a) Shop assembly shall be maximized, to minimize the on-site erection work. Equipment should thus be shipped in as few subassemblies as is practical and in accordance with overall erection schedule.
- (b) Containers and components clearly identified for transportation and field assembly.

E86.24 Packaging and Shipping

- (a) Each item shall be packed, crated or otherwise protected so that it is not damaged in transit and arrives in serviceable condition at the Site. In particular, measures shall be taken to prevent accumulation of water in equipment.
- (b) Crates, boxes and cartons shall be clearly marked to indicate the purchase order number and the name of the equipment.
- (c) Shipping invoice shall show the crate, box or carton number.
- (d) All finished rubbing surfaces which are not assembled in the shop shall be adequately protected during shipment by wrapping with burlap or canvas or other means which shall be secured by wooden batts securely wired together.

E86.25 Installation and Testing

- (a) Install embedded floor channels where applicable.
- (b) Set and secure MCC's in place, rigid, plumb and square, on channel bases.
- (c) Interconnect MCC cubicles with bus bar and wiring connectors supplied by manufacturer.
- (d) Check factory-made connections for mechanical security, electrical continuity, and current phasing.

- (e) Make grounding connections between equipment ground busses and building grounding system.
- (f) After finishing work, remove foreign material, including dust, before energizing equipment.
- (g) Perform all tests in accordance with these provisions.
- (h) Make all power and control field wiring connections.
- (i) Check overload trip unit settings against drawings and motor nameplate data.
- (j) Ensure moving and working parts are lubricated where required.
- (k) Operate starters in sequence to provide satisfactory performance of motor control centre during 8 hour period.

E86.26 Commissioning

- (a) The motor control manufacturer shall include for the testing and commissioning of the complete systems and instruct the City's personnel in the operation of the systems. Two additional site visits shall also be included during the warranty period.

E86.27 Measurement and Payment

(a) Method of Measurement

Motor control centre is incidental to and included in the work of "Electrical". No separate measurement will be made for this work.

(b) Basis of Payment

Motor control centre will be paid for as part of the Contract Lump Sum Price for "Electrical", which price shall include payment in full for performing all operations herein described including the cost of furnishing all necessary labour, materials, and equipment for the provision of motor control centre, and all other items incidental to the work included in this Specification.

E87. MOTOR CONTROL WIRING

E87.1 Scope

- (a) This section covers the following:
 - (i) Electrical work pertaining to installation of all mechanical and automatic equipment specified.
 - (ii) Wiring associated with control wiring schematics shown on electrical drawings.

E87.2 Quality Assurance

- (a) Coordinate with mechanical shop drawings for electrical requirements. Where mechanical shop drawings differ in control or power requirements this shall be reported to the Contract Administrator.

E87.3 Materials

- (a) Refer to other sections for equipment specifications.
- (b) Circuit breaker and feeder sizes as indicated on the electrical drawings for all motors, fans, HVAC equipment, etc., are based on preliminary data only. Contractor responsible for coordinating with the supplies to determine exact voltage and amperage of all equipment on Site and ensure starters, breakers, feeder wiring, conduit sizes, etc., are correctly sized for the equipment being fed in addition to informing the Contract Administrator of all required changes. No extras will be allowed for costs incurred resulting from failure to properly execute this coordination.

E87.4 Installation

- (a) Refer to individual sections for execution.
- (b) Coordinate overcurrent and overload protective devices with the nameplate ratings of the motors.
- (c) Fill out a "MOTOR DATA SHEET" for each single phase and 3 phase motor.

E88. PROCESS CONTROL AND INSTRUMENTATION – GENERAL PROVISIONS

E88.1 Description

- (a) This section specifies the General Provisions for the supply, delivery, installation, calibration and commissioning of the process control and instrumentation system, including all control and graphic panels, as specified herein and /or detailed on the drawings.
- (b) It is the intention of these specifications and drawings, to provide for a complete and fully operating control and instrumentation system, with facilities and services to meet the requirements described herein, and in complete accord with applicable codes and ordinances. The specifications do not purport to cover details entering into the design of the system which shall be the responsibility of the Contractor.
- (c) The Work to be done shall include the provision of all labour, materials, tools and equipment as well as the application of a competent knowledge of construction, whether or not directly specified or shown on the plans, required for the installation testing and placing into service the complete control and instrumentation system, except when it is specifically mentioned that certain materials and/or labour are not part of the contract.
- (d) These specifications shall apply to and govern all trades doing control and instrumentation work and shall be read in conjunction with and form a part of the specifications of the project.
- (e) The Control and Instrumentation work includes but is not limited to the following:
 - (i) Control panels
 - (ii) Programmable Logic Controller System
 - (iii) Primary Elements for flow, level, pressure, temperature, etc.
 - (iv) Indicators and annunciators
 - (v) Uninterruptible power supplies
 - (vi) Control Wiring and conduit
 - (vii) Spare Parts & Manuals

E88.2 Equipment Manufacturers

- (a) All equipment shall be manufactured by experienced manufacturers who can demonstrate in-use records for all equipment offered.
- (b) Requests for approval of alternative suppliers shall be submitted to the Contract Administrator.
- (c) The majority of equipment shall be supplied by a single manufacturer, particularly where aesthetics are of concern, such as in panels.

E88.3 Codes, Permits and Fees

- (a) The Work shall comply with the requirements of the current edition of the Canadian Electrical Code, Part 1, and the regulations of the Manitoba Government, Department of Labour, Electrical Protection Branch.

- (b) Obtain the required construction permits, arrange for inspections and supply the Contract Administrator with approval certificates pertaining thereto including a certificate of final inspection.

E88.4 Reference Standards

- (a) Unless otherwise specified, equipment shall conform to appropriate standards and recommendations of:
 - (i) The American Society of Mechanical Contract Administrators, hereinafter referred to as ASME Standards.
 - (ii) The Instrument Society of America, hereinafter referred to as ISA.
 - (iii) The Canadian Standards Association, hereinafter referred to as CSA.
- (b) All equipment shall be metric - SI Standard.

E88.5 Manuals

- (a) Provide operating and maintenance brochures for all equipment and arrange for their insertion into the Operation and Maintenance Manuals. The brochures shall include all applicable, descriptive and technical data, maintenance and operating procedures, wiring diagrams, spare parts lists, service representatives, and suppliers for replacement parts. The brochures shall be neatly and orderly assembled in binders.
- (b) Requirements for operation and maintenance of process control and instrumentation equipment shall be as specified in these provisions.

E88.6 Shop Drawings

- (a) Provide layout drawings of instrument panels and schematic diagrams as well as detailed drawings of all devices listed in the instrumentation data sheets. The Contract Administrator's review of shop drawings shall be for general arrangement only and shall not relieve the Contractor from responsibility for errors, proper fitting, construction of the Work and furnishing of materials.
- (b) The layout drawings and ladder drawings shall be prepared on reproducible sheets of the same size as the Contract drawings. These drawings shall be updated as the work progresses and shall be submitted to the Contract Administrator as drawings of record when the Work is completed.
- (c) Submit shop drawings for the following items:
 - (i) Control Panels
 - (ii) Panel wiring schematics and interconnection drawings
 - (iii) Field instruments
 - (iv) Power supplies
 - (v) PLC and I/O enclosures
 - (vi) PLC and I/O modules
 - (vii) PLC terminals
 - (viii) Interconnection drawings, showing system equipment and field device connections
 - (ix) PLC software documentation, which shall include as a minimum:
 - (x) I/O listing entailing a complete list of all system addresses, both used and spare, with a service description for each including mnemonics.
 - (xi) Ladder diagram listing, complete with description headings, comments for each rung, and mnemonics for each element.
 - (xii) Data table listing, identifying all preset values and their service.
 - (xiii) Written description of the program(s).

E88.7 Drawings of Record

- (a) Submit control ladder drawings and PLC programs for the instrumentation system.

E88.8 Coordination of Work

- (a) Cooperate and coordinate with other trades on the project.
- (b) Make suitable arrangements with other trades to make provision for the control and instrumentation work and be responsible for the assurance that such provisions are satisfactory for the control and instrumentation work.
- (c) Check drawings and specifications of other trades for conflict and coordination with the control and instrumentation trade. If any conflicts are found, obtain a ruling from the Contract Administrator before proceeding.

E88.9 As-Built Documentation

- (a) As work progresses, record on one (1) set of contract drawings, any change to conduit layout as well as any approved changes and deviations from the original contract and/or working drawings. At completion of Work, submit to the Contract Administrator.
- (b) In addition to the as-built contract drawings, submit as-built documentation for inclusion in the Maintenance Manuals.
- (c) Provide as-built PLC programming hard copy and back-ups (2 copies) on compatible CD ROM to the Contract Administrator.
- (d) All software development packages and manufacturer's development manuals shall be turned over to the Contract Administrator.
- (e) No final contract payment shall be made until all as-built documentation has been accepted by the Contract Administrator.

E88.10 Warranty

- (a) Warranty system assembly, installation, hardware, software, and communications operations for all parts and labour for a period of one year from date of Total Performance.

E88.11 Materials

- (a) All materials shall be new and the best of their respective kind.
- (b) All materials shall bear the approval of the Canadian Standards Association (CSA).
- (c) All materials shall be suitable for full operation within non-hazardous environments (EEMAC 12) as indicated.
- (d) See subsequent clauses for specific equipment and instrument specifications.

E88.12 Power Supply

- (a) Provide all necessary power supplies for controls and instruments.
- (b) Power wiring to field devices shall be #12 AWG.

E88.13 Control Wiring

- (a) Unless specified otherwise, all conductors for control wiring shall be copper with RW90, X-link insulation, 300 volts.
- (b) Neutral conductors shall be white, grounding conductors shall be green, DC conductors shall be blue and AC conductors shall be red.

- (c) Instrumentation wiring for analog signals shall be individually shielded - multipair cable #16 AWG (7x16) tinned copper.
- (d) Control wiring for level and pressure switches shall be #14 THHN Black.
- (e) Where dimensional details are required work with the applicable structural and architectural drawings.
- (f) The Contractor is responsible for correcting any work completed contrary to the intent of the drawings and specification and shall bear all costs for correcting same.

E88.14 Conduit, Wiring and Cable

- (a) Supply and install all conduit, wiring, control and instrumentation cables for the control, instrumentation and low line voltage control for building services.
- (b) Conduit and wiring for power, lighting, miscellaneous electrical systems and power supplies to control instrumentation and building service panels including other components requiring line voltage power supply shall be supplied and installed as specified.

E88.15 Installation

- (a) Install and interconnect all process control system equipment and components as indicated.
- (b) Install all equipment in accordance with the manufacturer's recommendations and in a manner that will ensure satisfactory operation upon completion.
- (c) Provide all labour and all necessary equipment including timbers, scaffolding, tools and rigging materials for installation of the equipment.
- (d) Contractor shall be responsible for coordinating all mechanical, electrical and other works for the equipment being installed.
- (e) Installation shall meet the minimum standards set forth by Standards and Practices for Instrumentation, Tenth Edition - 1989.
- (f) Use trained personnel to install systems and controls as per approved shop drawings and in accordance with manufacturer's recommendations.
- (g) Follow building lines with all piping and electrical wiring runs. Utilize proper separation and wiring techniques.

E88.16 Testing

- (a) Thoroughly test all control equipment, components, and systems for proper operation and report in writing to the satisfaction of the Contract Administrator.
- (b) Tests shall include:
 - (i) Complete operational test including interlocks, functions, features, options, etc., for all instrumentation, PLC, and computer system control operations.
 - (ii) Operation of alarm initiating devices.
 - (iii) Calibration of all instruments.
- (c) Supply all necessary test equipment and personnel to completely test the entire instrumentation and process control system.

E88.17 Start-Up and Commissioning

- (a) Upon completion of the installation, the Contractor shall be responsible for testing to determine correct system operation and sequences as intended in the Contract. Process Instruments such as flow, level, pressure transmitters, etc., shall be checked for operation prior to process start-up, by manipulating operating controls like set

points, auto-manual selectors, etc. Status and alarm contacts to be checked by manipulation or jumpering at the sensing element.

- (b) Results of tests are to be logged by the Contractor and submitted to the Contract Administrator. Any apparent defects shall be reported and corrected.
- (c) When preliminary checks have been completed and process equipment is operating or ready to operate, individual systems shall be calibrated in accordance with the latest ISA recommendation. After calibrations the system shall be placed in operation in conjunction with the Contract Administrator and/or the City's designated operating personnel.
- (d) In general, the start-up and commissioning shall be in accordance with these provisions.

E88.18 Spare Parts

- (a) The Contractor shall provide the following spare parts:
 - (i) Two (2) plug-in control relays of each type used complete with base.
 - (ii) Two (2) plug-in time delays of each type used complete with base.
 - (iii) Two (2) plug-in sequence relays complete with base.
 - (iv) Twenty (20) fuses of each type used.
 - (v) Ten (10) indicating lights of each type used.
 - (vi) Two (2) fuse holders of each type used.
 - (vii) One (1) push button of each type used.
 - (viii) One (1) selector switch of each type used.

E89. CONTROL PANELS

E89.1 Scope

- (a) This section covers the supply and installation of all field located motor control stations, control panels and the MCC.

E89.2 Quality Assurance

- (a) Control equipment to CSA C22.2 No. 14-M1987.

E89.3 Submittals

- (a) Submit shop drawings in accordance with these provisions and include schematic, wiring diagrams, and mounting information.

E89.4 Operator Control Stations

- (a) All enclosures and devices shall be rated EEMAC 12 in non-hazardous environments or EEMAC 3R outdoor environments, unless otherwise noted.

E89.5 Pushbuttons

- (a) Heavy duty oiltight, operator flush, black, with 1-NO and 1-NC contacts rated at 10 A, 120 VAC, labels as indicated. Stop pushbuttons colored red, provision for padlocking in depressed position.
- (b) Acceptable manufacturer shall be Telmeccanique, Allen-Bradley.

E89.6 Indicating Lights

- (a) Heavy duty Oiltight, push to test transformer type, lens color as indicated, supply voltage: 120 V (ac), labels as indicated.

- (b) Acceptable manufacturer shall be Telmecanique, Allen-Bradley.

E89.7 Selector Switches

- (a) 2 or 3 position as required, labelled as indicated heavy duty oiltight, operators as indicated, contact arrangement as indicated, rated 120 V (ac), 10 A.
- (b) Acceptable manufacturer shall be Telmecanique, Allen-Bradley.

E89.8 General

- (a) 2 or 3 position as required, labelled as indicated heavy duty oiltight, operators as indicated, contact arrangement as indicated, rated 120 V (ac), 10 A.
- (b) Acceptable manufacturer shall be Telmecanique, Allen-Bradley.

E89.9 Construction

- (a) Minimum EEMAC 12 construction for all panels unless otherwise specified.
- (b) Unless otherwise specified fabricate floor mounted panels, indicated, of high grade, cold rolled smooth sheet metal steel no thinner than 3 mm thick with all doors and edges neatly turned and finished smoothly. Visible welding seams will not be accepted.
- (c) Construct rigid panels and racks with an angle iron or channel supporting frame, suitably braced and stiffened to prevent any deformation during shipping or installation, and provide a surface free from dents, warping or other deformation. Provide a four-sided channel iron mounting base with front recess.
- (d) Provide flush fitting, gasketed doors hung on piano type hinges with three point latches and locking-type handles (CSA Type 12 construction).
- (e) Provide pans and rails for mounting terminal blocks, relays, wiring and other necessary devices.
- (f) Use rear connected fittings to hold equipment and instrument cases on the panel, but where not possible; any front fixing required shall be only by means of chrome-plated, brass or stainless steel machine screws.
- (g) Panel surfaces shall be thoroughly cleaned and degreased before painting. One primer coat shall be covered by two finished paint coats. Refer to Division 9 - Finishes.
- (h) The surface finish shall be free of runs, drops, ridges, waves and laps. The paints shall be applied in such manner as to provide an even film covering corners and crevices. The interior finish shall be white and the exterior finished will be selected after award of the contract.
- (i) Panel Accessories: a metal pocket, 250 mm wide x 150 mm high x 25 mm deep, to hold pertinent drawings and manuals on the lower half of the inside door.

E89.10 Internal Works

- (a) Provide an individual switch for disconnection and a fuse for isolation of all panel mounted instruments requiring a 120-volt supply.
- (b) Make all wiring connections in the shop from the equipment mounted on the panel to numbered terminal blocks conveniently located in the panel, including the power supply for all instruments. Conductors shall be extra flexible stranded copper of gauges sufficient to carry the required currents, and shall in no case be smaller than #16 AWG extra flexible.
- (c) Wire connections to all relays and instruments shall be made using easily removable good quality mechanical clips.

- (d) Identify all wiring by means of plastic slip-on type markers. Install all wiring neatly and laced or bunched into cable form using plastic wire clips, and where practical, contained in plastic wiring channels with covers.
- (e) Provide Weidmuller terminal blocks #SAK 2.5, T7 Carrier & EK 2.5N Grounding, tubular clamp, 300 V, complete with track. Each terminal shall be clearly indelibly marked with the wire number connection to it. Each field connecting conductor shall be served by one terminal. Provide 20% spare unit terminals, with a minimum of two spare terminals. Provide all necessary terminal block accessories such as manufactured jumpers and marking tape.
- (f) Mount all internally mounted equipment on a hinged sub-chassis or mount on a rack and arrange for ease of access and removal when necessary.
- (g) Arrange all terminal blocks in the panel in groups such that all low level signals such as 4-20 mA DC are located in one area, followed by contact closure type signals (limit switches, etc.), that do not subsequently energize starters, etc. but are for status indication, and the remainder that contain powered circuits, 120 volt, 50 Hz, are to be arranged in such a manner and location so as to prevent interference into the low level signal.
- (h) Submit proposed terminal block layout and identification scheme for review prior to manufacture.
- (i) Provide suitable spaces around the terminal blocks for incoming and outgoing conductors or cable assemblies.
- (j) Provide plastic cable troughs equal to Panduit complete with snap-on covers for containing the cables. Cables are not to be bunched and tied, but laid in.

E89.11 Panel Manufacturer

- (a) Panel assembly, subcomponents and all internal components shall be CSA approved. Cabinet construction shall be performed by an established panel manufacturer who shall comply with all building codes, factory, and Department of Labour regulations and has CSA approval as manufacturer for all components of the Work including control panels, MCCs, service entrance, etc. Local approvals for panel construction including CSA will not be accepted.
- (b) Acceptable panel manufacturer shall be Manco Control Systems Inc., Celco Controls.

E89.12 Alternate Panel Manufacturer

- (a) Bid Opportunity shall be based on the panel manufacturer specified. Alternate approvals shall be in accordance with B6 - Substitutes.
- (b) Proposed alternate panel manufacturer must submit package at time of Bid Submission for review and evaluation by the Contract Administrator containing the following information and material:
 - (i) Separate requests for approval as equal for all monitoring and control equipment (including system software) to be used not listed as approved in this specification. Provide complete technical data including manufacturer make and model number to allow for a thorough review of the system and equipment being proposed.
 - (ii) List of five (5) recent water and/or sewage treatment plant projects successfully completed by the firm as a panel manufacturer.
 - (iii) List of references from satisfied clients, Contractors and Project Administrators attesting to the firms product quality and performance in addition to the firms reputation, service, professionalism, and ability to meet deadlines.
 - (iv) Complete listing of all in house personnel to be working directly on the project indicating experience working with the proposed equipment and control system

of this type and experience working specifically on water and sewage treatment plant control systems. Detail years of relevant experience complete with listing of specific projects.

- (v) Documentation confirming full CSA approval as manufacturer for all components of the Work (e.g. control panels, MCCs, service entrance, etc.).

E89.13 Motor Control Centre

- (a) Custom built motor control centre shall be as specified in these provisions.

E89.14 Genset Ventilation System Control Panel

- (a) Provide complete generator ventilation control system as indicated c/w the following:
 - (i) Surface mounted EEMAC 12 enclosure.
 - (ii) 24 VAC electric damper actuators, Belimo AF-245R.
 - (iii) Control thermostat, Honeywell T79845
 - (iv) Space temperature controller, Honeywell
 - (v) Minimum position switch, Belimo SG24.
 - (vi) 120/24 VAC control transformer.
- (b) Sequence of operation as follows:
 - (i) Controls interlocked to function with operation of generator.
 - (ii) With generator off, all dampers revert to normally closed position.
 - (iii) On generator start-up, outside air damper opens to fixed setting of 15% (adjustable).
 - (iv) Temperature controller modulates the outside, return and relief air dampers to maintain temperature setpoint.
- (c) Acceptable manufacturer shall be Dynamic Building Control Inc.

E89.15 Exhaust Fan EF-1 Starter Panel

- (a) Provide exhaust fan EF-1 starter panel as indicated complete with the following:
 - (i) Surface mounted EEMAC 12 enclosure.
 - (ii) Hinged lockable door.
 - (iii) Lamacoid identification nameplates on all components.
 - (iv) Terminal strips (identified) for all wiring.
 - (v) 1 – ½ HP, 1Ø, 208V, 2 speed starter for exhaust fan EF-1.
 - (vi) Relays, OMRON MK3PN-5-S c/w PF113A bases.
 - (vii) Push to test LED type pilot lights, selector switches, pushbuttons, Telemecanique XB2B series.

E89.15.1 Panel finish shall be white epoxy paint for interior and ASA61 light grey enamel for exterior.

E89.16 Spare Parts

- (a) Provide one spare pushbutton, pilot light and selector switch for each type of switches and color of lights supplied.

E89.17 Installation

- (a) Install pushbutton stations, control and relay panels, control devices as indicated and interconnect as indicated.

E89.18 Tests

- (a) Perform tests in accordance with these provisions.

- (b) Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at a time and check out operation of section.
- (c) Upon completion of sectional test, undertake group testing.
- (d) Check out complete system for operational sequencing.
- (e) Submit one copy of test results to the Contract Administrator.

E89.19 Start-Up and Commissioning

- (a) Perform all panel start-up and commissioning in accordance with these provisions.

E90. PROGRAMMABLE LOGIC CONTROLLER

E90.1 Scope

- (a) This section covers the supply and installation of the programmable controller.

E90.2 Submittals

- (a) Submit shop drawings in accordance with these provisions and include details on all CPU functions, programming, flow charts, operator menus, control sequences, schematics, component dimensions, data storage quantity, data storage speed, data storage back-ups, and program storage back-ups.

E90.3 Pumping Station PLC

- (a) Pumping Station PLC system shall be as shown on the drawings and include:
 - (i) Central processing unit (CPU) including power supply
 - (ii) I/O modules: discrete input, discrete output, analog input and analog output
 - (iii) Remote monitoring hardware
 - (iv) All necessary supporting hardware, e.g. PLC backplane, terminal strips, etc.
 - (v) PLC programming
- (b) Environmental conditions
 - (i) Temperature ratings:
 - ◆ Storage temperature: -40 to 85°C
 - ◆ Operating temperature: 0 to 60°C
 - (ii) Humidity: 0 to 93% non-condensing
 - (iii) Altitude: 2000 metres full operation
 - (iv) Vibration and shock:
 - ◆ Shock (half sine wave): ∇ 15g peak, 11 msec, 3 pulses/axis
 - ◆ Vibration: 10 to 57 Hz @ 0.075 mm d.a 57 to 150 Hz @ 1G
 - ◆ Free fall: 1m
 - (v) RFI and EMF Protection:
 - ◆ RFI/EMF susceptibility: 27 to 500 Mhz: 10 V/m
 - ◆ Electrostatic discharge: 8 kV/ 4 kV contact
 - ◆ Surge withstand: IEC 801-5 2000 V, shield to ground
- (c) Central Processing Unit (CPU):
 - (i) General:
 - ◆ The CPU shall consist of rack-mounted sub-assemblies (modules) which solve application logic, store the application program, store numerical values related to the logic, and interface to the I/O modules.

- ◆ The CPU shall provide local diagnostic information via LED indicators and relay contact outputs. All indicators shall be marked as to its respective function.
 - ◆ A dry contact shall provide for remote PLC failure alarm indication. The CPU shall come complete with all necessary software to provide for this alarm function.
 - ◆ Power back-up for one year via lithium battery.
- (ii) Communication Networking:
- ◆ One Modbus interface port for connection via twisted pair. Data transfer communication rate shall be 19200 bits/sec.
 - ◆ One Modbus+ interface port for high performance peer-to-peer communication and high speed data acquisition applications via twisted pair (Belden 9841). Data transfer communication rate shall be 106 bits/sec.
- (iii) Program Storage:
- ◆ 8K words of program memory.
 - ◆ PLC program storage medium shall be solid state RAM. RAM memory shall have battery back-up capability of retaining all stored program data through a continuous power outage for 12 months under worst case conditions. Capability shall exist to remove battery from RAM module without interrupting system power.
 - ◆ Removable EEPROM card for non-volatile RAM memory back-up (loads on power-up) and program portability.
 - ◆ Total 256K of memory
 - ◆ 0.3ms/k to 1.4ms/k scan time.
 - ◆ Time-of-day clock.
 - ◆ Watchdog timer.
- (iv) Programming Technique:
- ◆ The programming format shall be traditional relay ladder logic/function block.
- (v) Acceptable manufacturer shall be Modicon TSX Quantum Automation Series Model No. 140 CPU 113 02, Allen-Bradley No. 1756-L55M13.
- (d) Input/Output (I/O) Modules:
- (i) General:
- ◆ All I/O inputs shall be individually fused.
 - ◆ All I/O modules shall be of the rack-mounted plug-in type modular design. Each I/O module shall be keyed to prevent module insertion into the wrong rack slot.
 - ◆ LED indicators adjacent to each I/O point, along with identification label.
 - ◆ All user wiring to the I/O modules shall be through a heavy duty terminal strip. Removable, push-in type terminal strip shall allow for module replacement without disturbing field wiring. Pressure type screw terminals shall be used to provide fast, secure wire connections.
 - ◆ Malfunction of an I/O module shall not affect the operation of the remaining I/O modules or the CPU.
 - ◆ CPU shall retain status of all I/O points of a failed I/O module.
 - ◆ Isolation shall be provided between all internal logic and external power circuits. Isolation shall meet minimum specification of 1500V RMS.

- (ii) Discrete Inputs:
 - ◆ No. of modules: As required
 - ◆ Description: 115 VAC Isolated Input Module
 - ◆ Number of points: 16
 - ◆ Operating voltage: 79-132VAC @ 60Hz
 - ◆ Points per group: Isolated
 - ◆ Acceptable manufacturer shall be Modicon Model No. 140 DAI 540 00, Allen-Bradley No. 1756-IA161.
- (iii) Discrete Outputs:
 - ◆ No. of modules: As required
 - ◆ Description: Relay (NO) Output Module
 - ◆ Number of points: As required
 - ◆ Operating voltage: 115 VAC
 - ◆ Points per group: Isolated
 - ◆ Max. current/pt.: 2 Amp, Resistive
 - ◆ Acceptable manufacturer shall be Modicon Model No. 140 DRA 840 00, Allen-Bradley No. 1756-OW161.
- (iv) Analog Input:
 - ◆ No. of modules: As required
 - ◆ Description: Analog Input Module (Uni-Polar)
 - ◆ No. of channels: 8
 - ◆ Operating current: 4 to 20 maDC
 - ◆ Isolation: 1000 VAC Channel to Bus
 - ◆ Accuracy: 0.05% of full scale current
 - ◆ Acceptable manufacturer shall be Modicon Model No. 140 ACI 030 00, Allen-Bradley No. 1756-IF8.
- (v) Analog Output:
 - ◆ No. of modules: As required
 - ◆ Description: Analog Output Module (Uni-Polar)
 - ◆ No. of channels: 4
 - ◆ Operating current: 4 to 20 maDC
 - ◆ Isolation: 2500 VDC Channel to Bus
 - ◆ Accuracy: 0.2% of full scale current
 - ◆ Acceptable manufacturer shall be Modicon Model No. 140 ACO 020 00, Allen-Bradley No. 1756-OF4.
- (e) Remote Communication Hardware:
 - (i) Communication interface module, single cable as manufactured by Modicon Model No. 140 NOE 771 00, Allen-Bradley No. 1756-ENBT.
 - (ii) External telephone modem c/w all necessary cables.
- (f) Accessories:
 - (i) One 16 slot mounting backplane shall house the CPU, AC power supply, discrete input, discrete output, analog input, and analog output modules as required. Acceptable manufacturer shall be Modicon Model No. 140 XBP 016 00, Allen-Bradley No. 1756-A13.

- (ii) Analog modules require separate terminal strips as manufactured by Modicon Model No. 140 XTS 002 00, Allen-Bradley.

E90.4 Installation

- (a) Mount and install PLC and associated equipment in motor control centre control section as indicated on the drawings and as specified in these provisions.
- (b) Complete PLC and control system installation, testing, start-up and commissioning shall be as specified in these provisions.

E91. INSTRUMENTATION

E91.1 Scope

- (a) This section specifies the supply installation, field testing, and placing into operation of flow, pressure, temperature, level turbidity, and other instruments of control and instrumentation.

E91.2 Submittals

- (a) Submit shop drawings in accordance with these provisions.

E91.3 Instruments

- (a) Provide each instrument with mechanisms that are corrosion resistant.
- (b) Provide each instrument with mechanisms enclosed in a dustproof and a moistureproof case.
- (c) Provide all indicator and gauge dials finished in permanent white with black graduations and figures.
- (d) Potentiometric signals shall have a "live" zero or positive minimum value in the signal range.
- (e) Each component shall be carefully selected and designed for a long lifetime with ample margin to withstand transient and other surge voltages, which may occur in the circuits from any source in the power supply.
- (f) Each component and composite instrument shall be suitable for the location and installation position at the attitude designated on the drawings, e.g., horizontal, vertical or sloped position.
- (g) The Contractor shall provide all power supplies. Provide each instrument having a 115 volt supply with a receptacle and plug assembly. Receptacles and plug to be of "twist-lok," type.
- (h) Provide each instrument with a circuit breaker.
- (i) Integrating counters and elapsed time meters shall show the total quantity that has passed through the meter and shall not require the use of a multiplier other than cipher additions. The integrators shall have at least seven figures.
- (j) All control panel mounted instruments shall be suitable for flush mounting and shall be furnished with bezel.
- (k) Unless otherwise indicated or specified, all signals shall be of the 4-20 mA DC type. This applies to both transmitting and receiving instruments.
- (l) All materials shall conform to the standards of the Canadian Standards Association (CSA).
- (m) Instrumentation Data Sheets are included in this Section.

E91.4 Ultrasonic Level Sensor/Transmitter

- (a) Provide one (1) ultrasonic level sensing system suitable for wastewater applications as indicated to monitor water level in the following chamber:
 - (i) Pumping Station Wet Well
- (b) Surface mounted continuous level monitoring device to provide one 4-20 mA signal proportional to storage tank water level.
- (c) Power input: 120 VAC.
- (d) Power output: 4-20 mA DC and digital communication. Signal to be input to PLC.
- (e) Range: confirm with Contract Administrator prior to shipment.
- (f) Chemical resistant polyester/polycarbonate alloy surface mounted EEMAC 4X rated enclosure complete with LCD and bar graph display.
- (g) Four level sensing transducers complete with built-in temperature compensation and submersible transducer shield. Remotely mount transducers to underside of slab above respective chambers as indicated on drawings. Supply necessary length of transducer cable between transducer and panel mounted transmitter.
- (h) Acceptable manufacturer shall be Milltronics MultiRanger 100 c/w XRS-5C submersible transducer, Endress & Hauser FMU 862 c/w FDU 80 transducer or approved equal.

E91.5 Float Switches

- (a) Provide float switches as indicated, teardrop shaped submersible, weighted and encapsulated in an enclosure suitable for immersion in potable water and wastewater. Acceptable manufacturer shall be Flygt No.ENM-10 or approved equal.
- (b) Float switches shall be individually suspended by means of a submersible cable affixed to a galvanized steel float bracket as indicated on the drawings. Provide float rings to prevent cable entanglement. Acceptable manufacturer shall be Flygt No.13-520006 or approved equal.
- (c) Building flood alarm switch shall be ultrasonic gap type as manufactured by SOR No.711-K1-N-P7-C-CS.

E91.6 Temperature Switches

- (a) Provide building low temperature switches as indicated. Acceptable manufacturer shall be Honeywell No. T631A.

E91.7 Installation

- (a) Coordinate the work of this Section with the installation of the equipment specified in the relevant Sections in these provisions and shown on the drawings.
- (b) Perform all work in compliance with the relevant sections.

E91.8 Field Instrument Monitoring

- (a) "Mounting" shall mean the positioning and fastening with proper brackets in the position required.
- (b) All equipment shall be mounted in accordance with manufacturer's recommendations.
- (c) Locations of all field instruments are subject to modification by the Contract Administrator who reserves the right to move any item up to 3 meters from the position shown, without change to the contract price, provided notice is given before the related work has commenced.

- (d) Exact locations of all field instruments shall be site determined by the Contractor to the satisfaction of the Contract Administrator to ensure proper operation of the device.
- (e) Employ any and all means of trade, skill, and workmanship to install all field instruments to the satisfaction of the Contract Administrator.

E91.9 Commissioning

- (a) Instrument manufacturer's qualified field service representative shall be onsite as required to perform instrument calibration, testing and commissioning and to instruct City's representative in all aspects of instrument operation and maintenance.

DIVISION 14 - SPECIALTIES

E92. BRIDGE CRANE

E92.1 Scope of Work

- (a) This section covers the supply, installation and testing of the complete conveying system located in the Pump Station in accordance with the Canadian Electrical Code and CSA S-B167 and Z256 "Safety Code for Material Hoists". The supply and installation of the rail beams as well as supervision of rails' installation shall be included in this section.
- (b) The drawings indicate the general arrangement of the crane and hoists. The Contractor shall provide all necessary appurtenances and incidentals required for operating the crane and hoists in accordance with the specifications and in accordance with national and local governing codes of the safety standards for cranes, as published by ASME.
- (c) This section shall also include for placing the hoists in service and for making all necessary adjustments and corrections required for proper operation to the satisfaction of the Project Administrator.
- (d) The crane and hoist systems shall be the product of a company regularly engaged in the manufacture of this type of equipment and whose equipment is of a design which has been in satisfactory service under similar conditions for not less than five years.
- (e) Supplementary steel where used to provide support for suspension hardware from building structures other than those shown on the drawings shall conform to the specifications under E35 – Structural Steel.
- (f) The electric power feeder cables and disconnect switches are specified under Division 16 - Electrical, and connections shall be made by the electrical trade, as directed by the manufacturer of the crane and hoisting equipment.
- (g) Conform to Division 1 - General Requirements.

E92.2 Submittals

- (a) The Contractor shall submit shop drawings and information of the travelling crane system as follows:
 - (i) Assembly drawings and materials list.
 - (ii) Details of all parts and principal dimensions.
 - (iii) Details of the electrical trolleys and hoists, the electrical connections and power requirements.
 - (iv) Submit installation manuals before shipment of any equipment.
 - (v) Submit operation and maintenance manuals 30 days prior to startup.

E92.3 Electrical Requirements

- (a) All power supply shall be 575 V, 3 phase, 60 Hz alternating current.

- (b) Supply and install all necessary wiring to connect all parts of the equipment to the junction boxes installed by the electrical trade. All wiring shall be installed in accordance with the Canadian Electrical Code.
- (c) All controls from hoists, trolleys, etc. where electrified shall be of the pendent push-button type and shall operate on 110 V, single phase, 60 Hz power. The pendent shall be suspended from the hoist trolleys.

E92.4 Description

- (a) The crane shall be single girder, dual drive, top running, overhead electric travelling crane complete with electric hoist and electric trolley as manufactured by Richards-Wilcox or approved alternate.
- (b) The crane unit shall be R-W Model 11-130 or approved alternate. The hoist unit shall be R-W Model DA 508N or approved alternate.
- (c) Provide bridge crane as described briefly:

Capacities:

Bridge	2 Tonnes
Hoist	2 Tonnes
Span:	9 m (approx)
Runway Length:	11 m (approx)
Maximum Lift:	13 m
Hoisting Speeds: (2-speed)	2.4 m/min and 9.7 m/min
Trolley Speed: (2-speed)	6.0 m/min and 24 m/min
Bridge Speed: (2-speed)	3.6 m/min and 15.2 m/min

E92.5 Bridge

- (a) The girder shall be Richards Wilcox galvanized Tru-Tred I-beam complete with capping as required, or approved alternate.
- (b) End trucks shall be of a heavy steel construction, reinforced for axles and welded together with diaphragms and end plates to form a rigid one-piece unit. The end truck and plates shall form rail sweeps and be provided with hard rubber bumpers.
- (c) End trucks shall be bolted to girders. High tensile and fitted bolts shall be used to assure permanent alignment. Heavy seat plates and gusset plates shall be welded to the girders to ensure a rigid connection. Each end truck shall be angle braced to girder for additional lateral rigidity.
- (d) Each end truck shall be provided with two double flanged, high carbon, hardened steel wheels to 210-265 HB, mounted on two anti-friction bearings.
- (e) Each end truck shall be equipped with its own separate drive unit fixed directly on the side by a flanged mounting. The drive wheels are powered by spur gears on a secondary shaft. All wheels shall be aligned in a uniaxial direction by optical equipment. Each drive unit shall be powered by a dual speed electric motor.
- (f) Four rubber bumpers shall be provided to mate with the runway end stops.

E92.6 Load Chain

- (a) Load chain to be thru and case hardened steel.
- (b) Load chain shall be proof tested to twice the working load limit.

E92.7 Brakes

- (a) The hoist motor shall be provided with an electrically operated and controlled brake so arranged as to become automatically applied in case of power failure. It shall be arranged to release automatically upon the application of power to the motor. The brakes shall be so constructed that the motor must reverse to lower the load.
- (b) The bridge and trolley drive shall be provided with a magnetically operated friction brake. The magnet shall release the brake when the bridge or trolley are in motion. A drifting interval shall be provided between motor and brake operation.
- (c) The friction brakes shall be sufficiently powerful to bring the bridge or trolley and carried load to rest without reversing the motor and shall be adjustable.
- (d) End truck wheels shall be steel castings, turned to equal diameter and contoured to fit the rail track provided under this Section.

E92.8 Trolley

- (a) The trolley shall be a four-wheel unit or combinations of two wheel units with load bars or frames from which carrier, and hoist are hung and moved along the tracks. They shall be of a design to suit the type of track furnished and may have flattread or flanged wheels.
- (b) Load bars or special frames shall be cradled in the trolley yokes on swivel pins with thrust bearings for the maximum load. The load bars and special frames hung from the trolley yokes shall be of all steel or forged steel construction. Other design and construction features of wheels, bearings and their lubrication shall comply with the current Standard Specifications for steel railway bridges, serial designation S1, of the Canadian Standards Association.
- (c) The trolley drive shall be an integral part of the hoist. At least one wheel on each side of the track shall be driven. The drive shall be electric driven.
- (d) Trolleys shall be driven by a reversible two speed motor either through a gearhead on the motor or a separate gear train. Gears shall be of steel and shafts shall be fitted with anti-friction bearings. The drive shall have an integral brake.
- (e) All bearings to be lifetime lubricated.
- (f) Four (4) rubber bumpers shall be provided to mate with the bridge end stops.

E92.9 Hoists

- (a) The hoist shall be of the highest standard designed for equipment of this type. The hoists shall be dual speeds, electrically operated and shall be electric motor powered. It shall have a hoisting capacity as specified in this section.
- (b) Hoist shall meet ASME B30.16 Specifications.
- (c) Hoist to have metric rating.
- (d) Hoist to have true vertical lift.
- (e) Provide 4 pocket, heat treated lift wheel.
- (f) All bearings to be lifetime lubricated.
- (g) The hoisting drum shall be of ample diameter, machine-grooved and of sufficient length to wind the necessary length of hoisting rope without overlapping. The hoisting rope shall be of best quality plow steel wire with hemp centres and with a minimum safety factor of 5:1.
- (h) Hoist to have on H4 Duty Cycle (30min/hr runtime – 300 start-stop per hour).
- (i) The hoist and trolley shall be integrally constructed and shall be a lowhead type of capacity specified to suit the elevations shown on drawings.

- (j) Rope guides shall be provided with hoists. The hoist switches shall be activated by the rope guide and shall be fully adjustable at both the top and bottom hook positions. Hoist overload switches shall also be provided.
- (k) Each hoist and rope shall be load tested to 125% capacity and test certificates provided to the Contract Administrator.

E92.10 Hook Block

- (a) The hook block shall be of the swivel type carrying a heavy forged steel hook. The hook shall swivel on ball bearings of ample capacity, and include a latch.

E92.11 Electrical

E92.11.1 Motors and Brakes

- (a) All motors shall be of the conical brake type motor with Class "F" insulation, totally enclosed and fan cooled, and with a 40% minimum duty factor. All motors shall be equipped with thermistor type overload protectors.
- (b) All motors shall be supplied with a high torque conical disc brake to ensure minimal impact to the drive train. Hoist brakes shall be provided a minimum of 250% full-load motor torque braking. The bridge brakes shall be provided a minimum of 150% full-load motor torque braking and on the trolley motor.

E92.11.2 Controls

- (a) The controls shall consist of all necessary electrical contactors, relay, transformers and fuses in NEMA 4 electrical enclosure.
- (b) Control circuit shall be 120V.
- (c) The control unit for each crane shall consist of a contactor for each speed variation, a reversing contactor and overload protection. Overload protection shall be of the automatic reset type.
- (d) A main line magnetic contactor shall be included and operated from the push-button station. A main line safety disconnect switch, manually controlled, shall also be included.
- (e) A load switch limiting the capacity of the hoist shall be an integral part of the hoist control system.

E92.11.3 Push-Button Station

- (a) The push-button station shall be festooned across the bridge on an independent trolley track.
- (b) The push-button station shall have an industrial dust tight enclosure CSA Type 12 and have buttons for the following:
 - Stop- reset
 - Bridge, Low Speed - High Speed, Forward - Reverse
 - Trolley, Low Speed - High Speed, Forward - Reverse
 - Hoist, Low Speed - High Speed - Up-Down

E92.11.4 Conductors

- (a) Main conductors shall consist of duct-o-bar, Figure 8, 110 amp, galvanized steel conductor, complete with insulated hanger clamps, steel mounting brackets and end caps.
- (b) Cross conductors shall be festooned across the bridge on an independent trolley track.

E92.12 Rails

- (a) Supply and install all required rails as shown on the drawings. All top running crane rails shall be ASCE 27.2 kg rail Standard.

E92.13 Painting

- (a) The crane assembly shall receive one shop coat of high visibility yellow anti-corrosive paint. Refer to Section 09900 - Painting for details.
- (b) All exposed surfaces of crane be painted after installation.

E92.14 Installation

- (a) Before leaving the factory the crane and hoist shall be tested under all motions.
- (b) Install the equipment described above in accordance with the drawings and with strict adherence to the manufacturer's instructions.
- (c) Ensure that the crane rails are perfectly horizontal, correctly aligned, and properly fastened to the supporting structures. Install the travel limit stops on each end of rails.
- (d) Lubricate all necessary points on the bridge hoist, draw block and the trolleys using the manufacturer's recommended lubricates.

DIVISION 17 – MEASUREMENT AND PAYMENT

E93. MEASUREMENT AND PAYMENT

E93.1 Land Drainage Sewers

- (a) "Land Drainage Sewers" shall include all work related to E22 – Land Drainage Sewers. Included as part of this work is excavation, shoring, dewatering, tunneling, piping, jointing, bedding, backfill, compaction, testing, restoration, and miscellaneous items. Include all relevant work whether identified, implied, or required to perform the Work.
- (b) Method of Measurement
 - (i) "Land Drainage Sewers" will be measured on a linear basis based on measurements taken along the centerline of the pipe by the contract administrator or his representative.
- (c) Basis of Payment
 - (i) The amount to be paid for "Land Drainage Sewers" shall be the total number of linear meters of land drainage sewers installed at the contract price for "Land Drainage Sewers", and shall include all other work implied or incidental to the work of this specification. A designation shall be made for the method of installation, size, class, depth, and type of backfill used.

E93.2 Forcemain

- (a) "Forcemain" shall include all work related to E21 – Pressure Mains. Included as part of this work is excavation, shoring, dewatering, tunneling, piping, jointing, bedding, backfill, compaction, testing, restoration, and miscellaneous items. Include all relevant work whether identified, implied, or required to perform the Work.
- (b) Method of Measurement
 - (i) "Forcemain" will be measured on a linear basis based on measurements taken along the centerline of the pipe by the contract administrator or his representative.
- (c) Basis of Payment
 - (i) The amount to be paid for "Forcemain" shall be the total number of linear meters of land drainage sewers installed at the contract price for "Forcemain", and shall

include all other work implied or incidental to the work of this specification. A designation shall be made for the method of installation, size, depth, and type of backfill used.

E93.3 750mm LDS Connection

- (a) "750mm LDS Connection" shall include all work related to E23 – Connection of 750mm LDS to Pump Station. Included as part of this work is excavation, shoring, dewatering, coupling, connection, bedding, backfill, compaction, testing, restoration, and miscellaneous items. Include all relevant work whether identified, implied, or required to perform the Work.
- (b) Method of Measurement
 - (i) "750mm LDS Connection" will be measured on a unit basis.
- (c) Basis of Payment
 - (i) The amount to be paid for "750mm LDS Connection" shall be the total number of connections in accordance with the specification and as accepted by the Contract Administrator, and shall include all other work implied or incidental to the work of this specification.

E93.4 750mm Forcemain Connection

- (a) "750mm Forcemain Connection" shall include all work related to E24 – Connection of 750mm Forcemain to Pump Station. Included as part of this work is excavation, shoring, dewatering, coupling, connecting, bedding, backfill, compaction, testing, restoration, and miscellaneous items. Include all relevant work whether identified, implied, or required to perform the Work.
- (b) Method of Measurement
 - (i) 750mm Forcemain Connection" will be measured on a unit basis.
- (c) Basis of Payment
 - (i) The amount to be paid for "750mm Forcemain Connection" shall be the total number of connections in accordance with the specification and as accepted by the Contract Administrator, and shall include all other work implied or incidental to the work of this specification.

E93.5 General Conditions, Supplemental Conditions, Office and Construction Facilities

- (a) General Conditions, Supplemental Conditions, Office Facilities and Construction Facilities" shall include all work related to Part C, Part D, E3 – Office Facilities, and E4 – Construction Facilities. Include all work related to these Parts and specification sections whether identified or implied. Specifically include the provision of project insurance, bonding, office facilities, construction facilities, and other relevant items.
- (b) Method of Measurement
 - (i) "General Conditions, Supplemental Conditions, Office Facilities and Construction Facilities" will be measured as a lump sum.
- (c) Basis of Payment
 - (i) "General Conditions, Supplemental Conditions, Office Facilities and Construction Facilities" will be paid for throughout the duration of the project as a percentage calculated monthly of the number of working days used with relation to the total number of working days for the project. Payment shall include all operations described in Part C, Part D, E3 – Office Facilities, and E4 – Construction Facilities and include all other work implied or incidental to the work of these specification parts / sections.

E93.6 Site Works

- (a) "Site Works" shall include all work related to E19 – Site Work and Excavation. Included as part of this work is clearing, grubbing, stripping, grading, site fencing, traffic barriers, ditching and miscellaneous items. Include all relevant work whether identified, implied, or required to perform the Work.
- (b) Method of Measurement
 - (i) "Site Works" will be measured as a lump sum.
- (c) Basis of Payment
 - (i) "Site Works" shall include payment in full for performing all operations herein described including the cost of furnishing all necessary labour, materials, and equipment for the provision of Site Works, and include all other work implied or incidental to the work of this specification.

E93.7 Structural Excavation, Shoring, and Dewatering

- (a) "Structural Excavation, Shoring, and Dewatering" shall include all work identified in and related to E18 – Structural Excavation and Backfill, and portions of E26 - Structural Concrete relating to shoring and dewatering. Included as part of this work is dewatering, excavation, shoring, backfilling, compaction and miscellaneous items. Include all relevant work whether identified, implied, or required to perform the Work.
- (b) Method of Measurement
 - (i) "Structural Excavation, Shoring, and Dewatering" will be measured as a lump sum.
- (c) Basis of Payment
 - (i) "Structural Excavation, Shoring, and Dewatering" shall include payment in full for performing all operations described in E18 – Structural Excavation and Backfill, and portions of E26 - Structural Concrete relating to shoring and dewatering. Include the cost of furnishing all necessary labour, materials, and equipment including all other work implied or incidental to the work of this specification.

E93.8 Substructure

- (a) "Substructure" shall include all work identified in and related to E27 – Concrete Accessories, E28 – Concrete Reinforcement, E29 – Hydrostatic Testing, and portions of E26 - Structural Concrete relating to general concreting requirements. Included as part of this work is formwork, reinforcement, concrete, water stop, concrete accessories, concrete testing and miscellaneous items. Include all relevant work whether identified, implied, or required to perform the Work.
- (b) Method of Measurement
 - (i) "Substructure" will be measured as a lump sum.
- (c) Basis of Payment
 - (i) "Substructure" shall include payment in full for performing all operations described in E27 – Concrete Accessories, E28 – Concrete Reinforcement, E29 – Hydrostatic Testing, and portions of E26 - Structural Concrete relating to general concreting requirements. Include the cost of furnishing all necessary labour, materials, and equipment including all other work implied or incidental to the work of this specification.

E93.9 Superstructure

- (a) "Superstructure" shall include all work identified in and related to E35 through E50, inclusive, and E57 and E58. Included as part of this work is masonry, metals, wood products, thermal and moisture protection, doors and windows, finishes (including pipe lining), fire equipment and miscellaneous items. Include all relevant work whether

identified, implied, or required to perform the work and provide a complete and functional pump house building.

(b) Method of Measurement

(i) "Superstructure" will be measured as a lump sum.

(c) Basis of Payment

(i) "Superstructure" shall include payment in full for performing all operations described in specification sections E35 through E50, inclusive, and E57 and E58. Include the cost of furnishing all necessary labour, materials, and equipment including all other work implied or incidental to the work of this specification to provide a complete and functional pump house structure.

E93.10 Overhead Crane System

(a) "Overhead Crane System" shall include all work identified in and related to E92 – Bridge Crane. Included as part of this work is columns, support beams, electric trolleys, hoist, and miscellaneous items. Include all relevant work whether identified, implied, or required to perform the work and provide a complete and functional overhead crane system.

(b) Method of Measurement "Overhead Crane System" will be measured as a lump sum.

(c) Basis of Payment

(i) "Overhead Crane System" shall include payment in full for performing all operations described in specification section E92 – Bridge Crane. Include the cost of furnishing all necessary labour, materials, and equipment including all other work implied or incidental to the work of this specification to provide a complete and functional overhead crane system.

E93.11 Process Mechanical and Domestic Plumbing

(a) "Process Mechanical and Domestic Plumbing" shall include all work identified in and related to specification sections E51 through E56, inclusive. Included as part of this work is submersible solids handling pumps and wet well accessories, process mechanical piping, domestic plumbing water and waste piping, valves, sluice gates, testing, and miscellaneous items. Include all relevant work whether identified, implied, or required to perform the work and provide a complete and functional process mechanical and domestic plumbing systems.

(b) Method of Measurement

(i) "Process Mechanical and Domestic Plumbing" will be measured as a lump sum.

(c) Basis of Payment

(i) "Process Mechanical and Domestic Plumbing" shall include payment in full for performing all operations described in specification sections E51 through E56, inclusive. Include the cost of furnishing all necessary labour, materials, and equipment including all other work implied or incidental to the Work of this specification to provide a complete and functional process mechanical and domestic plumbing systems.

E93.12 HVAC

(a) "HVAC" shall include all work identified in and related to specification sections E59 through E66, inclusive. Included as part of this work is air handling units, exhaust fans, unit heaters, force flow heaters, louvers, dampers, ducting, duct insulation and coverings, vibration isolation, testing, and miscellaneous items. Include all relevant work whether identified, implied, or required to perform the Work and provide complete and functional heating and ventilation system.

- (b) Method of Measurement
 - (i) "HVAC" will be measured as a lump sum.
- (c) Basis of Payment
 - (i) "HVAC" shall include payment in full for performing all operations described in specification sections E59 through E66, inclusive. Include the cost of furnishing all necessary labour, materials, and equipment including all other work implied or incidental to the Work of this specification to provide a complete and functional process heating and ventilation system.

E93.13 Electrical

- (a) "Electrical" shall include all work identified in and related to specification sections E67 through E81, inclusive. Included as part of this work is motor control center, panels, conduit, wire, cable, box connectors, fastenings and support, wiring devices, switches, grounding, transformers, panel boards, circuit breakers, surge suppressors, terminations, mounting and wiring of the emergency generator transfer switch, lighting, testing, and miscellaneous items. Include all relevant work whether identified, implied, or required to perform the Work to provide a complete and functional electrical and controls system.
- (b) Method of Measurement
 - (i) "Electrical" will be measured as a lump sum.
- (c) Basis of Payment
 - (i) "Electrical" shall include payment in full for performing all operations described in specification sections E67 through E81, inclusive. Include the cost of furnishing all necessary labour, materials, and equipment including all other work implied or incidental to the Work of this specification to provide a complete and functional electrical and controls system.

E93.14 Emergency Generator

- (a) "Emergency Generator" shall include all work identified in and related to specification sections E82 – Emergency Generator and E83 – Transfer Switch. Included as part of this work is the emergency generator, supply of the emergency generator transfer switch, testing, and miscellaneous items. Include all relevant work whether identified, implied, or required to perform the Work to provide a complete and functional emergency generator system system.
- (b) Method of Measurement
 - (i) "Emergency Generator" will be measured as a lump sum.
- (c) Basis of Payment
 - (i) "Emergency Generator" shall include payment in full for performing all operations described in specification sections E82 – Emergency Generator and E83 – Transfer Switch. Include the cost of furnishing all necessary labour, materials, and equipment including all other work implied or incidental to the work of this specification to provide a complete and functional emergency generator system system.