FIELD ENGINEERING

1. REQUIREMENTS INCLUDED

.1 Field engineering survey services to measure and stake the Site.

.2 Survey services to establish (and confirm) invert measurements for the Work.

.3 Subsurface conditions.

2. SURVEY REFERENCE POINTS

.1 Existing base horizontal and vertical control points are designated on Drawings.

.2 Locate, confirm, and protect control points. Preserve permanent reference points during construction.

.3 Make no changes or relocations without prior written notice to the Contract Administrator.

.4 Report to the Contract Administrator when a reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.

.5 Require Manitoba Land Surveyor to replace control points in accordance with the original survey control.

3. SURVEY REQUIREMENTS

.1 Employ a Manitoba Land Surveyor to establish two (2) permanent benchmarks on-site, referenced to establish benchmarks by survey control points. Record locations with horizontal and vertical data in Project Record Documents.

.2 Establish lines and levels; locate and lay out by instrumentation.

.3 Stake for grading, fill and topsoil placement, and landscaping features.

.4 Stake slopes and berms.

.5 Establish pipe invert and centerline elevations.

.6 Establish lines and levels for mechanical and electrical Work.

4. RECORDS

.1 Maintain a complete accurate log of control and survey Work as it progresses.

5. SUBMITTALS

.1 On request of the Contract Administrator, submit documentation to verify accuracy of field engineering Work.

.2 Submit certificate signed by Manitoba Land Surveyor certifying that elevations and locations of completed Work are in conformance or non-conformance with Contract Documents.

END OF SECTION

SCOPE OF WORK

1. DESCRIPTION OF WORK

.1 The Work to be performed under this Contract shall include the labour, equipment, and materials required to complete the Phosphorus Removal Facility at the North End Water Pollution Control Centre in Winnipeg, Manitoba, all as specified in the Contract Documents.

.2 The Work includes, but is not limited to the following elements:

.1 New structure with associated mechanical and electrical systems to house the chemical storage tanks

.2 Railcar shelter

.3 Rail spur

.4 Two chemical storage tanks

.5 Chemical pumping systems with associated controls, piping, and electrical systems

.6 Upgrade, additions, and modifications to the electrical supply system and services as detailed in Division 16 Electrical Scope of Work

.7 Upgrade and modifications to the distributed control system (DCS) to control new systems

.8 Sitework and Site Utility Work associated with the new facilities and with the general Site

.9 Heating, ventilation, and cooling (HVAC) systems

.10 All other auxiliary equipment, structures, and systems required to complete the Work

2. COORDINATION

.1 Cooperate and liaise with other Contractors, utility agencies, City employees or their appointed representatives in order to make appropriate working arrangements to ensure satisfactory execution and timely completion of the Work.

.2 Attend coordination meetings, as directed by the Contract Administrator, when the Contract Administrator considers that they are necessary for ensuring the sufficiency of the liaison and cooperation with other contractors. The Contractor shall be deemed to have allowed in his Bid Price for any interference to his operations, which may result from any of the above. He must also take all precautions necessary to ensure that he does not hinder or delay in any way the progress of these other parties or cause damage to their completed Work.

3. CONNECTIONS TO EXISTING PIPING

3.1 Work Plan

.1 For each of the following tie-ins, submit a detailed work plan, including as a minimum:

.1 equipment and materials list

.2 number of employees required and qualifications

.3 detailed schedule, describing progress at a maximum of 30 minute intervals

.4 contingency plan

3.2 Sludge Piping Connections

.1 The digested sludge and primary sludge systems can be shut down for a maximum continuous interval of four to eight hours. The Contractor shall provide at least ninety-six (96) hours advance notice to the Contract Administrator in order that the shutdown of the sludge systems to facilitate connections can be scheduled.

3.3 Centrate Piping Connections

.1 The centrifuge system can be shut down for eight hours. The Contractor shall provide at least forty-eight (48) hours advance notice to the Contract Administrator in order that the shutdown of the sludge systems to facilitate connections can be scheduled.

3.4 Potable Water Connections

.1 Potable water systems can be shut down in conjunction with the centrifuges (see 3.2). Any potable water connections that require shut down of the potable water feed shall be made in conjunction with the scheduled centrifuge shutdowns. If this is not possible, the Contractor shall provide at least forty-eight (48) hours advance notice to the Contract Administrator in order that the shutdown of the potable water sytem to facilitate connections can be scheduled.

3.5 Natural Gas Connections

.1 Natural gas connections will require the boilers and burners be taken out of service. It is anticipated these systems can be shut down for a maximum eight-hour period during warm weather. The Contractor shall provide at least ninety-six (96) hours advance notice to the Contract Administrator in order that the shutdown of the boilers to facilitate connections can be scheduled.

4. CONTRACTOR USE OF PREMISES

.1 Generally restrict operations to the designated construction and contractor laydown areas indicated on the Drawings. Access to the NEWPCC will not be permitted, except for construction purposes as arranged in advance with the Contract Administrator..

.2 The City will make reasonable efforts to accommodate the Work of the Contractor. However, the NEWPCC must remain in operation through the Construction Period.

.3 Obtain written authorization from the respective landowners to enter private lands, which will be the subject of temporary working easements. Obtaining temporary working easements will be the responsibility of the Contractor.

.4 Ascertain and abide by conditions pertaining to the use of temporary working easements or right-of-ways.

.5 Obtain and pay for use of additional storage, access, or work areas needed for Work under this Contract.

5. COMPLETION DATES

.1 Time and all time limits stated in the Contract Documents are of the essence of the Contract. The Contractor shall perform his Work expeditiously and with adequate forces to achieve the completion dates.

END OF SECTION

1. SITE CONDITIONS AND LIMITS

1.1 Examination of Site

.1 Prior to commencing actual construction Work, inspect field conditions, obtain and confirm actual Site dimensions, examine surface conditions as required to ensure correct execution of the Work.

.2 Maintain or arrange for the removal, relocation, and replacement as appropriate of any existing utilities, which may be affected by the Work.

.3 Arrange for the removal, relocation, and replacement as appropriate, of process piping, equipment, electrical conduit, and concrete pads and supports.

2. DOCUMENTS AND INSTRUCTIONS

2.1 Discrepancies and Omissions

.1 Notify the Contract Administrator immediately upon discovery of discrepancies or omissions in the Contract Documents or of any doubt as to the meaning or intent of any part thereof.

.2 To proceed with the Work when an error is suspected or when there is doubt as to the interpretation of the project requirements constitutes full acceptance of any cost associated with any remedial Work, which may be required.

2.2 Documents On-Site

.1 Maintain one (1) copy of all current Contract Documents and all Shop Drawings on-site, in good order and available to the Contract Administrator or his representatives.

.2 This requirement does not include the executed Contract Documents.

3. CHANGES TO THE WORK

.1 Refer to the Contract General Conditions regarding changes to the Work.

.2 Contemplated Change Notice (CCN): issued after award of Contract, does NOT constitute an order to perform the change but is a notice of a proposed change only. Submit to the Contract Administrator within seven (7) days after receipt of a CCN a statement of cost adjustments and effect upon construction schedule required by the proposed change. Itemize statement in accordance with all items separately listed.

.3 Field Order (FO): during Construction, the Contract Administrator may issue a Field Order to authorize a change or additional Work of an emergency nature. A firm total cost (extra or

credit) or a method for determining this cost must be included (unit price, cost plus, or time basis).

.4 Change Order (CO): after receipt of the statement of cost adjustment and the City's approval, the Contract Administrator will issue a Change Order in the amount of the approved cost adjustment, which will authorize the Contractor to proceed with the change to the Work, or alternatively will notify the Contractor that the proposed change is cancelled.

.5 Field Instructions (FI): the Contract Administrator may issue during construction, a Field Instruction to supplement or clarify the Contract Documents. Neither the contract price nor the contract time is affected by a Field Instruction.

4. SUBSURFACE CONDITIONS

.1 A copy of the Geotechnical Report with respect to the project is included in this document and is for general information only. The contents of this report shall not be construed as a requirement of this Contract. The Bidder shall make his own interpretation of the data provided and shall carry out such additional investigations, as he deems necessary for the preparation of his Bid at his own expense.

.2 The Contractor shall take appropriate precautions to protect existing structures and any underground utilities that could be affected by performance of any of the Work.

5. SITE PREPARATION

5.1 Description

.1 This Specification shall cover Site preparation, including mobilization, field office facilities, equipment and fuel compounds, Site drainage, access roads, storage areas, and turnarounds, Site contamination and clean-up, demobilization and Site restoration, and other Contractor related tasks required as a portion of the Works for this Contract.

.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour materials, all things necessary for and incidental to the satisfactory performance and completion of all Work as hereinafter specified.

5.2 Construction Methods

.1 Use of Public Roads and Right-of-Ways

.1 Maintenance

.1 It shall be the responsibility of the Contractor to keep public roads and right-of-ways used by their construction activities and traffic clean and maintained during the Construction Period.

.2 Earth, gravel, sand, or other construction materials spilled from hauling equipment onto public roads and right-of-ways shall be picked up promptly and continuously at the Contractor's expense.

.3 Any damage to public roads and right-of-ways caused by the Contractor's construction activities shall be repaired at the Contractor's expense as directed by the Contract Administrator or the authority having jurisdiction.

.4 Public roads and right-of-ways on the Site are used daily for delivery of septage and other materials. The Contractor shall ensure the roadways are kept unobstructed and not used for stockpiling or storage of materials, equipment, garbage, or Contractor's vehicles and parking.

.2 Construction Traffic Crossing and Entering Public Roads

.1 The Contractor shall limit their construction traffic crossing or entering public roads to as few locations as possible. Crossing and entrance locations shall be provided to the Contract Administrator for review and approval prior to construction starting.

.2 Where construction traffic crosses or enters onto public roads and right-of-ways the Contractor shall obtain the necessary approvals and provide signage and temporary traffic controls detailed in the Workzone Traffic Control Manual from the Manitoba Transportation and Government Services.

.2 Site Drainage

.1 Provision of adequate Site drainage during the Work shall be the Contractor's responsibility. No extra payments or time extensions will be granted as a result of difficulties associated with Site access resulting from poor Site drainage during any part of the Work.

.2 Any areas requiring clearing and grubbing to maintain adequate Site drainage shall be reviewed with the Contract Administrator prior to commencement of the Work.

.3 Demobilization and Site Restoration

.1 Further to GC:6.29, the Contractor shall demobilize, clean up, and remove all surplus materials, tools, equipment, waste and debris, access roads, storage areas, turnarounds, approaches to public roads, ditch crossings, and temporary culverts and dispose off-site and backfill excavations by the day set for Substantial Performance.

.2 The Contractor shall at their own expense, restore all surface areas damaged or disturbed by their activities at or adjacent to the Site to a condition equal to or better than was existing.

.4 Restricted Access Areas

.1 Refer to the Site plan for any areas identified as restricted access. No admittance to this area by the Contractor or Contractor's personnel without the Contract Administrator's permission.

6. ENVIRONMENTAL PROTECTION

.1 The Contractor shall plan and implement the Work of this Contract strictly in accordance with the requirements of the environmental protection measures as herein specified.

.2 The Contractor is advised that at least the following Acts, Regulations, and By-laws apply to the Work.

.1 Federal

.1 Canadian Environmental Protection Act (CEPA)

.2 Transportation of Dangerous Goods Act

.2 Provincial

.1 NEWPCC EA Licence

.2 The Dangerous Goods Handling and Transportation Act D12

.3 The Endangered Species Act E111

.4 The Environment Act E125

.5 The Fire Prevention Act F80

.6 The Manitoba Nuisance Act N120

.7 The Public Health Act P210

.8 The Workplace Safety and Health Act W120

.9 Other current associated regulations that may be applicable

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

.1 Materials Handling and Storage

.1 The Contractor shall abide by the requirements of Manitoba Conservation for handling and storage of fuels.

.2 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.

.2 Fuel Handling and Storage

.1 Fuels, lubricants, and other potentially hazardous materials as defined in The Dangerous Goods and Transportation Act shall be stored and handled within the approved storage areas.

.2 The Contractor shall ensure that all fuel storage containers are inspected daily for leaks and spillage. Damaged or leaking fuel storage containers shall be promptly removed from the Site.

.3 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. This groundsheet may be supplemented with absorbent fabric material.

.4 Refuelling of mobile equipment and vehicles shall take place at least 100 m from a water reservoir shoreline.

.5 The areas around storage areas and fuel lines shall be distinctly marked and kept clear of snow and debris to allow for routine inspection and leak detection.

.6 A sufficient supply of materials, such as absorbent material and plastic oil booms, to clean up minor spills shall be stored nearby on-site. The Contractor shall ensure that additional material can be made available on short notice.

.3 Waste Handling and Disposal

.1 The construction area shall be kept clean and orderly at all times during and at completion of construction.

.2 At no time during construction shall personal or construction waste be permitted to accumulate for more than one (1) day at any location on the construction Site, other than at a dedicated storage area as may be acceptable to the Contract Administrator.

.3 Indiscriminate dumping, littering, or abandonment shall not take place.

.4 No on-site burning of waste is permitted.

.5 The Contractor shall provide waste collection bins within the laydown area acceptable to the Contract Administrator.

.4 Dangerous Goods and Hazardous Waste Handling and Disposal

.1 Dangerous goods and hazardous waste are identified by, and shall be handled according to, the Dangerous Goods Handling and Transportation Act and Regulations.

.2 The Contractor shall be familiar with the Dangerous Goods Handling and Transportation Act and Regulations.

.5 Emergency Spill Response

.1 The Contractor shall ensure that due care and caution is taken to prevent spills.

.2 The Contractor shall report all spills of petroleum or other hazardous substances as required by Act or Regulation with the potential for impacting the environment and threat to human health and safety to the Contract Administrator and Manitoba Conservation, immediately after occurrence of the environmental accident, by calling the 24-hour emergency telephone number (204) 944-4888.

.3 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.

.4 The following actions shall be taken by the person in charge of the spilled materials or the person(s) arriving at the scene of a hazardous material accident or the on-site emergency response coordinator.

.5 Notify emergency response coordinator of the accident:

.1 Identify exact location and time of accident.

.2 Indicate injuries, if any.

.3 Request assistance as required by magnitude of accident (Manitoba Conservation 24-hour Spill Response Line (204) 944-4888, Police, Fire Department, Ambulance, company back-up).

.6 Assess situation and gather information on the status of the situation, noting:

.1 Personnel on-site

.2 Cause and effect of spill

.3 Estimated extent of damage

.4 Amount and type of material involved

.5 Proximity to waterways and the reservoirs

.7 If safe to do so, try to stop the dispersion or flow of spill material:

.1 Approach from upwind

.2 Stop or reduce leak if safe to do so

.3 Dike spill material with dry, inert absorbent material or dry clay soil or sand

.4 Prevent spill material from entering waterways and utilities by diking

.5 Prevent spill material from entering manholes and other openings by covering with rubber spill mats or diking

.8 Resume any effective action to contain, clean up, or stop the flow of the spilled Product.

.9 The emergency response coordinator shall ensure that all environmental accidents involving contaminants shall be documented and reported to Manitoba Conservation according to the Dangerous Goods Handling and Transportation Act Environmental Accident Report Regulation 439/87.

END OF SECTION

REGULATORY REQUIREMENTS

1. PERMITS AND INSPECTIONS

.1 The Contractor shall obtain and pay for all permits, licences, certificates, and governmental inspections required for the performance of the Work.

.2 Give all required notices and comply with all local, provincial and federal laws, ordinances, rules, regulations, codes, and orders relating to the Work, which are or become in force during the performance of the Work.

.3 The Contractor shall make application, obtain, and pay for all development permits required for the project, and shall make application, obtain, and pay for all relevant permits. The Building Code information with respect to the Building Permit requirements are:

.1 Building footprint: 1556 m^2

.2 Occupancy classification: Group F Division 3

2. APPLICABLE CODES AND STANDARDS

.1 The applicable codes and standards for the performance of Work are generally indicated in this Specification.

.2 Where specified codes and standards are not dated, conform to the latest issue of specified codes and standards as amended and revised to the Tender closing date.

.3 Confine apparatus, the storage of Products and the operations of workers to limits indicated by laws, ordinances, and permits and by directions of the Contract Administrator. Do not unreasonably encumber the premises with Products.

.4 In the event of discrepancies between codes, standards, and other provisions, the most stringent shall apply.

3. SAFETY

3.1 General

.1 In case of an emergency the Contractor shall immediately contact the McPhillips Control Centre at 204-986-4781 or the shift operator at 204-794-4468. In the event an emergency occurs while Work is being performed on CP Rail property, CP Rail shall also be notified.

.2 Observe and enforce all construction safety measures required by code, Workers' Compensation Board, Manitoba Workplace Safety and Health, Canadian Pacific Railway Minimum Safety Requirements for Contractors Working on Railway Propoerty, and all applicable statutes. Appoint a suitably qualified employee who has sole responsibility on-site on behalf of the Contractor, for compliance with the requirements and so advise the City

in writing with copy to the Contract Administrator. The Contractor shall follow safe working practices.

.3 Conform to the requirements of the City of Winnipeg Water and Waste Department Asbestos Response Guide in working with or near asbestos.

.4 In the event of discrepancies between such provisions, the most stringent provision shall apply.

.5 Employ a qualified Professional Engineer, registered in the Province of Manitoba, for the design of all shoring and falsework for the temporary supports of all structural elements.

.6 Employ employees, agents, and Sub-contractors who are properly qualified and skilled to do the Work.

.7 Provide ongoing training in safe working practices and safety manuals for employees, agents and Sub-contractors.

.8 Use safe tools and equipment.

.9 Obtain all permits, licenses, and clearances.

.1 Establish compliance procedures and take all other necessary measures to protect the safety of works and all other persons who may be in the vicinity of the work Site.

.10 Hard hats and safety boots are mandatory requirements for all workers while on-site. Make available four (4) "VISITOR" safety helmets for authorized visitors.

.11 No-smoking regulations are in effect in all areas of the Work. Ensure that all workers comply with the regulations.

.12 Ensure that all workers comply with the City's safety regulations where such regulations are in effect.

.13 Do not load or permit to be loaded any part of the Work with a weight, load or force that will exceed the design load or endanger its safety or integrity.

3.2 Safety Measures and Services

.1 The Contractor shall be responsible for the safety of all his employees and other persons entering the Site and shall take all measures necessary to ensure their safety. In particular such measures shall include but shall not be limited to the following:

.1 Observation and provision of proper safety and emergency regulations, fire, gas, and electric shock precautions, stretchers, and a first aid box generally for each place of work.

.2 Safe storage, handling and use of explosives, gases, fuels, and other dangerous goods.

.3 Provision of approved safety helmets for all personnel including authorized visitors to the Site.

.4 Control of water, including the provision of standby pumping and generating plant where necessary.

.5 Provision of lighting to provide adequate illumination of Work, including spares and standby equipment.

.6 Provision and maintenance of safe, sound mechanical cranes, hoists, and conveying facilities for the transport of materials and personnel, each item of plant having an up to date test certificate. All cranes, hoists, and the like shall be fitted with audible overload warning devices.

.7 Provision and maintenance of safe, sound ropes, slings, blocks, and other lifting tackle, each appliance having an up to date test certificate.

.8 Provision of competent operators for control of all lifting and hoisting equipment, with operating personnel.

.9 Provision and maintenance of all temporary electrical installations.

.10 The Contractor shall provide and securely fix into position temporary timber covers not less than 50 mm thick to all openings in floors and roofs.

.11 Provision and maintenance of all welding equipment and concrete cutting/coring equipment.

.12 All equipment to be used by qualified, trained personnel.

.13 Provision of adequate ventilation and testing of air quality prior to and while working in all indoor or enclosed locations. Equipment for continuous monitoring of gases must be explosion-proof and equipped with a visible and audible alarm. The conditions that must be monitored include oxygen deficiency, explosive and toxic gases. The ventilation equipment must work continuously.

.2 The Contractor shall allow the City timely and complete access to the Contractor's records and documentation, to allow the City to confirm the Contractor's ongoing compliance with the safety requirements in the Specification. At all times, the Contractor shall, at the City's request, provide copies of documentation related to safety at no extra cost to the City, including without limitation, copies of:

.1 Resumes, licenses, certification papers, and like documentation for employees of the Contractor, its agents and Sub-contractors engaged in the Work.

.2 Specifications, permits, test results and licenses, for all equipment to be used in the Work.

.3 All other permits and licenses for the Work.

.3 At all times, the City may inspect and test the equipment to be used in the Work.

.4 The Contractor shall maintain a Workplace Hazardous Materials Information System (WHMIS) file for all hazardous materials used at each work Site. Prior to commencement of the Work, the Contractor shall submit Material Safety Data Sheets (MSDS) to the City for all hazardous materials at work Site. Material brought to a work Site without prior submission of a MSDS shall not be used in the Work.

.5 The Contractor shall comply with the requirements of the Manitoba Labour Guidelines for Confined Entry Work, and the Manitoba Labour Fall Protection Guideline.

.6 If deemed necessary, the Contractor may be required to submit a Safety Mitigation Plan for approval by the City.

3.3 Rail Traffic Protection

.1 Note that part of the work shall be carried out under and adjacent to the Railway's operating tracks.

.2 Flag persons, if required, will be furnished by the City at no cost to the Contractor, up to the Contract Completion date specified. After this date, the Contractor will be required to pay all additional flagging costs, which will be automatically deducted from the amounts due to the Contractor in the progress payments.

.3 The Contractor will be responsible for ensuring that construction operations are carried out without interfering with the continued safe movement of rail traffic. The Contractor will be liable. for the cost of train delays and for the cost of repairs to any rail, ties and ballast required as a result of damage caused by his operation.

.4 Give the Site Supervisor at least five (5) working days notice of the hours within which work is to be carried out in order that protection may be provided. Time wasted unnecessarily by flagging personnel due to the Contractor will be charged against the Contractor.

.5 Ensure that a responsible person is present at all times to whom the Railway personnel will issue orders regarding work near the tracks. Comply immediately with such orders and instructions.

.6 Red colour shall not be used for safety helmets, safety vests or surrey markers on the City of Winnipeg and CP Rail property in order to avoid conflict with Railway Operational Practice. Other highly visible colours such as orange are acceptable.

.7 At no time shall idling equipment be left unattended by the operator.

.8 Ensure that both rails of the same track are never connected with any conductor of electricity such as steel measuring tapes or metal traction equipment.

3.4 Track Protection

.1 At all locations where there is the possibility of trees, rocks or other debris falling on the tracks, provide track protection such as timber mats or an approved equivalent in order to prevent possible damage to rail, ties and ballast.

.2 Prevent excavated material from fouling ballast and sub-ballast.

3.5 Restrictions on Rail Construction Operations

.1 In order to ensure the continued safe movement of rail traffic, certain restrictions shall be imposed on the construction operations. Without in any way limiting the generality of the foregoing statement, the following are some of the limitations or restrictions that shall be imposed.

.1 When mucking, clearing or other operations are being carried out which may endanger the existing track or impede the safe passage of trains, perform such work only during such times as there is a block on the mainline rail traffic.

.2 Confine all work activities to daylight hours except where noted otherwise, or as, directed by the Contract Administrator, and do not exceed 12 hours per day unless authorized by the Contract Administrator.

.3 All men and equipment within 8 m from the nearest rail must stop working on the approach of: a train and remain stopped until the train has passed.

.4 Do not work closer than 5 m from the nearest rail without the prior consent of the Contract Administrator and only during such times as there is rail traffic protection provided by the Railway.

3.6 Crossing Tracks

.1 Do not cross tracks of the Railway Company with scrapers, bulldozers, trucks, barrows or other mechanical equipment at grade nor place crossing planks except by authority of the Contract Administrator at locations designated by him. Ensure that both rails of the same tracks are never connected with any conductor of electricity such as steel measuring tapes or metal traction equipment.

.2 If necessary, the Contractor shall install and remove temporary construction crossings. The Contractor shall supply the required 7" x 10" planking of length to suit their needs (7 planks per track), shim stock and filter fabric. The Contractor shall be responsible for constructing and maintaining the approaches to the crossing to a standard acceptable to the Railway. Crossings constructed shall only be used by equipment when flagging protection has been provided.

.3 The crossing shall:

.1 have a level gradient on either side for a distance of 8 m or not less than the maximum length of vehicle using it.

.2 have approach grades not greater than 5 percent.

.4 To minimize fouling the ballast, install filter fabric over the entire ballast section under the crossing planks and approaches.

.5 Each rail of the track shall be protected by use of rubber mats or tires, before any crawler mounted equipment is, allowed to cross the track affected.

.6 Upon completion of all construction requiring use of the temporary crossings, the Contractor shall remove the approaches and restore the track ballast section, all to the satisfaction of the Contract Administrator.

.7 Install temporary gates, approved by the Contract Administrator, to prevent use of the crossings by unauthorized personnel and keep gates locked when crossings are not in use.

4. NOISE CONTROL ON-SITE

.1 All plant and equipment supplied by the Contractor for use on the Work shall be effectively "sound-reduced" by means of silencers, mufflers, acoustic linings or shields or acoustic sheds or screens to a level of 85 decibels (dBA) measured outside the nearest occupied property or to the satisfaction of the Contract Administrator.

.2 Provided that the provisions of this clause shall not be applicable in the case of emergency work necessary for the saving of life, property, or for the safety of the Work.

5. CLEANING OF STREETS

.1 Conform to local ordinances and by-laws relating to littering of streets.

.2 Take precautions to prevent depositing mud or debris on public or private roadways adjacent to the Work. Clean up any debris or detritus immediately. The Contract Administrator may direct necessary cleanup with all costs deducted from the Contractor's first succeeding Progress Billing.

6. WORKING LIMITS

.1 Confine all operations within the City's property limits and within the general area of the Work and away from any restricted access zones as identified on the Site plan. Keep existing roadways and access routes open to regular vehicular and pedestrian traffic throughout the duration of the construction.

7. EXISTING UTILITIES

.1 Conform to Provincial and Municipal regulations during construction in proximity to utility structures.

.2 Notify appropriate utility companies and municipal departments a minimum one (1) week in advance of commencing such work.

.3 Make arrangements with utility companies and municipal department for protection of pipelines, conduits, drainlines, wiring and other structures, whether underground, on the surface or overhead, and satisfy the company or department that the methods or operations are effective.

END OF SECTION

PERSONAL PROTECTIVE EQUIPMENT

1. GENERAL

1.1 Purpose

.1 Provide industry standard personal protective equipment (PPE) for eyes, face, head, and extremities; specialized protective clothing; and protective barriers.

.2 All personal protective equipment shall meet all applicable current CSA and ANSI standards for the particular equipment, and to be approved for ferric chloride handling.

2. PRODUCTS

2.1 Minimum Acceptable PPE Requirements

.1 **Railcar Shelter**

Equipment		Quantity	Size
Eye Protection	Mono goggles - Anti-fog		
Hard Hat			
Rubber Gloves	Acid resistant		
Safety Shoes	Acid Resistant		
Reflective Vest	CP Rail standard		
Hearing Protection	Earmuff style		

.2 **Chemical Storage Building**

Equipment		Quantity	Size
Eye Protection	Mono goggles - Anti-fog		
Hard Hat			
Rubber Gloves	Acid resistant		
Safety Shoes	Acid resistant		

3. EXECUTION

.1 Not used.

PROJECT MEETINGS

1. MEETINGS

1.1 Preconstruction Meeting

.1 Within fifteen (15) days after award of Contract, the Contract Administrator will request a project meeting of parties in the Contract to discuss and resolve administrative procedures and responsibilities.

.2 Representatives of the City, Contract Administrator, Contractor, and major Sub-contractors must be in attendance.

.3 Representatives of the Contractor and Sub-contractors attending the preconstruction meeting must be qualified and authorized to act on behalf of the party each represents.

.4 After the time and location of this meeting has been established, the Contractor shall notify all parties concerned a minimum of ten (10) days before the meeting.

.5 The Contract Administrator will arrange space and facilities for this meeting.

.6 The Contract Administrator will chair and record discussions and decisions, and circulate the meeting notes to all parties concerned.

.7 Preconstruction Meeting Agenda

.1 Appointment and notification of official representatives of participants in the Work

.2 Schedule of the Work, progress scheduling

.3 Schedule of Shop Drawing submissions

.4 Schedule for the procurement and delivery of specified equipment

.5 Plant orientation program

.6 Requirements for temporary facilities, Site signs, offices, storage sheds, utilities, hoarding, Site access, and use

.7 Site security

.8 Health and Safety issues

.9 Modification procedures, Contemplated Change Notices and Change Order procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements as originated by the City or in the case of a savings, by the Contractor.

.10 Product and tool storage

.11 Weather protection

.12 Record drawings

.13 Operation and maintenance (O&M) manuals

.14 Commissioning, acceptance, and handover

.15 Warranties

.16 Monthly progress claims, administrative procedures, photographs, holdbacks

.17 Appointment of inspection and testing agencies or firms

.18 Insurances and transcript of policies

.19 Communications routing and logistics

.20 Access to the Site and Work areas (security)

.21 Survey

.22 A schedule for progress meetings

.23 Emergency telephone numbers

.24 Other items arising at the meeting

1.2 Progress Meetings

.1 Provide input to the Contract Administrator for the meeting agenda.

.2 Construction Progress Meetings Agenda

.1 Review and approval of minutes of previous meeting

.2 Field observations, problems, conflicts

.3 Review submittal schedules: expedite as required

.4 Review of off-site fabrication and delivery schedule

.5 Progress, schedule, during succeeding Work period

.6 Problems, which impede construction schedule

.7 Corrective measures and procedures to regain projected schedule

.8 Revisions to construction schedule

.9 Site coordination review

.10 Maintenance of quality standards

.11 Review of Site cleanliness

.12 Review of Site safety and security

.13 Review of temporary facilities

.14 Review requests for information

.15 Review of Contemplated Change Notices (CCN), Field Orders (FO), Change Orders (CO), and Field Instructions (FI)

.16 Review proposed changes for effect on construction schedule and on completion date

.17 Review of progress payments

.18 Outstanding action items

.19 Date and location of next meeting

.20 Other business

.3 The Contract Administrator will preside at the meetings.

.4 The Contract Administrator will record notes of the project meetings, including significant proceedings, decisions, “Action By" parties, dates for completion of duties, etc.

1.3 Special Meetings

.1 Special meetings may be requested by the Contract Administrator, or Contractor to discuss specific issues. Generally, three (3) days notice is required for special meetings. The agenda will be fashioned to suit the meeting. Minutes will be kept by the Contract Administrator.

END OF SECTION

SUBMITTALS

1. SHOP DRAWINGS AND PRODUCT DATA

.1 "Shop Drawings" mean custom Drawings, Product data, diagrams, illustrations, schedules, performance charts, brochures and other data, which are to be provided by the Contractor to illustrate details of a portion of the Work.

.2 Arrange for the preparation of clearly identified Shop Drawings as specified or as the Contract Administrator may reasonably request. Shop Drawings are to clearly indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of the Work. Where articles or equipment attach or connect to other articles or equipment, clearly indicate that all such attachments and connections have been properly coordinated, regardless of the trade under which the adjacent articles or equipment will be supplied and installed. Shop Drawings are to indicate their relationship to design Drawings and Specifications. Notify the Contract Administrator in writing of any deviations in Shop Drawings from the requirements of the Contract Documents.

.3 Shop Drawings shall be submitted with a copy of the associated Specification. For each Specification clause, note compliance or deviation from Specification. Provide full explanation for any deviation. Shop Drawings submitted without the associated Specification Sections will be returned to the Contractor as “Rejected”.

.4 Examine all Shop Drawings prior to submission to the Contract Administrator to ensure that all necessary requirements have been determined and verified and that each Shop Drawing has been checked and coordinated with the requirements of the Work and the Contract Documents. Examination of each Shop Drawing shall be indicated by stamp, date and signature of a responsible person of the Sub-contractor for supplied items and of the General Contractor for fabricated items. Shop Drawings not stamped, signed and dated will be returned without being reviewed and stamped Re-submit".

.5 Submit Shop Drawings with reasonable promptness and in an orderly sequence so as to cause no delay in the Work. Failure to submit Shop Drawings in ample time is not to be considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed. Jointly prepare a schedule fixing the dates for submission and return of Shop Drawings.

.6 The Contract Administrator will review and return Shop Drawings in accordance with the schedule agreed upon or otherwise with reasonable promptness so as to cause no delay in the Work.

.7 Submit six (6) copies of white prints, plus one (1) copy of reproducibles, and six (6) copies of all fixture cuts and brochures.

.8 Shop Drawing review by the Contract Administrator is solely to ascertain conformance with the general design concept. Responsibility for approval of detail design inherent in Shop Drawings rests with the Contractor and review by the Contract Administrator shall not imply such approval.

.9 Review by the Contract Administrator shall not relieve the Contractor of his responsibility for errors or omissions in Shop Drawings or for proper completion of the Work in accordance with the Contract Documents.

.10 Responsibility for verification and correlation of field dimensions, fabrication processes, techniques of construction, installation and coordination of all parts of the Work rests with the Contractor.

.11 Shop Drawings will be returned to the Contractor with one of the following notations:

.1 When stamped "REVIEWED" or "NO EXCEPTIONS TAKEN", distribute additional copies as required for execution of the Work.

.2 When stamped "REVIEWED AS MODIFIED" or "MAKE NOTED CORRECTIONS", ensure that all copies for use are modified and distributed, same as specified for "REVIEWED".

.3 When stamped "REVISE & RESUBMIT", make the necessary revisions, as indicated, consistent with the Contract Documents and submit again for review.

.4 When stamped "NOT REVIEWED" or "REJECTED", submit other Drawings, brochures, etc., for review consistent with the Contract Documents.

.5 Only Shop Drawings bearing "REVIEWED", "NO EXCEPTIONS TAKEN", "MAKE NOTED CORRECTIONS", or "REVIEWED AS MODIFIED" shall be used on the Work unless otherwise authorized by the Contract Administrator.

.12 After submittals are stamped "REVIEWED", "NO EXCEPTIONS TAKEN", "MAKE NOTED CORRECTIONS" or "REVIEWED AS MODIFIED", no further revisions are permitted unless re-submitted to the Contract Administrator for further review.

.13 Any adjustments made on Shop Drawings by the Contract Administrator are not intended to change the Contract Price. If it is deemed that such adjustments affect the Contract Price, clearly state as such in writing prior to proceeding with fabrication and installation of Work.

.14 Make changes in Shop Drawings, which the Contract Administrator may require, consistent with Contract Documents. When re-submitting, notify the Contract Administrator in writing of any revisions other than those requested by the Contract Administrator.

.15 Shop Drawings indicating design requirements not included in the Contract Documents require the seal of a qualified Professional Engineer, registered in the province of the place of the Project. Consulting calculations shall be submitted for review, if requested, and sealed by a qualified Professional Engineer.

.16 Only two (2) reviews of Shop Drawings will be made by the Contract Administrator at no cost. Each additional review will be charged to the Contractor at the Contract Administrator’s scheduled rates. The Contract Administrator’s charges for the additional Work will be deducted from the Contractor’s Progress Certificates.

2. SAMPLES

.1 Submit samples for the Contract Administrator's review as specified or as the Contract Administrator may reasonably request. Clearly label samples as to origin and intended use in the Work. Reference samples to Drawings and Specifications.

.2 Submit samples with reasonable promptness and in orderly sequence so as to cause no delay in the Work. Failure to submit samples in ample time is not to be considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed. Jointly prepare a schedule fixing the dates for submission and return of samples (refer to Section 01200 – Project Meetings).

.3 Notify the Contract Administrator in writing, at the time of submission, of any deviations in samples from requirements of Contract Documents.

.4 The Contract Administrator's review will be for conformity of design concept and general arrangement only. Such review is not to be considered relief of responsibility for errors or omissions in samples or of responsibility for meeting all requirements of the Contract Documents.

.5 Any adjustments made on samples by the Contract Administrator are not intended to change the Contract Price. If it is deemed that such adjustments affect the Contract Price, clearly state as such in writing prior to proceeding with fabrication and installation of the Work.

.6 Make changes in samples, which the Contract Administrator may require, consistent with Contract Documents.

3. OPERATING AND MAINTENANCE MANUALS

.1 For the guidance of the City's operating and maintenance personnel, the Contractor shall prepare operation and maintenance manuals for the Work, describing in detail the construction of each part of the Work and the recommended procedure for operation, servicing and maintenance.

.2 Three (3) advance copies of the manuals shall be submitted prior to Substantial Performance of the Work and shipment for review and comments. A minimum of eight (8) weeks after review, six (6) copies of the final manuals shall be supplied. Each copy shall be clearly titled to show all of the information required by the Specifications as well as operational information including: the item of Work concerned, a City's contract number, the name and address of the Contractor, the issue date, operational information on equipment, cleaning and lubrication schedules, filters, overhaul, and adjustment schedules.

.3 All instructions in these manuals shall be in simple language to guide the City in the proper operations and maintenance of this installation.

.4 Submit O&M Manuals in electronic format. Organize contents into applicable sections of Work, parallel to Specifications break-down.

.5 In addition to information called for in the specifications, include the following:

.1 Title sheet, labeled "Operation and Maintenance Instructions", and containing project name and date.

.2 List of contents.

.1 Brochures/catalogue excerpts of all architectural, mechanical and electrical components of the Work

.2 Documentation of all test results

.3 Complete set of equipment and assembly drawings

.4 Installation, start-up, O&M manuals

.5 Commissioning data sheets and reports

.6 Air balancing reports

.7 Spare parts lists/priced, and special tools requirements/priced

.8 Any specific Product or maintenance manual requirements from the Technical Specifications

.3 Reviewed Shop Drawings of all equipment

.4 Record Drawings of all civil, structural, process equipment, mechanical, electrical, instrumentation, and controls installations

.5 Full description of entire mechanical system and operation

.6 Names, addresses and telephone numbers of all major Sub-contractors and Suppliers

.7 Detailed operations and maintenance instructions for all items of equipment, including a preventative maintenance program

.6 The Contractor shall modify and supplement the manual as required by the Contract Administrator.

.7 Provide list of spare parts and consumables, including name and address of nearest Supplier.

.8 The O&M Manuals shall be supplied to the City before delivery and provision shall be made for additions and deletions, which may be dictated by the City’s operational experience. Where these amendments to the manuals are indicated to be necessary during initial operation before acceptance, the Contractor shall supply the amended Sections free of charge.

.9 Payment for this Item of the Work, as listed in Form B: Prices, will not be issued until all requirements for the O&M manuals have been satisfied.

4. RECORD DRAWINGS

.1 After award of Contract, the Contract Administrator will provide a complete set of Drawings for the purpose of maintaining Project Record Drawings, electronic files in AutoCAD format will be supplied. Accurately record significant deviations from Contract Documents caused by Site conditions and changes ordered by the Contract Administrator. Update daily.

.2 Record locations of concealed elements of mechanical and electrical services.

.3 Identify Drawings as "Project Record Copy". Maintain in good condition and make available for inspection on-site by Contract Administrator at all times.

.4 On completion of the Work, two (2) weeks prior to final inspection, submit Record Drawings to Contract Administrator for review.

.5 Within one (1) month after return of Record Drawings by the Contract Administrator, obtain and pay for a complete set of original reproducible sepias. Transfer all changes from Record Drawings to electronic format (AutoCAD) and certify accuracy. Deliver electronic Drawings to the Contract Administrator.

5. PHOTOGRAPHS AND PUBLICITY

.1 No photographs of the Site or of any portion of the Work will be permitted without prior approval of the Contract Administrator.

.2 No press or publicity releases will be permitted without prior approval of the Contract Administrator.

6. PROCEDURES

.1 The Contractor shall, if required by the Contract Administrator, submit for the review of the Contract Administrator method statements which describe in detail, supplement with Drawings where necessary, the methods to be adopted for executing any portion of Work.

.2 These statements shall also include details of constructional plant and labour to be employed. Acceptance by the Contract Administrator shall not relieve the Contractor of any of his responsibilities, nor shall reasonable refusal to approve entitle the Contractor to extra payment or an extension of time.

END OF SECTION

QUALITY ASSURANCE

1. INSPECTION AND TESTING OF WORK

1.1 General

.1 The City, the Contract Administrator, and other authorities having jurisdiction shall have access to the Work. If parts of the Work are in preparation at locations other than the Place of the Work, access shall be given to such Work whenever it is in progress.

1.2 Laboratories and Agencies

.1 Independent inspection and testing agencies may be engaged by the City for the purpose of inspecting or testing portions of the Work. All costs of such services will be borne by the City. Costs of additional tests required due to defective Work shall be paid by the Contractor.

.2 All equipment required for carrying out inspection and testing will be provided by the respective agencies.

.3 Employment of inspection and testing agencies in no way relieves the Contractor of responsibility to perform the Work in accordance with the Contract Documents.

.4 Allow the inspection and testing agencies access to all portions of the Work on the Site and manufacturing or fabrication plants, as may be necessary. Provide facilities for such access.

1.3 Reference Standards and Acronyms

.1 Within the Drawings and Specifications, reference may be made to the following standards and organizations by their acronyms, as defined below. Conform to such standards, in whole or in part, as specified.

AABC	Associated Air Balance Council
AFBMA	Anti-Friction Bearings Manufacturers Association
ACI	American Concrete Institute
AMCA	Air Movement and Control Association
AGMA	American Gear Manufacturers Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
APHA	American Public Health Association
ARI	Air-conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BS	British Standard
CCA	Canadian Construction Association

CCMC	Canadian Construction Materials Centre
CEA	Canadian Electricity Association
CEC	Canadian Electrical Code
CEMA	Canadian Electrical Manufacturers Association
CGSB	Canadian Government Specification Board
CISC	Canadian Institute of Steel Construction
CLA	Canadian Lumberman's Association
CPCA	Canadian Painting Contractors Association
CPCI	Canadian Prestressed Concrete Institute
CRCA	Canadian Roofing Construction Association
CSA	Canadian Standards Association
CSSBI	Canadian Sheet Steel Building Institute
DIN	Deutsche Industrie Norm
EEMAC	Electrical and Electronic Manufacturers Association of Canada
EJMA	Expansion Joint Manufacturers Association
FM	Factory Mutual Engineering Corporation
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IPCEA	Insulated Power Cable Engineers Association
ISA	Instrumentation, Systems, and Automation Society
MSDS	Material Safety Data Sheets
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
NAAMM	National Association of Architectural Metal Manufacturers
NABA	National Air Barrier Association
NACE	National Association of Corrosion Engineers
NBC	National Building Code
NECA	National Energy Conservation Association
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NLGA	National Lumber Grading Authority
RSIC	Reinforcing Steel Institute of Canada
SAMA	Scientific Apparatus Makers Association
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SSPC	Steel Structures Painting Council
TTMAC	Terrazzo Tile and Marble Association of Canada
ULC	Underwriters Laboratories of Canada
WCB	Workers Compensation Board
WEF	Water Environment Federation
WHMIS	Workplace Hazardous Materials Information System

.2 If there is question as to whether any Product or system is in conformance with applicable standards, the Contract Administrator reserves the right to have such Products or systems tested to prove or disprove conformance. The cost for such testing will be borne by the City in the event of conformance with Contract Documents or by the Contractor in the event of non-conformance.

.3 Where specified standards are not dated, conform to latest issue of specified standards as amended and revised to the Bid closing date.

1.4 Design Standards, Code Requirements

.1 Inspection and testing will be performed in accordance with, but not limited to, the following:

.1 Concrete to CSA A23.2 and mix designs to CSA-A23.1

.2 Welding to CSA W59.1 and ASTM E109

.3 Bolted connections to CSA S16 or S16.1

.4 Roofing to CRCA Manual

1.5 Tests and Mix Design

.1 Prior to start of the Work, submit to the Contract Administrator the following:

.1 Test results and mix designs of each class of concrete

.2 Mill test certificates for all structural steel and bolts

2. PROCEDURES

.1 Notify the Contract Administrator two (2) Working Days in advance of the requirements for tests in order that necessary arrangements can be made.

.2 Submit samples and materials required for testing with reasonable promptness so as to cause no delay in the Work.

.3 Provide facilities to allow inspection and testing and make available space for storage and curing of the test samples.

.4 If defects are revealed during inspection and testing, then the Contract Administrator may issue instructions for removal or correcting defective work and irregularities. The Contractor shall notify the Contract Administrator within two (2) working days if such instructions are in error or at variance with the Contract Documents.

.5 Costs for re-inspection and retesting of rejected Work shall be borne by the Contractor.

END OF SECTION

TEMPORARY FACILITIES

1. FIELD OFFICES AND SHEDS

1.1 Contractor's Office

.1 Accommodation for the Contractor's office, plant, tools, equipment, and materials (including fuel) shall be the responsibility of the Contractor. Such accommodation at the Site shall be located after consultation with the Contract Administrator. The Contractor shall be responsible for the protection of its plant, tools, equipment, and materials stored on-site. Materials stored on the City's premises shall be neatly stacked and protected from the weather.

.2 Provide and maintain in clean condition during entire progress of the Work, a suitable office adequately lighted, heated, and ventilated, for own use.

.3 Locate where directed by Contract Administrator in area shown on the Site plan.

.4 Provide within office space adequate first aid facilities as recommended by the Ministry of Labour and Worker's Compensation regulations.

.5 The Contractor shall further confine their activities to the minimum area necessary for undertaking and completing the Work. Material and equipment storage areas shall be at locations acceptable to the Contract Administrator.

.6 The Contractor's construction activities shall not encroach or enter onto private property without written consent from the owner of the property concerned. The Contractor shall provide the Contract Administrator with a copy of the written agreement with the property owner.

.7 Sub-contractors are to provide their own offices as necessary, as directed by the Contract Administrator.

1.2 Laydown and Storage

.1 All construction materials shall be stored at designated Site laydown and storage areas. Stored combustible materials shall be separated by clear space to prevent fire spread and allow access for manual fire fighting equipment, including fire hoses, extinguishers, hydrants, etc.

.2 Designated areas shall be used for storage of flammable and combustible liquids and gases, which shall be properly equipped for grounding and bonding when refueling vehicles and equipment. Spills shall be contained as required by Provincial Regulations.

.3 Pressurized dry chemical fire extinguishers of suitable capacity or equally effective extinguishers as per National Fire Protection Association (NFPA) 10 shall be provided where:

.1 Flammable liquids are stored or handled

.2 Temporary oil or gas fire equipment is used

.3 Welding or flame cutting is performed

1.3 Temporary Construction Materials

.1 Tarpaulins and plastic coverings shall consist of fire retardant materials, which are UL or FM listed or approved, or which have passed the Large Scale Test specified in NFPA-701.

1.4 Contractor's Trailers

.1 The Contractor shall provide all construction power to the Work Site and to the Contractor's temporary Site office trailers.

.2 The Contractor shall, at its own cost, supply, install, maintain, and move extensions to the above services as required during the Construction Period, subject to CSA Standard C22.1 latest edition and Manitoba Hydro Standards and approval.

.3 The Contractor shall:

.1 Prevent hazardous accumulations of dust, fumes, mist, vapours, or gases in areas occupied during construction.

.2 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.

.3 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.

.4 Ventilate storage spaces containing hazardous or volatile materials.

.5 Ventilate temporary sanitary facilities.

.6 Continue operation of ventilation and exhaust system for time after cessation of Work process to assure removal of harmful elements.

.4 Suitable fire control equipment shall be provided by the Contractor for protection of its facilities, the portion of the City's building under construction and materials and equipment at all Work areas. All fire protection equipment and fuel storage shall meet the approval of the Contract Administrator.

.5 Unless approved by the Contract Administrator, burning of any materials is not allowed at the Site of the Work.

.6 The Contractor shall be responsible for any damage resulting from fires caused by the Contractor or its employees and shall be solely responsible for all costs, which may be incurred in extinguishing such fires.

1.5 Toilets and Washrooms

.1 Washroom facilities are not available at the North End Water Pollution Control Centre for the Contractor's use.

.2 The Contractor shall supply and maintain all necessary toilets and washrooms for its employees engaged in the Work. These toilets and washrooms shall comply with the requirements of The Public Health Act, R.S.M. 1987, c. P210, including sewage holding facilities and water storage. Sewage connections are not available.

1.6 Disposal of Waste Materials

.1 Spoiled and/or waste materials shall not be dumped, under any circumstances, in any locations other than those approved by the local authorities. Any cost for permits and fees for disposing of waste materials shall be at the Contractor's expense.

.2 Disposal of all excavated and waste materials shall be in accordance with the requirements of the appropriate provincial regulatory agencies.

.3 When working anywhere within the Works the Contractor shall at the end of each working day remove his rubbish and leave the Site in a clean and tidy state, to the satisfaction of the Contract Administrator. If this is not done, the City will clean the Site and charge the Contractor.

1.7 Parking

.1 The Contractor shall provide parking in the area designated on the plans for Contractor laydown and trailers. The Contract Administrator may designate additional parking areas for the Contractor's vehicles. The parking shall be arranged and maintained so that is does not disrupt the plant's operation and access for the City's operations and maintenance staff.

.2 The Contractor shall provide appropriate base course material for the laydown, trailer and parking area to allow vehicle traffic and parking. The Contractor shall restore this area to its original state at the completion of construction.

1.8 Contractor's Site Storage for Equipment and Materials

.1 The Contractor shall provide and maintain in a clean and orderly condition an adequately sized storage facility on-site, which will provide weather protected storage for all the tools, equipment, and materials necessary for the undertaking and completion of the Work.

.2 The storage facility shall be located where directed by the Contract Administrator in the area identified on the Site plan.

.3 The compound shall have a hard base suitable for the storage of heavy equipment. Adequate temporary drainage shall be provided around the facility.

.4 The storage of equipment and materials shall be limited to the storage facility only.

.5 The responsibility for the security of the Site storage and the condition of all the equipment and materials therein shall rest solely with the Contractor.

.6 The Contractor will be responsible for removal of this facility prior to issuance of Total Performance.

1.9 Access to Site Office and Storage Facilities

.1 The Contractor shall provide vehicular accesses to the Site office and storage facilities from the existing access road. The access shall be suitable for use by heavy trucks and shall be kept in a clean serviceable condition and free of obstructions for as long as these offices and storage facilities are required for use.

.2 The access roads, turnarounds, parking areas and storage areas, shall be left in a rut-free condition.

.3 Any areas requiring clearing and grubbing for the access roads, turnarounds, parking and storage areas, and approaches to public roads shall be reviewed with the Contract Administrator prior to commencement of the Work.

2. UTILITIES

2.1 Water Supply

.1 The City shall supply water used for construction purposes including the water used for the initial watertightness testing. The Contractor shall be responsible for conveying the water (hook-ups, pipes, maintenance, etc.) to the construction Site from the City source.

.2 The Contractor is responsible to provide water for retesting watertightness if required.

.3 The Contractor shall, at its own cost, supply, install, maintain, and move extensions to water services as required during the Construction Period, subject to the City's approval.

2.2 Heating and Hoarding

.1 The Contractor shall provide all temporary heating required during Construction Period for storage facilities and concrete curing, including attendants, maintenance, and fuel. The Contractor will maintain temperatures of minimum 10°C in the temporary facilities, unless indicated otherwise in Specifications. Properly ventilate all heated areas.

.2 The Contractor shall pay for all costs in maintaining and providing temporary heat to the temporary facilities.

.3 The Contractor shall be responsible for any damages to the Work due to failure in providing adequate heat and protection during construction.

2.3 Power and Light

.1 The Contractor shall provide temporary power and light for own use. Install in accordance with regulations of governing authorities.

.2 The Contractor shall provide and pay for all temporary power required during Construction for temporary lighting and the operations.

.3 The wiring for temporary lighting is to be entirely separate from temporary power installation except for a common supply connection at either an electrical service or distribution centre.

2.4 Telephone

.1 The Contractor shall provide for all temporary communications, telephone service including services to the Contract Administrator's offices.

2.5 Use of Permanent Water Supply, Heat, Power Light, and Telephone

.1 The Contractor shall not make use of permanent water supply, heat, power, lighting, or telephone inside the NEWPCC without obtaining permission from the Contract Administrator.

2.6 Fueled Welding Machines and Air Compressors

.1 Fueled welding machines and air compressors required for performance of the Work are to be the responsibility of the respective users. Locate outside of building.

3. BARRIERS

3.1 Guard Rails and Barricades

.1 Provide guard railings and barricades, around all openings, open shafts, open stairwells. Construct as recommended by local governing authorities.

4. CONSTRUCTION AIDS

4.1 Scaffolding

.1 Provide and maintain adequate scaffolding as required. Scaffolding is to be rigid, secure, and constructed to ensure adequate safety for workers. Erect without damage to the building or finishes.

4.2 Ladders, Stairs

.1 Provide and maintain adequate temporary ladders and stairs required for construction.

.2 Secure to structure.

.3 Ladders and stairs are to comply with all requirements of safety authority.

.4 Provide temporary wood treads on steel pan stairs for use prior to placement of permanent treads.

4.3 Explosive Actuated Fastening Tools

.1 Provide for the use of explosive actuated fastening tools when required. When using, conform to the requirements of CSA Z166 - "Explosive Actuated Fastening Tools" and local governing authorities.

5. ROADS

5.1 Access to Site

.1 Provide and maintain access roads, sidewalk crossings, ramps, and construction runways as required for access to, from, and through the Site. Conform to requirements of local governing authorities when required and when necessary make arrangements with adjacent property owners. Locate these traffic facilities where they are least disruptive to normal street traffic and local Site traffic.

.2 Maintain City access to the Dewatering Facility, Septage Disposal Facility, and associated service roads at all times.

5.2 Temporary Vehicular and Pedestrian Access

.1 Maintain existing vehicular and pedestrian accesses properly at all times during Construction.

.2 The Contractor shall confine his equipment, storage of materials, and operations of his workmen to minimize Site damage. The Contractor shall be responsible to restore all areas damaged or affected by construction to equal or better conditions, which existed prior to construction, unless designated otherwise.

5.3 Access Roadway to City Facilities

.1 Provide and maintain access road as required for access to, from, the City of Winnipeg facilities located immediately adjacent ot or west of the Site as detailed on the Drawings.

6. TRAFFIC CONTROL

6.1 Public Traffic Flow

.1 Provide and maintain flag persons, traffic signals, barricades, and flares/lights/lanterns as required to direct the flow of equipment used in performance of the Work and to protect

public traffic. Make arrangements with local governing authorities when these facilities will disrupt the normal flow of public traffic.

7. PROTECTION OF WORK AND PROPERTY

7.1 Protection for Off-Site and Public Property

.1 Protect adjacent private and public property from damage during the performance of the Work.

.2 Be responsible for all damages incurred due to improper protection.

7.2 Fire Protection

.1 Provide and maintain adequate temporary fire protection equipment during performance of the Work as required by insurance companies having jurisdiction.

.2 Provide minimum one (1) fire extinguisher in each equipment and tool shed, temporary office, material storage shed workshop.

.3 Where subjected to low temperatures, extinguishers are to be anti-freeze type. In proximity to gas, oil, grease or paint storage locations they are to be No. 10 - carbon dioxide type. Extinguishers for all other locations are to be soda-acid type. All extinguishers are to be minimum 10 litre capacity and be ULC labelled.

.4 Handle gasoline and like combustible materials with good, safe practice.

.5 Remove combustible debris from Site daily.

7.3 Protection of Building Finishes and Equipment

.1 Provide adequate protection for finished and partially finished building finishes and existing equipment and services during the performance of the Work. Provide necessary screens, covers, hoardings, etc. as required. Be responsible for all damages incurred due to improper or lack of protection.

.2 The Contractor shall use methods of construction on concrete Work that will not generate dust.

.3 The Contractor shall protect existing mechanical and electrical equipment from damage.

.4 Maintain and protect existing services in operation during the course of the Work. Repair services damaged at no cost to the City.

.5 If service interruptions are necessary, such interruptions shall be made only at times approved by the City.

.6 Advise the Contract Administrator of any necessary service relocations not identified by the Contract documents.

7.4 Protection of Trees

.1 Protect trees located on or adjacent to the Site, which may be affected by the Work, from any potential damage which could occur as a result of the construction and related activities.

.2 Site enclosures, fencing, hoarding or other protective walkways, or facilities shall not be secured, braced, or otherwise fastened to trees.

.3 Do not remove trees unless specifically noted on the plans, or as directed and approved by the Contract Administrator.

.4 Conform to the requirements of the City of Winnipeg Standard Construction Specifications.

7.5 Snow Removal

.1 Remove snow and ice from access roads, Contractor parking and laydown areas, office and storage areas. The Contractor shall be responsible for repairing any damage to the access road to, and the parking and storage areas within, the Contractor's Site Laydown area directly attributable to their operation.

.2 Remove snow and ice from building surfaces as necessary for construction.

.3 Except where noted otherwise, the Contractor shall be responsible for snow removal and maintaining the access roads, turnarounds, parking areas and storage areas during the course of the Work to facilitate safe access to the Work areas.

.4 Remove snow and ice from access road to the City of Winnipeg facilities located immediately east of the Site as detailed on the Drawings

8. ACCESS TO SITE AND BUILDING

8.1 Site

.1 Access to the Site will be available from the existing roadways. The locations for vehicular accesses from these roadways are generally as shown on the Drawings.

.2 It will be the Contractor's responsibility to check that these accesses are in suitable condition before any plant, equipment or materials are dispatched to Site.

.3 Access on the Site is restricted by existing buried and surface utilities and structures. Contractor to confirm location of all potential obstructions and to review routing of construction vehicles with the Contract Administrator.

.4 The Contractor is to maintain access at all times for City personnel or the Contract Administrator.

9. ACCESS TO WORK

.1 Normal working hours for City staff working inside the building shall be the period between 7:30 a.m. and 4:00 p.m., Monday to Friday, except holidays.

.2 The Contract Administrator shall be informed at least 24 hours in advance where the Contractor intends to carry out Work outside Normal Working Hours and no such Work shall be done without the Contract Administrator's approval except when the Work is unavoidable or absolutely necessary for:

.1 Preventing injury to any person or saving the life of any person; or

.2 Preventing damage to property where the circumstances placing the property in danger could not reasonably have been foreseen and where the immediate carrying out of such Work is necessary in order to prevent damage to that property; in which case the Contractor shall immediately advise the Contract Administrator in writing that such Work outside the Normal Working Hours is necessary and of the reasons for this. He shall also state the nature and extent of Work to be carried out.

.3 The Contractor is to coordinate activities with City personnel and any other contractors that may be working concurrently on the Site.

10. SECURITY

10.1 Site Lighting

.1 Provide and pay for temporary Site lighting as required for non-daylight times. Install lamps in suitable locations to obtain unobstructed light over all Work areas.

.2 Perform daily inspection of Site lighting and replace burned out and missing lamps. Relocate promptly any lights that become obstructed by new Work.

11. ENVIRONMENTAL CONTROLS

11.1 Noise Control

.1 Abide by all local ordinances. Adjust hours of operation accordingly.

11.2 Dust Control

.1 Initiate dust control measures to minimize dust generation.

12. PROJECT IDENTIFICATION

12.1 Warnings and Traffic Signs

.1 When Work is performed within public areas, provide and erect adequate warning signs as necessary to give proper warning. Place signs sufficiently in advance to enable public to respond to directions.

.2 Warning and traffic signs shall be illuminating type, visible to public and traffic during day and night.

.3 Provide and maintain signs and other devices required to indicate construction activities or other temporary or unusual conditions resulting from the Work.

END OF SECTION

MATERIAL AND EQUIPMENT

1. PRODUCTS

1.1 Quality of Materials

.1 Provide new materials, equipment and articles incorporated in the Work, not damaged or defective and of the best quality (compatible with Specifications) for the purpose intended. If requested furnish evidence as to type, source, and quality of Products provided.

.2 Defective materials, equipment, and articles whenever found may be rejected regardless of previous inspection. Inspection by the Contract Administrator or an inspector does not relieve the Contractor of his responsibility but is merely a precaution against oversight or error. Remove and replace defective materials at own expense and be responsible for all delays and expenses caused by rejection.

.3 Should any dispute arise as to the quality or fitness of materials, equipment or articles, the decision rests strictly with the Contract Administrator based upon the requirements of the Contract Documents.

.4 Unless otherwise indicated in the Specifications, maintain uniformity of Manufacturer for any particular or like item throughout the Work.

.5 Permanent labels, trademarks and nameplates on materials, equipment, and articles are not acceptable in prominent locations except where required for operating instructions and when located in mechanical or electrical rooms.

1.2 Availability of Materials

.1 No substitution of any item will be permitted unless the item cannot be delivered to the job Site in time to comply with the Schedule.

.2 To receive approval, proposed substitutes must equal or exceed the quality, finish and performance of those specified and/or shown, and must not exceed the space requirements allotted on the Drawings.

.3 Provide documentary proof of equality, difference in price (if any) and delivery dates in the form of certified quotations from Manufacturers of both the specified item and the proposed substituted item.

1.3 Storage, Handling, and Protection of Materials

.1 Handle and store materials in a manner to prevent damage, contamination, deterioration, and soiling and in accordance with Manufacturer's recommendations when applicable.

.2 Store packaged or bundled Products in original and undamaged condition with Manufacturers' seals and labels intact. Do not remove packaging or bundling until required in the Work.

.3 Materials subject to damage from weather are to be stored in weatherproof enclosures.

.4 Store cementitious materials clear of earth or concrete floors and away from walls.

.5 When used for grout or mortar materials, keep sand clean and dry. Store on polyethylene and cover with waterproof tarpaulins during inclement weather.

.6 Store sheet material, lumber, etc., on flat, solid supports and keep clear of ground.

.7 Store and mix paints in a room assigned for this purpose. Keep room under lock and key at all times. Remove oily rags and any other combustible debris from Site daily. Take every precaution necessary to prevent spontaneous combustion.

.8 Damaged Products shall be removed and replaced at the Contractor's expense.

1.4 Manufacturers' Directions

.1 Unless otherwise specified, install or erect all Products in accordance with Manufacturers' recommendations. Do not rely on labels or enclosures provided with Products. Obtain instructions directly from Manufacturers.

.2 Notify the Contract Administrator, in writing, of any conflicts between the Specifications and Manufacturers' instructions so that the Contract Administrator may establish the course of action.

.3 Improper installation or erection of Products due to failure in complying with these requirements authorizes the Contract Administrator to require any removal and re-installation that may be considered necessary, at no increase in Contract Price.

1.5 Transportation Costs of Materials

.1 Pay all costs for transportation of materials required for the Work.

2. WORKMANSHIP

2.1 General Requirements

.1 Workmanship is to be of the best quality executed by workers fully experienced and skilled in their respective trades.

.2 At all times enforce discipline and good order among workers. Do not employ any unfit person or anyone unskilled in the duties assigned to him. The Contract Administrator reserves the right to require the removal from Site of workers deemed incompetent, careless, insubordinate, or otherwise objectionable.

.3 Decisions as to the quality or fitness of workmanship in cases of any dispute rests solely with the Contract Administrator whose decision is final.

2.2 Coordination

.1 Coordinate the Work of all Sub-contractors.

.2 Ensure that all Sub-contractors examine the Drawings and Specifications for other parts of the Work, which may affect the performance of their Work.

.3 Ensure that sleeves, openings, and miscellaneous equipment bases are provided as required for the Work.

.4 Ensure that items to be built in are supplied when required with all necessary templates, measurements, and Shop Drawings.

2.3 Concealment

.1 In finished areas conceal all pipes, ducts and wiring except where indicated otherwise on Drawings or in Specifications.

.2 Before installation inform the Contract Administrator if there is a contradictory situation. Install as directed.

2.4 Location of Fixtures

.1 Consider the location of fixtures, outlets, and other mechanical and electrical items indicated on Drawings as approximate. The actual location of these items is to be as required or directed to Site conditions at the time of installation and as is reasonable.

.2 Before installation inform the Contract Administrator if there is a contradictory situation. Install as directed.

2.5 Cutting and Remedial Work

.1 Perform all cutting and remedial Work that may be required to make the several parts of the Work come together properly. Coordinate and schedule the Work to ensure that cutting and remedial Work are kept to a minimum.

.2 Employ specialists familiar with the materials affected in performing cutting and remedial Work. Perform in a manner to neither damage nor endanger any portion of the Work.

.3 Do not cut, drill, or sleeve any load-bearing members without written acceptance of the Contract Administrator.

.4 The Contractor is to perform Work so that no dust is generated.

2.6 Fastenings

.1 Provide metal fastenings and accessories in same texture, colour, and finish as adjacent material unless otherwise specified.

.2 Prevent electrolytic action between dissimilar metals and materials.

.3 Use non-corrosive, non-staining fasteners and anchors for securing exterior Work unless otherwise specified.

.4 Space anchors within their load limit or shear capacity and ensure that they provide positive permanent anchorage. Wood plugs are not acceptable.

.5 Keep exposed fastenings to a minimum, space evenly and lay out neatly.

.6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

2.7 Protection of Work In Progress

.1 Adequately protect all Work completed and in progress. Repair or replace all damaged Work.

.2 Prevent overloading of any part of the Work.

2.8 Cleaning

.1 Remove waste materials and debris from the Site at regular intervals. Do not burn waste materials and debris on-site.

3. MEASUREMENT

3.1 Metric Project

.1 Unless otherwise noted, this Project has been designed and is to be constructed in the International System (SI) of Units metric system of measurements.

.2 During construction, when specified metric elements are unattainable at the time they are required to meet the Construction Schedule, the Contractor shall notify the Contract Administrator in writing and suggest alternative substitutions. Costs due to these substitutions shall be borne by the Contractor.

END OF SECTION

EQUIPMENT INSTALLATION

1. INTENT

.1 This Section describes general requirements for all equipment supplied under the Contract relating to the supervision of installation, testing, operation, and performance verification. The Contractor shall be responsible for the installation Work, testing, operation, and performance verification of the supplied equipment.

2. DEFINITIONS

.1 Manufacturer: the Manufacturer is the person, partnership, or corporation responsible for the manufacture and fabrication of equipment provided to the Contractor for the completion of the Work.

.2 Manufacturer’s Representative: the Manufacturer’s Representative is a trained serviceman empowered by the Manufacturer to provide installation, testing, and commissioning assistance to the Contractor in his performance of these functions.

3. EXPERTISE AND RESPONSIBILITY

.1 The Contract Administrator recognizes the expertise of the Manufacturer.

.2 Should the Contract Administrator issue a Field Order, Change Order, or Instruction to change the Work, which would, in the opinion of the Contractor, compromise the success or safety of the Work, then it shall be incumbent on the Contractor to notify in writing the Contract Administrator to this effect within two (2) days.

4. INSTALLATION ASSISTANCE

.1 Before commencing installation of equipment, the Contractor shall arrange for the attendance of the Manufacturer's Representative to provide instructions in the methods, techniques, precautions, and any other information relevant to the successful installation of the equipment.

.2 The Contractor shall inform the Contract Administrator, in writing, of the attendance at the Site of any Manufacturer's Representative for installation training at least fourteen (14) days prior to arrival.

.3 When the Manufacturer's Representative is satisfied that the Contractor is aware of all installation requirements, he shall so certify by completing Form 101 attached to this Specification.

.4 The completed form shall be delivered to the Contract Administrator prior to departure of the Manufacturer's Representative from the Site.

.5 Installation of the equipment shall not commence until Contract Administrator has advised that he has received the completed Form 101.

.6 Separate copies of Form 101 shall be used for different equipment.

5. INSTALLATION

.1 If necessary, or if so directed by the Contract Administrator during the course of installation, the Contractor shall contact the Manufacturer to receive clarification of installation procedures, direction, or any other additional information necessary to continue or complete the installation in an appropriate manner.

.2 If it is found necessary, or if so directed by the Contract Administrator, the Contractor shall arrange for the Manufacturer's Representative to visit the Site to provide assistance during installation, all at no cost to the City.

.3 Prior to completing installation, the Contractor shall inform the Manufacturer and arrange for the attendance at the Site of the Manufacturer's Representative to verify successful installation.

.4 The Manufacturer’s Representative shall conduct a detailed inspection of the installation including alignment, electrical connections, belt tensions, rotation direction, running clearances, lubrication, workmanship, and all other items as required to ensure successful operation of the equipment.

.5 The Manufacturer’s Representative shall identify any outstanding deficiencies in the installation.

.6 The deficiencies shall be rectified by the Contractor and the Manufacturer’s Representative will be required to re-inspect the installation, at no cost to the City.

.7 When the Manufacturer’s Representative accepts the installation, he shall certify the installation by completing Form 102, attached to this Specification.

.8 Deliver the completed Form 102 to the Contract Administrator prior to departure of the Manufacturer's Representative from the Site.

.9 Tag the equipment with a 100 mm by 200 mm card stating “Equipment Checked. Do Not Run.” stenciled in large black letters. Sign and date each card.

.10 Provide separate copies of Form 102 for different equipment.

6. OPERATION AND PERFORMANCE VERIFICATION

.1 Equipment will be subjected to a demonstration, running test, and performance tests after the installation has been verified and any identified deficiencies have been remedied.

.2 Inform the Contract Administrator at least fourteen (14) days in advance of conducting the tests and arrange for the attendance of the Manufacturer's Representative. The tests may be concurrent with the inspection of satisfactory installation if mutually agreed by the Contractor and the Contract Administrator.

.3 The Manufacturer's Representative will conduct all necessary checks to equipment and if necessary, advise the Contractor of any further checking, flushing, cleaning, or other Work needed prior to confirming the equipment is ready to run.

.4 The Contractor shall then operate the equipment for at least one (1) hour to demonstrate to himself the operation of the equipment and any required ancillary services. Any remedial measures required to ensure satisfactory operation shall be promptly undertaken.

.5 The Contractor shall then notify the Contract Administrator of his readiness to demonstrate the operation of the equipment. The Contract Administrator shall attend, as expeditiously as possible.

.6 With the assistance of the Manufacturer's Representative, the Contractor will demonstrate that the equipment is properly installed. Alignment, piping connections, electrical connections, etc. will be checked and if appropriate, code certifications provided.

.7 The equipment shall then be run for one (1) hour. Local controls shall be satisfactorily verified by cycling the equipment through several start-stop operations, modulating its output, or some combination. Operating parameters such as temperature, pressure, voltage, vibration, etc., will be checked to ensure that they are within the specified or Manufacturer's recommended limits, whichever is more stringent.

.8 On satisfactory completion of the one (1) hour demonstration, the equipment will be stopped and critical parameters, such as alignment, will be rechecked.

.9 The equipment will be restarted and run continuously for three (3) days. During this period, as practicable, conditions will be simulated which represent maximum or most severe, average, and minimum or least severe conditions. These conditions will be mutually agreed by the Manufacturer's Representative, the Contractor, and Contract Administrator on the basis of the information contained in the Technical Specifications, as well as the methods utilized to create the simulated conditions and the time periods allotted to each.

.10 Performance tests will be conducted either concurrent with or subsequent to the running test, as practicable and agreed between the Contract Administrator, the Manufacturer's Representative, and the Contractor.

.11 Performance tests shall be as dictated in the Technical Specifications for each item of equipment or as reasonably required by the Contract Administrator to prove adherence to the requirements listed in the Specification.

.12 The Contractor shall submit the results of the performance tests to the Contract Administrator, documented and summarized in a format acceptable to the Contract Administrator. The Contract Administrator reserves the right to request additional testing.

No equipment shall be accepted and handed over to the City prior to the satisfactory completion of the performance test(s) and receipt of the test reports.

.13 All water, chemicals, temporary power, heating, or any other ancillary services required to complete the initial demonstration, running test and performance tests are the responsibility of the Contractor.

.14 Should the initial demonstration, running test or performance tests reveal any defects, then those defects shall be promptly rectified and the demonstration, running tests, and/or performance tests shall be repeated to the satisfaction of the Contract Administrator. Additional costs incurred by the Contractor, the Contract Administrator, or the City, due to repeat demonstration, running tests, and/or performance tests shall be the responsibility of the Contractor.

.15 On successful completion of the demonstration, running test, and performance tests, Form 103 attached to this Specification will be signed by the Manufacturer's Representative, the Contractor, and the Contract Administrator.

.16 The Contractor shall affix to the tested equipment a 100 mm by 200 mm card reading "Operable Condition - Do Not Operate without Contractor's Permission." stenciled on in large black letters.

CERTIFICATE OF EQUIPMENT DELIVERY
FORM 100

We certify that the equipment listed below has been delivered into the care of the Contractor. The equipment has been found to be in satisfactory condition. No defects in the equipment were found.

PROJECT: _____

ITEM OF EQUIPMENT: _____

_____

TAG NO: _____

REFERENCE SPECIFICATION: _____

_____ _____
(Authorized Signing Representative of the Contractor) Date

_____ _____
(Authorized Signing Representative of the Sub-contractor) Date

_____ _____
(Authorized Signing Representative of the Contract Administrator) Date

CERTIFICATE OF READINESS TO INSTALL
FORM 101

I have familiarized the installer of the specific installation requirements related to the equipment listed below and am satisfied that he understands the required procedures.

PROJECT: _____

ITEM OF EQUIPMENT: _____

_____

TAG NO: _____

REFERENCE SPECIFICATION: _____

_____ _____
(Authorized Signing Representative of the Manufacturer) Date

_____ _____
(Authorized Signing Representative of the Sub-contractor) Date

I certify that I have received satisfactory installation instructions from the equipment Manufacturer/ Supplier.

_____ _____
(Authorized Signing Representative of the Contractor) Date

_____ _____

CERTIFICATE OF SATISFACTORY INSTALLATION
FORM 102

I have completed my check and inspection of the installation listed below and confirm that it is satisfactory and that defects have been remedied to my satisfaction except any as noted below:

PROJECT: _____

ITEM OF EQUIPMENT: _____

_____

TAG NO: _____

REFERENCE SPECIFICATION: _____

OUTSTANDING DEFECTS: _____

_____ _____

(Authorized Signing Representative of the Manufacturer) Date

_____ _____

(Authorized Signing Representative of the Contractor) Date

CERTIFICATE OF EQUIPMENT SATISFACTORY PERFORMANCE
FORM 103

We certify that the equipment listed below has been continuously operated for at least three (3) consecutive days and that the equipment operates satisfactorily and meets its specified operating criteria. No defects in the equipment were found. The equipment is therefore classed as "conforming".

PROJECT: _____

ITEM OF EQUIPMENT: _____

_____

TAG NO: _____

REFERENCE SPECIFICATION: _____

_____ _____
(Authorized Signing Representative of the Manufacturer) Date

_____ _____
(Authorized Signing Representative of the Sub-contractor) Date

_____ _____
(Authorized Signing Representative of the Contractor) Date

_____ _____
(Authorized Signing Representative of the Contract Administrator) Date

Acknowledgement of Receipt of O&M Manuals.

_____ _____
(Authorized Signing Representative of the City) Date

END OF SECTION

TRAINING

1. DESCRIPTION

.1 This Section contains requirements for training the City staff, by persons retained by the Contractor specifically for the purpose, in the proper operation and maintenance of the equipment and systems installed under this Contract.

.2 Training sessions are required during the equipment testing.

.3 As a minimum, the Contractor is to allow at least four (4) hours of training per shift, as required for each item of equipment or system, unless specified otherwise in the equipment Specifications.

.4 The intent is that the City should receive sufficient training on the equipment system that they are going to operate and maintain. The Contract Administrator shall have the authority to determine the duration and content of each training session required.

2. QUALITY ASSURANCE

.1 Where required by the equipment Specifications, provide on-the-job training of the City staff. Training sessions will be conducted by qualified factory-trained representatives of the various equipment suppliers with a minimum of two (2) years experience. Training includes instruction of City staff in equipment operation and preventive maintenance and instruction on mechanics, electricians, instrumentation, and communications technicians in normal maintenance up to major repair.

.2 The trainer(s) proposed by the Contractor shall be experienced in training plant operators and shall have relevant experience in similar work.

3. SUBMITTALS

.1 Submit the following information in accordance with Section 01300. For phased testing and start-up activities, separate submittals can be prepared for equipment items or systems. The material will receive a "REVIEWED" or "REVIEWED AS MODIFIED" status by the Contract Administrator no later than four (4) weeks prior to delivery of the training:

.1 Lesson plans and training manuals, handouts, visual aids, and other reference materials for each training session to be conducted by the Contractor's trainer(s).

.2 Date, time, and subject of each training session.

.3 Training schedule. Concurrent classes will not be allowed.

4. LOCATION

.1 Where specified, conduct training sessions for the City staff, operations and maintenance personnel, on the operation, care, and maintenance of the equipment and systems installed

under this Contract. Training will take place at the Site of the Work and under the conditions specified in the following paragraphs.

.2 Field training sessions will take place at the site of the equipment. Classroom training to take place in the boardroom in the Administration Building. The Contract Administrator may direct the classroom training to take place at another suitable location.

5. LESSON PLANS

.1 Prepare formal written lesson plans for each training session and coordinate with the Contract Administrator. Lesson plans to contain an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each plan will contain a time allocation for each subject. Furnish ten (10) copies of necessary training manuals, handouts, visual aids, and reference materials at least two (2) weeks prior to each training session.

6. FORMAT AND CONTENT

.1 Include time in the classroom and at the location of the equipment or system for each training session. As a minimum, cover the following topics for each item of equipment or system:

.1 Familiarization

.2 Safety

.3 Operation

.4 Troubleshooting

.5 Preventive maintenance

.6 Corrective maintenance

.7 Parts

.8 Local representatives

7. VIDEO RECORDING

.1 Advise all suppliers providing training sessions that the training sessions may be video-recorded. The material may be edited and supplemented with professionally produced graphics to provide a permanent record for the City's use.

8. TRAINING

8.1 General Requirements

.1 Conduct training in conjunction with the equipment testing period (see 01650). Schedule classes such that classroom sessions are interspersed with field instruction in logical sequence. Arrange to have the training conducted on consecutive days, with no more than four (4) hours of classes scheduled for any one (1) shift.

.2 Provide final operation and maintenance manuals, as defined in Section 01300, for the specific equipment to the City at least four (4) weeks prior to the start of any training. Video recording may take place concurrently with all training sessions.

8.2 Operator Classroom Training

.1 As a minimum, classroom equipment training for operations personnel will include:

.1 The equipment's specific location in the plant and an operational overview. Use slides and drawings to aid discussion.

.2 Purpose and plant function of the equipment

.3 The operating theory of the equipment

.4 Start-up, shutdown, normal operation, and emergency operating procedures, including system integration and electrical interlocks, if any

.5 Safety items and procedures

.6 Routine preventive maintenance

.7 Operator detection, without test instruments, of specific equipment trouble symptoms

.8 Required equipment exercise procedures and intervals

.9 Routine disassembly and assembly of equipment if applicable for purposes such as operator inspection of equipment

.10 Exam

8.3 Operator Hands-On Training

.1 As a minimum, hands-on equipment training for operations personnel will include:

.1 Identifying instrumentation: location of primary element; location of instrument readout; discuss purpose, basic operation, and information interpretation.

.2 Discussing, demonstrating, and performing standard operating procedures and daily visual inspection of system operation.

.3 Discussing and performing the preventive maintenance activities.

.4 Discussing and performing start-up and shutdown procedures.

.5 Performing the required equipment exercise procedures.

.6 Performing routine disassembly and assembly of equipment if applicable.

.7 Identifying and reviewing safety items and performing safety procedures, if feasible.

8.4 Maintenance Classroom Training

.1 Classroom equipment training for the maintenance and repair personnel will include:

.1 Basic theory of operation

.2 Description and function of equipment

.3 Routine start-up and shutdown procedures

.4 Normal and major repair procedures

.5 Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings

.6 Routine and long-term calibration procedures

.7 Safety procedures

.8 Preventive maintenance and up to and including major repairs such as replacement of major equipment part(s) with the use of special tools

8.5 Maintenance Hands-On Training

.1 Hands-on equipment training for maintenance and repair personnel will include:

.1 Locating and identifying equipment components

.2 Reviewing the equipment function and theory of operation

.3 Reviewing normal repair procedures

.4 Performing routine start-up and shutdown procedures

.5 Reviewing and performing the safety procedures

.6 Performing City-approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems

.7 Reviewing and using Contractor's manuals in the hands-on training

8.6 Equipment and Systems for Training

.1 Provide training during the EPT period for the following equipment and systems:

.1 Chemical Feed Pump Systems

.2 Tank Filling Systems

.2 Coordinate and finalize with the Contract Administrator on training schedules and duration of each training session.

8.7 Training Completion Forms and Payment

.1 Training for the Contractor-Supplied equipment shall be conducted before the operation period as described in **Form 103** (included in Section 01650 of this Contract).

.2 The Contract shall not be considered complete, for the purpose of issuing a Certificate of Substantial Performance, until the training has been provided and **Form 103** has been completed and signed.

.3 Form T1: to be completed for initial training. One (1) form is to be used for each system or piece of equipment for which training has been provided.

.4 Form T2: to be completed for training during the Warranty Period. One (1) form is to be used for each system or piece of equipment for which training has been provided.

.5 Payment for this Work will be released only when the training has been completed to the City's satisfaction and the respective forms are signed.

.6 A sample of Forms T1 and T2 are attached to this Specification Section.

CERTIFICATE OF SATISFACTORY TRAINING
FORM T1

We certify that the initial training for the equipment listed below has been provided as per the Specifications.

PROJECT: _____

ITEM OF EQUIPMENT: _____

_____

TAG NO: _____

REFERENCE SPECIFICATION: _____

_____ _____
(Trainer) Date

_____ _____
(Authorized Signing Representative of the City) Date

CERTIFICATE OF SATISFACTORY TRAINING
FORM T2

We certify that the final training for the equipment listed below has been provided as per the Specifications.

PROJECT: _____

ITEM OF EQUIPMENT: _____

TAG NO: _____

REFERENCE SPECIFICATION: _____

_____ _____
(Trainer) Date

_____ _____
(Authorized Signing Representative of the City) Date

END OF SECTION

1. COMMISSIONING

1.1 General

.1 At the time of the Commissioning, the Contract Administrator shall advise the Contractor of the Commissioning requirements. These requirements are dependent on the anticipated operational requirements of the City's wastewater treatment system.

.2 The Contractor shall refer to all Divisions for details on the Commissioning procedures not included in this Section.

.3 The Contractor shall note that on materials and equipment installed in this Contract, warranty will not begin until issuance of Total Performance.

2. INTENT

.1 This Section describes the Contractor’s responsibilities in the Commissioning and handover of the process, electrical, and other systems to be installed as part of this Work.

3. DEFINITIONS

.1 System: for the purpose of this Specification Section, a system shall be defined as the equipment, piping, controls, ancillary devices, electrical power, etc., which together perform a specific function at the facility.

.2 Commissioning: for the purpose of this Specification Section, Commissioning shall be defined as the successful operation of a system in accordance with its design requirements for a period of twenty-eight (28) days, the last seven (7) of which shall be consecutive, unless otherwise specified.

.3 Acceptance: for the purpose of this Specification section, Acceptance shall be defined as the formal turnover of a system to the City for his operation and maintenance. This shall occur after the successful end of Commissioning of each system through a formal agreement between the Contract Administrator, the City, and the Contractor. Success of the Commissioning Period is determined by the Contract Administrator.

4. COMMISSIONING TEAM

.1 The Work of Commissioning will be conducted by teams made up of personnel from the Contractor, the City, and the Contract Administrator.

.2 The City’s appointed staff shall represent process personnel and operating staff.

.3 The Contractor shall provide personnel representing the appropriate trades, including Instrumentation and Controls (I & C) personnel during the Commissioning. These personnel

shall be skilled workmen, able to expedite any minor repairs, adjustments, etc., as are required to complete Commissioning with as few delays as possible.

5. COMMISSIONING PLAN

.1 The Commissioning Team shall develop a detailed methodology for the Commissioning of each system at least ninety (90) calendar days prior to planned start of Commissioning. The plan shall be drafted by the Contractor and Contract Administrator and include the following:

.1 Detailed schedule of events, including but not limited to the schedule for completion of testing of all component parts of the system in accordance with Section 01650 prior to Commissioning of a system.

.2 Method for introducing flow, disposing of partially treated effluent, and disposing of any sludge or other residual solids generated during the Commissioning process. The Contractor will take responsibility for the implementation of these measures.

.3 Sampling and analytical program for tests necessary to verify compliance with performance Specifications.

.4 Planned attendance schedule for Manufacturer's Representatives.

.5 Contingency plans in the event of a process malfunction.

.6 Drawings and sketches as required to illustrate the planned sequence of events.

.7 List and details for all temporary equipment (pumps, etc.) required to facilitate Commissioning.

.8 List of all personnel who the Contractor plans for Commissioning and hand-over with information indicating their qualifications for this Work.

.2 The Commissioning Plan shall be reviewed and agreed by the Commissioning Team prior to its implementation. The Contract Administrator shall be the final arbiter.

6. EQUIPMENT

.1 All process, mechanical, electrical, control, and miscellaneous equipment related to a system shall be successfully installed and tested in accordance with Section 01650 and any specific requirements noted in other divisions. Form 103 (Contractor-Supplied Equipment) shall be executed for each item.

.2 As required in Section 01300 – Submittals, Operation and Maintenance Manuals will be submitted and reviewed by the Contract Administrator.

.3 Staff training sessions shall be completed.

.4 Temporary equipment will be installed and tested as necessary to ensure that it functions reliably and consistently through the commissioning period.

.5 Conduct sampling and analysis in accordance with the requirements of the latest version of "Standard Methods for the Examination of Water and Wastewater", AWWA/WEF.

7. CONTROLS

.1 All controls which are the responsibility of this Contractor shall be installed and tested prior to commissioning.

.2 The Contract Administrator shall arrange for the simulation of the control sequences or shall allow for the operation of the system without the features included in the Work of others. Every effort shall be made to ensure that the Commissioning Period provides for the full and comprehensive operation of the equipment under all anticipated normal and adverse operating conditions.

8. PLANT UTILITY SERVICES

.1 The City shall provide power, chemicals, and other ancillary services as necessary to operate the plant through the Commissioning Period. Provision of these services shall be limited to reasonable levels.

9. MANPOWER

.1 Supply all staff required during Commissioning as necessary to assist the City's staff in the operation of the plant.

.2 Supply competent staff capable of maintaining, repairing, and adjusting the equipment and controls to achieve the intended design functions during the Commissioning Period.

.3 Ensure equipment Manufacturer's Representatives are available as necessary to certify adjustments in equipment, to guide in setting correct operating limits, and to generally provide input as required for the appropriate operation of the equipment.

10. OPERATING DESCRIPTIONS

.1 Operating descriptions have been prepared for the plant systems. To some degree, the intent of these has been included in the Drawings and Specifications. Other information outlining the operating requirements is available from the Contract Administrator. The Contractor will review these descriptions and will make himself familiar with the requirements in order that he can undertake commissioning in an appropriate manner.

11. DESIGN PARAMETERS

.1 Design parameters for the systems to be commissioned shall be as defined in the Specifications and the operating descriptions, as modified by the Commissioning Team. The Commissioning Team will identify to the Contractor which parameters shall be modified prior to Commissioning and shall be responsible for any subsequent changes during the Commissioning Period.

12. PREPARATION

.1 Each item of equipment included in the system to be commissioned shall be satisfactorily tested and Form 103 completed.

.2 Piping, wiring, and other conduit systems shall be finished and tested.

.3 Electrical connections shall be completed and inspected to the satisfaction of the governing authorities.

.4 All other regulatory inspections shall be completed to the satisfaction of the governing authorities.

.5 Control systems shall be completed and the related control software debugged.

13. SEQUENCE

.1 Systems shall be commissioned in a logical manner. Upstream components shall be commissioned first to the degree possible.

.2 The following sequence of events shall be followed:

.1 O&M Manuals shall be available as per the requirements of Section 01300 at least fourteen (14) days prior to the start of Commissioning.

.2 The Contract Administrator will make Operating Descriptions available prior to testing. Draft Operating Descriptions are included in this Contract.

.3 Initial operator training shall be undertaken two (2) weeks prior to Commissioning.

.4 Equipment performance tests shall be conducted successfully.

.5 Start and run system in manual mode.

.6 Turn separate items of equipment to automatic in a planned and logical manner. Ensure that the control system is operating the equipment in a manner which precludes damage of the equipment and which is consistent with the process operating requirements.

.7 Commence Commissioning Period of twenty-eight (28) days. The equipment shall operate continuously and successfully through the last seven (7) days of a Commissioning Period. Minor failures shall not void the Commissioning Period. A minor failure is defined as one which does not present a safety hazard, does not impact overall process functioning and can be temporarily overcome by the use of available standby equipment. The last seven (7) days of the Commissioning Period shall be re-started if a critical failure occurs. A critical failure shall be deemed as one, which prohibits the process from functioning successfully for an eight (8) hour period or one, which creates a safety hazard.

.8 Upon completing the Commissioning Period, the system shall be granted formal acceptance by the Contract Administrator.

14. COMMISSIONING

.1 Water will be introduced to the system in a manner, which precludes the damage of any equipment or structures.

.2 Twice during the Commissioning Period, plant component settings will be modified to ensure that the system is subjected to flows and loads as close to design conditions as possible. Where necessary to achieve this, flows to the area being commissioned will be augmented to exaggerate the naturally occurring flows and loads. Where it is necessary to modify settings outside the limits of this Contract area within the plant, coordinate the changes with plant staff.

.3 Assist in the operation of the plant to achieve the process objectives.

.4 All components and systems shall be operated in the automatic/manual and the remote/local modes as required to prove proper operation.

.5 Ensure all bypasses and backup provisions function satisfactorily.

.6 All minor and major alarm conditions will be induced to ensure that the process reacts as intended, the applicable alarms are annunciated.

.7 Samples of process flows, when necessary to prove performance, will be obtained and analyzed on a regular basis.

15. ACCEPTANCE

.1 The Commissioning of a system shall be considered acceptable when the process has operated in a stable manner, satisfying the design criteria for a period of twenty-eight (28) days, the last seven (7) of which shall be continuous and consecutive, unless otherwise specified.

.2 When a process system has been commissioned satisfactorily, the process system shall be formally accepted for operation and routine maintenance by the City's forces. On successful completion of Commissioning Form 104, Certificate of Satisfactory Process Performance attached to this specification will be signed by the representative of the Manufacturer, Contractor, Contract Administrator, and the City.

.3 An Acceptance Meeting must be held at the end of the twenty-eight (28) day test to confirm the status of each system.

.4 Notice of Acceptance for the entire project will be granted when all systems have been commissioned and accepted, and all requirements of the General Conditions have been completed.

CERTIFICATE OF SATISFACTORY PROCESS PERFORMANCE
FORM 104

We certify that the equipment listed below has been operated and tested as per the Specifications using water and that the equipment meets its Performance Testing Criteria. The equipment is therefore classed as "conforming".

PROJECT: _____

SYSTEM DESCRIPTION: _____

_____

TAG NO (S): _____

REFERENCE SPECIFICATION (S): _____

_____ _____
(Authorized Signing Representative of the Manufacturer) Date

_____ _____
(Authorized Signing Representative of the Contractor) Date

_____ _____
(Authorized Signing Representative of the Contract Administrator) Date

_____ _____
(Authorized Signing Representative of the City of Winnipeg) Date

END OF SECTION

CONTRACT CLOSEOUT

1. FINAL CLEANING

.1 When the Work has reached Substantial Performance, remove surplus Products, tools, construction machinery, and equipment not required for the completion of the remaining Work.

.2 Remove waste and debris and leave the Work clean and suitable for occupancy by the City.

.3 When the Work has reached Total Performance, remove surplus Products, tools, construction machinery, equipment, waste, and debris.

.4 Leave the Work areas broom clean before the final inspection.

2. SITE RESTORATION

.1 The Contractor shall remove the temporary offices and storage facilities prior to Total Performance being issued.

.2 The Contractor will be responsible for grounds restoration to original state, as determined necessary by the Contract Administrator.

.3 The Contractor will be responsible for any damage caused by his forces on roadways or accesses.

END OF SECTION

OPERATING AND MAINTENANCE DATA

1. DESCRIPTION

.1 This Section supplements the requirements for the provision of O&M manuals as described in Section 01300.

.2 Furnish complete operations manuals and maintenance information as specified in this section for installation check-out, operation, maintenance, and lubrication requirements for each unit of mechanical, electrical, and instrumentation equipment or system and each instrument.

.3 In some instances, this requirement is reinforced by additional references within individual Specification Sections, however, the inclusion or exclusion of additional references within the Contract shall not supersede or otherwise limit the generality of the foregoing and these requirements shall govern.

.4 Customize the operations manuals and maintenance information to describe the equipment actually furnished. Do not include extraneous data for models, options, or sizes not furnished. When more than one model or size of equipment type is furnished, show the information pertaining to each model, option, or size.

2. SUBMITTALS

.1 The submission and acceptance of the “Equipment Operating and Maintenance Instruction” manual is a condition precedent to the certification of substantial performance.

.2 Submit operation manuals and maintenance information in accordance with Section 01300. Submittals may be checked for general compliance with the requirements of this Section.

.3 Submit complete operations manuals and maintenance information as soon as possible after review of project submittals but no later than 14 days prior to commissioning or 120 days before the Date of Substantial Performance, whichever occurs first.

.4 Submit operations and maintenance data in electronic format: text sections compatible with Microsoft Word 2000; drawings and graphics in PDF format.

3. GENERAL REQUIREMENTS

.1 Provide materials of equal clarity and quality as the originals.

.2 Provide drawings, diagrams, and Manufacturer's literature which are legible.

.3 All instructions in the O&M manuals are to be in simple language.

.4 Edit Manufacturer’s standard documents to delete extraneous information not applicable to the equipment, assembly, subassembly or material supplied. Cross out or remove and eliminate any extraneous material for models, options, or sizes not furnished.

4. CONTENTS AND ORGANIZATION

.1 Arrange the O&M manuals to match the numbering system in the Specifications.

.2 Provide the Manufacturer's standard O&M manuals for the equipment or instrument supplied. If the Manufacturer's standard manuals do not contain all the required information, provide the missing information in supplementary documents and drawings.

.3 When more than one (1) piece of identical equipment or instruments is supplied, provide only one (1) set of operations manuals.

.4 One (1) set of operations manuals may be provided when more than one (1) piece of similar equipment or instruments are supplied, such as different sizes of the same model, and all similar pieces are covered in the same standard Manufacturer's O & M manual.

.5 When similar equipment or instruments are provided by the same Manufacturer, but are not covered in the same standard Manufacturer's O&M manual, their specific manuals may be included in the same electronic manual.

.6 Provide a cover page, as the first page of each manual, with the following information:

.1 Contract name and number

.2 Equipment number or, if more than one piece of equipment is provided, equipment numbers for equipment or instruments covered by the manual. Include functional description of equipment after each number.

.7 Provide a table of contents listing the contents of the manual and identifying where specific information can be located.

.8 Include the specific information described below in the O&M manuals:

.1 General Information

.1 Functional title of the system, equipment, material, or instrument

.2 Relevant Specification Section number and Drawing reference

.3 Address and telephone number of the Manufacturer and the nearest Manufacturer's Representative

.2 Equipment Data

.1 Insert Specification Section and completed Equipment and Instrumentation data sheets for equipment supplied. Attach all Addenda, Change Orders, and change directives that refer to that specific item of equipment.

OPERATING AND MAINTENANCE DATA

.3 Operation Information

.1 Include the Manufacturer's recommended step-by-step procedures for starting and stopping under normal and emergency operation. Include all specified modes of operation including recommended operation after the assembly or equipment has been in long-term storage.

.2 Provide control diagrams with data and information to explain operation and control of systems and specific equipment. Identify normal operating setpoints and alarm conditions.

.3 Provide technical information on all alarms and monitoring devices provided with the equipment.

.4 Technical Data

.1 Insert Manufacturer's technical specification and data sheets.

.2 Insert Manufacturer’s certified performance and calibration curves for the equipment and instruments.

.5 Maintenance Information

.1 Include the description and schedule for all Manufacturers’ recommended routine preventative maintenance procedures including specific lubrication recommendations. Indicate service intervals: daily, weekly, monthly, quarterly, semi-annually, annually, or after a specified number of hours of operation.

.6 Maintenance Instructions

.1 Provide requirements to set up and check out each system for use. Include all required and recommended step-by-step inspections, lubrications, adjustments, alignments, balancing and calibrations. Include protective device settings and warnings and cautions to prevent equipment damage and to insure personnel safety.

.2 Provide Manufacturer’s description of routine preventive maintenance, inspections, tests, exercise cycles, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair.

.3 Provide Manufacturer’s recommendations on procedures and instructions for correcting problems and making repairs.

.4 Provide step-by-step procedures to isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or requires replacement.

.5 Provide step-by-step procedures and list special required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required.

.7 Assembly Drawings

.1 Provide drawings which completely document the equipment, assembly, subassembly, or material for which the instruction is written. Provide the following drawings as applicable: fabrication details, wiring and connection diagrams, electrical and piping schematics, block or logic diagrams, Shop Drawings, installation drawings, layout and dimension drawings, and electrical component fabrication drawings.

.2 Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

.8 Bills of Materials

.1 Provide a clear, legible copy of the bill of materials that was shipped with the equipment. The bill of materials should list all equipment, instruments, components, accessories, tools, and other items that were shipped with the equipment.

.9 Lubrication Data

.1 Provide a table showing recommended lubricants for specific temperature ranges and applications.

.2 Provide charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities.

.3 If the equipment or instrument is not lubricated, add a sheet under this Tab with the words "Not Applicable".

5. FIELD CHANGES

.1 Following the acceptable installation and operation of an equipment item, modify and supplement the item's instructions and procedures to reflect any field changes or information requiring field data.

6. COMMISSIONING DATA

.1 Provide hard cover three-ring binder for 215 mm x 280 mm paper labelled "Commissioning Data" three (3) copies of:

.1 All completed equipment testing and commissioning forms, arranged in Specification Section order.

.2 All completed equipment checklists and performance reports, including noise and vibration analysis, instrumentation calibration data, and all other relevant information.

.3 All system performance reports

.2 In addition to the above specified binders, provide a disc (CD or DVD) of the above documents scanned into electronic PDF format.

7. WARRANTIES

.1 Provide hard cover three-ring binder for 215 mm x 280 mm paper labelled "Warranties" three (3) copies of:

.1 A list in Specification Section order of all warranties and guarantees required by the Contract Documents and all Manufacturers' standard warranties and guarantees. Include contact names and telephone numbers. Indicate the time frame of each warranty or guarantee on the list.

.2 Include, in Specification Section order, a copy of all written warranties and guarantees, which are required by the Contract Documents. Include all additional standard warranties and guarantees received by the Contractor.

END OF SECTION

EXCAVATION AND BACKFILLING FOR STRUCTURES

1. GENERAL

1.1 Description

.1 Work includes, but is not necessarily limited to the following items:

.1 Excavating for Work required under this Contract generally including, but not limited to, the substructure of the Railcar Facility and the Chemical Storage Building.

.2 Supply, placing, and compaction of backfill and fill materials to attain indicated grades and profiles

.3 Disposal of surplus excavated material

.4 Dewatering, shoring, and bracing of excavations

1.2 Job Conditions

.1 Examination

.1 Visit the Site and note all characteristics and irregularities affecting the Work of this Section.

.2 To proceed with the Work will mean acceptance of the conditions, and failure to comply with the above will in no way form the basis for any claim.

.3 Review the Geotechnical Report prior to submitting Bid for the Work.

.2 Protection

.1 Use all means necessary to protect all materials of this Section before, during, and after installation, and to protect all objects designated to remain.

.2 In the event of damage, immediately make all repairs and replacements necessary at no additional cost.

.3 Protect benchmarks and structures against damage from equipment and vehicular traffic.

1.3 Reference Standards

.1 Conform to requirements of the National Building Code and the Canadian Construction Safety Code.

.2 Comply with excavation and trenching regulations of Provincial authorities.

1.4 Samples

.1 If requested by Contract Administrator submit 25 kg sample of each type of fill material specified for analysis by testing laboratory; for coarse, gravelly soil or coarse, crushed stone, submit 75 kg sample of each.

.2 Ship samples prepaid or deliver in tightly closed containers to testing laboratory designated by Contract Administrator.

.3 Costs for analysis will be paid by the City.

1.5 Compaction Testing

.1 Testing of compacted fill materials will be performed by an independent inspection and testing firm appointed and paid by the City. Testing will be performed so as to least encumber the performance of Work.

.2 The City will pay for the first series of tests only, on the area being evaluated. Pay costs for additional testing, if required, due to improper performance of Work.

.3 Tests are to be performed in accordance with ASTM D698 for Standard Proctor Density.

.4 Notify the Contract Administrator when Work of this Section or portions of Work are completed to own satisfaction. Do not proceed with additional portions of Work until test results have been verified and accepted.

.5 During Work tests, if tests indicate that compacted materials do not meet specified required materials, remove defective Work, replace and re-test at own expense as directed by the Contract Administrator.

.6 Ensure compacted fills are tested and accepted before proceeding with placement of surface materials.

2. PRODUCTS

2.1 General

.1 All materials to be subject to Contract Administrator's review and acceptance.

.2 Granular materials to be composed of sound, hard, uncoated particles, free from injurious quantities of clay, flaky particles, soft shale, friable materials, roots, vegetable matter, and frozen lumps.

.3 Grading of granular materials to show no marked fluctuations between opposite ends of extreme limits.

.1 Type 1: select pit run gravel or crushed natural stone graded within the following limits:

Canadian Metric Sieve Size	Percent Passing
75,000	100
28,000	80 - 100
5,000	40 - 70
2,200	25 - 50
425	10 - 35
80	5 - 30

.2 Type 2: crushed gravel graded within following limits:

Canadian Metric Sieve Size	Percent Passing	
	Crushed Granular	Crushed Limestone
25,000	100	-
20,000	80 - 100	100
5,000	40 - 70	40 - 70
2,500	25 - 55	25 - 60
315	13 - 30	8 - 25
80	5 - 15	6 - 17

At least 60% of material retained on 5 mm sieve to have at least one (1) freshly fractured face.

.3 Type 3: natural river or beach sand, free from silt, clay, loam, friable, or soluble material and vegetable matter, graded within the following limits:

Canadian Metric Sieve Size	Percent Passing
10,000	100
5,000	90 - 100
630	25 - 60
80	0 - 3

.4 Suitable Excavated Material: shall be free from organic material and rocks larger than 150 mm in size and building debris. Fill under landscaped areas to be free from alkali, salt, petroleum products, and other materials detrimental to plant growth. Use subsoil excavated from Site only if accepted by Contract Administrator and if conforming to requirements for suitable excavated material.

3. EXECUTION

3.1 General

.1 Familiarization

.1 Prior to all Work of this Section, become thoroughly familiar with the Site, the Site conditions, and all portions of the Work falling within this Section.

.2 Review and understand the Geotechnical Report – refer to Section 01055, Clause 4.1.

.2 Protection

.1 Before starting Work, locate all utilities crossing the Work Site. Notify all agencies or companies having jurisdiction over the specific utilities and protect, relocate, remove, or discontinue service according to their requirements. Any damages shall be repaired at the Contractor's expense.

.2 Protect and restore pavements, boulevards, grassed areas, etc., that may be opened or damaged in the performance of the Work.

.3 During construction, maintain roadways in a clean and safe condition and, at the completion of the Contract, clean and restore all roads used to perform the Contract.

3.2 Finish Elevations and Lines

.1 For setting and establishing finish elevations and lines, secure the services of a registered surveyor or experienced instrumentman acceptable to the Contract Administrator.

.2 Carefully preserve all data and all monuments set by him. If data or monuments are displaced or lost, immediately replace at no additional cost to the City.

3.3 Excavation

.1 Two (2) weeks prior to commencement of the Work, submit an excavation plan sealed and signed by a qualified Professional Engineer registered in the Province of Manitoba to the Contract Administrator for review. The qualified Professional Engineer shall have a minimum of 10 years experience in geotechnical work including slope stability. No excavation work shall proceed and no claim for delay will be allowed, until the excavation plan has been reviewed and accepted by the Contract Administrator.

.2 Perform excavation in strict compliance to Work Place Safety and Health and authorities have jurisdiction.

.3 Excavate to noted limits and as required for walls and foundations. Stockpile material to be used for backfilling on-site as directed by the Contract Administrator. Excess material is to be disposed of immediately as per Clause titled “Disposal” below.

.4 When complete, request Contract Administrator to review excavations.

.5 Local pockets of material which, in the opinion of the Contract Administrator are unsuitable, shall be removed to such depths as required by the Contract Administrator.

.6 The completed excavation shall provide clean, level, solid, and water-free surfaces at the required elevations, ready to receive construction.

.7 Excavations are not to encroach on normal 45 degree bearing support under any foundation or structure and as indicated in the Geotechnical Report.

.8 Backfill and compact all over-excavated areas under structure bearing surfaces and footings with Type 1 fill and compact to 95 percent Standard Proctor Density and at no additional cost to the City.

.9 Make good all damage occurring as a result of inadequate, unauthorized, or defective methods of protection.

.10 Areas used for temporary stockpiling shall be restored to existing condition or better.

3.4 Shoring, Bracing, and Sheet Piling

.1 Provide shoring, bracing, and sheet piling as required to prevent damage to existing structures, excavations, and injury to personnel. Submit drawings and calculations sealed and signed by a professional Engineer registered in the Province of Manitoba for all shoring, bracing, and sheet piling used for the construction of this project.

.2 Comply with all applicable rules and regulations of governmental authorities.

.3 Erect shoring, bracing, and sheet piling as required, independent of utilities and structures.

.4 Prefabricated cages or shields may be used to supplement or replace conventional shoring, provided they comply with all applicable safety regulations and permit placing and tamping of bedding material under and around new construction.

.5 Maintain shoring, bracing, and sheet piling if used during backfilling and remove in stages as backfilling progresses.

.6 Remove shoring, bracing, and sheet piling unless otherwise permitted by Contract Administrator.

.7 If shoring, bracing, and sheet piling are allowed if used to remain, cut off to an elevation at least 1000 mm below finish grade and structures.

.8 Assume full responsibility for any slope or structure failure, collapse, or movement of existing structures, shoring, bracing, sheet piling, earth banks, trenches, and other excavations.

3.5 Dewatering

.1 Excavation, pits, and the entire sub-grade in the vicinity of the Work shall be kept free of water. Positive surface drainage shall be maintained away from the excavation at all times. Provide and operate pumps or other suitable equipment, and provide and maintain a temporary drainage system within the excavation. Discharge from pumps or other dewatering equipment shall be located and controlled such that loss, damage, nuisance, or injury to the Work does not result. Additional excavation made necessary by water in the excavation shall be at no additional cost to the City.

3.6 Backfilling, Fill, and Compaction

.1 Preparation

.1 Ensure areas to be backfilled are free from debris, snow, ice, and water and that ground surfaces are not in a frozen condition.

.2 Perform all necessary compaction of existing sub-grade surfaces under structures and slabs on grade if densities are not equal to that required for fill materials.

.3 Cut out soft areas of existing sub-grade, backfill with Type 1 fill, and compact to density specified for fill.

.2 Backfilling and Filling

.1 Backfill and fill to grades, contours, levels, and elevations indicated on Drawings.

.2 Where temporary unbalanced pressures are liable to develop on walls, erect necessary shoring to counteract imbalance.

.3 Backfill simultaneously on both sides of walls or structures to equalize soil pressures and to prevent unbalanced loading conditions.

.4 Do not backfill water-containing structures until after the watertightness tests have been completed and the structures accepted by the Contract Administrator.

.5 Do not backfill against foundation walls until the concrete has attained the 28-day minimum compressive strength and without the prior permission of the Contract Administrator.

.6 After sub-grade has been accepted by the Contract Administrator, spread accepted fill material in layers, not exceeding specified uncompacted thickness, and then compact to required density prior to the addition of the next layer.

.7 Maintain optimum moisture content of materials to permit compaction to specified densities.

.3 Compaction and Fill Types

.1 Compact each soil layer to at least the specified minimum degree; repeat compaction process until plan grade is attained. Compaction densities indicated herein are based on ASTM D698 for Standard Proctor Density.

.2 Type 1 fill to be placed in uniform lifts not greater than 200 mm in thickness around the structures and shall be compacted to a density of at least 95 percent Standard Proctor.

.3 Type 2 fill under concrete slabs on grade shall be placed in uniform lifts not greater than 150 mm in thickness and shall be compacted to a density of at least 100 percent Standard Proctor.

.4 Suitable Excavated Material to be placed in lifts not greater than 200 mm in thickness around the structures and shall be compacted to a density of at least 95 percent Standard Proctor.

3.7 Disposal

.1 Surplus material not required for backfill and fill purposes shall be disposed of off-site within the City limits to a location designated by the City at no extra cost to the City.

3.8 Clean-Up

.1 As excavation proceeds, keep roads, streets, and sidewalks clean of dirt and excavated material.

.2 Clean-up and wash down to remove all dirt and excavated materials caused by Work of this Section.

.3 Clean at the end of each working day as directed by the Contract Administrator.

END OF SECTION

EXCAVATION, TRENCHING AND BACKFILLING

1. GENERAL

1.1 Description

.1 This Section provides the requirements associated with the excavation trenching and backfilling for utilities.

1.2 References

.1 The following Specifications of the City of Winnipeg Standard Construction Specifications-latest edition are applicable to the Work:

.1 CW 2030-R7 Excavation, Bedding and Backfill

.2 Division 3 Standard Details – Underground Works

.1 SD-001 Standard Pipe Bedding

.2 SD-002 Standard Trench and Excavation Backfill

.3 SD-003 Jetting Nozzle Insertion Locations

.3 Division 3 Approved Products for Underground Works

.2 Measurement and payment clauses in the above Specifications are not applicable to the Contract.

.3 Division 2 General Requirements of the City of Winnipeg Standard Construction Specification are not applicable to the Work.

1.3 Existing Conditions

.1 Review the Geotechnical Report prior to submitting Tender for the Work.

.2 Notify Contract Administrator in writing if subsurface conditions at Site differ materially from those indicated and await further instructions from the Contract Administrator.

2. PRODUCTS

2.1 Materials

.1 Products shall be as specified in CW 2030-R7.

3. EXECUTION

3.1 General

.1 Familiarization

.1 Prior to all Work of this section, become thoroughly familiar with the Site, the Site conditions, and all portions of the Work falling within this section.

.2 Review and understand the Geotechnical Report.

.2 Protection

.1 Before starting Work, locate all utilities serving the Site. Notify all agencies or companies having jurisdiction over the specific utilities and protect, relocate, remove, or discontinue service according to their requirements. Any damages shall be repaired at the Contractor's expense.

.2 Protect and restore pavements, boulevards, grassed areas, etc., that may be opened or damaged in the performance of the Work.

.3 During construction, and at the completion of the Contract, all roads used to haul materials shall be cleaned of materials dropped on them.

.3 Do excavation, trenching and backfill to CW 2030.

.4 Backfill requirements are as follows:

.1 Beneath, or within 1 m of all existing and proposed pavements, structures or rail subgrades: Class 2 Backfill.

.2 Within boulevard areas, except as noted above: Class 4 Backfill.

.5 Stockpile material to be used for backfilling on-site as directed by the Contract Administrator. Excess material is to be disposed of immediately off-site.

.6 All excavated or disturbed areas are to be restored to a condition better than or equal to original. Restoration of boulevard areas will be with topsoil and sod; seeding will not be acceptable.

END OF SECTION

RAILROAD WORK

1. GENERAL

1.1 Description

.1 Work includes, but is not necessarily limited to the following items:

.1 The installation of one Number 9 Turnout and approximately 131 m of track for the new ferric chloride unloading spur

.2 Retirement of existing track at a clearance of 4.877 m opposite Stations 1+122.996 and 1+141.924

.3 Supply and install Fixed Bumping Post at end of track Station 1+193.407

.4 Supply and install Fixed Bumping Post at end of track opposite Station 1+122.996

.5 Excavation and backfilling

.6 Installation of track, ties, ballast, and sub-ballast within the Railcar Shelter structure

1.2 Job Conditions

.1 Examination

.1 Visit the Site and note all characteristics and irregularities affecting the Work of this Section.

.2 To proceed with the Work will mean acceptance of the conditions, and failure to comply with the above will in no way form the basis for any claim.

.2 Protection

.1 Use all means necessary to protect all material of this Section before, during, and after installation, and to protect all objects designated to remain.

.2 In the event of damage, immediately make all repairs and replacements necessary to the acceptance of the Contract Administrator at no additional cost.

.3 Railway Safety and Coordination

.1 The project will require work to be carried out in the vicinity of tracks operated by the Canadian Pacific Railway. The Contractor will be required to carry out the work such that interference with railway operations is minimized.

.2 The Contractor, when constructing trackage and turnouts on or near operating trackage, shall ensure safe and clear passage of all train traffic.

.3 The Contract Administrator, after consulting with the Canadian Pacific Railway will, when required, endeavour to allow the Contractor to block the affected track or tracks for the number of consecutive hours required to perform the Work indicated on the Drawings.

.4 During this block time, no rail traffic shall pass through the construction area except in case of emergency.

.5 The Contract Administrator shall notify the Contractor, at least seven hours in advance, of the approximate hours of commencement and of the extent of the block. The hour of commencement shall be confirmed to the Contractor 60 minutes prior to actual commencement as shall be the hour when the tracks must be open and ready to receive rail traffic.

.6 The Contractor shall provide the Contract Administrator a minimum of 48 hours advance notice of the day on which Work requiring a block is to be carried out and shall not commence any Work requiring such a block until the Contractor has received confirmation from the Railway that the block is in effect.

1.3 Reference Standards

.1 AREMA Manual for Railway Engineering, Part 4 Track Construction and Trackwork Plans

.2 Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate, ASTM Designation C88

.3 Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing, ASTM Designation C117

.4 Standard Test Method for Lightweight Particles in Aggregate, ASTM Designation C123

.5 Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate, ASTM Designation C127

.6 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine, ASTM Designation C131

.7 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates, ASTM Designation C136

.8 Determination of particle shape - Flakiness index, British Standard BS EN 933-3:1997

1.4 Field Samples

.1 Material Samples

.1 Submit 75 kg sample of sub-ballast and ballast material specified for analysis by testing

.2 Ship samples pre-paid or deliver in tightly closed containers to testing laboratory designated by the Contract Administrator

.3 Costs for analyses will be paid by the City

2. PRODUCTS

2.1 Steel

.1 Rail

.1 Rail for turnout shall be PW 100 lb RE. The spur shall be constructed using partly worn 100 lb RE.

.2 Vertical head wear shall not exceed 8mm for 100 LB RE head free and 11 mm for 100 lb RE.

.3 Rail used shall be without known defects and may only contain bends that can be straightened easily.

.4 Joint batter is not to be in excess of 3 mm

.5 Rails of different manufacturer should not be mixed in any stretch.

.6 The position of brand marks should be uniform in the same line of rail.

.2 Number 9 Turnout

.1 The turnout shall be No. 9 Turnout, 16 ft 6 inch Points, R.B.M. Frog, 100 lb RE Rail

.2 Switch point guard shall be a Western-Cullen-Hayes Model FM Switch Point Guard or approved equal

.3 Switch Stands

.1 Switch stand shall be new Racor 36-E Trihandle or approved equal

.4 Splice Bars

.1 Partly-worn toeless 4-hole splice bars

.2 New track bolts and washers: bolt diameter 25.4 mm

.5 Tie Plates

.1 14 inch tie plates on turnouts

.2 11 inch tie plates on 100 lb tracks

.6 Rail Anchors

.1 Rail anchors shall be new improved Fair anchors and will be applied to all trackage and through all turnouts

.7 Spikes

.1 Spike shall be new 150 mm spikes and will be applied to both 14 inch tie plates and 11 inch tie plates.

.8 Bumping Posts

.1 Bumping posts shall be Fixed Bumping Post to suit AAR coupler as manufactured by Cornell Welding or approved equal.

2.2 Wood

.1 Track Ties

.1 Track ties shall be No. 2 softwood treated ties.

.2 Switch Ties

.1 Switch ties shall be new hardwood switch ties.

2.3 Crush Rock Ballast

.1 The Contractor, shall supply, haul and distribute all track ballast required for the Works.

.2 Railway ballast shall be composed of hard, strong and durable particles, clean and free from injurious amounts of deleterious substances and conforming to the following requirements of this Specification:

Material	Maximum percent by mass
Soft and friable places	5.0
Material finer than 75 sieve	2.0
Clay lumps	0.5

.3 The percentage of wear shall be less than 32 percent, as determined by the LA Abrasion Test, ASTM Designation C131

.4 The soundness loss shall be less than 13.0 percent, as determined by the magnesium sulphate soundness test for coarse aggregate, ASTM Designation C88

.5 The railway ballast shall contain less then 5 percent by mass of flat pieces. In case of dispute, the test method “Determination of particle shape - Flakiness index”, British Standard BS EN 933-3:1997, shall be used

.6 The minimum bulk specific gravity shall be 2.80, ASTM Designation C127

.7 At least 60 percent of the railway ballast shall have 2 or more fractured faces

.8 Railway ballast shall conform to the following gradation in accordance with ASTM Designation C136 and C117:

Canadian Metric Sieve Size	Percent Passing
50,000	100
38,000	90 - 100
25,000	20 - 55
19,000	0 - 15
9,500	0 - 5
75	0 - 2

2.4 Sub-ballast

.1 The granular material supplied shall be crushed or screened pit run gravel conforming to the following gradation:

Canadian Metric Sieve Size	Percent Passing
75,000	100
25,000	60 - 90
4,750	35 - 60
75	0 - 5

.2 The granular material shall not contain more than 3 percent organics by mass as determined by ASTM C-123.

2.5 Bumping Post

.1 Bumping posts shall be fixed bumping post to suit AAR coupler, quadruple wedge design, extra strong body, as manufactured by H J Skelton (Canada) Ltd of London Ontario.

3. EXECUTION

3.1 Steel

.1 Rail

.1 The Contractor shall lay rail as specified and as directed by the Contract Administrator.

.2 Gauge of track must be laid to be 1435.1 mm with maximum tolerance + 3mm. Gauge of track after laying must be uniform.

.3 Rails will be laid with staggered joints; the stagger between joints in opposite rails will not be less than 3658 mm except when otherwise authorized by the Contract Administrator.

.4 Cutting and drilling of rail shall be performed using rail saws and rail drilling equipment. Under no conditions shall welding equipment be used to cut rail or cut holes in rail.

.5 On completion of the rail laying, the track must be surfaced and lined if necessary, as soon as possible, to avoid damage to the rail.

.6 The Contractor will line all trackage conforming to the line established by the Contract Administrator with a tolerance of ±13 mm.

.2 Number 9 Turnout

.1 The turnout must be installed in accordance with accepted Standard Practice and the standard plan contained in the AREMA Portfolio of Track Plans.

.2 Supply and installation of a switch point guard is required.

.3 Turnout stockrail must be horizontally bent as shown on the standard plan by an approved type of rail bender.

.4 Switch points must fit snugly against the stock rails for the entire length of the planning.

.5 Switches, frogs and guard rails must be fully bolted. All bolts must be provided with a spring washer or cotter pin, and must be kept tight.

.6 The distance between the gauge side of a frog and the bearing side of the guardrail must be maintained at 1387 mm. If the gauge of track is increased the flangeway at the guard rail must be increased by the same amount.

.7 Frog guard rails must be fully spiked inside and outside.

.8 The top surface of the switch points shall be installed 6mm higher than the stock rail. Switch points must be installed with the proper thimble at the heel casting.

.9 Switch point and guard rail faces should be lubricated.

.10 Line, surface and gauge through turnouts must be accurately maintained. The Contractor will line all turnouts conforming to the line established by the Contract Administrator with a tolerance of ±13 mm.

.11 A detailed inspection of all turnouts shall be made and deficiencies rectified to the satisfaction of the Contract Administrator.

.3 Switch Stands

.1 Switch rod bolts, and connecting rod bolts, except the bolt under the switch stand, must be installed with the nut on the upper side to permit ready inspection of the cotter pin. The connecting rod bolt under the switch stand must be installed with the head on the upper side. All connecting and switch rod bolts must be installed with cotter pins. Switch stands must be fully spiked, bolted, or lagged down.

.2 Switch stands, switch plates, connecting rod bolts and spring frogs must be properly lubricated after assembly.

.4 Splice Bars

.1 Partly worn splice bars may be used. Splice bars shall be toeless and must be applied before the rail is spiked.

.2 Rail joints must be fully bolted and the bolts kept to the proper torque. When installed, the fishing surfaces of joints must be lubricated with grease and the threads of bolts lubricated with oil. All joints, except insulated joints, must have their fishing surfaces lubricated.

.3 New track bolts and washers are to be supplied. Install bolts with alternate nuts on the inside of the track. Strike both bars with a sledgehammer during the tightening process to help seat the bars properly. Do a final re-tightening of the two middle bolts.

.4 Bolts in the rail joints shall be tightened in the following sequence:

.1 The two bolts at the centre of the bar

.2 The second bolt from the end of each rail

.3 The third bolt from the end of each rail

.5 Bolts must be torqued to the following specification:

Bolt Diameter	Torque (N-m)
25	750

.6 An approved lubricant will be applied at the joints.

.7 Fibre or hardwood shims must be used to obtain proper expansion space. Expansion shims must not be removed until the rail is properly spiked, bolts tightened and rail anchors applied. The required expansion space will be determined by the Contract Administrator at the time of construction.

.5 Tie Plates

.1 All tracks and turnouts shall be tie plated with partly worn double shouldered tie plates

.2 Tie plates that are bent, broken or badly corroded must not be used

.3 Use two plates per tie on tracks and follow standard plan layouts for turnout tie plates

.4 Tie plates must be installed so that:

.1 The cant of the rail is inward

.2 The tie plates are centred on the tie

.3 The outside shoulder of the tie plate has a full bearing against the base of the rail

.4 No portion of the shoulder at the tie plate will be under the base of the rail

.5 The plates provide a flat, uniform bearing on the tie

.5 Tie plates must be installed in continuous stretches.

.6 Tie plates having different slopes on the rail seat must not be mixed together in the same stretch of track. Tie plates must have a cant of 1:20.

.6 Rail Anchors

.1 Anchors applied to any one tie should be of the same type

.2 To avoid tie skewing, rail anchors must be installed in same direction against the same tie on the opposite rail

.3 Rail anchors must not be applied where they are inaccessible for visual inspection

.4 Sufficient rail anchors shall be applied through both tracks of turnouts, and on each side of turnouts to prevent rails from moving sufficiently to disturb location of switch points or frogs. The number and distribution of anchors to be applied will be as follows:

Application	Requirement
Track	4 boxed anchors every second tie
Turnouts	8 anchors every second switch tie or as shown on the standard plans or as directed by the Contract Administrator, including the switch point area using anchors which will not interfere with the points

.5 When installing rail anchors ensure the base of the rail is reasonably clean or it will not accept the anchor

.6 Anchors must be applied so as to have full bearing against the tie or tie plate. Before applying anchors which bear against the tie plate, the tie plate should be properly placed and spiked

.7 Anchors should be applied on the gauge side of the rail

.8 Care must be taken when applying rail anchors to ensue that they are not over driven. They must be applied and removed with the proper tools. When they are applied by machine, the machine must be properly adjusted

.7 Spikes

.1 Before spikes are driven, ties should be properly spaced and square to the rail

.2 Where tie plates are to be installed, they must be centred on the tie and provide a full bearing with the tie

.3 Uniform track gauge must be maintained within permissible tolerances when spiking, and must be checked by use of a standard track gauge

.4 The number of spikes to be used shall be as follows:

Application	Requirement
Tangent and curved track	2 spikes per rail, 4 per tie
Special trackwork frogs, switches, frog guard rails, etc	fully spiked in all plate holes provided except where twin tie plates are used where one spike per plate end shall be used

.5 When 2 spikes per rail, 4 per tie are used, they must, where possible, be staggered so that the field side spikes are on the same side of the same tie and the gauge side spikes are on the other side of the same tie

.6 When laying rail, spikes must not be driven until splice bars have been bolted in place

.7 When spiking, care must be taken not to strike the rail, fastenings, or signal appliances with the spiking tool

.8 Spikes must not be driven against the end of splice bars and must not be driven in the slots of slotted splice bars

.9 Spikes may be driven by use of a Standard Spike Maul or by machine but in either case:

.1 Spikes must be driven with the head pointing to the rail

.2 Spikes must be started and driven vertically and square to provide a full bearing against the edge of the base of rail

.3 Spikes must not be driven to contact the top of the base of the rail. They should be so driven as to allow not more than 4.76mm clearance between the underside of the head of the spike and the top of the base of rail. Properly adjusted stops must be used on power operated spiking machines

.4 Spikes must be driven into sound wood

.8 Bumping Posts

.1 Bumping Posts shall be installed in accordance with the Manufacturer's instruction at the following locations:

Track	Station
New spur	1 + 193.407
Existing track	Opposite 1 + 122.996

3.2 Wood

.1 Track Ties

.1 The Contractor must install new No. 2 softwood treated ties at right angles to the rail. Ties shall be spaced at 2980/mile or at 21 1/4" centre to centre.

.2 Treated ties must not be handled with a pick, shovel or other tool that may cause damage to the tie. Ties must not be allowed to become centre bound. Track ties must be laid with the heart side facing down.

.3 The end of the track ties should be lined true on one side of the entire length of the track.

.4 When ties are respiked, the spike holes must be plugged. Where rail is re-laid and ties not replaced, ties must be adzed a minimum amount to give uniform bearing for the tie plates. All adzed surfaces of ties must be coated with an approved preservative.

.5 All ties installed on existing track must be thoroughly tamped and spiked before the close of the day.

.2 Switch Ties

.1 The requirements of Clause 3.2.1 Track Ties shall apply to switch ties, except gauge, spacing, and the layout must be in accordance with standard plans.

.2 Turnout ties must be firmly tamped for 400 mm on either side of the Mainline and Turnout rails. Head block ties must be firmly tamped as above with the voids filled on the remainder of the tie. Ties must be installed using spacing straps and lag screws

3.3 Crush Rock Ballast

.1 The Contractor will place the ballast on top of the skeleton track and lift the track to top of ballast.

.2 The Contractor shall place and distribute the ballast in sufficient quantities on trackage and turnouts to achieve the required lift, as determined by the grade of the stakes, and to conform to the ballast sections as shown on the drawings and as directed by the Contract Administrator.

.3 The Contractor is cautioned that damage caused by his equipment to track and turnouts during the distribution of ballast will be repaired by the Contractor at his expense, as directed by and to the satisfaction of the Contract Administrator.

.4 The Contractor will raise all trackage and turnouts with the ballast to provide a minimum depth of 300 mm from the top of the tie on all trackage and turnouts to top of sub ballast or to such depth as shall be directed by the Contract Administrator. Ballast shall be laid in lifts, not exceeding 150 mm in thickness.

.5 Ballast shall be well packed or tamped with tamping machines or other approved mechanical tamping equipment as directed from a point 400mm inside each rail for 2440mm ties, on both sides of the ties to the end of the ties. Tamping will not be permitted at the centre of the tie between the above stated limits. The centre shall be tamped simultaneously and tamping inside and outside of the rail shall be done at the same time. Turnout ties are to be firmly tamped for 400mm on either side of the mainline and turnout rails. The areas under the frog, guard rails and heel castings must be hand tamped with bars or mechanical hand tampers. Hand tamping will be permitted only for minor tamping work.

.6 The Contractor shall trim the ballast to allow for 225 mm of shoulder and two (2) horizontal to one (1) vertical side slopes. The Contractor will dispose of any surplus ballast after trimming the ballast section as directed by and to the satisfaction of the Contract Administrator

3.4 Sub-ballast

.1 The Contractor shall spread and blade the sub-ballast material to form layers conforming to the required cross section and grade as shown on the drawings. The sub-ballast shall be placed in 150mm layers. Each layer shall be compacted to its full width by rolling with a vibratory roller to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor Compaction Test (ASTM D698, latest edition). The vibratory roller shall meet the following minimum requirements:

.1 Vibratory force: 4500 pounds per cycle per foot width (65.8 kN per m width)

.2 Vibratory frequency: 1600 cycles per minute.

.2 Rolling shall continue until a satisfactory compacted grade is obtained. In general, a minimum of four complete passes by the roller shall be given. The Contractor shall maintain the sub-ballast layer in a clean condition, free-draining and unfouled by the addition of other material until final acceptance of the work. Any portion of the sub-ballast layer which becomes fouled shall be replaced by the Contractor at his expense.

3.5 Disposal

.1 Track materials to be retired shall become the property of the Contractor are to be removed from the site. All ties from retired track are to be disposed of offsite in an approved and environmentally responsible manner

3.6 Subgrade

.1 Subgrade shall be constructed in accordance with City of Winnipeg Standard Construction Specification CW3170-R3. Measurement and payment clauses of CW3170-R3 shall not apply.

.2 All topsoil and organic growth within the limits of embankment construction shall be excavated and disposed of offsite.

.3 Embankments shall be constructed from suitable clay materials from the building excavation

END OF SECTION

PILE FOUNDATIONS, GENERAL

1. GENERAL

1.1 Description

.1 This Section provides the requirements associated with the installation of precast concrete piles as specified in Section 02468.

1.2 Delivery, Storage and Handling

.1 Protect piles from damage due to excessive bending stresses, impact, abrasion, or other causes during delivery, storage, and handling.

.2 Replace damaged piles to satisfaction of Contract Administrator. Causes for pile rejection are as follows:

.1 Out of fabrication tolerances at time of installation

.2 Cracked, spalled, or broken piles

.3 Out of driving tolerances

1.3 Existing Conditions

.1 Review the Geotechnical Report prior to submitting Bid for the Work.

.2 Notify Contract Administrator in writing if subsurface conditions at Site differ materially from those indicated and await further instructions from the Contract Administrator.

1.4 Scheduling

.1 Submit schedule of planned sequence of driving to Contract Administrator for review, not less than two (2) weeks prior to commencement of pile driving.

2. PRODUCTS

2.1 Materials

.1 Material requirements for piles are specified in Section 02468.

.2 Supply or fabricate full length piles as indicated and provide equipment to handle full length piles without cutting and splicing.

.3 Do not splice piles without written permission of Contract Administrator. When permitted, provide details for Contract Administrator review. Design details of splice to bear dated seal and signature of Professional Engineer registered in the Province of Manitoba.

3. EXECUTION

3.1 Equipment

.1 Prior to commencement of pile installation, submit to Contract Administrator for review, details of equipment for installation of piles.

.1 Impact hammers: give Manufacturer's name, type, rated energy per blow at normal working rate, mass of striking parts of hammer, mass of driving cap and type and elastic properties of hammer and pile cushions.

.2 Hammer

.1 Hammers to be selected on basis of driveability analysis using wave equation theory, performed to show that piles can be driven to levels indicated.

.2 The driveability analysis shall include, but not be limited to, the following: hammer, cushion, and capblock details; static soil parameters; quake and damping factors, total soil resistance, blow count, pile stresses, and energy throughput at representative penetrations.

.3 Driveability analysis shall be submitted to the Contract Administrator for review of the hammer or hammers.

.4 When required criteria cannot be achieved with the proposed hammer, use larger hammer and take other measures as required.

.5 Drop hammers are not permitted.

.3 Leads

.1 Construct pile driver leads to provide free movement of hammer. Hold leads in position at top and bottom, with guys, stiff braces, or other means to ensure support to pile while being driven.

.2 Length: provide length of leads so that use of a follower is unnecessary.

.3 Swing leads: firmly guy top and bottom to hold pile in position during driving operation.

.4 Followers: when permitted, provide followers of such size, shape, length, and mass to permit driving pile in desired location to required depth and resistance. Provide followers with socket or hood carefully fitted to top of pile to minimize loss of energy and prevent damage to pile.

3.2 Preparation

.1 Ensure that ground conditions at pile locations are adequate to support pile driving operation. Make provision for access and support of piling equipment during performance of Work.

.2 Pre-bore holes to depths indicated for piles within 5 m of the existing structures.

.3 Pre-bore with an oversized auger bit to the depths as indicated in the Geotechnical Report.

.4 Prior to starting pile installation, undertake a review of all adjacent infrastructures with the Contract Administrator complete with a photographic record and notes sufficient to establish pre-driving conditions of the existing adjacent infrastructures.

3.3 Field Measurement

.1 Contractor shall cooperate with the Contract Administrator and shall allow access during pile installation operations to facilitate all the field measurements to be performed expeditiously.

.2 Maintain accurate records of driving for each pile, including:

.1 Type and make of hammer, stroke or related energy

.2 Other driving equipment including water jet, driving cap, cushion

.3 Pile size, cast date, batch number or designation, and supply length, location of pile in pile group, location or designation of pile group

.4 Date driven

.5 Sequence of driving piles in grout

.6 Number of blows per 25-mm (1 in.) for last 150-mm (6 in.)

.7 Final tip, cutoff and grade elevations

.8 Re-driving records

.9 Pile plumbness upon completion of driving

.10 Other pertinent information such as interruption of continuous driving and pile damage

.11 Record elevation taken on adjacent piles during, before and after driving of each pile

.12 All measurements, observation and calculations associated with pile driving analyzer and wave equation analysis

.3 Provide Contract Administrator with three (3) copies of records.

3.4 Driving

.1 Drive precast piles only when concrete has attained strength of 35 MPa as determined by related concrete compression testing in accordance with CSA A23.2-00.

.2 Use driving caps and cushions to protect piles. Reinforce pile heads as required by Contract Administrator. Piles with damaged heads as determined by Contract Administrator will be rejected.

.3 Hold piles securely and accurately in position while driving.

.4 Deliver hammer blows along axis of pile.

.5 Drive piles to practical refusal, as outlined in the Geotechnical Report. Blow count requirements shall be determined by the Contract Administrator. If followers are used, established criteria for refusal will be increased as determined by the Contract Administrator.

.6 When driving precast concrete piles, adjust hammer, as required, to deliver reduced impact so that reflected tensile stress in pile does not exceed allowable.

.7 Do not drive piles within 10 m of masonry or concrete which has been in place less than seven (7) days. Do not drive piles within 30 m of masonry or concrete which has been in place less than one (1) day.

.8 Re-strike already driven piles lifted during driving of adjacent piles to confirm and assure set.

.9 Remove loose and displaced material from around piles after completion of driving, and leave clean, solid surfaces to receive foundation concrete.

.10 Cut off piles neatly and squarely at elevations as indicated. Provide sufficient length above cut-off elevation so that part damaged during driving is cut off. Do not cut tendons or other reinforcement which will be used to tie supported structure above to pile. A minimum of 450 mm of strands shall remain for this purpose. The cut off surface of the piles shall be mechanically shipped to expose sound concrete.

.11 Remove cut-off lengths from Site on completion of Work.

3.5 Design Load Capacity

.1 Allowable design load capacity of piles at specified loads is:

.1 300 mm diameter hex - 445 kN

.2 350 mm diameter hex - 625 kN

.3 400 mm diameter hex - 800 kN

.2 Installation of each pile will be subject to review of Contract Administrator. Contract Administrator will be sole judge of acceptability of each pile with respect to final driving resistance, depth of penetration, or other criteria used to determine load capacity. Contract Administrator to review final driving of all piles prior to removal of pile driving rig from Site.

3.6 Driving Tolerances

.1 Pile heads shall be within ± 50 mm of locations as indicated.

.2 Piles shall not to be more than 2 percent of length out of vertical alignment.

3.7 Obstructions

.1 Where obstruction is encountered that causes sudden unexpected change in penetration resistance or deviation from specified tolerances, proceed as directed by Contract Administrator.

3.8 Repair/Restoration of Rejected Piles

.1 The Contract Administrator may require one or more of the following remedial measures in case of rejected piles:

.1 Pull out rejected piles and replace with new piles.

.2 Remove rejected pile and replace with a new, and if necessary, a longer pile.

.3 Remove rejected pile and fill hole as directed by Contract Administrator.

.4 Leave rejected pile in place and cut off as directed by Contract Administrator.

.5 Leave rejected pile in place, place adjacent pile(s), and modify pile cap as directed by Contract Administrator.

.2 No extra compensation will be made for removing and replacing or other Work made necessary through rejection of defective piles.

3.9 Protection

.1 Protect adjacent structures, services, and Work of other Sections from hazards due to pile driving operations.

.2 Arrange sequencing of pile driving operations and methods such that no damage occurs to adjacent existing structures. If damaged, remedy damaged items to restore to original or better condition at own expense.

.3 After the pile driving is complete, undertake a review of the existing adjacent infrastructures with the Contract Administrator to identify any damage to the infrastructures resulting from the pile driving operations.

.4 Protection for pile strand ends:

.1 Highly visible protection safety caps shall be installed for all pile reinforcing strand ends immediately following strand exposure operations. One protection cap may be used for each pile by grouping and securely tying the strands.

.2 The protection caps shall be highly visible and shall be made secure so that accidental contact will not easily dislodge the caps. Dislodged caps shall be re-installed immediately.

.3 Pile reinforcing strands shall be protected from severe bending. Kinked or broken strands shall be repaired to the satisfaction of the Contract Administrator.

END OF SECTION

PRECAST CONCRETE PILES

1. GENERAL

1.1 Work Included

.1 Fabrication, delivery, and installation of precast concrete piles.

1.2 References

.1 CSA-A23.1-00/A23.2-00, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete

.2 CSA A23.4/A251, Precast Concrete – Materials and Construction/Qualification Code for Architectural and Structural Precast Concrete Products

.3 CAN/CSA-A3000, Cementitious Materials Compendium (consists of A5, A8, A23.5, A362, A363, A456.1, A456.2, and A456.3)

1.3 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01300.

.2 Each Drawing submitted shall be signed and sealed by a Professional Engineer registered in the Province of Manitoba.

.3 Indicate the following items:

.1 Lifting point details and locations

.2 Storage support point locations

.3 Connector details complete with calculations

.4 Concrete strength

.5 Steel grades

.6 Reinforcing details

.7 Type and grade of steel

1.4 Certificates

.1 Piles delivered to Site to be certified by Manufacturer that each batch of piles to have strength of 35 MPa at 28 days.

1.5 Review and Monitoring

.1 Notify Contract Administrator at least four (4) days prior to pile driving operations.

.2 Pile driving review and monitoring is to be performed by a geotechnical inspection and testing firm appointed and paid by the City.

.3 Provide free access to all portions of Work and cooperate with appointed firm.

2. PRODUCTS

2.1 Materials

.1 Concrete mixes and materials: to CSA-A23.1-00 and CSA-A23.4

.2 Reinforcing steel: to CAN/CSA-G30.18

.3 Cold-drawn steel wire for concrete reinforcement: to ASTM A82

.4 Fabricate and supply full length piles as indicated and provide equipment to handle full length piles without cutting and splicing.

2.2 Qualifications

.1 Pile type shall have a proven record of successful service in the Province of Manitoba of at least twenty (20) years.

2.3 Concrete Mixes

.1 Proportion normal density concrete in accordance with CSA-A23.1-00, Alternative 1, to give following properties:

.1 Use Type 50 cement

.2 Minimum compressive strength at twenty-eight (28) days: 35 MPa

.3 Minimum cement content: 365 kg/m^3 of concrete

.4 Maximum water/cement ratio: 0.45

.5 Nominal size of coarse aggregate: 20 mm maximum

.6 Coarse and fine aggregates to be on the City accepted list

.7 Air content: 5 to 8 percent, to ASTM C260

.8 Chemical admixtures: in accordance with ASTM C494

.9 Pozzolanic mineral admixtures: in accordance with CSA 3000

3. EXECUTION

3.1 Fabrication

.1 Fabricate precast concrete piles to lengths determined through the soils information and required cut-off elevations.

.2 Fabricate piles to following finish tolerances:

.1 Length: plus or minus 3 mm/m of length.

.2 Cross section:

.1 Solid hexagon sections: minus 5 to plus 10 mm

.2 Deviation from straight line: not more than 3 mm/m of length; 10 mm in full length

.3 Deviation of internal core or void from true position: 10 mm

.4 Pile head: 10 mm/m from true right angle plane; surface irregularities 3 mm

.5 Strand projection: strands shall be cut off flush or be slightly below pile head surface

.6 Location of reinforcing steel main reinforcing cover: minus 3 to plus 5 mm; spiral: 10 mm

.3 Prestress piles under the direction of an experienced and competent supervisor. All personnel operating the stressing equipment shall have been trained in its use.

.4 De-tension in a manner to keep eccentricity to a minimum. Cut prestress strands in a manner to minimize the internal stress variation to the pile as much as possible.

.5 Quality and dimensions of piles will be determined by Contract Administrator. Remove rejected piles from Site.

.6 Submit to Contract Administrator concrete quality control records for all precast piles delivered to Site prior to installation.

3.2 Handling

.1 Protect piles from damage due to excessive bending stresses, impact, abrasion, or other causes during handling, storage, and delivery both at the fabrication plant and on Site.

.2 Replace damaged piles to satisfaction of Contract Administrator.

END OF SECTION

WATERMAINS

1. GENERAL

1.1 Work Included

.1 Construction of new water service from the new chemical storage building to the new railcar shelter

1.2 References

.1 The following Specifications of the City of Winnipeg Standard Construction Specifications-latest edition are applicable to the Work:

.1 Section 02315 Excavation, Trenching and backfilling

.2 CW 2110-R8 Watermains

.3 Division 3 Standard Details – Underground Works

.1 SD-001 Standard Pipe Bedding

.2 SD-002 Standard Trench and Excavation Backfill

.3 SD-012 Water Service 20 Millimeter to 50 Millimeter

.4 Division 3 Approved Products for Underground Works

.2 Measurement and payment clauses in the above Specifications are not applicable to the Contract.

.3 Division 2 General Requirements of the City of Winnipeg Standard Construction Specification are not applicable to the Work.

2. PRODUCTS

2.1 Materials

.1 Use only those Products listed as Approved Products for Underground Use in the City of Winnipeg.

3. EXECUTION

3.1 General

.1 Familiarization

.1 Prior to all Work of this section, become thoroughly familiar with the Site, the Site conditions, and all portions of the Work falling within this section.

.2 Review and understand the Geotechnical Report.

3.2 Excavation, Bedding and Backfill

.1 Do excavation, bedding and backfill to Section 02315.

3.3 Installation

.1 Installation to CW 2110.

.2 Install pipes by open trench methods with minimum cover of 2.5 m from finished ground surface.

END OF SECTION

SANITARY SEWERS

1. GENERAL

1.1 Work Included

.1 Construction of new sanitary sewer services from the Chemical storage building and railcar shelter and including replacement of an existing manhole and sewer renewal.

1.2 References

.1 The following Specifications of the City of Winnipeg Standard Construction Specifications-latest edition are applicable to the Work:

.1 Section 02315 Excavation, Trenching and Backfilling

.2 CW 2130-R9 Gravity Sewers

.3 CW 2160-R6 Concrete Underground Structures and Works

.4 Division 3 Standard Details – Underground Works

.1 SD-001 Standard Pipe Bedding

.2 SD-002 Standard Trench and Excavation Backfill

.3 SD-003 Jetting Nozzle Insertion Locations

.4 SD-010 Standard Precast Concrete Manhole (for up to 525 Diameter Pipe)

.5 SD-014 Sewer Service with Alternate “A” Riser

.6 SD-015 Sewer Service with Alternate “B” Riser

.7 SD-022A Sewer Repair Up to 3.0 Meters Long

.5 Division 3 Approved Products for Underground Works

.2 Measurement and payment clauses in the above Specifications are not applicable to the Contract.

.3 Division 2 General Requirements of the City of Winnipeg Standard Construction Specification are not applicable to the Work.

2. PRODUCTS

2.1 Materials

.1 Use only those Products listed as Approved Products for Underground Use in the City of Winnipeg.

.2 All sewer piping shall be supplied with Nitrile gaskets.

.3 Flexible couplings at connections to structure shall conform to City of Winnipeg Standard AT-4.1.1.65.

3. EXECUTION

3.1 General

.1 Familiarization

.1 Prior to all Work of this Section, become thoroughly familiar with the Site, the Site conditions, and all portions of the Work falling within this Section.

.2 Review and understand the Geotechnical Report.

3.2 Excavation, Bedding and Backfill

.1 Do excavation, bedding and backfill to CW 2030.

.2 Pipe bedding shall be Class B compacted sand bedding except where noted on drawing to be in accordance with SD-022A.

.3 In excavated areas adjacent to structures construct cement stabilized fill foundation from undisturbed soil to 150 mm below bottom of pipe and minimum 375 mm each side of outside of pipe.

3.3 Installation

.1 Installation to CW 2130.

.2 Maintain all sewer flows at all times during installation.

3.4 Connection to the Existing System

.1 Locate and confirm size and material of the existing sewer prior to making connection.

.2 Remove exiting manhole and connect new manhole to the existing sewer. Renew 3 m of existing sewer west of manhole in accordance with SD-022A.

END OF SECTION

STORM SEWER

1. GENERAL

1.1 Work Included

.1 Relocation of existing catchbasin leads and land drainage sewers, including new manholes and new land drainage sewer isolation valve.

1.2 References

.1 The following Specifications of the City of Winnipeg Standard Construction Specifications-latest edition are applicable to the Work:

.1 Section 02315 Excavation, Trenching and Backfilling

.2 CW 2130-R9 Gravity Sewers

.3 CW 2145-R2 Sewer and Manhole Inspections

.4 CW 2160-R6 Concrete Underground Structures and Works

.5 Division 3 Standard Details – Underground Works

.1 SD-001 Standard Pipe Bedding

.2 SD-002 Standard Trench and Excavation Backfill Classes

.3 SD-003 Jetting Nozzle Insertion Locations

.4 SD-010 Standard Precast Concrete Manhole (for up to 525 Diameter Pipe)

.5 SD-014 Sewer Service with Alternate “A” Riser

.6 SD-015 Sewer Service with Alternate “B” Riser

.7 SD-024 Catchbasin with Curb and Gutter Inlet

.6 Division 3 Approved Products for Underground Works

.2 Measurement and payment clauses in the above Specifications are not applicable to the Contract.

.3 Division 2 General Requirements of the City of Winnipeg Standard Construction Specification are not applicable to the Work.

2. PRODUCTS

2.1 Materials

.1 Use only those Products listed as Approved Products for Underground Use in the City of Winnipeg.

.2 All sewer piping shall be supplied with Nitrile gaskets.

.3 Where indicated, land drainage sewer piping shall be PVC C900 conforming to City of Winnipeg Standard AT-4.1.1.10. PVC C900 piping shall be furnished with Nitrile gaskets.

.4 Where indicated, gate valve shall conform to City of Winnipeg Standard AT-4.1.1.80.

.5 Valve boxes for gate valves on land drainage sewers shall be approved City of Winnipeg valve boxes with the exception that the hinged lid shall indicate "S".

3. EXECUTION

3.1 General

.1 Familiarization

.1 Prior to all Work of this Section, become thoroughly familiar with the Site, the Site conditions, and all portions of the Work falling within this Section.

.2 Review and understand the Geotechnical Report.

3.2 Excavation, Bedding and Backfill

.1 Do excavation, bedding and backfill to CW 2030.

.2 Pipe bedding shall be Class B compacted sand bedding.

3.3 Installation

.1 Installation to CW 2130.

.2 Install gate valves in accordance with CW 2110.

.3 Maintain all sewer flows at all times during installation.

.4 Abandon or remove elements of existing land drainage sewer system as indicated.

.5 Where ground conditions permit, install land drainage sewers and catchbasin leads by trenchless methods under existing pavements to remain.

3.4 Testing

.1 Perform sewer and manhole inspections in accordance with CW 2145.

END OF SECTION

PORTLAND CEMENT CONCRETE PAVEMENT FOR BUILDING SITES

1. GENERAL

1.1 Work Included

.1 Reconstruction of existing pavements removed for construction of new buildings or utilities

1.2 References

.1 The following Specifications of the City of Winnipeg Standard Construction Specifications-latest edition are applicable to the Work:

.1 CW3110-R6 Sub-Grade, Sub-Base and Base Course Construction

.2 CW3130 Supply and Installation of Geotextile Fabrics

.3 CW3310-R7 Portland Cement Concrete Pavement Works

.4 CW3325-R2 Portland Cement Concrete Sidewalk

.5 CW3710-R4 Products Approved for Use in Surface Works

.6 Division 4 – Standard Details Surface Works

.1 SD-203A Barrier Curb (Separate)

.2 SD-209 Keyway for Portland Cement Concrete Pavement

.3 SD-210A Longitudinal Joint for Concrete Pavement

.1 SD-210B Tie Bar Installation for Lane-At-A-Time Paving Where Bending of Tie Bars is Required

.2 SD-211A Construction Joint and Contraction Joint for Reinforced Concrete Pavement

.3 SD-212 Sawn Joint, Keyed Joint and Butt Joint for Reinforced, Plain Concrete and Plain-Dowelled Pavement

.4 SD-216 Placement of Steel in Reinforced Concrete Pavements, 5000 mm Joint Spacing

.5 SD-217 Layout for Type “A” and “B” Barmat Reinforcement, 5000 mm Joint Spacing

.6 SD-218A Typical Joint Details for Portland Cement Concrete Pavements

.4 SD-218B Location of Longitudinal Joints in Concrete Pavements

.2 Measurement and payment clauses in the above Specifications are not applicable to the Contract.

.3 Division 2 General Requirements of the City of Winnipeg Standard Construction Specification are not applicable to the Work.

2. PRODUCTS

2.1 Materials

.1 Use only those Products listed in the Surface Works Approved Products in the City of Winnipeg Standard Construction Specifications.

.2 Use only approved concrete mixes from approved concrete suppliers.

3. EXECUTION

3.1 General

.1 Familiarization

.1 Prior to all Work of this Section, become thoroughly familiar with the Site, the Site conditions, and all portions of the Work falling within this Section.

.2 Review and understand the Geotechnical Report.

.2 Protection

.1 Before starting Work, locate all utilities serving the Site. Notify all agencies or companies having jurisdiction over the specific utilities and protect, relocate, remove, or discontinue service according to their requirements. Any damages shall be repaired at the Contractor's expense.

.2 Protect and restore pavements, boulevards, grassed areas, etc., that may be opened or damaged in the performance of the Work.

.3 During construction, and at the completion of the Contract, all roads used to haul materials shall be cleaned of materials dropped on them.

3.2 Excavation

.1 Saw cut and remove existing pavement to the limits required for construction of new buildings or utilities in accordance with CW-3110. Pavement shall be removed for the full width of the roadway. Haul material and dispose of off-site.

.2 Excavate to the lines and grades shown on the Drawings and Surface Works Standard Details in accordance with CW-3110. Dispose of all excavated material off-site.

3.3 Subgrade Preparation

.1 Prepare subgrade in accordance with CW-3110. Upon approval of the excavation bottom by the Contract Administrator, compact subgrade to 95 percent Standard Proctor Density.

.2 Prior to installation of Geotextile fabric, proof roll subgrade. Notify Contract Administrator of Defective areas of subgrade. Excavate and remove defective subgrade areas as directed by the Contract Administrator. Backfill excavated areas with suitable Site material as directed by the Contract Administrator.

.3 Install separation/reinforcement geotexile fabric in accordance with CW-3130 as indicted on the Drawings and Surface Works Standard Details.

3.4 Sub-base and Base Course Construction

.1 Construct sub-base and base course to the lines and grades shown on the Drawings in accordance with CW-3110 for roadways and approaches.

.2 Construct base course for sidewalks as shown on Surface Works Standard Details in accordance with CW-3325.

3.5 Paving

.1 Construct roadways and sidwalks as shown on the Drawings and Surface Works Standard Details in accordance with CW-3310. Pavement to be installed at elevation of original pavement.

.2 Transition from 180 mm barrier curb to 125 mm lip curb over a distance of 0.9 m.

END OF SECTION

CHAIN LINK FENCING AND GATES

1. GENERAL

1.1 Work Included

.1 Removal of existing fencing. Salvage of existing fencing fabric and gates for reuse. Construction of new fencing. Construction of bollards.

1.2 References

.1 The following Specifications of the City of Winnipeg Standard Construction Specifications-latest edition are applicable to the Work:

.1 CW3550-R2 Chain Link Fencing

.2 CW2160-R6 Concrete Underground Structures and Works

.2 Measurement and payment clauses in the above Specifications are not applicable to the Contract.

.3 Division 2 General Requirements of the City of Winnipeg Standard Construction Specification are not applicable to the Work.

2. PRODUCTS

2.1 Materials

.1 All materials shall conform to the requirements of CW3550.

.2 Overhang tops to provide waterproof fit, to hold top rails and an outward projection to hold barbed wire overhang.

.3 Provide projection with clips or recesses to hold 3 strands of barbed wire spaced 100 mm apart.

.4 Projection of approximately 300 mm long to project from fence at 45 degrees above horizontal.

.5 Barbed wire to ASTM A 121 2 mm diameter galvanized steel wire, 4 point barbs 125 mm spacing.

3. EXECUTION

3.1 Removal and Salvage

.1 Remove existing fence as indicated.

.1 Take down existing fence fabric, roll-up and store for later re-use.

.2 Remove and store existing gates and gate hardware for later re-use.

.3 Completely remove posts and concrete bases and dispose of off-site. Dispose of remaining fence material not to be reused offsite.

3.2 Grading

.1 Remove debris and correct ground undulations along fence line to obtain smooth uniform gradient between posts.

.2 Prune trees as required under the supervision of a licensed arborist.

3.3 Installation

.1 Install new fence in accordance with CW-3550.

.2 Terminal and line posts to be set in concrete.

.3 Supply additional fencing fabric and hardware as needed to complete installation.

.4 Provide horizontal bracing at all terminal and corner posts, and at sharp changes in elevation.

END OF SECTION

CONCRETE FORMWORK

1. GENERAL

1.1 Work Included

.1 Forms for all concrete and supporting falsework including design

.2 Wood and/or steel forms for all cast-in-place concrete

.3 Void forms between structural elements and soil below

.4 Shoring, bracing, and anchorage

.5 Form openings for other trades

.6 Coordinate installation of concrete accessories

.7 Set anchor bolts, anchors, sleeves, frames, and other items supplied by other trades

.8 Clean erected formwork prior to concrete placement

.9 Remove forms and supporting falsework

1.2 Design Standards

.1 Design and detail forms and supporting falsework in accordance with the National Building Code of Canada, CAN/CSA-A23.1-00, CSA S269.1, CAN/CSA S269-3, ACI 347R, and applicable construction safety regulations.

.2 Design to be sealed and signed by a Professional Engineer registered in the Province of Manitoba.

1.3 Quality Assurance

.1 Construct and erect concrete formwork in accordance with CAN/CSA-A23.1-00, CAN/CSA S269.3, ACI 347R, and all applicable construction safety regulations for the place of Work.

2. PRODUCTS

2.1 Exposed Surfaces

.1 Square-edged, smooth surfaced panels true in plane, free of holes, surface markings, or defects.

2.2 Unexposed Surfaces

.1 Square-edged tongue and groove lumber, plywood or other material, suitable to retain concrete without leakage or distortion

2.3 Wood Materials

.1 Plywood: Douglas fir, conforming to CSA O121-M solid one-side, sheathing grade. Sound undamaged sheets with clean true edges.

.2 Lumber: conforming to CSA O141-M

.3 Nails, spikes, and staples: galvanized; conforming to CSA B111

2.4 Prefabricated Forms

.1 Steel type: minimum 1.6 mm steel thickness; well matched, tight fitting, and adequately stiffened to support weight of concrete without deflection detrimental to structural tolerances and appearance of finished concrete surface

.2 Tubular column type: round, spirally wound laminated fiber material, internally treated with release agent; sizes indicated on Drawings

.3 Void forms: moisture resistant treated paper faces; bio-degradable, structurally sufficient to support weight of wet concrete mix and construction loads until initial set

2.5 Accessories

.1 Form ties: removable snap-off metal type, galvanized, fixed length, minimum working strength of 13 kN when assembled. For water retaining structures use form ties that leave a minimum cutback of 50 mm. Form ties using sleeves that remain are not permitted for water retaining structures. For non-water retaining structures use form ties that leave a minimum cutback of 25 mm. Use plastic cone snap type or screw type on exposed surfaces. Wire ties are not permitted.

.2 Form release agent: colourless mineral oil which will not stain concrete or impair natural bonding or colour characteristics of coating intended for use on concrete

.3 Corner fillets or chamfers: mill finished pine, 20 mm by 20 mm, maximum possible lengths, mitre ends.

.4 Reglets: mill finished pine, shaped to required cross-section, maximum possible lengths, mitre ends.

.5 Sealing tape: reinforced, self-adhesive, waterproof kraft.

3. EXECUTION

3.1 Examination

.1 Before starting this Work, examine Work done by others which affects this Work.

.2 Notify the Contract Administrator of any conditions which would prejudice proper completion of this Work.

.3 Commencement of Work implies acceptance of existing conditions.

3.2 Erection

.1 Verify lines, levels, and centres before proceeding with formwork. Ensure dimensions agree with Drawings.

.2 Construct formwork and falsework to meet design and regulatory requirements, and to produce finished concrete conforming to surfaces, shapes, lines, and dimensions indicated on Drawings.

.3 Arrange and assemble formwork to permit removal without damage to concrete.

.4 Align joints and make watertight to prevent leakage of cement paste and disfiguration of concrete. Keep form joints to a minimum. Tape joints as necessary.

.5 Arrange forms to allow removal without removal of principal shores, where these are required to remain in place.

.6 Obtain the Contract Administrator's acceptance before framing openings in concrete slabs, walls, beams, and columns not indicated on Drawings.

.7 Provide falsework to ensure stability of formwork. Prop or strengthen all previously constructed parts liable to be overstressed by construction loads.

.8 Position form joints to suit any expressed lines required in exposed concrete.

.9 Provide chamfer on all external corners and fillets on all internal corners and edges of exposed concrete unless shown otherwise.

.10 Form chases, slots, openings, drips, and recesses as detailed on the Drawings.

.11 Set screeds with top edge level to required elevations.

.12 Check and readjust formwork to required lines and levels during placing of concrete.

.13 Where construction joints are required in beams and suspended slabs, form joints at the third points in the span unless shown or noted otherwise on Drawings.

.14 Provide reveals or reglets on construction joints as shown on the Drawings.

3.3 Tolerance

.1 Construct formwork to produce concrete with dimensions, lines, and levels within tolerances specified in ACI 347R, Guide to Formwork for Concrete.

.2 Camber slabs and beams 6 mm per 3 m of span unless otherwise indicated on the Drawings. Review method of providing camber with Contract Administrator prior to proceeding. Maintain beam depth and slab thickness from cambered surface.

3.4 Inserts, Embedded Items, and Openings

.1 Provide formed openings where required for pipes, conduits, sleeves, and other Work to be embedded in and passing through concrete members.

.2 Accurately locate and set in place items which are to be cast directly into concrete.

.3 Coordinate Work of other Sections and cooperate with trades involved in forming openings, slots, recesses, chases, and setting sleeves, bolts, anchors, and other inserts.

.4 Coordinate installation of concrete accessories specified in Section 03250.

.5 Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

.6 Close temporary ports or openings with tight fitting panels, flush with inside face of forms, neatly fitted so no leakage occurs, and to provide uniform surface on exposed concrete.

3.5 Field Quality Control

.1 Inspect and check complete formwork, falsework, shoring, and bracing to ensure that Work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and parts are secure.

.2 Inform Contract Administrator when formwork is complete and has been cleaned, to allow for review. Contract Administrator's review will be for verification that earth bottoms are clean and that forms are clean and free from debris.

.3 Re-use of forms shall be subject to the requirements of CAN/CSA-A23.1-00.

3.6 Cleaning

.1 Clean formwork in accordance with CAN/CSA-A23.1-00.

.2 During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out completed forms, unless formwork and concrete construction proceed within a heated enclosure. Use compressed air or other means to remove foreign matter.

3.7 Formwork Preparation

.1 Apply form release agent in accordance with Manufacturer's recommendations, prior to placing reinforcing steel, anchoring devices, and embedded parts.

.2 Do not apply form release agent where concrete surfaces are to receive special finishes or applied coverings which are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces moist prior to placing concrete.

3.8 Form Removal

.1 Notify Contract Administrator prior to removing formwork.

.2 Do not remove forms and falsework until concrete has gained sufficient strength to carry its own weight, plus construction loads and design loads which are liable to be imposed or 75 percent of design compressive strength, whichever is greater. Verify strength of concrete by compression tests.

.3 Remove falsework progressively, in accordance with regulatory requirements and ensure that no shock loads or imbalanced loads are imposed on structure.

.4 Loosen forms carefully without damaging concrete surfaces. Do not apply tools to exposed concrete surfaces.

.5 Leave forms loosely in place for protection until curing requirements are complete.

END OF SECTION

CONCRETE REINFORCEMENT

1. GENERAL

1.1 Work Included

.1 Reinforcing steel bars for cast-in-place concrete, complete with tie wire

.2 Support chairs, bolsters, bar supports, spacers and tie wire for reinforcing

1.2 Quality Assurance

.1 Perform concrete reinforcing Work in accordance with CAN/CSA-A23.1-00.

1.3 Inspection and Testing

.1 If requested by Contract Administrator, submit three (3) certified copies of mill test report of reinforcement supplied, indicating physical and chemical analysis.

1.4 Shop Drawings

.1 Submit bar lists and placing Drawings in accordance with Section 01300.

.2 Clearly indicate bar sizes, spacings, locations, and quantities of reinforcing steel, bending and cutting schedules, and supporting and spacing devices.

.3 Drawings and details shall conform to CAN/CSA-A23.1-00, CAN/CSA-A23.3, and RSIC Reinforcing Steel Manual of Standard Practice.

.4 Detail placement of reinforcing where special conditions occur.

.5 Detail lap lengths and bar development lengths to CAN/CSA-A23.1-00, unless otherwise shown on the Drawings.

1.5 Delivery and Storage

.1 Deliver, handle, and store reinforcement in a manner to prevent damage and contamination.

.2 Deliver bars in bundles, clearly identified in relation to bar lists.

2. PRODUCTS

2.1 Reinforcing Materials

.1 Reinforcing steel: minimum 400 MPa yield grade; deformed billet steel bars conforming to CAN/CSA-G30.18; plain finish.

2.2 Accessory Materials

.1 Tie wire: minimum 1.6 mm annealed type, or patented system accepted by Contract Administrator.

.2 Chairs, bolsters, bar supports, spacers: adequately sized for strength and support of reinforcing steel during construction.

.3 Bar chairs for exposed surfaces: to be non-corrosive PVC chairs or concrete chairs purpose made. Steel bar chairs, galvanized bar chairs, concrete bricks, broken concrete blocks, or wood supports are not acceptable.

.4 Bar chairs for non-exposed surfaces: concrete bricks are acceptable for support of bottom layer of bars for slabs on fill. Broken concrete blocks, stones, and wood supports are not acceptable.

3. EXECUTION

3.1 Examination

.1 Before starting this Work, examine work done by others which affects this Work.

.2 Notify the Contract Administrator of any conditions which would prejudice proper completion of this Work.

.3 Commencement of Work implies acceptance of existing conditions.

3.2 Fabrication

.1 Fabricate reinforcing steel in accordance with CAN/CSA-A23.1-00 and Drawings.

.2 Locate reinforcing splices not indicated on Drawings at points of minimum stress.

.3 Fabricate within the following tolerances:

.1 Sheared length: plus 0, minus 25 mm

.2 Stirrups, ties, and spirals: plus 0, minus 10 mm

.3 Other bends: plus 0, minus 25 mm

.4 All bending shall be done cold with a suitable machine accurately producing all lengths, depths, and radii shown on the bending details.

.5 After initial fabrication, reinforcing steel shall not be rebent or straightened unless so indicated on the Drawings.

.6 Heating of reinforcing steel will not be permitted.

3.3 Installation

.1 Place reinforcing steel in accordance with reviewed placing Shop Drawings and CAN/CSA-A23.1-00. Chair slab reinforcing shall not be further apart than 1200 mm in either direction. Tie reinforcing steel at maximum 600 mm spacing.

.2 Adequately support reinforcing and secure against displacement within tolerances permitted.

.3 Place reinforcing steel to provide concrete cover required by CAN/CSA-A23.1-00, but not less than shown below or noted otherwise on the Drawings:

.1 Beam stirrups: 40 mm; main steel: 50 mm

.2 Slabs (top and bottom): 50 mm

.3 Column ties: 40 mm; main steel: 50 mm

.4 Walls: 50 mm

.5 Concrete formed against earth (including bottom of slab on grade): 75 mm

.4 Maintain alignment tolerances as follows:

.1 Slabs: plus or minus 5 mm

.2 Other structural members: plus or minus 10 mm

.3 Rebar bends and ends: plus or minus 50 mm

.5 Do not disturb or damage vapour barrier or void form while placing reinforcing steel.

.6 Install purpose made highly visible protective safety caps on all exposed projecting bar ends.

3.4 Safety Protection for Reinforcing Ends

.1 Highly visible protection safety caps shall be installed for all reinforcing ends immediately following placement of bars.

.2 The protection caps shall be highly visible and shall be made secure so that accidental contact will not easily dislodge the caps. Dislodged caps shall be re-installed immediately.

3.5 Cleaning

.1 Ensure concrete reinforcing is clean and free from oil and deleterious matter.

.2 Remove all loose scale, loose rust, concrete from prior pours, and other deleterious matter from surfaces of reinforcing.

END OF SECTION

CONCRETE ACCESSORIES

1. GENERAL

1.1 Work Included

.1 Joint sealants

.2 PVC waterstop

.3 Non-ferrous grout

.4 Latex patching agent

.5 Curing compound

.6 Moisture retention film

.7 Fasteners

2. PRODUCTS

2.1 Materials

.1 Curing and sealing compounds: Master Builders Masterseal, Sika Florseal, or accepted alternate

.2 Joint sealants: non-staining, non-sagging, grey two-part polysulphide liquid polymer base or a two-part polyurethane base such as Sikaflex 2c NS/SL or Vulkem 245 for horizontal and vertical joints with compatible primer as per sealant Manufacturer's requirements. For water retaining areas the joint sealant shall be suitable for submerged service.

.3 PVC Waterstop: to conform to CGSB 41-6P-35M polyvinyl chloride, size indicated on Drawings, edges wire looped for tying. Acceptable product is Wirestop CR-9380 by Paul Murphy. PVC waterstop joints (tees, crosses, and ells) shall be factory fabricated and tested.

.4 Non-ferrous grout: pre-mixed, non-shrink, Master Builders 713, Sika M-Bed, CPD Non-Shrink Grout, Steel C1 Grout, minimum 35 MPa compressive strength

.5 Latex patching agent: Daraweld-C Latex Bonding Agent, or accepted alternate

.6 Curing compound: conforming to ASTM C309

.7 Moisture retention film: Master Builders Confilm or accepted alternate

.8 Pre-moulded expansion joint filler (for joints associated with slabs on grade such as pads at doors): asphalt impregnated vegetable or cane fibreboard, conforming to ASTM D1751, sizes indicated on Drawings, such as W. R. Meadows Sealtight Fibre Expansion Joint, and Sika Flexcell

.9 Fasteners: fasteners (all nuts, bolts, washers, screws, etc.) stainless steel for all aluminum items, conforming to ASTM 304 or 316, sizes and locations as required by item Manufacturer

3. EXECUTION

3.1 Installation

.1 Coordinate Work of this Section with other construction.

.2 Install all concrete accessories in accordance with Drawings and Manufacturer's recommendations and ensure compatibility. Install straight, level, and plumb.

.3 Ensure items are not disturbed during concrete placement.

.4 Curing and sealing compounds are to be used for curing purposes of all concrete where practical or compatible with finishes.

.5 Joint sealant shall be applied per Manufacturer’s instructions. If joint surfaces are damp, dry the surfaces and apply primer as recommended by Manufacturer. Apply polyethylene debonding tape as indicated on the Drawings.

.6 Joint filler: install joint filler in expansion joints as indicated on Drawings

.7 PVC Waterstop

.1 Install PVC waterstop in joints as indicated on Drawings.

.2 All waterstop joints other than straight butt joints shall be factory fabricated by the waterstop supplier. All field splices to be heat-fused and tested for complete seals by use of a corona discharge unit, costs for testing to paid for by Contractor.

.3 Install waterstop continuous without displacing reinforcement. Butt weld splices to Manufacturer’s directions. Secure in place to prevent dislodgment during placing of concrete.

.4 Take particular care to correctly position the waterstop during installation. Tie the waterstop adequately for support in accordance with manufacturer’s instructions, but at spacings no greater than 300 mm to ensure proper embedment, symmetrical about the joint, and to prevent displacement during concrete placement. Fully compact the concrete in the region of the waterstop during the placing of the concrete.

.5 Do not place concrete until waterstop has been reviewed by the Contract Administrator.

.8 Latex patching agent is to be used for patching formed concrete surfaces where required.

END OF SECTION

CAST-IN-PLACE CONCRETE

1. GENERAL

1.1 Work Included

.1 All plain and reinforced cast-in-place concrete shown on the Drawings

.2 Setting anchors, inserts, frames, sleeves, and other items supplied by other Sections

.3 Repairing concrete imperfections

.4 Finishing formed concrete surfaces

.5 Finishing slab surfaces

.6 Curing of concrete

1.2 Quality Assurance

.1 Cast-in-place concrete to conform to CAN/CSA-A23.1-00.

.2 Testing shall conform to CAN/CSA-A23.2-00.

.3 These standards shall be available in the Contractor's Site office for the use of the Contractor, sub-trades, and Contract Administrator.

1.3 Qualification

.1 Concrete flatwork finishing is to be done by an established firm having at least five (5) years of proven, satisfactory experience in this trade and employing skilled personnel.

.2 Submit proof of qualifications in writing to the Contract Administrator.

1.4 Inspection & Testing

.1 Notify the Contract Administrator at least forty-eight (48) hours before complete formwork and concrete reinforcement is ready for review. Reinforcing in walls shall be reviewed prior to closing forms.

.2 Allow ample time for notification, review, and corrective Work, if required, before scheduling concrete placement.

.3 Concrete sampling, inspection, and testing is to be performed by a CSA certified inspection and testing firm appointed and paid for by the City.

.4 Provide unencumbered access to all portions of Work and cooperate with appointed firm.

.5 Submit proposed mix design of each class of concrete to the Contract Administrator for review two (2) weeks prior to commencement of the Work.

.6 Tests of cement and aggregates may be performed to ensure conformance with requirements stated herein.

.7 Notify the Contract Administrator at least forty-eight (48) hours in advance of any concrete placement.

.8 Three (3) concrete test cylinders will be taken for every 50 or less cubic meters of each class of concrete placed.

.9 At least three (3) test cylinders will be taken daily for each class of concrete placed.

.10 One (1) slump test and one (1) air content test will be taken for each set of test cylinders taken.

.11 Additional slump and air content tests may be taken as necessary to verify quality of concrete.

.12 Testing of concrete will be performed in accordance with CAN/CSA-A23.2-00. Test results will be issued to the Contractor, the Contract Administrator, and the City.

.13 The Contractor is to pay costs for required retesting due to defective materials or workmanship.

.14 If accepted by the Contract Administrator, the Contractor may arrange and pay for additional tests for use as evidence to expedite construction.

.15 Strength requirements:

.1 To conform to the strength requirements of this Specification, the results of tests performed on laboratory cured cylinders for each class of concrete shall meet the requirements of Clause 17.6 of CAN/CSA-A23.1-00.

.2 If the strength requirements are not met the Contract Administrator shall have the right to require one or more of the following, all costs of which will be the responsibility of the Contractor:

.1 Changes in the mix proportions of the remainder of the Work.

.2 Additional curing on those portions of the structure represented by the test specimens that failed and cores drilled and tested in accordance with CAN/CSA-A23.2-00; the strengths shall be indicative of the strength of the in-place concrete.

.3 Load testing of the structural elements.

.3 After the completion of the testing procedure, if the Contract Administrator is not satisfied with the indicated quality of the concrete in the structure, the Contractor may be required to strengthen or replace those portions which the Contract Administrator deems to be unsatisfactory.

2. PRODUCTS

2.1 Concrete Materials

.1 Cement: Normal Type 10 and Type 50 Portland Cement conforming to CSA-A5.

.2 Fine aggregate: conforming to Normal Density Fine Aggregate, CAN/CSA-23.1-00. If requested by the Contract Administrator, submit evidence at least two (2) weeks before use in concrete mix showing conformance to normal Density Fine Aggregate, CAN/CSA-A23.1-00, Table 4 and Table 6.

.3 Coarse aggregate: conforming to Normal Density Coarse Aggregate, CAN/CSA-23.1-00, Group I, 20-5 mm and 10 to 2.5 mm. If requested by the Contract Administrator, submit evidence at least two (2) weeks before use in concrete mix showing conformance to normal Density Coarse Aggregate, CAN/CSA-A23.1-00, Table 5 and Table 6.

.4 Ensure that no aggregates are used that may undergo volume change due to alkali reactivity, moisture retention, or other causes. Confirm suitability of aggregate with a petrographic analysis if requested by the Contract Administrator.

.5 Water: potable, clean, and free from injurious amounts of oil, alkali, organic matter, or other deleterious matter

.6 Materials are to be obtained from the same source of supply or Manufacturer for the duration of the project.

.7 Pozzolans: Type C fly ash, conforming to CSA-A23.5, source of material to be acceptable to the Contract Administrator

2.2 Admixtures

.1 Air entrainment: conforming to ASTM Standard C260

.2 Chemical admixtures: conforming to ASTM Standard C494

.3 Calcium chloride or admixtures containing calcium chloride shall not be used in concrete.

2.3 Concrete Mixes

.1 Pay all costs for mix design. Submit mix design to the Contract Administrator for review a minimum of two (2) weeks prior to concrete pour.

.2 Provide concrete mixed in accordance with requirements of CAN/CSA-A23.1-00 and Table A (see below at end of this Section). Table A requirements shall govern where there is a difference between Table A and CAN/CSA-A23.1-00, Tables 6 to 10 requirements.

.3 Maximum allowable substitution of cement with fly ash material shall be 20 percent by weight when acceptable to the Contract Administrator.

.4 Use accelerating admixtures in cold weather only when accepted by the Contract Administrator. If accepted, the use of admixtures will not relax cold weather placement requirements. Do not use calcium chloride.

.5 Use set-retarding admixtures during hot weather only when accepted by the Contract Administrator.

.6 All admixtures must be compatible within the mix. Concrete with freezing and thawing exposure must satisfy the durability requirements of CAN/CSA-A23.1-00, Sections 14 and 15.

.7 All admixtures are subject to acceptance by the Contract Administrator. List all proposed admixtures in mix design submission. Do not change or add admixtures to accepted design mixes without the Contract Administrator's acceptance.

.8 The water: cementing material ratio must be calculated and shown based on all available mixing water excluding aggregate absorption.

.9 Concrete delivered to Site must be accompanied by a delivery slip indicating time of completion of mixing, design strength of concrete, air content, and actual water-cement ratio.

3. EXECUTION

3.1 Examination

.1 Before starting this Work examine work done by others which affects this Work.

.2 Notify the Contract Administrator of any conditions that would prejudice proper completion of this Work.

.3 Commencement of Work implies acceptance of existing conditions.

3.2 Placing Concrete

.1 Place concrete in accordance with requirements of CAN/CSA-A23.1-00 and as indicated on the Drawings. Layout and accuracy of the Work is the Contractor's sole responsibility.

.2 Notify the Contract Administrator a minimum of forty-eight (48) hours prior to pouring concrete. Under no circumstances pour concrete without notifying Contract Administrator, or in his absence, arranging for review of the Work and sampling of concrete.

.3 The concrete shall be placed rapidly and evenly as near to its final position as possible to reduce the risk of segregation, flowlines, and cold joints. Concrete shall be placed within 1.5 hours of mixing.

.4 Ensure all anchor bolts, seats, plates, and other items to be cast into concrete are securely placed and will not interfere with concrete placement.

.5 Before placing concrete all equipment for transporting the concrete shall be cleaned of hardened concrete and foreign materials.

.6 Immediately before concrete is placed, the Contractor shall carefully inspect all forms to ensure that they are properly placed, sufficiently rigid and tight, and that embedded parts are in the correct position and secured against movement during the placing operation. All reinforcing steel and forms shall be thoroughly cleaned of hardened concrete and other foreign materials.

.7 Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods, which will prevent the separation or loss of the ingredients. Concrete shall be deposited in the forms as nearly as practicable in its final position to avoid re-handling or flowing. Vibrators shall not be used to move concrete. Under no circumstances shall the concrete, which has partially hardened, be deposited in the forms.

.8 Concrete shall be thoroughly compacted by mechanical vibrators during placing operations. It shall be thoroughly worked around the reinforcement, embedded fixtures, and into the corners of the forms.

.9 Vibrate concrete using the appropriate size equipment as placing proceeds, in accordance with CAN/CSA-A23.1-00. Check frequency and amplitude of vibrations prior to use. Provide additional standby vibrators in the event of equipment failure.

.10 Prepare set or existing concrete by removing all laitance and loose or unsound materials and apply bonding agent in accordance with Manufacturer's recommendations.

.11 Where placing operations would involve dropping the concrete more than 1500 mm, it shall be placed through canvas hoses or galvanized steel chutes. Concrete shall not be raised at a rate greater than that for which proper vibration may be achieved.

.12 In locations where new concrete is dowelled to existing concrete, drill holes in existing concrete, insert steel dowels, and pack solidly with non-shrink grout.

.13 A minimum of three (3) days shall elapse between adjacent pours separated by construction joints or expansion joints.

.14 Do not place concrete if carbon dioxide producing equipment has been in operation in the building during the twelve (12) hours preceding the pour. This equipment shall not be used during placing or for twenty-four (24) hours after placing. During placing and curing concrete, surfaces shall be protected by formwork or an impermeable membrane from direct exposure to carbon dioxide, combustion gases, or drying from heaters.

.15 Honeycomb or embedded debris is not acceptable.

.16 Remove and replace defective concrete.

.17 Maintain accurate records of cast-in-place concrete items.

3.3 Cold Weather Concreting

.1 The requirements of this section shall be applied to all concreting operations during cold weather, i.e., if the mean daily temperature falls below 5°C during placing or curing.

.2 Supplementary equipment as required below shall be at the Site if concrete is likely to be placed in cold weather.

.3 Formwork and reinforcing steel shall be heated to at least 5°C before concrete is placed.

.4 The temperature of the concrete shall be maintained at not less than 10°C for seven (7) days. The concrete shall be kept above freezing temperature for at least a period of seven (7) days from the time of placement. In no case, shall the heating be removed until the concrete has reached a minimum compressive strength which will be specified by the Contract Administrator as determined from compressive strength tests on specimens cured under the same conditions as the concrete Works in question.

.5 Aggregates shall be heated to a temperature of not less that 20°C and not more than 65°C. Water shall be heated to a temperature between 55°C and 65°C. The temperature of the concrete at the time of placing in the forms shall be within the range specified in CAN/CSA-A23.1-00 for the thickness of the section being placed.

.6 When the mean daily temperature may fall below 5°C, a complete housing of the Work, together with supplementary heat, shall be provided.

.7 Combustion-type heaters may be used if their exhaust gases are vented outside the enclosures and not allowed to come into contact with concrete surfaces. Fire extinguishers must be readily at hand wherever combustion-type heaters are used.

.8 When the ambient temperature is below minus 15°C, the housing shall be constructed so as to allow the concrete to be placed without the housing having to be opened. If the mixing is done outside of the housing, the concrete shall be placed by means of hoppers installed through the housing. The hoppers are to be plugged when not in use.

.9 When the ambient temperature is equal to or above minus 15°C, the Contractor will be permitted to open small portions of the housing for a limited time to facilitate the placing of the concrete.

.10 Refer to Section 01500 for temporary enclosure and heating requirements.

.11 Before depositing any of the concrete, the Contractor shall show that enough heating equipment is available to keep the air temperature surrounding the forms within the specified range. This shall be accomplished by bringing the temperature inside of the housing to the specified 20°C at least twelve (12) hours prior to the start of the concrete placing.

.12 The Contractor shall supply all required heating apparatus and the necessary fuel. When dry heat is used, a means of maintaining atmospheric moisture shall be provided.

.13 Sufficient standby heating equipment must be available to allow for any sudden drop in outside temperatures and any breakdowns which may occur in the equipment.

.14 The Contractor shall keep a curing record of each concrete pour. The curing record shall include date and location of the pour, mean daily temperature, temperatures above and below the concrete within the enclosures, temperatures of the concrete surface at several points, and notes regarding the type of heating, enclosure, unusual weather conditions, etc. This record shall be available for review by the Contract Administrator at all times, and shall be turned over to the Contract Administrator at the end of the concreting operations.

3.4 Hot Weather Concreting

.1 General

.1 The requirements of this Section shall be applied during hot weather, i.e., air temperatures above 25°C during placing.

.2 Concrete shall be placed at as low a temperature as possible, preferably below 15°C, but not above 27°C. Aggregate stockpiles may be cooled by water sprays and sun shades.

.3 Ice may be substituted for a portion of the mixing water provided the ice has melted by the time mixing is completed.

.4 Form and conveying equipment shall be kept as cool as possible before concreting by shading them from the sun, painting their surfaces white, and/or the use of water sprays.

.5 Sun shades and wind breaks shall be used as required during placing and finishing.

.6 Work shall be planned so that concrete can be placed as quickly as possible to avoid “cold joints”.

.7 The Contract Administrator’s acceptance is necessary before the Contractor may use admixtures such as retardants to delay setting, or water-reducing agents to maintain workability and strength, and these are to be included in the mix designs submitted to the Contract Administrator.

.8 Curing shall follow immediately after the finishing operation.

.2 Hot-weather curing

.1 When the air temperature is at or above 25°C, curing shall be accomplished by water or by using saturated absorptive fabric, in order to achieve cooling by evaporation. Mass concrete shall be water cured for the basic curing period when the air temperature is at or above 20°C, in order to minimize the temperature rise of the concrete.

.3 Job preparation

.1 When the air temperature is at or above 25°C, or when there is the probability of it rising to 25°C during the placing period, facilities shall be provided for protection of the

concrete in place from the effects of hot and/or drying weather conditions. Under severe drying conditions, as defined in Clause 3.4.5.2 of this Specification Section, the formwork, reinforcement, and concreting equipment shall be protected from the direct rays of the sun or cooled by fogging and evaporation.

.4 Concrete temperature

.1 The temperature of the concrete as placed shall be as low as practicable and in no case greater than indicated below for the indicated size of the concrete section.

.1 Section thickness less than 300 mm: 10°C min, 27°C max

.2 Section thickness 300 mm to 1000 mm: 10°C min, 27°C max

.3 Section thickness greater than 1000 mm: 5°C min, 25°C max

.5 Protection from drying

.1 Moderate drying conditions

.1 When surface moisture evaporation exceeds 0.75 $kg/m^2/h$, windbreaks shall be erected around the sides of the structural element.

.2 Severe drying conditions

.1 When surface moisture evaporation exceeds 1.0 $kg/m^2/h$, additional measure shall be taken to prevent rapid loss of moisture from the surface of the concrete. Such additional measures shall consist of the following:

.1 Erecting sunshades over the concrete during finishing and placing operations

.2 Lowering the concrete temperature

.3 Increasing humidity by applying fog spray immediately after placement and before finishing

.4 Care shall be taken to prevent accumulation of water that may reduce the quality of the cement paste.

.5 Beginning the concrete curing immediately after trowelling

.3 Surface moisture evaporation rate

.1 The monograph, Figure D1, Appendix D of CAN/CSA-A23.1-00 shall be used to estimate surface moisture evaporation rates.

3.5 Concrete Protection for Reinforcement

.1 Ensure reinforcement is placed to provide specified concrete cover in accordance with Section 03200.

3.6 Construction Tolerance

.1 The Work shall be carefully and accurately set out; true to the positioning, levels, slopes, and dimensions shown on the Drawings and conforming to Sections 03100 and 03200.

.1 Sizes of member or thickness of slabs: +6 mm - 0 mm

.2 Cover of concrete over reinforcement: ±3 mm

.3 Variations from plumb: 6 mm in 3.0 m, 10 mm maximum

.4 Variations from flat: 3 mm in 3.0 m, 6 mm maximum

.2 If these tolerances are exceeded the Contractor may, at the discretion of the Contract Administrator, be required to remove and replace or to modify the placed concrete before acceptance. The costs incurred by the Contract Administrator for such investigation, testing, or review of reconstruction and the cost of reconstruction shall be borne by the Contractor.

3.7 Finishing Slab Surfaces

.1 Finish all slab surfaces conforming to CAN/CSA-A23.1-00, Clause 22 and as specified below.

.2 Bull floating

.1 Flatness for suspended concrete slabs to be achieved by means of hiway straight edge (minimum 3 m width) in lieu of standard bull float. Immediately after screeding, bull float floor surfaces to remove ridges and fill voids.

.2 Complete bull floating before any excess moisture or bleed water is visible on surface.

.3 Mechanical floating

.1 Mechanical float floor surfaces when bleed water has disappeared and surfaces are sufficiently hard to prevent working excess mortar to surface.

.2 Continue floating as necessary to produce surfaces of uniform texture, free from hollows, bumps, and screed marks.

.3 For surfaces to be trowelled, continue floating as necessary to embed coarse aggregate particles firmly below surface mortar.

.4 Hand float in restricted areas, corners, etc.

.4 Trowelling

.1 Trowel floor surfaces with mechanical trowelling machines fitted with steel blades.

.2 Commence trowelling when surfaces are sufficiently hard to prevent working excess fine material to surface.

.3 Perform additional trowelling at intervals so final trowelling is done just before concrete becomes so hard that further trowelling is ineffective.

.4 Finish trowelled surfaces to be hard, dense, and free from blemishes and other imperfections.

.5 Hand trowel in restricted areas, corners, around cast-in items, etc.

.6 Cure concrete as specified.

.7 Protect all floors from damage during construction.

.5 Preparation of Surfaces to Receive Specialty Coatings

.1 Refer to Section 09912 for surface preparation for specialty chemical resistant floor coating for secondary containment floor surface; application shall be performed only after watertightness testing has been accepted.

3.8 Curing and Protection

.1 Cure and protect freshly placed concrete in accordance with Clause 21 of CAN/CSA-A23.1-00.

.2 All concrete shall receive moist curing for a period of at least seven (7) days. One (1) of the following methods shall be used as soon as the concrete has hardened sufficiently to prevent marring:

.1 Surface covered with canvas or other satisfactory material and kept thoroughly wet.

.2 Surface sealed with polyethylene sheeting at least 0.15 mm thick and the concrete kept thoroughly wet.

.3 Subject to the acceptance of the Contract Administrator or as specified, a liquid, membrane forming, curing compound supplied at the rate recommended by the Manufacturer may be used. Curing compounds shall not be used on a surface where bond is required for the finishes.

.4 Surfaces of concrete that are protected by formwork left in place for seven (7) days, shall not require any additional curing (except as specified for hot weather). If the formwork is removed in less than seven (7) days, the concrete shall receive a moist curing as above or until seven (7) days have elapsed since the concrete was placed, whichever occurs first.

.3 No concrete placement will be allowed until all materials required for the curing phase are on Site and ready for use.

.4 At the end of the curing and protection period, the temperature of the concrete shall be reduced gradually at a rate not exceeding 10°C per day until the outside air temperature has been reached.

.5 Concrete that is allowed to freeze or attain insufficient curing conditions shall be subject to all necessary investigations and testing as deemed necessary by the Contract Administrator and all such concrete shall be removed and the portion reconstructed as directed by the Contract Administrator, at Contractor's cost.

3.9 Formed Concrete

.1 Allow the Contract Administrator to review concrete surfaces immediately upon removal of the forms.

.2 Any imperfect joints, voids, stone pockets, or other defective areas and tie holes, as specified, shall at once be patched before the concrete is thoroughly dry.

.3 Modify or replace concrete not conforming to qualities, lines, details, and elevations specified herein or indicated on the Drawings.

3.10 Finishing Formed Surfaces

.1 Interior formed concrete surfaces.

.1 Refer to Section 09912 for surface preparation for specialty chemical resistant wall coating for secondary containment wall surfaces; application shall be performed only after watertightness testing has been accepted.

.2 Finish exposed surfaces (other than specified for specialty chemical resistant surfaces) to Smooth Rubbed Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.7.2.

.2 Exterior formed concrete surfaces.

.1 Surfaces to receive insulation shall be finished to Smooth-Formed Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.6.

.2 Other surfaces shall be finished to Rough-Formed Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.5.

3.11 Patching

.1 Allow Contract Administrator to review concrete surfaces immediately upon removal of all formwork.

.2 Patch imperfections when concrete is green.

.3 Remove all exposed metal form ties, nails and wires, break off fins, and remove all loose concrete.

.4 Thoroughly wet all form tie holes and patch with patching mortar followed by proper curing.

.5 Chip away honeycombed and other defective surfaces to a depth of not less than 40 mm with the edges perpendicular to the surface. The area to be patched and a space at least 150 mm wide entirely surrounding it shall be wetted to prevent absorption of water from the patching mortar. Apply bonding agent to Manufacturer's instructions and patch with patching mortar followed by proper curing.

.6 The patch shall be made of the same material and of the same proportions as used for the concrete except that the coarse aggregate shall be omitted, and cement added to match the colour of the surrounding concrete. The amount of mixing water shall be as little as is consistent with the requirements.

3.12 Equipment Pads, Pipe Supports, and Cast in Items

.1 Provide concrete pads and supports for equipment and pipes where and as indicated on Drawings. Adjust dimensions to accepted equipment Shop Drawings.

.2 Insert bolts and sleeves and pack solidly with non-shrink grout, in accordance with setting details and templates.

.3 Steel trowel surface smooth. Chamfer exposed horizontal and vertical edges.

.4 Clean excess concrete from metal frames, inserts, weld plates, etc. Clean and tool concrete around the above noted items.

3.13 Grouting

.1 Grout all miscellaneous anchor bolts with non-ferrous or epoxy grout as specified using templates for accurate positioning.

.2 Grout between pipes and pipe supports as required to provide continuous support over the entire contact area.

.3 Grout under base plates and other items as required and shown on the Drawings.

.4 Grout dowels to existing concrete as indicated on the Drawings.

3.14 Defective Concrete

.1 Concrete not meeting the requirements of the Specifications and Drawings shall be considered defective concrete.

.2 Concrete not conforming to the lines, details, and grade specified herein or as shown on the Drawings shall be modified or replaced at the Contractor's expense. Finished lines,

dimensions, and surfaces shall be correct and true within tolerances specified herein and in the Section 03100.

.3 Concrete not properly placed resulting in honeycombing and other defects shall be repaired or replaced at the Contractor's expense.

.4 To conform to the strength requirements, the average of all tests shall exceed the specified strength. When three (3) or more tests of the same class of concrete are available, the average of any three (3) consecutive tests shall be equal to, or greater than the specified strength, and no strength test shall fall more than 3.5 MPa below the specified strength. If any of the criteria of the above clause are not met, the Contract Administrator shall have the right to require one or more of the following:

.1 Changes in mix proportions for the remainder of the Work

.2 Cores drilled and tested from the areas in question as directed by the Contract Administrator and in accordance with CAN/CSA-A23.2-00. The test results shall be indicative of the strength of the in-place concrete.

.3 Load testing of the structural elements.

.4 The changes in the mix proportions, cores drilled and tested, and load testing shall be at the Contractor's expense.

.5 Concrete failing to meet the strength requirements of this Specification shall be strengthened or replaced at the Contractor's expense.

3.15 Watertightness Testing

.1 The liquid retaining secondary containment in the Chemical Storage Building shall be watertight and all precautions shall be taken, especially joint treatment, to construct watertight structures.

.2 Notify the Contract Administrator at least two (2) working days before commencing the watertightness test.

.3 The watertightness test shall be performed prior to the application of the coating for the containment area.

.4 The structure, when filled to 1000 mm above expected containment level, shall be reviewed over a forty-eight (48) hour period for leakage including monitoring of visible leaks and testing for leaks by measurement.

.5 Filling the structures in preparation of the watertightness test shall be performed only after the wall and floor concrete have attained 100 percent of the design strength. Fill the structure with clean water forty-eight (48) hours prior to the watertightness test to allow for full saturation of the concrete.

.6 All water used for testing and re-testing shall be supplied as described in Section 01500.

.7 The Contractor shall measure leakage during next forty-eight (48) hour period. The measurements shall be witnessed by the Contract Administrator. With the water at maximum operating level for forty-eight (48) hours, there shall be no visible moisture or wetness on areas that will be seen or backfilled and the leakage measured over a period of twenty-four (24) hours shall not exceed 0.10 percent of the water volume in the test period.

.8 Locate and repair all leaks until all leakage is remedied and repeat the forty-eight (48) hour watertightness test following each repair operation, at no additional cost to the City.

.9 All water used for testing and re-testing shall be supplied as described in Section 01500. Disposal of the water for all tests shall be at the Contractor's expense.

3.16 Clean-Up

.1 As Work progresses and at the completion of Work, remove from Site all debris, excess materials, and equipment.

Table A

Mix Type	Portion of Structure	Min. Compressive Strength @ 28 Days (MPa)	Cement Type	Min. Cement Content (kg/m^3)	Max. Water Cementing Material Ratio	Nominal Aggregate Size (mm)	Slump (mm) Max./ Min.	Air Content (%)
1.	Liquid retaining structural concrete – slabs and walls	35	50	335	0.42	20 to 5	65 ± 25	5 to 8
2.	Non-water retaining structural concrete in contact with soil or exposed to weather – grade beams, exterior pads	32	50	--	0.45	20 to 5	80 ± 30	4 to 7
3.	Interior structural concrete – slabs-on-grade, concrete lintel for overhead door	30	10	--	0.55	20 to 5	80 ± 30	--
4.	Miscellaneous concrete – curbs, equipment bases, pipe supports	25	10	--	0.55	20 to 5	80 ± 30	--
5.	Masonry fill concrete	20	10	--	--	10 to 2.5	150 ± 30	--
6.	Lean mix concrete	10	50	--	--	Max. 40	--	--

END OF SECTION

MASONRY PROCEDURES

1. GENERAL

1.1 Work Included

.1 Masonry Work is described in other Sections of Division 4.

1.2 References

.1 CSA A179 Mortar and Grout for Unit Masonry

.2 CSA 3-A371 Masonry Construction for Buildings

1.3 Source Quality Control

.1 Submit laboratory test reports in accordance with Section 01300.

.2 Submit laboratory test reports certifying compliance of masonry units and mortar ingredients with Specification requirements.

1.4 Samples

.1 If requested by the Contract Administrator, submit samples in accordance with Section 01300.

.2 Submit samples:

.1 Two (2) of each type of masonry unit specified

.2 One (1) of each type of masonry accessory specified

.3 One (1) of each type of masonry reinforcement and tie proposed for use

.4 As required for testing purposes

1.5 Product Delivery, Storage, and Handling

.1 Deliver materials to job Site in dry condition.

.2 Keep materials dry until use, except where wetting of bricks is specified.

.3 Store under waterproof cover on pallets or plank platforms held off ground by means of plank or timber skids.

1.6 Cold Weather Requirements

.1 Supplement Clause 5.15 of CSA A371 with the following requirements:

.1 Maintain temperature of mortar between 5ºC and 50ºC until batch is used.

1.7 Hot Weather Requirements

.1 Protect freshly laid masonry from drying too rapidly, by means of waterproof, non-staining coverings.

1.8 Protection

.1 Keep masonry dry using waterproof, non-staining coverings that extend over walls and down sides sufficient to protect walls from wind driven rain, until masonry Work is completed and protected by flashings or other permanent construction.

.2 Protect masonry and other Work from marking and other damage. Protect completed Work from mortar droppings. Use non-staining coverings.

.3 Provide temporary bracing of masonry Work during and after erection until permanent lateral support is in place.

2. PRODUCTS

2.1 Materials

.1 Masonry materials are specified in other Sections of Division 4.

3. EXECUTION

3.1 Workmanship

.1 Do masonry Work in accordance with CSA A371 except where specified otherwise.

.2 Build masonry plumb, level, and true to line, with vertical joints in alignment.

.3 Layout coursing and bond to achieve correct coursing heights, and continuity of bond above and below openings, with minimum of cutting.

3.2 Tolerances

.1 Tolerances in notes to Clause 5.3 of CSA A371 apply.

3.3 Exposed Masonry

.1 Remove chipped, cracked, and otherwise damaged units in exposed masonry and replace with undamaged units.

3.4 Jointing

.1 Allow joints to set just enough to remove excess water, and then tool with round joints to provide smooth, compressed, uniformly concave joints where concave joints are indicated.

.2 Strike flush all joints concealed in walls and joints in walls to receive plaster, tile, insulation, or other applied material except paint or similar thin finish coating.

3.5 Cutting

.1 Cut out neatly for electrical switches, outlet boxes, and other recessed or built-in objects.

.2 Make cuts straight, clean, and free from uneven edges.

3.6 Building-in

.1 Build in items required to be built into masonry.

.2 Prevent displacement of built-in items during construction. Check plumb, location, and alignment frequently, as Work progresses.

.3 Brace door jambs to maintain plumb. Fill spaces between jambs and masonry with mortar.

3.7 Parging

.1 Use parging mortar specified in Section 04100.

.2 Apply parging mortar where indicated in uniform coating not less than 10 mm thick.

3.8 Support of Loads

.1 Use concrete to Section 03300, where concrete fill is used in lieu of solid units, such as vertical cores, bond beams, and lintels.

.2 Install building paper below voids to be filled with concrete or grout; keep paper 25 mm back from faces of units.

3.9 Provision for Movement

.1 Leave a minimum of 40 mm space or as indicated on the Drawings, between top of non-load bearing walls and partitions and structural elements. Do not use wedges.

.2 Build masonry to tie-in with stabilizers, with provision for vertical movement.

3.10 Control Joints

.1 Construct continuous control joints as indicated on the Drawings.

3.11 Expansion Joints

.1 Build-in continuous expansion joints as indicated.

3.12 Field Quality Control

.1 Inspection and testing will be carried out by a testing laboratory designated by the Contract Administrator.

.2 The City will pay costs for testing.

.3 Costs for additional testing required as a result of defective materials will be the responsibility of the Contractor.

END OF SECTION

MORTAR AND GROUT FOR MASONRY

1. GENERAL

1.1 Work Included

.1 Provide all materials and labour to perform the mortar and grout Work for all masonry walls indicated on the Drawings.

1.2 References

.1 CSA A179 Mortar and Grout for Unit Masonry.

1.3 Samples

.1 Submit samples in accordance with Section 01300.

2. PRODUCTS

2.1 Materials

.1 Mortar and grout: conforming to CSA A179

.2 Aggregate: conforming to CSA A82.56

.3 Water: clean, potable, free of injurious amounts of acids, alkalis, and organic material

.4 Masonry cement: conforming to CAN/CSA-A8, Type H

.5 Portland cement: conforming to CAN/CSA-A5, normal Type 10

.6 Hydrated lime: conforming to CSA A82.43

.7 Use aggregate passing 1.18 mm sieve where 6 mm thick joints are indicated.

.8 Dirt resistant additives: aluminum tristearate, calcium stearate, or ammonium stearate

2.2 Material Source

.1 Use same brands of materials and source of aggregate for entire project.

2.3 Mortar Types

.1 Mortar for all masonry:

.1 Type S based on Property Specifications

2.4 Grout

.1 Grout: to CSA A179, Table 3

2.5 Parging

.1 Parging mortar: Type S to CSA A179

3. EXECUTION

3.1 Mixing

.1 Do masonry mortar and grout Work in accordance with CSA A179 except where specified otherwise.

.2 Mix grout to semi-fluid consistency.

.3 Incorporate admixtures into mixes in accordance with Manufacturer's instructions.

.4 Comply with cold weather requirements specified in CSA A371 Masonry Construction for Buildings.

3.2 Testing

.1 Testing of mortar materials will be carried out by an inspection and testing firm designated by the Contract Administrator.

.2 The City will pay costs for tests.

.3 Costs for additional testing required as a result of defective materials will be the responsibility of the Contractor.

.4 Submit samples of all materials proposed for testing.

END OF SECTION

MASONRY REINFORCEMENT, CONNECTORS AND ACCESSORIES

1. GENERAL

1.1 Work Included

.1 Supply all material and labour for the incorporation of the masonry reinforcement and connectors into the Work of this Contract.

1.2 References

.1 CAN/CSA A23.1, Concrete Materials and Methods of Concrete Construction

.2 CSA A370, Connectors for Masonry

.3 CSA A371, Masonry Construction for Buildings

.4 CSA G30.3, Cold-Drawn Steel Wire for Concrete Reinforcement

.5 CAN/CSA G30.18, Billet-Steel Bars for Concrete Reinforcement

.6 CSA S304.1, Masonry Design for Buildings (Limit States Design)

.7 CSA W186, Welding of Reinforcing Bars in Reinforced Concrete Construction

1.3 Source Quality Control

.1 If requested by the Contract Administrator, submit certified copy of mill test report of reinforcement steel and connectors, showing physical and chemical analysis, minimum five (5) weeks prior to commencing reinforcement Work.

.2 Inform the Contract Administrator of proposed source of material to be supplied.

1.4 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01300.

.2 Shop Drawings shall consist of bar bending details, lists, and placing drawings.

.3 On placing Shop Drawings, indicate sizes, spacing, location, and quantities of reinforcement and connectors.

2. PRODUCTS

2.1 Materials

.1 Bar reinforcement: to CSA A371 and CAN/CSA-G30.18, Grade 400

.2 Wire reinforcement: to CSA A371 and CSA-G30.3, truss type

.3 Connectors: to CSA A370 and CSA S304.1

.4 Corrosion protection: to CSA S304.1, galvanized

.5 Masonry anchors: acceptable products by Hilti, Simpson Strong-Tie, and Ramset/Redhead

.6 Control joint filler: preformed rubber, neoprene, or polyvinyl chloride materials of size and shape indicated.

2.2 Fabrication

.1 Fabricate reinforcing in accordance with CSA A23.1.

.2 Fabricate connectors in accordance with CSA A370.

.3 Obtain the Contract Administrator's acceptance for locations of reinforcement splices other than shown on placing drawings.

.4 Subject to review by the Contract Administrator, weld reinforcement in accordance with CSA W186.

.5 Ship reinforcement and connectors, clearly identified in accordance with the Drawings.

3. EXECUTION

3.1 General

.1 Install masonry connectors and reinforcement in accordance with CSA A370, CSA A371, CAN/CSA-A23.1 and CSA S304.1 unless indicated otherwise.

.2 Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

.3 Prior to placing concrete and mortar, obtain Contract Administrator's acceptance of placement of reinforcement and connectors.

.4 Do additional reinforcement of masonry as indicated.

3.2 Bonding and Tying

.1 Bond walls of two (2) or more wythes using metal connectors in accordance with National Building Code, CSA S304.1, CSA A371, and as indicated.

.2 Tie masonry veneer to backing in accordance with National Building Code, CSA S304.1, CSA A371, and as indicated.

.3 Block shear connector by FERO to be installed as shown on the Drawings.

3.3 Reinforced Lintels and Bond Beams

.1 Reinforce masonry lintels and bond beams as indicated.

.2 Place and grout reinforcement in accordance with CSA S304.1.

3.4 Grouting

.1 Grout masonry in accordance with CSA S304 and as indicated.

3.5 Masonry Anchors

.1 Install metal anchors where indicated.

.2 If masonry anchors are not specified on the Drawings, review proposed anchor and application with the Contract Administrator prior to use.

3.6 Lateral Support and Anchorage

.1 Do lateral support and anchorage in accordance with CSA S304.1 and as indicated.

3.7 Control Joints

.1 Terminate reinforcement 25 mm short of each side of control joints unless otherwise indicated.

.2 Install continuous control joint fillers in control joints.

3.8 Field Bending

.1 Do not field bend reinforcement and connectors except where indicated or authorized by Contract Administrator.

.2 When field bending is authorized, bend without heat, applying a slow and steady pressure.

.3 Replace bars and connectors which develop cracks or splits.

3.9 Cleaning

.1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

CLAYBRICK MASONRY

1. GENERAL

1.1 Description of Work

.1 Extent of each type of masonry Work is indicated on Drawings and schedule.

.2 Types of masonry Work required include:

.1 Brick masonry

1.2 Quality Assurance

.1 Appearance and blend characteristics: provide face brick type to match existing face brick on main building as closely as reasonable in colour type, colour range and blend percentage.

.2 Single source responsibility for masonry units: obtain masonry units from one Manufacturer.

.3 Single source responsibility for mortar materials: obtain mortar ingredients of uniform quality including colour for exposed masonry, from one Manufacturer for each cementitious component and from one source and producer for each aggregate.

.4 Field constructed mock-ups: prior to installation of masonry Work, erect sample wall panels to further verify selections made for colour and texture characteristics, under sample submittals of masonry units and mortar, and to represent completed masonry Work for qualities of appearance, materials, construction and workmanship.

.5 Build mock-ups for the following types of masonry in sizes approximately 1800 mm long by 1220 mm high, by full thickness.

.1 Typical exterior face brick wall

1.3 Submittals

.1 Product Data: submit Manufacturer’s Product Data for each type of masonry unit, accessory and other manufactured Products.

.2 Compliance: submit certifications that each type of masonry unit complies with specified requirements.

.3 Colour selection: for initial selection submit:

.1 Unit masonry samples showing full extent of colours and textures available for each type of exposed masonry unit required.

.2 Coloured mortar samples showing full extent of colours available.

.4 Samples: for verification purposes submit:

.1 Unit masonry samples for each type of exposed masonry unit include full range of colour and texture to be expected in completed Work.

.2 For selection of brick, submit products of all Manufacturers that the Manufacturers or their agents consider to be their closest match. Re-submit until match meets approval of Architect.

.3 Coloured masonry mortar samples for each colour required showing the full range of colour which can be expected in the finished Work. Label samples to indicate type and amount of colorant used.

1.4 Referenced Standards

.1 Comply with the applicable provisions of all codes, standards and Specifications referenced in this Section, except as modified by the requirements of these Contract Documents, including, but not limited to the following:

.1 ACI 531 - Building Code Requirements for Masonry Structures

.2 ACI 531R - Commentary on Building Code Requirements for Masonry Structures

.3 ACI 530.1 - Specification for Masonry Construction

.4 ASTM C-129 - Non-Load Bearing Masonry Units

.5 BIA - Technical Notes on Brick Construction

.6 NCMA - TEK Bulletins

1.5 Delivery, Storage, and Handling

.1 Deliver masonry materials to project in undamaged condition. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, or other causes.

.2 Limit moisture absorption of concrete masonry units during delivery and until time of installation to the maximum percentage specified for Type I units for the average annual relative humidity as reported nearest project Site.

.3 Store cementitious materials off the ground, under cover and in a dry location.

.4 Store and protect aggregates where grading and other required characteristics can be maintained.

.5 Store masonry accessories including metal items to prevent deterioration by corrosion and accumulation of dirt.

1.6 Project Conditions

.1 Protection of Work: during erection, cover top of walls with waterproof sheeting at end of each day's Work. Cover partially completed structures when Work is not in progress.

.1 Extend cover a minimum 600 mm down both sides and hold cover securely in place.

.2 Do not apply uniform floor or roof loading for at least twelve (12) hours after building masonry walls or columns.

.3 Staining: prevent grout, mortar or soil from staining the face of masonry to be left exposed or painted. Remove grout or mortar in contact with such masonry immediately.

.4 Do not apply concentrated loads for at least three (3) days after building masonry walls or columns.

.5 Protect base of walls from rain-splashed much and/or mortar splatter by means of coverings spread on ground and over wall surfaces.

.6 Protect sills, ledges, and projections from droppings or mortar.

.7 Cold Weather Protection:

.1 Do not lay masonry units that are wet or frozen.

.2 Remove any ice or snow formed on masonry bed by carefully applying heat until top surface is dry to the touch.

.3 Remove masonry damaged by freezing conditions.

.4 For clay masonry units with initial rates of absorption which require them to be wetted before laying, comply with the following:

.1 For units with surface temperature above 0°C, wet with water heated to above 21°C.

.2 For units with surface temperature below 0°C, wet with water heated to above 54°C.

.8 Perform the following construction procedures while masonry Work is progressing. Temperature ranges indicated below apply to air temperature existing at time of installation, except for grout:

.1 For grout: temperature ranges apply to anticipated minimum night temperatures. In heating mortar and grout materials, maintain mixing temperature selected within 5.5°C.

.2 5°C to 0°C.

.1 Mortar: heat mixing water to produce mortar temperature between 5°C and 49°C.

.2 Grout: follow normal masonry procedures.

.3 0°C to -4°C:

.1 Mortar: heat mixing water and sand to produce mortar temperatures between 5°C and 49°C. Maintain temperatures of mortar on boards above freezing.

.2 Grout: heat grout materials to 32°C to produce in-place grout temperature of 21°C at end of Work day.

.4 -4°C to -7°C:

.1 Mortar: heat mixing water and sand to produce mortar temperatures between 5°C and 49°C. Maintain temperatures of mortar on boards above freezing.

.2 Grout: heat grout materials to 32°C to produce in-place grout temperature of 21°C at end of Work day.

.3 Heat both side of walls under construction using salamanders or other heat sources.

.4 Use windbreaks or enclosures when wind is in excess of 24 km/h.

.5 -7°C and below:

.1 Mortar: heat mixing water and sand to produce mortar temperatures between 5°C and 49°C.

.2 Grout: heat grout materials to 32°C to produce in-place grout temperature of 21°C at end of Work day.

.3 Masonry units: heat masonry units so that they are above 7°C at time of laying.

.4 Provide enclosure and auxiliary heat to maintain an air temperature of at least 5°C for twenty-four (24) hours after laying units.

.5 Do not heat mixing water for mortar and grout to above 71°C.

.9 Protect completed masonry and masonry not being worked on in the following manner: (temperature ranges indicated apply to mean daily air temperatures except for grouted masonry; if for grouted masonry, temperature ranges apply to anticipated minimum night temperatures.)

.1 5°C to 0°C.

.1 Protect masonry from rain or snow for at least twenty-four (24) hours by covering with weather-resistant membrane.

.2 0°C to -4°C.

.1 Completely cover masonry with weather-resistant membrane for at least twenty-four (24) hours.

.3 -4°C to -7°C:

.1 Completely cover masonry with weather-resistant insulating blankets or similar protection for at least twenty-four (24) hours; forty-eight (48) hours for grouted masonry.

.4 -7°C and below:

.1 Except as otherwise indicated, maintain masonry temperature above 0°C for twenty-four (24) hours using enclosures and supplementary heat, electric blankets, infrared lamps or other methods proven to be satisfactory. For grouted masonry maintain heated enclosure to 5°C for forty-eight (48) hours.

2. PRODUCTS

2.1 Masonry Units, General

.1 Obtain masonry units from one Manufacturer, of uniform texture and colour for each kind required, for each continuous area and visually related areas.

2.2 Brick Made From Clay or Shale

.1 General: comply with referenced standards and other requirements indicated below applicable to each form of brick required.

.2 Size: provide brick manufactured to the following actual dimensions:

.1 Metric Modular Face Brick, 90 x 57 x 190

.3 Provide special molded shapes where indicated and for application requiring brick of form, size and finish on exposed surfaces which cannot be produced from standard brick sizes by sawing.

.4 For sills, caps, and similar applications resulting in exposure of brick surfaces which otherwise would be concealed from view, provide uncored or unfogged units with all exposed surfaces finished.

.5 Facing Brick: STM C-216, and as follows:

.1 Grade SW, .32 texture and colour: match main building

3. EXECUTION

3.1 Workmanship

.1 Build masonry Work true-to-line, plumb, square, and level, with vertical joints in proper alignment.

.2 Tolerances for exposed masonry Work shall be:

.1 Variation from mean plane: 3 mm under 2.5 m straight edge

.2 Variation in masonry openings: 6 mm maximum

.3 Variation from plumb: 9 mm in 6 m

.3 Assume complete responsibility for dimensions, plumbs, and levels of this Work and constantly check same with graduated rod.

.4 Masonry courses to be of uniform height, and both vertical and horizontal joints to be of equal and uniform thickness.

.5 Construct walls upward in a uniform manner, no one portion being raised more than 1219 mm above another at any time. Build no more than 1500 mm of wall measured vertically in any one day.

.6 Buttering corners of units, throwing mortar into joints, and deep or excessive furrowing of bed joints will not be permitted. Do not shift or tap units after mortar has taken initial set. Where adjustments must be made after mortar has started to set, remove mortar and replace with fresh supply.

3.2 Mortar and Pointing

.1 Make all joints uniform in thickness, straight, in line, and with mortar compressed to form concave joints.

3.3 Building In

.1 Build in door and window frames, steel lintels, sleeves, anchor bolts, anchors, nailing strips, and other items to be built into masonry.

.2 Do not distort metal frames. Bed anchors of frames in mortar and fill frame voids with mortar or grout as walls are erected.

3.4 Control Joints

.1 Provide continuous vertical control joints in veneer walls at locations indicated. Form control joints as detailed. Stop masonry reinforcing each side of joints.

3.5 Masonry Reinforcing

.1 Veneer shall be continuously reinforced and tied together in bed joints with masonry reinforcing at 400 o.c.

.2 Place masonry reinforcing in first and second bed joints above and below openings. Reinforcing in first bed joint shall be continuous. Second bed joint reinforcing shall extend 600 mm beyond each side of opening.

.3 Place continuous reinforcing in second bed joint below the tops of walls.

.4 Lap reinforcement minimum of 150 mm at splices and cut and bend corners.

3.6 Cutting Masonry

.1 Cutting of masonry units exposed in finished Work is to be done with accepted type power saw. Where electrical conduit outlets and switch boxes occur, grind and cut units before services are installed.

.2 Obtain the Contract Administrator's permission before cutting any part of area which may impair appearance or strength of the Work.

.3 Patching of masonry is not permitted without the Contract Administrator's authorization.

3.7 Provisions for Other Trades

.1 Provide openings in masonry walls where required or indicated.

.2 Accurately locate chases and openings and neatly finish to required sizes.

.3 Where masonry encloses conduit, ducts, and piping, bring to proper level indicated and as directed. Do not cover any pipe or conduit chases or enclosures until advised that Work has been reviewed and tested.

.4 Build masonry neatly around conduit, ducts, sleeves, and piping passing through.

3.8 Cleaning

.1 On completion, remove any excess mortar and smears that may remain, using wood paddles or scrapers.

.2 Point or replace defective mortar to match existing as required or directed.

.3 Scrub surfaces to be cleaned using non-acid cleaning solution of type which will not harm constructed masonry. Consult with masonry unit Manufacturer for acceptable Product. Clean trial test area and obtain the Contract Administrator's permission to proceed.

.4 Use large amounts of water and do cleaning in accordance with solution Manufacturer's instructions.

.5 Repeat cleaning operations as often as necessary until Work is satisfactory.

END OF SECTION

CONCRETE UNIT MASONRY

1. GENERAL

1.1 Work Included

.1 Concrete Block Masonry

.2 Installation of Masonry Accessories

1.2 Standards

.1 CAN 3-A165 Series, Standards on Concrete Masonry Units

.2 Perform masonry Work to CSA S304.1, CSA A370 and CAN 3-A371 except where specified otherwise.

.3 Conform to the National Building Code of Canada.

1.3 Cold Weather Requirements

.1 Conform to weather protection requirements of Clause 5.15 in CSA A371.

1.4 Protection

.1 Cover tops of completed and partially completed walls with waterproof coverings at end of each working day. Drape covers over walls and extend 600 mm down both sides. Anchor securely in position.

.2 Protect adjacent finished surfaces from marking or damage due to masonry Work.

.3 Provide temporary bracing of masonry Work during erection to prevent damage due to winds or other lateral loads until permanent structure provides adequate bracing.

1.5 Storage and Handling

.1 Store materials on-site in a manner to prevent damage. Store masonry units off the ground.

.2 Protect all materials from damage due to weather conditions.

.3 Handle materials carefully to prevent chipping and breaking.

2. PRODUCTS

2.1 Materials

.1 Concrete blocks: to CSA A165.1, normal weight and strength units, type H/15/A/M, modular size

.2 Special shapes: provide Type H/15/A/M bull-nosed units for exposed corners. Provide purpose made shapes for lintels and bond beams. Provide additional special shapes as indicated or required.

2.2 Exposed Faces

.1 Notwithstanding visual inspection requirements of CSA Standards, masonry units shall be free of surface indentations, surface cracks due to manufacture, or chipping. Units so delivered shall not be used where exposed to view, but may be used where concealed.

3. EXECUTION

3.1 Workmanship

.1 Build masonry Work true-to-line, plumb, square, and level, with vertical joints in proper alignment.

.2 Tolerances for exposed masonry Work shall be:

.1 Variation from mean plane: 3 mm under 2500 mm straight edge

.2 Variation in masonry openings: 6 mm maximum

.3 Variation from plumb: 9 mm in 6 m

.3 Assume complete responsibility for dimensions, plumbs, and levels of this Work and constantly check same with graduated rod.

.4 Masonry courses to be of uniform height, and both vertical and horizontal joints to be of equal and uniform thickness.

.5 Extend non-load bearing partitions to underside of floor or roof construction above and provide 40 mm deflection clearance. Install lateral support angles and insulation filler as detailed.

.6 Construct walls upward in a uniform manner, no one portion being raised more than 1200 mm above another at any time. Build no more than 1500 mm of wall measured vertically in any one day.

.7 Buttering corners of units, throwing mortar into joints, and deep or excessive furrowing of bed joints will not be permitted. Do not shift or tap units after mortar has taken initial set. Where adjustments must be made after mortar has started to set, remove mortar and replace with fresh supply.

3.2 Blockwork

.1 Lay concrete block in running bond, with thicker end of face shell upward. Coursing to be modular 200 mm for one block and one joint.

.2 Use special shaped units where indicated, specified, or required. Use bull-nosed units for exposed external corners at door and window jambs. Exposed open cells not permitted.

.3 Concrete masonry units shall have face shells and their end joints fully filled with mortar, and joints squeezed tight. Also fill webs at cores, to be reinforced and grouted, and strike flush at core taking care to prevent mortar from falling into core.

.4 Tie intersecting non-bearing walls together with masonry reinforcing every second course.

.5 Do not tie intersecting bearing walls together in masonry bond, except at corners.

3.3 Mortar and Pointing

.1 Make all joints uniform in thickness, straight, in line, and with mortar compressed to form concave joints.

3.4 Building In

.1 Build in door and window frames, steel lintels, sleeves, anchor bolts, anchors, nailing strips, and other items to be built into masonry.

.2 Do not distort metal frames. Bed anchors of frames in mortar and fill frame voids with mortar or grout as walls are erected.

3.5 Bearings

.1 Fill concrete block solid with 20 MPa concrete for two (2) courses below bearing points of structural members and where indicated on Drawings.

.2 Install building paper and wire mesh reinforcing in the bed below the second block course from top.

3.6 Control Joints

.1 Provide continuous vertical control joints in concrete block partitions and walls at locations indicated, or at a maximum 7600 mm on center.

.2 Form control joints as detailed. Stop masonry reinforcing 25 mm from each side of joints.

3.7 Expansion Joints

.1 Construct expansion joints where indicated, as detailed.

3.8 Masonry Reinforcing

.1 Concrete block walls and partitions shall be continuously reinforced and tied together with masonry reinforcing in every second block bed joint.

.2 Place masonry reinforcing in first and second bed joints above and below openings. Reinforcing in first bed joint shall be continuous. Second bed joint reinforcing shall extend 600 mm beyond each side of opening.

.3 Place continuous reinforcing in second bed joint below the tops of walls.

.4 Lap reinforcement minimum of 150 mm at splices and cut and bend corners.

.5 Vertical reinforcing bars to be continuous into lintels, through intermediate bond beams, and hooked into top of wall bond beams. Fill cores with 20 MPa concrete.

3.9 Cutting Masonry

.1 Cutting of masonry units exposed in finished Work is to be done with accepted type power saw. Where electrical conduit outlets and switch boxes occur, grind and cut units before services are installed.

.2 Obtain Contract Administrator's permission before cutting any part of area which may impair appearance or strength of the Work.

.3 Patching of masonry is not permitted without Contract Administrator's authorization.

3.10 Bond Beams

.1 Install concrete block bond beams where indicated and where required for bearing of structural members.

.2 Make bond beams of knockout blocks with two (2) 15M reinforcing bars and fill with 20 MPa concrete.

3.11 Reinforced Block Lintels

.1 Install reinforced concrete block lintels over openings as indicated on the Drawings using 20 MPa concrete.

.2 Cast and cure lintels on plank. Set special channel lintel blocks using specified mortar. Place wood stops at either end of lintel to prevent movement.

.3 Place 25 mm of concrete in voids, place in deformed reinforcing bars and place concrete to level of block sides. Rod and tamp concrete well without disturbing reinforcing. Allow lintels to cure seven (7) days before removing shores.

.4 Minimum bearing shall be 400 mm each side of openings.

3.12 Provisions for Other Trades

.1 Provide openings in masonry walls where required or indicated.

.2 Accurately locate chases and openings and neatly finish to required sizes.

.3 Where masonry encloses conduit, ducts, and piping, bring to proper level indicated and as directed. Do not cover any pipe or conduit chases or enclosures until advised that Work has been reviewed and tested.

.4 Build masonry neatly around conduit, ducts, sleeves, and piping passing through.

3.13 Cleaning

.1 Allow mortar droppings on masonry to partially dry then remove by means of trowel, followed by rubbing lightly with small piece of block and finally by brushing.

.2 Scrub surfaces to be cleaned using non-acid cleaning solution of type which will not harm constructed masonry. Check masonry unit Manufacturer for acceptable solution. Clean trial test area and obtain permission to proceed.

.3 Use large amounts of water and do cleaning in accordance with solution Manufacturer's instructions.

.4 Point or replace defective mortar to match existing as required or directed.

.5 Repeat cleaning operations as often as necessary until Work is satisfactory.

END OF SECTION

STRUCTURAL STEEL

1. GENERAL

1.1 Work Included

.1 Structural framing columns and beams for Chemical Storage Building (painted)

.2 Main floor framing for Chemical Storage Building (specialty chemical resistant coating)

.3 Catwalk framing for Chemical Storage Building (painted)

.4 Bearing plates and anchor bolts

.5 Welds, bolts, washers, nuts, and shims

.6 Prime interior structural steel members and appurtenances

.7 Field touch-up of primed and painted surfaces including field welding

1.2 Design Standards, Code Requirements

.1 Conform to requirements of CSA S16.1, CSA-S136, the CISC Code of Standard Practice for Buildings, and the Provincial Construction Safety Act.

.2 Use the loads shown on Drawings and in accordance with the National Building Code of Canada.

.3 Connections not shown on the Drawings are to be designed by a Professional Engineer registered in the Province of Manitoba. Design connections for loads shown or indicated on the Drawings.

.4 Perform all welding in accordance with requirements of CSA W59.

1.3 Qualifications

.1 All work is to be performed by a firm certified by the Canadian Welding Bureau to the requirements of CSA W47.1 in Division 1 or Division 2.1.

.2 All welders employed for erection are to possess valid "S" Classification Class "O" certificates issued by the Canadian Welding Bureau.

1.4 Inspection and Testing

.1 Shop and field inspection and testing is to be performed by an Inspection and Testing Firm appointed and paid by the City.

.2 Provide free access to all portions of work in the shop and in the field and cooperate with appointed firm.

.3 Pay all additional costs for inspection and re-inspection due to defective workmanship or materials.

.4 If requested by the Contract Administrator, submit four (4) copies of mill test reports, properly correlated to materials actually used.

.5 Radiographic and magnetic particle inspection of welds is to be performed by the Inspection and Testing Firm, in accordance with CSA W59 and ASTM E109, when required by the Contract Administrator.

.6 Welds are to be considered defective if they fail to meet quality requirements of CSA W59.

.7 Additionally, all welds are to be visually inspected.

.8 High Tensile bolted connections are to be inspected and tested in accordance with CSA S16.1.

1.5 Shop Drawings, Submittals

.1 Provide a fabrication and erection schedule to the Contract Administrator prior to commencement of shop fabrication and field erection, in ample time to allow proper scheduling of inspection and testing.

.2 Submit details of typical connections and special connections for review prior to preparation of Shop Drawings.

.3 Coordinate with steel joist supplier for any connections to joists.

.4 Shop Drawings and design briefs are to bear the seal and signature of a Professional Engineer registered in the Province of Manitoba.

.5 Submit Shop Drawings for review in accordance with the Section 01300.

.6 Clearly indicate profiles, sizes, spacing, and locations of structural members, connections, attachments, reinforcing, anchorage, size and type of fasteners, cambers and loads, accessories, and setting details.

.7 Include erection drawings, elevations, and details.

.8 Indicate welded connections using welding symbols in compliance with CISC Welding Standards. Clearly indicate net weld lengths.

.9 Shop Drawing review by the Contract Administrator is solely to ascertain conformance to the general design concept.

.10 Responsibility for approval of detail design inherent in Shop Drawings rests with the Contractor and review by the Contract Administrator shall not imply such approval.

.11 Review shall not relieve the Contractor of his responsibility for errors or omissions in Shop Drawings or for proper completion of the Work in accordance with the Contract Documents.

.12 Responsibility for verification and correlation of field dimensions, fabrication processes, techniques of construction, installation, and coordination of all parts of the Work rests with the Contractor.

2. PRODUCTS

2.1 Materials

.1 All materials shall be new

.2 Structural steel: conforming to CSA G40.21, Type W with minimum yield strength of 350 MPa

.3 Hollow structural sections: conforming to CSA G40.21, Type W, minimum yield strength of 350 MPa, Class C

.4 Bolts, nuts, and washers: conforming to ASTM A325; galvanized or painted to match fastened items

.5 Welding materials: conforming to CSA W59

.6 Interior structural steel primer: CISC/CPMA 2-75

2.2 Fabrication

.1 Fabricate structural steel members in accordance with CSAS16.1 and CSA S136.

.2 Verify all drawing dimensions prior to commencing fabrication.

.3 Provide connections for design loads shown on the Drawings.

.4 Provide for field connections to be bolted except where field welded connections are shown on the Drawings. Bolted connections shall be bearing-type connections with the thread excluded from the planes of shear.

.5 All shop connections are to be welded.

.6 All exposed welds shall be of smooth neat appearance; grind or file if required.

.7 Design and detail connections for structural steel so that corrosion potential is minimized.

2.3 Shop Painting

.1 Structural steel shall be finish-painted at the fabrication shop.

.2 Special Coating: primed steel columns and beams to receive specialty chemical resistant coating; see Section 11912 for any surface preparation requirements.

.3 Clean all members remove loose mill scale, rust, oil, dirt, and other foreign matter. Prepare surfaces according to SSPC SP7.

.4 Apply paint in the shop to all steel surfaces, except:

.1 Surfaces to be encased in concrete

.2 Surfaces and edges to be field welded

.5 Apply paint under cover, on dry surfaces only and when surface and air temperatures are above 5°C.

.6 Maintain dry condition and 5°C minimum temperature until paint is thoroughly dry.

.7 Patch paint sharp edges and corners one coat before full coat is applied.

.8 Apply paint by brush or spray to specified dry film thickness.

3. EXECUTION

3.1 Examination

.1 Before starting erection, take field measurements and examine other work that may affect this work.

.2 Notify the Contract Administrator of any conditions, which would prejudice proper installation of this work.

.3 Commencement of this work implies acceptance of existing conditions.

3.2 Damaged Members

.1 Repair or replace members damaged during transit or erection before securing in position.

3.3 Erection

.1 Erect structural steel in accordance with CSA S16.1 and Drawings.

.2 Field connections are to be bolted wherever possible.

.3 Do not field weld wet surfaces or during rain unless under cover.

.4 Do not weld at temperature below 5°C except with express permission of the Contract Administrator.

.5 Conform to requirements of CSA W59 for minimum preheat and interpass temperatures.

.6 Make adequate provision for all erection loads, and for sufficient temporary bracing to maintain structure safe, plumb, and in true alignment until completion of erection and installation of necessary permanent bracing.

.7 Use only light drifting to draw parts together. Enlarge holes for bolted connections with reamers or twist drill only. Do not burn to form holes, enlarge holes, or match unfair holes.

.8 Erection error is not to exceed requirements of CSA S16.1.

.9 Obtain Contract Administrator's written permission prior to field cutting or altering structural members.

.10 After erection, field paint welds and touch-up abrasions and damaged surfaces. Bolt tightening to be done in accordance with Turn-of-Nut Tightening as per CSA S16.1.

END OF SECTION

STEEL JOISTS

1. GENERAL

1.1 Work Included

.1 Joist design

.2 Standard type steel joists and bridging

.3 Bearing plates and angles with anchors

.4 Joist stools and anchor bolts for joists

.5 Plate clips for additional roof framing

.6 Welding to steel supports

.7 Shop prime paint steel joists and appurtenances

.8 Field touch-up of primed surfaces

1.2 Design Standards, Code Requirements

.1 Conform to requirements of CAN/CSA-S16.1, CSA S136, CISC "Code of Standard Practice for Buildings" and CISC "Steel Joist Facts".

.2 Conform to the Provincial Construction Safety Act.

.3 Use loads, load combinations, and stress levels shown on Drawings and in accordance with the latest edition of the National Building Code of Canada.

.4 Design joists to withstand their own weight and design loads indicated on Drawings, with no more than allowable deflection of L/400 for joists adjacent and parallel to continuous support walls and L/240 for all intermediate joists based on live load.

.5 Joists and connections are to be signed and sealed by a Professional Engineer registered in the Province of Manitoba.

.6 Perform all welding in accordance with requirements of CSA W59.

1.3 Qualifications

.1 All Work is to be performed by a firm certified by the Canadian Welding Bureau to the requirements of CSA W47.1 Division 1 or 2.1.

1.4 Inspection and Testing

.1 Shop and field inspection and testing is to be performed by an Inspection and Testing Firm appointed and paid by the City.

.2 Provide free access to all portions of Work in the shop and in the field and cooperate with appointed firm.

.3 Pay all additional costs for inspection and re-inspection due to defective workmanship or materials.

.4 If requested by the Contract Administrator, submit four (4) copies of mill test reports, properly correlated to materials actually used.

1.5 Shop Drawings and Submittals

.1 Provide a fabrication and erection schedule to the Contract Administrator prior to commencement of shop fabrication and field erection, in ample time to allow proper scheduling of inspection and testing.

.2 Shop Drawings and design briefs are to be signed and sealed by a Professional Engineer registered in the Province of Manitoba.

.3 Submit Shop Drawings and design briefs in accordance with Section 01300.

.4 Clearly indicate profiles of rolled sections, sizes, spacing, and location of joists, connections, bridging, reinforcing, anchorage, cambers, loads, and accessories.

.5 Include erection drawings, elevations, and details.

.6 Coordinate with the metal fabrication supplier for connections to joists for the catwalk hangers.

.7 Indicate welded connections using welding symbols in compliance with CISC Welding Standards. Clearly indicate net weld lengths.

.8 Shop Drawing review by the Contract Administrator is solely to ascertain conformance to the general design concept.

.9 Responsibility for approval of detail design inherent in Shop Drawings rests with the Contractor and review by the Contract Administrator shall not imply such approval.

.10 Review shall not relieve the Contractor of his responsibility for errors or omissions in Shop Drawings or for proper completion of the Work in accordance with the Contract Documents.

.11 Responsibility for verification and correlation of field dimensions, fabrication processes, techniques of construction, installation, and coordination of all parts of the Work rests with the Contractor.

2. PRODUCTS

2.1 Materials

.1 All materials are to be new.

.2 Steel: structural type conforming to CAN/CSA-G40.21, Type W 380 MPa for chord sections and 260 MPa minimum for web material, shop primed

.3 Anchor Bolts: fabricated from material conforming to CAN/CSA G40.21, Type W, yield strength 300 MPa; nuts and washers to be of equal or greater strength than bolts

.4 Welding Materials: conforming to CSA W59

.5 Primer: CISC/CPMA 2-75 for joists to be finish painted

2.2 Fabrication

.1 Fabricate steel joists in accordance with CAN/CSA S16.1.

.2 Verify all Drawing dimensions prior to commencing fabrication.

.3 Fabricate joists of straight members arranged to form a triangulated truss type structure without joint eccentricities.

.4 No splices are allowed in chord members.

.5 Fabricate bottom joist chord extensions where indicated.

.6 Fabricate joist webs to permit passage of mechanical ducts as detailed. Reinforce joists in accordance with design conditions.

.7 Fabricate and weld plate clips to steel joist as indicated on the Drawings for additional channel roof framing. Coordinate with metal fabrication supplier for requirements.

.8 Camber joists for dead load deflection.

2.3 Shop Painting

.1 Clean all members and remove loose mill scale, rust, oil, dirt, and other foreign matter. Prepare surface according to SSPC SP 7.

.2 Apply one (1) coat of prime paint in the shop to all steel surfaces, except:

.1 Surfaces to be encased in concrete

.2 Surfaces to receive field installed stud shear connectors

.3 Surfaces and edges to be field welded

.3 Apply primer paint under cover on dry surfaces only and when surface and air temperatures are above 5°C.

.4 Maintain dry condition and 5°C minimum temperature until paint is thoroughly dry.

.5 Patch paint bolts, nuts, sharp edges, and corners one coat before full prime coat is applied.

.6 Apply paint by brush or spray to a dry film thickness of 0.05 mm minimum.

3. EXECUTION

3.1 Examination

.1 Before starting erection, take field measurements and examine other Work which may affect this Work.

.2 Notify the Contract Administrator of any conditions which would prejudice proper installation of this Work.

.3 Commencement of this Work implies acceptance of existing conditions.

3.2 Damaged Members

.1 Repair or replace members damaged during transit or erection, before securing in position.

3.3 Erection

.1 Erect steel joists in accordance with CAN/CSA-S16.1 and Drawings.

.2 Provide minimum 100 mm bearing for joists supported on concrete and masonry. Provide minimum 65 mm bearing for joists supported on steel supports.

.3 Extend bearing chords to center of supports to reduce eccentricity.

.4 During erection provide all temporary bracing required for induced loads and stresses.

.5 Coordinate placement of anchor bolts and bearing plates in masonry construction.

.6 Field weld joists to bearing plates and steel supports after alignment and positioning.

.7 Provide bridging and bracing.

.8 Do not weld at temperature below 5ºC except with written permission of the Contract Administrator.

.9 Do not field weld wet surfaces or during rain unless under cover.

.10 Conform to CSA W59 for minimum preheat and interpass temperatures.

.11 Do not permit erection of decking until joists are sufficiently braced and bridging is installed.

.12 Obtain Contract Administrator's written permission prior to field cutting or altering joists or bridging.

.13 After erection, field prime anchorages, bearing plates, field welds, and other appurtenances, abrasions, and damage to shop primer.

END OF SECTION

METAL DECK

1. GENERAL

1.1 Work Included

.1 Metal roof deck complete with cover plates, closures, flashing, fastenings, and installation

.2 Angles complete with required anchorage

.3 Angle framing around openings up to 450 mm maximum in any dimension

.4 Cut openings through deck

1.2 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01300.

.2 Clearly indicate decking plan, deck profile dimensions and thicknesses, anchorage, supports, projections, openings and reinforcement, closures, flashings, applicable accessories, and details.

.3 Shop Drawings and design briefs are to be signed and sealed by a Professional Engineer registered in the Province of Manitoba.

1.3 Design

.1 Design deck to safely support live and dead loads shown on Drawings and in accordance with CSA S136. Ensure ponding affects are included.

.2 Maximum working stress under full live and dead loads shall not exceed 140 MPa.

.3 Live load deflection shall not exceed 1/240 of span.

.4 Roof deck shall provide building stability through diaphragm action.

2. PRODUCTS

2.1 Materials

.1 Metal: galvanized sheet steel conforming to ASTM A446, Grades A or B as shown in Manufacturers' current literature

.2 Primer: zinc dust/zinc oxide alkyd type, conforming to CAN/CGSB-1.181, compatible with finish painting (see Section 09900)

2.2 Deck and Related Accessories

.1 Roof deck: minimum 0.76 mm thickness or as indicated on the Drawings, base sheet steel, galvaneal, three (3) equal spans, 38 mm deep profile

.2 Closure strips, flashing, and cover plates: minimum 0.76 mm thickness base sheet steel, galvaneal coating, of required profiles and sizes

2.3 Fabrication

.1 Fabricate metal deck in accordance with requirements of CSA S136, and CSSBI Standards and Drawings.

.2 Fabricate deck with interlocking side laps.

.3 Fabricate to generally span over three or more supports unless shown otherwise on the Drawings.

3. EXECUTION

3.1 Examination

.1 Before starting erection, take field measurements and examine other Work which may affect this Work.

.2 Notify the Contract Administrator of any conditions which would prejudice proper installation of this Work.

.3 Commencement of this Work implies acceptance of existing conditions.

3.2 Damaged Members

.1 Repair or replace sections damaged during transit or erection before securing in position.

3.3 Installation

.1 Erect metal deck in accordance with requirements of CSSBI and the Drawings. Align and level deck on structural supports.

.2 Locate all end joints over supports.

.3 Lap all end joints on non-cellular deck 75 mm minimum.

.4 Maintain minimum end bearing on steel supports of 38 mm for deck up to 45 mm deep.

.5 Maintain minimum end bearing on masonry supports of 100 mm for deck up to 45 mm deep.

.6 Lay out lines of supporting steel on top surface of deck to produce accurate welds and prevent burns through deck from improper weld location.

.7 Welding shall be done by qualified welders who shall make practice welds. Prior to actual job welding, practice welds shall be made on the deck to be used to check adequacy of the welding rod amperage and burn-off rate to produce satisfactory fusion for the various welds required. Both the practice welds and actual job welds shall be inspected by the steel deck erector as to size and spacing and tested by pry tests to assure metal to metal fusion.

.8 Fasten to all supports with 20 mm diameter fusion welds at 300 mm on center maximum.

.9 Mechanically fasten sidelaps at 600 mm on center by button punch.

.10 Install angle or channel closures full length on all deck edges at perimeter, walls, and openings.

.11 Install acoustical closures over all walls and partitions.

.12 Cut all holes required in deck for drains, vents, mechanical equipment, ducts, and conduits.

.13 Reinforce openings up to 450 mm in any dimension with 55 x 55 x 6 mm steel angles. Place reinforcing angles at right angles to ribs, extend out two ribs each side and weld.

.14 Install deck to provide flat upper surface, with all flange surfaces touching a 1200 mm straight edge over structural supports.

.15 If two or more adjacent flanges on any deck section are concave or convex so that only edges or crowns touch straight edge, repair or replace deck sections.

.16 Immediately after installation, touch up welds, burned areas, and damaged areas of zinc coating with primer paint.

END OF SECTION

STEEL FABRICATIONS

1. GENERAL

1.1 Work Included

.1 Shop fabricated ferrous metal items, galvanized and prime painted. The following is a list of principal items only. Refer to Drawings for items not specifically listed.

.1 Roof framing – perimeter angles as indicated (painted)

.2 Bearing plates for steel joists (painted)

.3 Exterior masonry supports (galvanized)

.4 Loose lintels (galvanized)

.5 Angles and bearing plates for metal deck (painted)

.6 Boot scrapers (galvanized)

.7 Strengthening of existing precast panels at new door opening for Chemical Storage Building (galvanized)

.8 Catwalk Grating for Chemical Storage Building (galvanized)

.9 Interior stairs, landings, and guardrailing for Chemical Storage Building (painted except treads galvanized)

.10 Interior stairs, landings, and guardrailing for Railcar Shelter (specialty chemical resistant coating)

.11 Exterior stairs and railing for Railcar Shelter (galvanized)

.12 Anchors, plates, bolts, nuts, screws, brackets, chains, etc., required for Work of this Section

1.2 Design Code, Quality Assurance

.1 Conform to requirements of the National Building Code of Canada, 1995.

.2 Perform welding in accordance with requirements of CSA W59.

.3 Welding Work on all load carrying structures and assemblies is to be performed by a firm certified by the Canadian Welding Bureau to the requirements of CSA W47.1 in Division 1 or 2.1.

1.3 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01300.

.2 Clearly indicate profiles, sizes, connections, attachments, reinforcing, anchorage, size and type of fasteners, and accessories.

.3 Coordinate with steel joist supplier for any connections to joists.

.4 Include erection drawings, elevations, and details where applicable.

.5 Indicate welded connections using CISC standard welding symbols. Clearly indicate net weld lengths.

.6 Shop Drawings and design briefs are to be signed and sealed by a Professional Engineer registered in the Province of Manitoba.

2. PRODUCTS

2.1 Materials

.1 Steel: conforming to CAN/CSA-G40.21; Type W with minimum yield strength of 300 MPa

.2 Welding materials: conforming to CSA W59

.3 Bolts, nuts, and washers: conforming to ASTM A325

.4 Accessories: anchors, plates, bolts, nuts, screws, brackets, etc., material to be compatible with items

.5 Accessories: wall brackets, with plaster rings, flanges, escutcheons, pre-formed bends, tee fittings, flush end caps, plugs, flush splice connectors; of same material and finish to match railings and hand railings

2.2 Finishes

.1 Primer: CISC/CPMA 2-75

.2 Galvanizing: conforming to CAN/CSA-G164; Galvalume for touch-up

.3 Specialty chemical resistant coating: see Section 11912 for product description and for surface preparation requirements

2.3 General Fabrication

.1 Verify all dimensions on site prior to shop fabrication.

.2 Fabricate items of sizes and profiles detailed on Drawings, with joints neatly fitted and properly secured.

.3 Fit and shop assemble in largest practical sections for delivery to Site.

.4 Supply all components required for proper anchorage of miscellaneous metals. Fabricate anchorage and related components of same material and finish as metal fabrications, unless otherwise specified or shown.

.5 Weld connections where possible, otherwise bolt connections. Cut off bolts flush with nuts.

.6 Accurately form all connections and joints with exposed faces flush, mitres, and joints tight.

.7 Exposed welds and metal sections shall be smooth and flush; grind or file if required.

.8 Provide for flush welded or hairline butt field joints.

.9 Shop fabricate openings in members for other building components. Reinforce openings to restore member to original design strengths.

.10 Provide lugs, clips, brackets, hangers, and struts as required for attaching miscellaneous metal items securely to building structure.

.11 Thoroughly clean all surfaces of rust, scale, grease, and foreign matter prior to prime painting or galvanizing.

.12 Galvanize and prime paint items as shown. Do not shop prime surfaces in contact with or embedded in concrete or requiring field welding.

3. EXECUTION

3.1 Examination

.1 Before starting erection, examine other Work which may affect this Work.

.2 Notify the Contract Administrator of any conditions which would prejudice proper installation of this Work.

.3 Commencement of erection Work implies acceptance of existing conditions.

3.2 Erection

.1 Obtain Contract Administrator’s permission prior to site cutting or making adjustments which are not part of scheduled Work.

.2 Install items plumb, square and level, fit accurately, and maintain free from distortion or defects detrimental to appearance and performance.

.3 Make provision for erection stresses and temporary bracing. Keep Work in alignment at all times.

.4 Replace items damaged in course of installation.

.5 Perform required field welding. All visible field welds shall be smooth; grind or file if required.

.6 Perform necessary cutting and altering for the installation of Work of other Sections, and as indicated on Drawings. No additional cutting is to be done without the permission of the Contract Administrator.

.7 Perform all field assembly bolting and welding to match standard of shop bolting and welding. Bolts and screws are to be concealed whenever possible.

.8 After installation, touch up field bolts, nuts, welds, and scratched and damaged prime painted surfaces. Field touch-up primer shall be same as shop primer. Touch up galvanized surfaces with galvalume.

.9 Supply, to appropriate Sections, items required to be cast into concrete and built into masonry, complete with necessary setting templates.

END OF SECTION

ROUGH CARPENTRY

1. General

1.1 Work Included

.1 Roof parapets

.2 Blocking in wall

.3 Wood furring and grounds

.4 Concealed wood blocking for support of items and equipment supported by walls

.5 Wood treatment

1.2 Related Sections

.1 Cast-in-place Concrete: Concrete openings to receive wood blocking: Section 03300

.2 Concrete Unit Masonry: Masonry openings to receive wood blocking: Section 04220

.3 Modified Bituminous Roofing: Section 07525

1.3 References

.1 CSA O80M - Wood Preservation.

.2 NLGA - Standard Grading Rules for Canadian Lumber.

.3 CSA O121M - Douglas Fir Plywood.

.4 CSA O141 - Softwood Lumber.

.5 CSA O151M - Canadian Softwood Plywood.

1.4 Quality Assurance

.1 Lumber grading agency: NLGA.

.2 Wood treatment: CSA O80M.

1.5 Delivery, Storage, and Handling

.1 Protect Products of this Section under waterproof coverings.

2. PRODUCTS

2.1 Materials

.1 Softwood lumber: CSA O141, non-structural light grading 19% maximum moisture content.

.2 Plywood: CSA O121M - Douglas fir CSA O151M - softwood type, with waterproof glue.

.3 Fasteners: Electro Hot dipped galvanized steel for exterior, high humidity, and treated wood locations; plain finish elsewhere; size and type to suit condition.

.4 Anchors: Toggle bolt type for anchorage to hollow masonry expansion shield and lag belt type for anchorage to solid masonry or concrete bolts or ballistic fasteners for anchorages to steel.

2.2 Wood Treatment

.1 Wood preservative pressure treatment: CSA O80M using waterborne preservative with 0.30 percent retainage, manufactured by Wolman.

3. EXECUTION

3.1 Site Applied Wood Treatment

.1 Apply preservative treatment in accordance with CSA O80M Manufacturer's instructions.

.2 Treat Site-sawn ends.

.3 Allow preservative to cure prior to erecting members.

3.2 Installation

.1 Erect wood framing members level and plumb.

.2 Space framing and furring as noted on the Drawings.

.3 Construct curb members of single pieces.

.4 Curb all roof openings except where prefabricated curbs are provided. Form corners by lapping side members alternately.

.5 Provide blocking, sized to suit, for support of surface mounted accessories and equipment.

.6 Provide wood blocking around each door frame opening.

.7 Place miscellaneous blocking, furring, strapping, canting, nailing strips, framing and sheathing where indicated on Drawings and as required for secure support of anchorage of other specified materials. Place members true to lines and levels. Secure rigidly in place.

.8 Coordinate the installation of bucks, anchors, blocking, which is to be placed in or behind partitions. Allow such items to be installed after partition framing is complete. Ensure that allowance is made for thickness of wall finish to be applied.

.9 Place sheathing with end joints staggered. Secure sheets over firm bearing. Maintain minimum 1.5 mm and maximum 3 mm spacing between joints on walls. Place perpendicular to framing members.

END OF SECTION

FRP FABRICATIONS

1. General

1.1 Work Included

.1 Supply and installation of FRP grating

1.2 References

.1 ASTM D-638 -Tensile Properties of Plastics

.2 ASTM D-790 – Flexural Properties of Unreinforced and Reinforced Plastics

.3 ASTM D-2344 – Apparent Interlaminar Shear Strength of Parallel Fiber Compsites by Short Beam Method

.4 ASTM D-495 – High Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation

.5 ASTM D-696 – Coefficient of Linear Thermal Expansion for Plastics

1.3 Design Criteria

.1 Member sizes shown on the Drawings are a minimum.

.2 Design the grating to support a uniform live load of 4.8 kPa or a concentrated live load of 2.2 kN, and other loads shown on the Drawings. Limit live load deflection to 1/300 of span. Design the members in accordance with the manufacturer's recommendations.

1.4 Submittals

.1 Submit Shop Drawings in accordance with Section 01300.

.2 Submit two samples of each type of grating.

.3 Submit a colour chart of the standard range of colours.

1.5 Quality Assurance

.1 Fabricators and erectors of this system to have a minimum of 5 years successful installation and if requested by the Consultant can provide a list of completed projects.

.2 The installation subcontractor shall be an erector approved by the Manufacturer and shall have completed a course in the method of erection. The installation subcontractor shall submit a letter from the Manufacturer stating he has successfully completed a course and is currently in good standing and is an approved installer of the product.

.3 Prior to the beginning of any fabrication or installation work, the Contract Administrator, at any reasonable time, may review the Work to ensure the material is free of visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles, and pits.

.4 Items delivered to site and erected to be free from chips, marks, or cracks.

1.6 Delivery, Storage, and Handling

.1 Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.

.2 All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Store items in an enclosed area and free from contact with soil and water. Store adhesives, resins and their catalysts, and hardeners in dry indoor storage facilities between 20 and 27 degrees Celsius until they are required.

2. PRODUCTS

2.1 Materials

.1 Grating

.1 Manufacture: grating components shall be high strength and high stiffness molded elements having a maximum of 70% and a minimum of 60% glass content (by weight) of continuous roving and continuous strand mat fiberglass reinforcements. The finished surface of the product shall be provided with a surfacing veil to provide a resin rich surface which improves corrosion resistance and resistance to ultraviolet degradation. Grating to be resistant to Ferric Chloride (38 percent) and Hydrochloric Acid (<5%). Grating to be manufactured with vinyl ester resins.

.2 Fire rating: grating shall be fire retardant with a tested ASTM E84 flame spread rating of 25 or less when tested in accordance with ULC S102. Manufacturer may be required to provide certification of ULC S102 test on grating panels from an independent testing laboratory. Certification shall be dated within the past two years. Test data shall be from full scale testing of actual production grating, of the same type and material supplied on the project. Test data performed only on the base resin shall not be acceptable.

.3 The manufacture of the grating may be required to submit corrosion data from tests performed on actual grating products in standard chemical environments. Corrosion resistance data of the base resin from the manufacturer is not a true indicator of grating corrosion resistance and shall not be accepted.

.4 Surfacing: grating shall be concave finished.

.5 Hardware: stainless steel Type 316 hold-down saddle clips, minimum 4 per panel.

.6 Size: grating shall be moulded bi-directional 38 mm by 38 mm and 38 mm height.

.7 Colour: to be selected from the manufacturer's standard range of colours.

.8 Acceptable products: Precision Grate CF by Precisioneering and Fibregrate Vi-Corr by StonCor Firbergrate.

3. EXECUTION

3.1 Examination

.1 Before starting erection, examine other Work which may affect this Work.

.2 Notify the Contract Administrator of any conditions which would prejudice proper installation of this Work.

.3 Commencement of erection Work implies acceptance of existing conditions.

3.2 Grating Installation

.1 Grating shall be installed in accordance with manufacturer's Shop Drawings. Lock grating panels securely in place with hold-down fasteners as specified herein. Field cut and drill panels with carbide or diamond tipped bits and blades. Seal cut or drilled surfaces in accordance with manufacturer's instructions; provide adequate ventilation.

.2 Fabricate and install grating panels such that adjacent panels have perpendicular bars lining up to present a continuous appearance. Clip panels together to prevent differential panel to panel movement.

.3 Grating shall meet the minimum dimensional requirements as shown or specified. The Contractor shall provide and/or verify measurements in field for work fabricated to field conditions as required by grating manufacturer. Determine correct size and locations of required holes or cutouts from field dimensions before grating fabrication.

.4 Each grating section shall be readily removable, except where indicated on Drawings. Manufacturer to provide openings and holes where located on the Drawings. Grating supports shall be provided at openings in the grating by contractor where necessary to meet load/deflection requirements specified herein. Grating openings which fit around protrusions (pipes, cables, machinery, etc.) shall be discontinuous at approximately the centerline of opening so each section of grating is readily removable. Gratings shall be fabricated free from warps, twists, or other defects which affect appearance and serviceability.

.5 All shop fabricated grating cuts and drilled holes shall be coated with vinyl ester resin to provide maximum corrosion resistance. All field fabricated grating cuts and drilled holes

shall be coated similarly by the Contractor in accordance with the manufacturer's instructions.

.6 Hold-down clips shall be provided and spaced at a maximum of 1000 mm apart with a minimum of four per piece of grating, or as recommended by the manufacturer.

END OF SECTION

BITUMINOUS DAMPPROOFING

1. GENERAL

1.1 Work Included

.1 Clean and prepare surfaces to receive dampproofing.

.2 Apply dampproofing to all exterior surfaces of exterior walls from 50 mm below finished grade levels or as shown on the Drawings down to top of piles.

.3 Caulk junction of walls and footings and around pipes and services entering through walls.

1.2 Related Work

.1 Backfilling for Structures: Section 02220

.2 Concrete Accessories: Section 03250

.3 Cast-In-Place Concrete: Section 03300

.4 Rigid Wall Insulation, Moisture Barrier, Sheet Air/Vapour Barriers: Section 07212

1.3 Examination

.1 Examine surfaces to be damp-proofed and have all defects remedied prior to application of dampproofing.

.2 Tie holes, honeycombs, and other imperfections - are to be made good under Section 03300 Cast-in-Place Concrete.

1.4 Storage and Handling

.1 Provide and maintain dry, off-ground weatherproof storage.

.2 Store materials on supports to prevent deformation.

.3 Remove only in quantities required for same day use.

.4 Store materials in accordance with Manufacturers' written instructions.

1.5 Environmental Requirements

.1 Do not proceed with Work when wind chill effect would tend to set bitumen before proper curing takes place.

.2 Maintain air temperature and substrate temperature at dampproofing installation area above 5°C for twenty-four (24) hours before, during and twenty-four (24) hours after installation, or as recommended by Manufacturer.

.3 Do not apply dampproofing in wet weather.

2. PRODUCTS

2.1 Materials

.1 Asphalt: to CAN/CGSB-37-GP-16Ma. Acceptable Products: Bakelite/Flintguard 710-11 Foundation Coating and Elsro 505 Fibrated Foundation Coating.

.2 Asphalt primer: to CAN/CGSB 37-GP-9Ma. Acceptable Products: Bakelite/ Flintguard 910-01 Asphalt Primer and Elsro 510 Asphalt Primer.

.3 Sealing compound: plastic cutback asphalt cement to CAN/CGSB-37.5. Acceptable Products: Bakelite/Flintguard 770-05, Elsro recommended sealing compound.

3. EXECUTION

3.1 Application

.1 Apply dampproofing Products in one (1) coat in accordance with the Manufacturer's written instructions.

.2 Thoroughly clean concrete surfaces with wire brushes to remove dirt and loose scale before applying dampproofing.

.3 Seal exterior joints between foundation walls and footings, and around penetrations through dampproofing with sealing compound.

.4 Apply primer.

.5 Apply dampproofing evenly by brush or spray in one application, completely covering surfaces with no bare spots. Application shall be inspected by the Contract Administrator before backfilling commences.

.6 Apply dampproofing at the rate of one (1) litre/m^2.

.7 Apply two (2) additional coats of dampproofing to vertical corners and construction joints for a minimum width of 230 mm on each side, and 230 mm minimum width around pipes passing through walls.

END OF SECTION

AIR VAPOUR BARRIER QUALITY CONTROL

1. GENERAL

1.1 Purpose

.1 The purpose of this Specification is to ensure control of the quality of air/vapour barrier membrane installations on new or existing buildings.

1.2 Work Included

.1 This Specification applies to most Site applied air/vapour barrier materials and systems for the building, including air barrier membranes adhered to wall surfaces of concrete, masonry, plywood or gypsum board, and to connections and transitions between these and windows, doors, floor slabs, lintels, roofing and waterproofing membranes. It includes, but is not limited to, modified bitumen, rubber and plastic compounds, sheet metal air/vapour barrier systems and the junctions, interconnections and tie-ins between these membranes and all other types of air/vapour barrier membranes and building components.

1.3 Work Not Included

.1 Except for junctions, interconnections and tie-ins noted above, this Specification does not apply to:

.1 Air tight drywall air/vapour barrier systems.

.2 Sprayed-in-place foam insulation systems. These are addressed in CAN/CGSB 51.39-92.

.3 Polyethylene sheet air/vapour barrier materials. These are addressed in CAN/CGSB 51.34 M86.

.4 Pre-engineered and prefabricated air/vapour barrier systems such as curtain wall systems.

1.4 References

.1 The following publications are applicable to this Specification:

.1 Canadian Construction Materials Centre (CCMC)

.2 Technical Guide for Air Barrier Systems for Exterior Walls of Low-Rise Buildings Canadian Standards Association

.3 Guideline on Durability in Building CSA S478-95

.4 Industrial Health and Safety Regulations, WCB of Manitoba

.5 WHMIS

2. PRODUCTS

2.1 Standard of Acceptance

.1 Air/vapour barrier materials which have been evaluated using Technical Guide for Air Barrier Systems for Exterior Walls of Low-Rise Buildings, Masterformat Section 07195, produced by CCMC and meet or exceed the properties as defined in Section 5.0 Technical Requirements, are acceptable for use. The Manufacturer is required to submit a copy of the CCMC evaluation report to the NABA office.

.2 In cases where a CCMC evaluation report is not yet available, the Manufacturers may submit documentation to the NABA office for approval. The documentation must include information on the Product history, the Manufacturer's history, and results from third party Product testing.

.3 Selected air/vapour barrier materials are considered acceptable for application on this project. Contact the NABA office for the latest list of approved Manufacturers.

2.2 Manufacturers Applications Guidelines

.1 The Manufacturers of air barrier membrane materials shall provide installation instructions for their materials. Copies of these instructions shall be provided to the Contract Administrator and to the Certified Applicator(s). Copies shall be kept on-site during air barrier installation for reference. The most current copy of these guidelines is to be filed with the NABA office by the Manufacturers.

2.3 Membrane Materials

.1 Membrane materials shall be approved by the Manufacturer for use on the substrate to which it is being applied and for both the conditions during installation and for the long-term operating conditions of the building.

.2 The Manufacturer shall supply the licensed Contractor and NABA with current laboratory test results for materials provided to the project. Test results shall be from an independent testing agency using approved test methods to establish expected performances of the air barrier membrane.

2.4 Accessory Products and Materials Compatibility

.1 Accessory Products including caulks and sealants, primers, etc. which are in direct contact with, or form part of the air barrier systems must be chemically and physically compatible with the materials to which they are applied and must be approved for that use by their Manufacturer and the Manufacturers of the air barrier materials they contact.

2.5 Delivery and Storage of Materials

.1 Materials shall be delivered to the jobsite in Manufacturer's standard commercial containers unopened, undamaged, and bearing the name of the Manufacturer, name of the

contents/Product code, net weight of contents, lot or batch number, storage temperature limits, shelf life expiration date, and safety information and instructions. Store and protect materials from direct sunlight, extreme temperatures, moisture conditions, chemicals, solvents, etc., as per Manufacturer's recommendations.

2.6 Durability

.1 Product Manufacturers must certify in writing that their Products will meet all the characteristics required by the Guidelines on Durability in Buildings CSA S478-95.

3. EXECUTION

.1 Coordinate Work of this Section with all other applicable Sections to ensure continuity of the air seal.

.2 Except as explicitly permitted by the materials Manufacturer, no installation Work shall be performed on surfaces exposed to inclement weather.

.3 Clean and prepare all substrates in accordance with membrane Manufacturer's application guidelines. Obtain the Certified Applicator’s approval prior to application of membrane or primer, and also before installation of insulation.

.4 Detail Work must be carefully carried out to ensure the air barrier membrane creates a continuous seal at all construction elements such as foundations, roofs and walls, and at junctures of different materials or construction types (curtain wall construction, etc.). Where installation cannot be carried out using the primary membrane compatible and materials, select other materials which suit the application.

.5 Protect finished Work. Close up air barrier membranes as soon as possible after application to protect the membranes from weather, sunlight, and damage by other trades. Insulate over the air barrier membrane immediately after installation, if expected range of environmental concerns on either side of the membrane could result in dew point temperatures occurring within the wall, or if the membrane is on the cold side of a building shell which is being heated from the inside.

.6 Apply transition membrane to prepared surfaces as indicated on Drawings and as required by Site conditions. Follow Manufacturer’s recommendations when installing air barrier membranes across unsupported openings (e.g., around windows, below edge beams, etc.).

.7 The installer shall ensure that the air/vapour barrier material is structurally supported in all areas, including transition areas, according to the requirements of the National Building Code. The material must transfer all applicable loads to the appropriate structure support which can carry all the required loads.

.8 The installer shall comply with all safety precautions, Manufacturers’ instructions, WHMIS, and WCB requirements for materials handling, storage, application and disposal, and regarding labelling and provision of material safety data sheets.

.9 Prior to commencement of Work, the installer shall report in writing to the Contract Administrator any defects in surfaces or conditions which may adversely affect the performance of Products installed under this Section.

4. QUALIFICATIONS OF AIR BARRIER CONTRACTORS AND INSTALLERS

.1 The air barrier Contractor shall be formally recognized as a licensed Contractor by NABA. The Contractor shall carry liability insurance and bonding.

.2 Each worker who is installing air barriers must be either a Certified Applicator or an apprentice who is registered with NABA.

.3 Each Certified Applicator can supervise a maximum of two (2) apprentices. The Certified Applicator shall have journeyman qualifications, defined as either (1) holding a certificate of qualifications or proficiency as an air barrier installer from a recognized authority, or (2) having acquired the skill of the trade by having worked as an air barrier installer for a period of not less than six years. This experience must be documented through project records which have been submitted to NABA for approval

.4 The Certified Applicator shall be thoroughly trained and experienced in the installation of air barriers of the types being applied. Certified Applicators shall perform or directly supervise all air vapour barrier Work on the project.

.5 One (1) person shall be assigned as Designated Applicator for this project. The Designated Applicator shall be a Certified Applicator in good standing with NABA. The Designated Applicator shall assume overall responsibility for installing, testing, and approving all air barrier membranes on the project.

.6 Each air barrier crew shall have available and utilize all adequate and necessary equipment, including safety equipment tools, testing and inspection devices, to execute its Work in accordance with good construction practices.

.7 A pre-job conference between the Contractor, licensed air barrier Contractor, Designated Applicator, the independent air barrier inspector or consultant, Manufacturers Representative, and any other trades affected by installation of the air barrier membrane must be held prior to the start of any installation of the air barrier membrane system. At this conference, installation and performance requirements, testing and inspection schedules, and documentation requirements will be reviewed.

5. QUALITY ASSURANCE

5.1 Work performed must be licensed under NABA Quality Assurance Program. Proof of license and certification is to be submitted to the Contract Administrator.

5.2 Air/vapour barrier installers must be trained and certified by NABA/NECA.

5.3 Testing

.1 The Designated Applicator and the Certified Installers and Apprentices shall routinely inspect and test their Work as they proceed. The results of their testing and inspection efforts shall be recorded in worksheets by the Certified Applicator on the crew and confirmed by the Designated Applicator. These worksheets shall be kept on-site and be available for routine inspection by the City or the air barrier inspector. A copy of the worksheet shall be submitted to NABA on a monthly basis. The cost of these requirements is to be born by the Contractor.

.2 Designated Applicator shall inspect/test all membranes and make all necessary repairs immediately prior to their being permanently covered up. He shall document repairs made and approvals given.

.3 The Designated Applicator shall cooperate with the air barrier inspector/consultant by making construction Drawings and records available to him, including the air barrier worksheets, and providing him with other information as requested. The Designated Applicator shall assist the air barrier inspector/consultant in the performance of his duties by providing him access to scaffolding, swing stages, etc.

5.4 Documentation

.1 The Designated Applicator shall be responsible for documentation and reporting requirements for all the air barrier membranes installed on the project.

.2 Jobsite records kept by the Designated Applicator shall include dates on which membrane was installed, wall areas covered on those dates, name of the Certified Applicator(s) and apprentices, the types and lot numbers of materials used, environmental and substrate conditions including at a minimum temperatures, humidity and cleanliness during installation, variations from Drawings or Specifications, and results of any testing or inspections done by the installation crew. The Designated Applicator's worksheets must identify all areas of substrate for which he has approved application of air barrier membrane. A copy of these worksheets shall be submitted to NABA on a monthly basis.

.3 Both the licensed Contractor and the Designated Applicator are jointly responsible to submit a copy of the worksheets to the NABA office.

5.5 Verification

.1 NABA will conduct random Site verification visits to determine whether the Licensed Contractor and the Certified Installers are conforming to the NABA Specifications and the NABA Quality Assurance Program.

5.6 Inspection

.1 An important part of the Quality Assurance Program is inspections done by an independent air barrier inspector/consultant and which is paid for by the City unless specified otherwise. The inspector/consultant should review the air barrier installation worksheets, and from it do random checks, inspections and tests on the air barrier. Air leakage testing is to be carried out on a specified test area of the exterior wall construction. The test area may remain as part of the new building construction provided it is acceptable. These inspections are intended to ensure quality control of the installed air/vapour barrier system.

.2 The inspection and testing program shall address air tightness, bond strength, and readiness of substrate for application of air/vapour barrier membranes. Testing of the exterior wall construction shall comply with the 1995 NBC. The maximum air leakage rate is to be 0.05 L/s/m^2 at 75 Pa. The standard for the exterior wall construction is to be based upon satisfactory test results of the test area of the exterior wall construction.

Adhesion testing must show 42 kPa (6 psi) minimum.

.3 The City or Contract Administrator may demand verification of the Work on any section of a wall or surface by an infiltration test, carried out by an accredited company. This test shall be used to confirm the quality of materials, installation, and elements affecting the proper functioning of the air/vapour barrier system. The cost of carrying out this test shall be paid by the City.

END OF SECTION

RIGID WALL INSULATION, MOISTURE BARRIER, SHEET AIR / VAPOUR BARRIERS

1. GENERAL

1.1 Work Included

.1 Perimeter foundation insulation

.2 Exterior wall insulation

.3 Sheet air/vapour barrier

1.2 References

.1 ASTM D2842 - Water Absorption of Rigid Cellular Plastics.

.2 CGSB 51-GP-20M - Thermal Insulation, Expanded, Extruded Polystyrene.

.3 CGSB 51-GP-21M - Thermal Insulation, Urethane and Isocyanurate.

1.3 Testing

.1 Testing of the air barrier system will be performed by a testing agency appointed and paid for by the City.

.2 Performance of the air barrier system will be evaluated with respect to Part 5 of the National Building Code of Canada 1995 and as amended by the Manitoba Building Code 1998.

2. PRODUCTS

2.1 Materials

.1 Thermostud channel: Available from Construction Products Division, W.R. Grace & Co. of Canada, Ltd.

2.2 Moisture Barrier

.1 Moisture barrier for below-grade application: Bithuthene 3000.

2.3 Board Insulation

.1 Rigid insulation (foundation): CGSB 51-GP-20M, Type 4, extruded cellular polystyrene, square edges: Celfort by Celfortec; thickness as indicated on Drawings.

.2 Rigid insulation (walls): minimum 610 mm wide glass fibre reinforced polyisocyanurate foam core with reflective foil facer on both sides. Thickness as indicated on Drawings. Thermax as manufactured by Celotex.

.3 Rigid insulation (roof): CGSB 51-GP-20M, Type 4, extruded cellular polystyrene, square edges: 'Roofmate' as manufactured by Dow. Thickness as indicated on Drawings

2.4 Air and Vapour Barrier

.1 Membrane type (wall to foundation): Self-adhesive: SBS modified bitumen membrane reinforced with glass scrim; 1 mm thick minimum; Blueskin SA. Primer to membrane Manufacturers' recommendations. Sealant: To membrane Manufacturers' recommendations. Primer: To membrane Manufacturers' recommendations.

3. EXECUTION

3.1 Preparation

.1 Verify substrate and adjacent materials and insulation boards are dry and ready to receive insulation and adhesive.

.2 Verify substrate surface is flat, free of honeycomb, fins, irregularities and material that will impede adhesion of insulation.

.3 Verify insulation boards are unbroken, free of damage, with face membrane undamaged.

.4 Verify surfaces within walls being insulated have been inspected and accepted.

3.2 Vapour Barrier – Concrete Block Walls

.1 Prime surfaces to membrane Manufacturers' recommendations.

.2 Apply membrane to Manufacturers' recommendations.

.3 Apply membrane horizontally starting at bottom of wall and weather lap 50 mm.

.4 Lap ends 50 mm.

.5 Roll membrane, including seam, with hand roller to ensure full contact.

.6 Cut membrane neatly around projections to form a tight seal. Seal area around any projections with application of sealant.

.7 Seal membrane where it meets the substrate, at the end of the days' Work.

3.3 Board Insulation – Foundation Walls

.1 Install insulation vertically.

.2 Butt edges and ends tight to adjacent board, protrusions or steel studs.

.3 Ensure boards are fitted tight to vapour barrier leaving no voids at joints.

.4 Weatherlap insulation joints.

END OF SECTION

MODIFIED BITUMINOUS MEMBRANE ROOFING

1. GENERAL

1.1 Work Included

.1 Conventional, 2-ply, modified bituminous roofing.

1.2 References

.1 CAN2-51.32M – Sheathing, Membrane, Breather Type

.2 CGSB 51-GP-20M – Thermal Insulation Extruded, Expanded Polystyrene

1.3 System Description

.1 Conventional roof system: two-ply torched on conventional SBS membrane system with insulation and gypsum board on steel deck.

1.4 Qualifications

.1 Applicator: company specializing in performing the Work of this Section with three (3) years documented experience and approved by system Manufacturer.

.2 Work of this Section to conform to Manufacturer's instructions.

1.5 Manufacturer's Representative

.1 The roofing material Manufacturer shall delegate a representative to visit the Work at commencement of Work and periodically during Work in progress.

.2 At all times permit and facilitate access to the Work Site and roofs to the Manufacturer's Representative.

1.6 Delivery, Storage, and Handling

.1 Deliver, store, protect, and handle Products to Site under provisions of the General Specifications Section.

.2 Deliver Products in Manufacturer's original containers, dry, undamaged, seals and labels intact.

.3 Store Products in weather-protected environment, clear of ground and moisture.

.4 Stand roll materials on end.

1.7 Environmental Requirements

.1 Do not apply roofing membrane during inclement weather.

.2 Do not apply roofing membrane to damp or frozen deck surface.

.3 Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed during the same day.

1.8 Warranty

.1 Provide warranty in accordance with General Specification but for a period of five (5) years.

2. PRODUCTS

2.1 Membrane Materials

.1 Membrane Air/Vapour Barrier: Soprema, torch-on.

.2 Membrane Base Sheet, Base and Cap Sheet Flashing: Soprema Sopralene Flam 180.

.1 Description: Roofing membrane with a non-woven polyester reinforcement and thermofusible SBS modified bitumen. Both sides shall be protected by a thermofusible plastic film. This membrane is to be applied by torching only.

.2 Components:

.1 Reinforcement: non-woven polyester, 180 g/m^2

.2 Thermofusible elastomeric bitumen: mix of selected bitumen and SBS thermoplastic polymer.

.3 Membrane Cap Sheet Flashing: Soprema Sopralene Flam 250 GR.

.1 Description: Roofing membrane with a non-woven polyester reinforcement and thermofusible SBS modified bitumen. The top side shall be self-protected with coloured granules. The underside shall be protected by a thermofusible film. This membrane is to be applied to torching only.

.2 Components:

.1 Reinforcement: 250 g/m^2 of non-woven polyester

.2 Elastomeric asphalt: mix of selected bitumen and SBS thermoplastic polymer.

.4 Torchable Self-Adhesive Membrane: “Sopraflam”.

2.2 Sheet Materials

.1 Fibreboard protection board: to CSA-A247-M, Type 2, 13 thick, asphalt impregnated.

.2 Gypsum board: CSA A82.27, sheathing grade, 13 thick, uncoated faces, fire rated.

.3 Torchable overlay: recovery board "Sopraboard" two (2) layers as per Drawings, thickness as indicated.

2.3 Insulation

.1 CGSB 51-GP-20M, flat, Type 4 extruded polystyrene board with skin surface, Roofmate by Dow Chemical. Total thickness of 125 mm. Other acceptable Manufacturers: Celfortec.

.2 Sloped, Type 2 expanded polystyrene board. Minimum thickness: 13mm. Acceptable Manufacturers: Dow Chemical, Celfortec.

3. EXECUTION

3.1 Preparation

.1 Gypsum board: screw gypsum board to metal deck. Butt ends and edges tight. Butt ends over firm bearing.

.2 Insulation: install two (2) layers of insulation, maximum thickness of 75 mm per layer; stagger joints of second layer with joints of first layer. Butt insulation tight with adjacent boards at all edges.

.3 Protection board: mop on one layer of fibreboard. Offset joints of fibreboard with joints of insulation.

.4 Torchable board: mop on one layer of recovery board.

3.2 Roof Membrane

.1 Install roofing membrane to Manufacturer's written instructions.

.2 Base sheet Installation

.1 Base sheet membrane shall be unrolled dry on torchable overlay panels for alignment.

.2 Base sheet shall be torch welded on torchable overlay, in accordance with recommendations of the membrane Manufacturer. Base sheet shall have side laps of 75 mm and end laps of 150 mm.

.3 Make sure the membrane is properly welded, without air pockets, wrinkles, fishmouths, or tears.

.4 Torch welding speed varies depending on the weather. In cold conditions, it slows down, in warm and dry conditions, it speeds up.

.3 Base sheet flashing installation

.1 Surface where membrane is applied shall receive an asphalt primer coating at the rate of 0.25 L/m^2. Primer must be dry before application of the base sheet flashing.

.2 Base sheet shall be laid in strips 1 m wide to the vertical surfaces, extending on to the flat surface of the roof a minimum of 100 mm. Side laps shall be 75 mm and shall be staggered a minimum of 100 mm with the laps of the base sheet in order to avoid excessive thickness.

.3 Base sheet shall be torch welded directly on its support from bottom to top. Torch welding shall soften the underside of the base sheet without overheating, resulting in a uniform adhesion over the entire surface. When allowed by the support, the base sheet top edge shall be nailed on 300 mm centres.

.4 Cap sheet installation

.1 Once the base sheet and stripping has been applied and does not show any defects, the cap sheet can then be laid.

.2 Cap sheet shall be unrolled starting from the lowest point of the roof. Cap sheet shall be rerolled from both ends prior to torching. Care must be taken to ensure alignment of the first roll (parallel with the edge of the roof).

.3 Cap sheet shall be torch welded on to the base sheet membrane. During this application, both surfaces shall be simultaneously melted, forming an asphalt bead that shall be pushed out in front of the cap sheet.

.4 Avoid overheating.

.5 Base sheet and cap sheet shall be staggered a minimum of 300 mm.

.6 Cap sheet shall have side laps of 75 mm and end laps of 150 mm.

.7 Make sure the two (2) membranes are properly welded without unwelded areas.

.8 After installation of the cap sheet, check all lap seams on the cap sheet.

.9 For aesthetics, care should be taken to avoid excessive asphalt seepage along the joints.

.5 Cap sheet flashing installation

.1 Cap sheet stripping shall be laid in strips 1 m wide. There must be at least 150 mm of cap sheet overlap on the deck. Side laps shall be 75 mm and shall be staggered a minimum of 100 mm from cap sheet laps and base sheet laps, in order to avoid excessive thickness.

.2 Cap sheet stripping shall be torch welded directly on its base sheet, proceeding from bottom to top. Torching shall soften the two membranes and ensure a uniform weld. Use a degranulator.

.6 Walkway installation

.1 Install over addition cap sheet (granulated) ply.

.2 Install adhesive between 10° to 35°C and as per Manufacturer's instructions.

3.3 Cleaning

.1 Remove bituminous markings from finished surfaces.

.2 In areas where finished surfaces are soiled caused by Work of this Section, consult Manufacturer of surfaces for cleaning advice and conform to their documented instructions.

.3 Repair or replace defaced or disfigured finish due to Work of this Section.

3.4 Protection

.1 Protect building surfaces against damage from roofing Work.

.2 Where traffic must continue over finished roof membrane, protect surfaces.

3.5 Coordination with Other Trades

.1 Coordinate with electrical and mechanical sub-trades for making all penetrations through roofing weather- and moisture-tight.

END OF SECTION

SHEET METAL FLASHING

1. GENERAL

1.1 Work Included

.1 Parapet cap flashings

.2 Base/drip flashings

.3 Pre-finished Brake Metal

1.2 Reference Standards

.1 CRCA - Canadian Roofing Contractors Association

.2 ASTM A525 - Sheet Steel, Zinc Coated, Galvanized by the Hot-Dip Process

.3 CGSB 37-GP-5M - Sealing Compound, Rubber Asphalt

1.3 Existing Conditions/Protection

.1 Exercise care when working on or about roof surfaces to avoid damaging or puncturing membrane or flexible flashings.

.2 Place plywood panels on roof surfaces to Work of this Section and on access routes. Keep in place until completion of Work.

2. PRODUCTS

2.1 Sheet Metals

.1 Galvanized steel: minimum 24 gauge core steel; conforming to requirements of ASTM A525 G90 Galvanized Coating.

.2 Prefinished galvanized flashing: ASTM A446; G90 zinc coating; 24 gauge core steel; shop precoated; Colour as per schedule.

2.2 Accessory Materials and Components

.1 Fasteners: concealed clip type, of same materials as flashings; sized to suit application.

.2 Rubber-asphalt sealing compound: conforming to requirements of CGSB 37-GP-5M.

.3 Bituminous paint: acid and alkali resistant type; black colour.

2.3 Fabrication

.1 Fabricate metal flashings in accordance with recommendations of CRCA and as indicated on Drawings.

.2 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.

.3 Form sections in 2438 mm (8 ft) lengths. Make allowances for expansion at joints.

.4 All seams are to be flat lock type except corners. Fabricate corners minimum 460 mm, mitred, soldered or welded, and sealed as one (1) piece.

.5 Hem exposed edges of flashings on underside 13 mm.

.6 Backpaint flashing with bituminous paint where expected to be in contact with cementitious materials or dissimilar metals. Fabricate scuppers as detailed.

3. EXECUTION

3.1 Examination

.1 Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, cant strips and reglets in place, and nailing strips located.

.2 Verify membrane termination and base flashings are in place, sealed, and secure.

.3 Beginning of installation means acceptance of existing conditions.

3.2 Preparation

.1 Field measure Site conditions prior to fabricating Work.

.2 Install starter and edge strips, and cleats before starting installation.

3.3 Installation

.1 Install flashings in accordance with CRCA recommendations and as indicated on Drawings.

.2 Secure flashing in place using concealed type fasteners. Use exposed fasteners in locations approved by the Contract Administrator only. When using exposed fasteners, they are to be of the same finish as flashings.

.3 Apply sealing compound at junction of metal flashings and asphalt felt flashings.

.4 Lock seams and end joints. Fit flashing tight in place. Make corners square, surfaces true and straight in all planes and all lines accurate to profiles.

.5 Counter-flash all mechanical and electrical items projecting through.

.6 Install galvanized flashing to all locations indicated on Drawings.

.7 Install pre-finished flashing to all locations indicated on Drawings.

.8 Seal metal joints watertight.

END OF SECTION

SEALANTS AND CAULKING

1. GENERAL

1.1 Work Included

.1 Supply and installation of all sealant and backing materials as required.

1.2 Environmental Conditions

.1 Sealant and substrate materials to be minimum 5°C.

.2 Should it become necessary to apply sealants below 5°C, consult sealant Manufacturer and follow their recommendations.

1.3 Reference Standards

.1 CSA 19-GP-13M - Sealing Compound, One Component, Elastomeric, Chemical Curing.

.2 CGSB 19-GP-22M - Sealing Compound, One Component, Silicone Base, Chemical Curing - Mildew Resistant.

.3 CGSB 19-GP-17M - Sealing Compound, One Component, Acrylic Emulsion Base.

1.4 Warranty

.1 Provide warranty in accordance with General Specification, but for three (3) years.

.2 Warranty: Include coverage of installed sealants and accessories which fail to achieve air tight and watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

2. PRODUCTS

2.1 Materials

.1 Primers: type recommended by sealant Manufacturer.

.2 Joint fillers

.1 General: compatible with primers and sealants, outsized 30 to 50%.

.2 Polyethylene, urethane, neoprene or vinyl: extruded closed cell foam, Shore A hardness 20, tensile strength 140 to 200 kPa.

.3 Neoprene or butyl rubber: round solid rod, Shore A hardness 70.

.4 Polyvinyl chloride or neoprene: extruded tubing with 6mm minimum thick walls.

.5 Impregnated precompressed polyurethane foam sealant tape. Acceptable Product: Emseal "Grayflex".

.3 Bond breaker: pressure sensitive plastic tape, which will not bond to sealants.

.4 Sealants

.1 Sealant shall be UV-resistant and ozone resistant, capable of supporting their own weight, conforming to CAN2-19.13.

.2 Sealants for vertical and horizontal non-traffic bearing joints, to Table 1, CGSB19-GP-23.

.3 Colour of sealants shall match adjacent surface. Colours to be selected by the Contract Administrator, from standard colour range.

.4 Joint cleaner: xylol, methylethyleketon or non-corrosive type recommended by sealant Manufacturer and compatible with joint forming materials.

2.2 Acceptable Products

.1 For all non-traffic bearing joints unless indicated otherwise Dow Corning No. 790.

.2 For joints between exterior doors, windows, ductwork, etc., and adjacent materials: Dow Corning No. 795.

3. EXECUTION

3.1 Preparation

.1 Remove dust, paint, loose mortar and other foreign matter. Dry joint surfaces.

.2 Remove rust, mill scale and coatings from ferrous metals by wire brush, grinding or sandblasting.

.3 Remove oil, grease, and other coatings from nonferrous metals with joint cleaner.

.4 Prepare concrete, glazed, and vitreous surfaces to sealant Manufacturer's instructions.

.5 Examine joint sizes and correct to achieve depth ratio one-half of joint width with minimum width and depth of 6 mm, maximum width 25 mm.

.6 Install joint filler to achieve correct joint depth.

.7 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.

.8 Apply bond breaker tape where required to Manufacturer's instructions.

.9 Prime sides of joints in accordance with sealant Manufacturer's instructions immediately prior to caulking.

3.2 Application

.1 Apply sealants, primers, joint fillers, bond breakers, to Manufacturer's instructions. Apply sealant using gun with proper size nozzle. Use sufficient pressure to fill voids and joints solid. Superficial pointing with skin bead is not acceptable.

.2 Apply sealant to joints between door frames to adjacent building components, around perimeter of every external opening, to control joints in concrete slabs and where indicated.

END OF SECTION

METAL DOORS AND FRAMES

1. GENERAL

1.1 Work Included

.1 Non-rated and fire rated rolled steel frames

.2 Non-rated and fire rated hollow steel doors

1.2 Related Sections

.1 Door Hardware: Section 08700

.2 Painting: Field painting of frames: Section 09900.

1.3 References

.1 Canadian Steel Door and Frame Manufacturers Association - Manufacturing Standard for Steel Doors and Frames.

.2 Canadian Steel Door and Frame Manufacturers Association - Canadian Fire Labelling Guide for Steel Doors and Frames.

1.4 Quality Assurance

.1 Conform to requirements of Canadian Steel Door and Frame Manufacturers Association Standards.

.2 Fire rated construction to conform to ULC standards.

1.5 Shop Drawings and Product Data

.1 Submit Shop Drawings and Product data to requirements of Section 01300.

.2 Indicate on Shop Drawings, frame configuration, anchor types and spacings, location of cutouts for hardware, reinforcement and finish.

.3 Indicate on Shop Drawings, door elevations, internal reinforcement, and closure method, and location of cutouts for glazing.

2. PRODUCTS

2.1 Acceptable Manufacturers

.1 Macotta

.2 Allmar

.3 Shanahans

2.2 Frames

.1 Type/Size: as shown on Drawings and Schedules.

.2 Frames: 1.52 mm (16 gauge) cold rolled sheet steel with ZF75 Colourbond coating.

.3 Bumpers: Resilient rubber.

.4 Anchors: purpose made to rigidly secure frames, 3 per jamb.

.5 Mortar Guard Boxes: 0.76 mm (22 gauge) welded in place.

.6 Primer: zinc chromate type.

.7 Insulation: Sprayed-in Polyurethane Foam.

2.3 Doors

.1 Insulated Core Doors: minimum 1.21 mm (18 gauge.) surface sheets, and top and bottom end channels; cores filled with insulation.

.2 Honeycomb Core Doors: minimum 1.21 mm (18 gauge) surface sheets and 1.21 mm (18 gauge) thick top and bottom end channels; cores filled with honeycomb material laminated under pressure to surface sheets.

.3 Reinforcement for hardware:

.1 Locks: minimum 1.52 mm (16 gauge) steel.

.2 Butts: minimum 3.42 mm (10 gauge) steel.

.3 Flush Bolts: minimum 3.42 mm (10 gauge) steel

.4 Door Closures: minimum 1.9 (14 gauge) mm steel.

.5 Door Holders: minimum 1.9 mm (14 gauge) steel.

2.4 Fabrication - Frames

.1 Fabricate frames as welded unit.

.2 Fabricate frames with hardware reinforcement plates welded in place. Provide mortar guard boxes.

.3 Prepare frame for silencers. Provide three (3) single silencers for single doors and mullions of double doors on strike side, and two single silencers on frame head at double doors without mullions.

.4 Attach channel spreaders at bottom of frames for shipping.

.5 Reinforce exterior frames at lock side, to prevent frame distortion.

2.5 Fabrication -Doors

.1 Fabricate hollow metal doors and panels in accordance with requirements of "Canadian Manufacturing Standards for Steel Doors and Frames" produced by the Canadian Steel Door and Frame Manufacturer's Association and as indicated on Drawings.

.2 Fabricate fire rated hollow metal doors in accordance with requirements of ULC. Place ULC labels where visible when in installed position.

.3 All doors in fire rated walls shall be listed and labelled with a maximum temperature rise limitation of 250°C after 30 minutes in accordance with the National Building Code.

.4 Mechanically interlock longitudinal seams of honeycomb core type doors weld seams and sand flush. Top and bottom of doors closed with end channels recessed and spot welded in place.

.5 Reinforce and prepare doors to receive hardware. Refer to Section 08700 for hardware requirements.

.6 Each exterior hollow metal door to be supplied complete with a full length 3.42 mm (10 gauge) anti-intrusion plate welded to latch side of door.

3. EXECUTION

3.1 Installation

.1 Install doors and frames in accordance with Canadian Steel Door and Frame Manufacturers Association standards.

.2 Install roll formed steel reinforcement channels between two abutting frames. Anchor to structure and floor.

.3 After installation, touch up all scratched or damaged surface and prime.

.4 Insulate all frames exposed to the exterior.

3.2 Tolerances

.1 Maximum diagonal distortion: 2 mm measured with straight edge, corner to corner.

END OF SECTION

OVERHEAD SECTIONAL DOORS

1. GENERAL

1.1 Related Documents

.1 All of the Contract Documents, including General and Supplementary Conditions, and Division 1 General Requirements, apply to the Work of this Section.

1.2 Summary

.1 The Work of this Section includes upward-acting sectional doors.

.2 Related Sections: other Specification Sections which directly relate to the Work of this Section include, but are not limited to, the following:

.1 Section 05500 Miscellaneous Metal; metal framing and supports.

.2 Section 08710 Finish Hardware; key cylinders for locks.

.3 Section 09900 Painting; field painting.

.4 Section 16100 Electrical; wiring.

1.3 Submittals

.1 Product Data: submit manufacturer's product data and installation instructions for each type of sectional door. Include both published data and any specific data prepared for this project.

.2 Shop Drawings: submit Shop Drawings for approval prior to fabrication. Include detailed plans, elevations, details of framing members, required clearances, anchors, and accessories. Include relationship with adjacent materials.

1.4 Quality Assurance

.1 Manufacturer: sectional doors shall be manufactured by a firm with a minimum of five years experience in the fabrication and installation of sectional doors. Manufacturers proposed for use, which are not named in these specifications, shall submit evidence of ability to meet performance and fabrication requirements specified, and include a list of five projects of similar design and complexity completed within the past five years.

.2 Installer: installation of sectional doors shall be performed by the authorized representative of the manufacturer.

.3 Single-source responsibility: provide doors, tracks, motors, and accessories from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.

.4 Pre-installation conference: schedule and convene a pre-installation conference just prior to commencement of field operations, to establish procedures to maintain optimum working conditions and to coordinate this Work with related and adjacent Work.

1.5 Delivery, Storage, and Handling

.1 Deliver materials and products in labeled protective packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from damage from weather, excessive temperatures and construction operations.

2. PRODUCTS

2.1 Acceptable Manufacturer

.1 Provide sectional doors by Overhead Door Corporation, Dallas, Texas; Telephone 800-887-3667 or 214-233-6611; Fax 214-233-0367.

2.2 THERMACORE® INSULATED STEEL SECTION DOORS

.1 Trade Reference: 595 Series Thermacore® Insulated Steel Doors by Overhead Door Corporation.

.2 Sectional Door Assembly: metal-foam-metal sandwich panel construction, with EPDM termal break and ship-lap design. Units shall have the following characteristics:

.1 Panel Thickness: 41 mm (1-5/8 inch)

.2 Exterior Surface: flush, textured.

.3 Exterior Steel: 20 gauge, hot-dipped galvanized.

.4 End Stiles: 16 gauge.

.5 Standard Springs: 10,000 cycles. (High cycles.)

.6 Insulation: CFC-free and HCFC-free polyurethane, fully encapsulated.

.7 Thermal Values: R-value of 14.86; U-value of 0.067.

.8 Air Infiltration: 0.0025 m^3/min at 27 km/h (0.09 cfm at 15 mph); 0.0023 m^3/min at 40 km/h (0.08 cfm at 25 mph).

.9 Sound Transmission: Class 26

.10 Pass-Door: not required

.11 High-Usage Package: not required

.12 Partial Glazing of Steel Panels: not required

.13 Full Glazing Requiring Aluminum Sash Panels: not required

.3 Finish and colour: two-coat baked-on polyester with white exterior and white interior colour.

.4 Windload design: ANSI/DASMA 102 standards and as required by code.

.5 Hardware: galvanized steel hinges and fixtures. Ball bearing rollers with hardened steel races.

.6 Lock: interior mounted slide lock

.7 Weatherstripping: EPDM rubber bulb-type strip at bottom, header seal and jamb weatherstripping

.8 Track: provide track as recommended by manufacturer to suit loading required and clearances available

.9 Manual operation: chain hoist

.10 Electric motor operation: provide UL-listed electric operator, size and type as recommended by manufacturer to move door in either direction at not less than 200 mm/s (8 inches/s) nor more than 300 mm/s (1 ft/s).

.1 Entrapment protection: pneumatic sensing edge up to 5486 mm wide.

.2 Operator controls: pushbutton operated control stations with open, close, and stop buttons for surface mounting, for interior location.

.11 Special operation: none.

3. EXECUTION

3.1 Preparation

.1 Take field dimensions and examine conditions of substrates, supports, and other conditions under which this work is to be performed. Do not proceed with work until unsatisfactory conditions are corrected. .

3.2 Installation

.1 Strictly comply with manufacturer's installation instructions and recommendations. Coordinate installation with adjacent work to ensure proper clearances and allow for maintenance.

.2 Instruct City's personnel in proper operating procedures and maintenance schedule.

3.3 Adjusting and Cleaning

.1 Test sectional doors for proper operation and adjust as necessary to provide proper operation without binding or distortion.

.2 Touch-up damaged coatings and finishes and repair minor damage. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer of material or product being cleaned.

END OF SECTION

DOOR HARDWARE

1. GENERAL

1.1 Work Included

.1 Hardware for hollow metal doors

.2 Thresholds and weatherstripping

1.2 Related Sections

.1 Metal Doors and Frames: Section 08100

1.3 References

.1 ULC - List of Equipment and Materials, Volume 2.

1.4 Coordination

.1 Coordinate Work of this Section with other directly affected Sections involving Manufacturer of and internal reinforcement for door hardware.

.2 Supply templates to Manufacturers of components affected by hardware.

1.5 Regulatory Requirements

.1 Conform to applicable code for requirements applicable to fire rated doors, frames and hardware.

.2 Conform to ULC requirements for fire rated doors, frames and hardware.

1.6 Shop Drawings

.1 Submit Shop Drawings to requirements of Section 01300.

.2 Indicate on Shop Drawings, locations and mounting heights of each type of hardware.

.3 Hardware list shall list each door individually and shall list hardware for each door as a described item, not by a code as is done in the Specification. Hardware list shall be in terminology understandable by a layman.

.4 Supply templates to door and frame Manufacturer to enable accurate sizes, locations of cut outs, and reinforcement for hardware.

.5 Provide Product data on specified hardware as requested.

.6 Submit one (1) copy of Manufacturers' catalogue cuts of each item, with hardware list.

.7 Put parts lists, Manufacturer's instructions, and catalogue cuts into maintenance manual as per Section 01300.

1.7 Delivery and Storage

.1 Store hardware in locked, dry area in individual packages or like groups.

2. PRODUCTS

2.1 Materials

.1 As per schedule on drawings.

.2 Use Products from a single Manufacturer for all similar items.

2.2 Door Hardware

.1 Butts: Provide 1-1/2 pair for all doors, except doors over 900 mm wide or over 2,200 mm high are to have two (2) pairs.

.2 Protective plates: supply to both sides of door unless otherwise specified.

2.3 Fasteners

.1 Supply all fastening devices for installation and operation of hardware.

.2 All exposed fasteners to be finished to match hardware.

.3 Use fasteners compatible with material through which they pass.

2.4 Keying

.1 Door locks: Use construction cylinders to allow for a grand master key system to match existing system by Medeco to be installed @ a later date.

.2 Supply three (3) keys for each lock. Supply three (3) master keys for each group, and three (3) grand master keys.

3. EXECUTION

3.1 Inspection

.1 Verify that door and frame components are ready to receive Work and dimensions are as required.

.2 Beginning of installation means acceptance of existing conditions.

3.2 Installation

.1 Install hardware in accordance with Manufacturer's instructions.

.2 Install locksets as specified with construction cylinder for later installation of Medeco cylinder keying system by owner.

.3 Use the templates provided by hardware item Manufacturer.

.4 Maintain the following mounting heights for doors, from finished floor to centre line of hardware item:

.1 Locksets: 1020 mm

.2 Dead locks: 1525 mm

.3 Exit devices: 1020 mm

3.3 Schedule

.1 Refer to Architectural Drawings.

END OF SECTION

STUCCO SYSTEM

1. GENERAL

1.1 Work Included

.1 Provide all labour, materials, methods, equipment, accessories to complete exterior wall stucco systems.

.1 Exterior stucco systems with coloured finish coats

.2 Metal suspension system, metal lath, metal furring, reinforcing mesh

.3 Metal accessories, trims, control joints

1.2 Related Documents

.1 Drawings, General Conditions and Divisions 1, 6, 7, and 9.

1.3 Samples

.1 Submit samples of any and all materials, stucco finishes requested, prepaid to Contract Administrator's office.

.2 Submit sample panels of stucco pattern, colours, finish for Contract Administrator approval prior to application, as finished Work standard.

1.4 Codes/Standards

.1 .Perform lath, stucco, cement plaster parging Work to CSA A82.30-M1980.

1.5 Materials Delivery, Storage, and Handling

.1 Deliver, store cement, lime, other manufactured materials in unbroken bags, barrels, packages, suitable containers, plainly marked prevent, labeled with Manufacturer's name and brand.

.2 Deliver and handle materials to prevent inclusion of foreign material, damage of materials by water, or breakage.

.3 Protect perishable materials, store in weathertight structures on floors maximum 300 mm above adjoining grade.

.4 Store aggregates in clean bins, on platforms having hard clean surfaces. Use positive means to prevent inclusion of foreign materials.

.5 Remove hardened or partially set cement, other cementious materials from Site.

.6 Thaw frozen aggregates before using. Permit aggregates (and aggregates produced or manipulated by hydraulic methods) to drain for twelve (12) hours before use.

1.6 Environmental Requirements

.1 Use only unfrozen materials. Apply cement stucco only to substrates free of frost.

.2 Perform, maintain cement stucco Work at ambient and substrate temperature above 10°C, below 30°C minimum twenty-four (24) hours prior, during application and for twenty-four (24) hours after.

.3 Stop cement stucco parging Work when ambient temperature might be expected to drop below 5°C within four (4) weeks after application.

2. PRODUCTS

2.1 Materials

.1 Water: to CSA A 179-M1976, clean, fresh, potable, free of acid, alum, oils, alkalies, salts, organic or mineral matter, other deleterious substances.

.2 Portland cement: to CAN/CSA –A5/A8/A362-M88, normal, type 10.

.3 Sand aggregate: to ASTM C897, CSA A82.57-M1977 (R9184), Table 1, approved colour, natural or manufactured, fresh water washed.

.4 Bonding agent: to ASTM C932, non-oxidizing, non-crystallizing, to improve bond strength, adhesion.

.5 Finish Coat: To match existing finish, Custom colour additives: pre-manufactured precision formulated custom colour pigments in dry powder form for addition to Imasco Premix 1000 stucco finish coat mixes, two (2) colours to be selected by Contract Administrator.

.6 Metal lath: to ASTM C841, CSA A82.30-M1980, Table 1 self-furring, diamond mesh, 1.85 kg/m^2 (3.4 lb./sq yd), galvanized.

.7 Tie wire: No. 16 gauge galvanized soft annealed steel.

.8 Fasteners: to CSA B111, screw type, corrosion resistant, galvanized, minimum 13 mm dia., sizes required to secure lath, sufficient length to penetrate insulation thickness, gypsum wallboard, 25.4 mm into steel stud, steel furring systems, to securely retain lath to Contract Administrator approval.

.9 Metal accessories, trim: to CSA A82.30, base screeds, cornerite, casing beads, control/expansion joints, perimeter vented reveal edge mouldings, perforated embedment flanges, interior corner reinforcement, weep and drip screeds, reveals, etc. as required to complete stucco installations.

2.2 Stucco, Cement Parging Mixes

.1 Mix stucco, cement plaster parging in accordance with CSA A82.30-1980.

.2 Mechanically mix exterior wall stucco systems base coats, finish coats in strict accordance with Manufacturer instructions, their field representative directions.

3. EXECUTION

3.1 Protection

.1 Do not stucco, plaster adjacent to aluminum, masonry, other finished Work until such Work is masked. Protect completed Work, other Sections Work form marking, staining, other damage, etc. use non-staining covers.

.2 Provide adequate protection from contaminates and weather for substrates prior to stucco applications, to stucco applications. Maintain in place until stucco cured.

3.2 Preparation

.1 Obtain, make ready, prepare all materials. Cause no delay to scheduling.

.2 Prepare surfaces to receive stucco finishes, cement plaster to CSA A82.30.

.3 Ensure grounds, screeds, beads, accessories, expansion/control joints, etc. in place.

.4 Ensure insulation properly installed, exterior building paper applied prior to lath application.

.5 Report any unsatisfactory conditions to Contract Administrator in writing. Commence Work when unsatisfactory conditions corrected.

3.3 Metal Lath

.1 Apply metal lath horizontally over building paper, secure to Insulok channels of insulation system where indicated with approved metal screw fasteners 600 mm o.c. horizontally, 150 mm o.c. vertically, at each bearing.

.2 Apply metal lath horizontally over face brick and concrete with approved metal screw fasteners 400 mm o.c. horizontally, 150 mm o.c. vertically, at each bearing.

.3 Apply metal lath horizontally over insulation, wood blocking to depth below grade indicated, minimum 300 mm, secure to concrete grade beams, walls with approved large head nails to wood blocking 400 mm o.c. horizontally, 150 mm o.c. vertically.

.4 Apply lath with long dimension at right angle to bearing, end joints over framing members. Lap all joints not less than 50 mm. Stagger end joints. Wire tie ends joints 100 mm o.c.

.5 Reinforce exterior, interior corners diagonally at each corner of openings exceeding one sq. ft. with vertical strips of wire lath. Internal corners. Do not use No. 1A expanded corner beads for exterior corners. Lath across dissimilar substrate junctures with minimum 200 mm wide lath strips.

3.4 Stucco Trim, Accessories, Etc. Installation

.1 Erect trims, accessories, etc. straight, plumb, level, rigid, at proper plane, in full lengths, secure at maximum 200 mm o.c.

.2 Install plaster stops, make trowel cuts to provide 6 mm clearance where objects penetrate through, into stucco, cement plaster parging to allow unrestricted shrinkage. Fully seal with back-up rod, approved caulking. Provide plaster stops where stucco, cement plaster parging abuts other materials, surfaces.

3.5 Control, Expansion Joint Installation

.1 Locate control/expansion joints at dissimilar materials, building expansion/control joints, wall spacing indicated, as required by Contract Administrator.

.2 Apply stucco system to clean, adequately prepared surfaces free from dust, dirt or other deleterious substances.

.3 Prepare, mix, apply 19 mm thick Greatwall Basecoat Concentrate system in strict accordance with Imasco Minerals Inc. written instructions, recommendations.

.4 Apply stucco base coats to entire wall surfaces interrupted only at junctions of plaster planes, at openings, control joints in on continuous operation using trowel or machine.

.5 Apply scratch coat to completely embed lath to minimum thickness 10 mm, allow 3 mm shallow scoring of surface. Allow to stiffen on wall surfaces, hard and rigid on horizontal soffit surfaces.

.6 Apply brown coat to maximum 10 mm thickness over fine spray dampened scratch coat with sufficient pressure to ensure tight, uniform bond to scratch coat, to bring combined total thickness to 19 mm.

.7 Rod brown coat to true, even plane, filling surface defects. Trowel float surfaces uniformly after it has set, when moisture still present.

.8 Moist cure stucco base coats if required by climatic conditions to maintain uniformly moist for minimum 48 hours. Provide adequate protection to retard evaporation when extreme conditions, hot, dry, windy weather occur. Use plastic sheets, other approved coverings.

.9 Prepare, mix, apply stucco finish coat systems in strict accordance with Imasco Minerals Inc. written instructions, recommendation.

.10 Install finish coat systems with enough workers to apply material in one continuous operation to finish entire sections of wall, soffit areas at one time. Interrupt applications only at natural breaks, expansion joints, change of plane, etc.

.11 Avoid application of separate batches of finish side by side, in direct sunlight or excessive wind, late in day if dew imminent, temperature below 10°C in twenty-four (24) hours.

.12 Spread on even coat of finish coat material using a trowel, always working away from a wet edge.

.13 Use pairs of applicators with first person applying finish, second person floating or trowelling finish to desired texture.

.14 Cure applied finish coat materials in strict accordance with Manufacturer's system requirements.

.15 Provide adequate protection, including plastic sheet coverings, to retard evaporation when extreme conditions occur.

.16 Allow finish coat "Premix 1000" a minimum of twenty-four (24) hours to set, with sufficient moisture retained, applied for proper hydration, prevent shrinkage.

3.6 Clean-up

.1 Clean-up rubbish, debris, resulting from Work promptly as proceeds, at conclusion, and at other times as directed by the Contract Administrator. Remove from Site.

END OF SECTION

PAINTING AND FINISHING

1. GENERAL

1.1 Work Included

.1 Prepare surfaces which are to receive finish.

.2 Finish surfaces as indicated in the schedule at the end of this Section.

1.2 Related Sections

.1 Cast-in-Place Concrete: Section 03300

.2 Concrete Unit Masonry: Section 04220

.3 Steel Joists: Section 05210

.4 Metal Deck: Section 05311

.5 Metal Fabrications: Prime painting: Section 05500

.6 Epoxy Floor Coating Stonkote GS4: Section 09730

.7 Room Finish Schedule: Architectural Drawings

.8 Field Applied Corrosion Protective and Maintenance Coatings: Section 11900

.9 Factory Applied Corrosion Protective and Maintenance Coatings: Section 11901

.10 Process Piping: Section 15050

.11 Mechanical Piping and Ductwork: Division 15

1.3 Quality Assurance

.1 Acceptable Manufacturers, materials, workmanship and all items affecting the Work of this Section are to be in accordance with CPCA Architectural Painting Specification Manual.

.2 Prior to ordering paints, submit to the Contract Administrator for review a complete schedule of paint materials proposed for use. This schedule shall include Manufacturer's name, brand name or code number, type and recommended application.

1.4 Colour Schedule

.1 Paint colours shall be as per room finish schedule and as selected by the Contract Administrator.

.2 Prior to commencement of Work, the Contract Administrator will furnish three (3) copies of colour schedule.

1.5 Samples

.1 Prepare 300 mm x 200 mm samples of paint type finishes when requested by Contract Administrator. Apply finishes on identical type materials to which they will be applied on job.

.2 Identify each sample as to finish, colour name and number and sheen name and gloss units.

1.6 Delivery

.1 Deliver paint materials in sealed original labelled containers, bearing Manufacturers name, type of paint, brand name, colour designation and instructions for mixing or reducing.

1.7 Storage

.1 Provide adequate storage facilities. Store paint materials at a minimum ambient temperature of 8°C and in a well ventilated area.

.2 Take all precautionary measures to prevent fire hazards and spontaneous combustion.

1.8 Environmental Conditions

.1 Ensure surface temperatures or the surrounding air temperature is above 5°C before applying finishes. Minimum application temperatures for latex paints for interior Work is 7°C and for exterior Work 10°C.

.2 Provide adequate continuous ventilation and sufficient heating facilities to maintain temperatures above 7°C for twenty-four (24) hours before, during and forty-eight (48) hours after application of finishes.

.3 Provide minimum 300 Lux of lighting on surfaces to be finished.

1.9 Protection

.1 Adequately protect other surfaces from paint and damage. Make good any damage as a result of inadequate or unsuitable protection.

.2 Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.

.3 Place cotton waste, cloths and material which may constitute a fire hazard in closed metal containers and remove daily from Site.

.4 Remove all electrical plates, surface hardware, fittings and fastenings, prior to painting operations. These items are to be carefully stored, cleaned and replaced on completion of Work in each area. Do not use solvents that may remove the permanent lacquer finish to clean hardware.

2. PRODUCTS

2.1 Materials

.1 Paint materials to be Products of a single Manufacturer.

.2 All painting materials shall be the best quality and shall be accepted by the Contract Administrator.

.3 Paint shall not be settled, caked or thickened in the container, shall be readily dispersed with a paddle to a smooth consistency, and shall have excellent application properties.

.4 Paint shall arrive on the job colour-mixed except for tinting of undercoats and possible thinning.

.5 All thinning and tinting materials shall be as recommended by the Manufacturer for the particular material thinned or tinted.

.6 Mixed colours shall match colour selection made by the Contract Administrator prior to application of the coating.

.7 Paint shall be ready mixed except field catalyzed coatings. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating.

.8 Paint shall have good flow and brushing properties, and be capable of drying or curing free of streaks or sags.

.9 Paint accessory materials: Linseed oil, shellac, turpentine, and other materials not specifically indicated but required to achieve the finishes specified, of commercial quality.

.10 Paint Acceptable Manufacturers: Pratt & Lambert, Benjamin Moore, C.I.L.,

.11 Specialty Coatings Acceptable Manufacturer shall be ARC FR system.

3. EXECUTION

3.1 Conditions of Surfaces

.1 Thoroughly examine all surfaces schedule to be painted prior to commencement of Work. Report in writing to the Contract Administrator any condition that may potentially affect proper application. Do not commence until all such defects have been corrected.

.2 Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below maximums established by the paint Manufacturer.

.3 Beginning of installation means acceptance of existing surfaces.

3.2 Preparation of Surfaces

.1 Impervious Surfaces: remove mildew by scrubbing with a solution of TSP and bleach. Rinse with clean water and allow surface to dry completely.

.2 Insulated Surfaces: remove dirt, grease and oil from canvas and cotton insulated coverings.

.3 Aluminum Surfaces scheduled for Paint Finish: remove contamination by steam, high pressure water or solvent washing. Remove acid etch and solvent washing. Apply etching primer immediately following cleaning.

.4 Galvanized surfaces: remove surface contamination and oils from surfaces and wash with solvent. Apply a coat of etching type primer.

.5 Zinc coated surfaces: remove surface contamination and oils from surfaces and prepare for priming in accordance with metal Manufacturers recommendations.

.6 Remove stains caused by weathering of corroding metals from concrete with a solution of sodium metasilicate after being thoroughly wetted with water. Allow to thoroughly dry.

.7 Steel and iron surfaces: remove grease, rust, scale, dirt and dust from surfaces. Where heavy coatings of scale are evident, remove by wire brushing, sandblasting or any other necessary method. Ensure all steel surfaces are satisfactory before paint finishing.

.8 Wood items and millwork: wipe off dust and grit from all miscellaneous wood items and millwork prior to priming. Spot coat knots, pitch streaks and sappy sections with sealer. Fill all nail holes and cracks after primer has dried and sand between coats. Back prime interior and exterior woodwork.

.9 Unprimed steel surfaces: clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts and nuts are similarly cleaned. Prime surfaces to identify defects. Prime paint after defects have been remedied.

.10 Copper surfaces scheduled for a paint finish: Remove contamination by steam, high pressure water, or solvent washing. Apply vinyl etch primer immediately following cleaning.

.11 Concrete and unit masonry surfaces scheduled to receive paint finish: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate, rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.

.12 Specialty Coating for UV shall be prepared for according to any additional instructions by Manufacturer.

3.3 Applications

.1 Apply paint and other finishes in accordance with good trade practice.

.2 Finishes specified are intended to cover surfaces satisfactorily when applied in accordance with Manufacturer's recommendations.

.3 Apply each coat at the proper consistency.

.4 Each coat of paint is to be slightly darker than the preceding coat unless otherwise acceptable to the Contract Administrator.

.5 Sand lightly between coats to achieve required finish.

.6 Do not apply finishes on surfaces that are not sufficiently dry.

.7 Allow each coat of finish to dry before a following coat is applied, unless directed otherwise by Manufacturer.

3.4 Process, Mechanical, and Electrical Equipment

.1 Refer to Process, Mechanical, and Electrical Sections with respect to painting and finishing requirements.

.2 Remove grilles, covers and access panels for mechanical and electrical systems from location and paint separately.

.3 Finish paint primed equipment.

.4 Prime and paint insulated and exposed pipes, conduits, boxes, hangers, brackets, collars and supports to match adjacent Work, except where items are plated or pre-finished unless otherwise noted as being painted as separate colour than surrounding Work - refer to Section 15010.

.5 Replace identification markings on mechanical or electrical equipment when painted over or spattered.

.6 Paint interior surfaces of air ducts, convector and baseboard heating cabinets that are visible through grilles and louvres with one (1) coat of flat black paint to limit of sight line. Paint dampers exposed behind louvres, grilles, convector and baseboard cabinets to match face panels.

.7 Paint exposed conduit and electrical equipment occurring in finished areas including baseboard heaters and force flow heaters. Colour and texture are to be selected by Contract Administrator.

.8 Paint both sides and edges of plywood backboards for electrical equipment before installing backboards and before mounting equipment on them.

.9 Colour coding equipment, piping, conduit and exposed ductwork and all colour banding and identification (flow arrows, naming, numbering, etc.) shall be performed to the requirements of Divisions 11 and 15. Piping and ductwork not required to be coded shall be painted in accordance with Mechanical and Process colour schedules.

.10 Paint all exposed exterior mechanical and electrical equipment that has not been factory finished.

.11 Ductwork and piping in truck bay to be finished with epoxy paint.

3.5 Protection

.1 Protect other surfaces from paint or damage. Repair damage.

.2 Furnish drop cloths, shields, and protective methods to prevent spray or droppings from disfiguring other surfaces.

.3 Collect cotton waste, cloths and material which may constitute a fire hazard, place in closed metal containers and remove daily from Site.

3.6 Cleaning

.1 As Work proceeds and upon completion, promptly remove all paint where spilled, splashed or spattered.

.2 During the progress of Work keep the premises free from any unnecessary accumulation of tools, equipment, surplus materials and debris.

.3 Upon completion of Work leave premises neat and clean, to the satisfaction of the Contract Administrator.

3.7 Painting and Finishing Schedule

.1 Exterior Painting

.1 Primed metal surface:

.1 Touch up with zinc chromate primer

.2 Two (2) coats exterior alkyd semi-gloss enamel

.2 Galvanized coated metal surfaces:

.1 One (1) coat zinc chromate primer

.2 Two (2) coats exterior alkyd semi-gloss enamel

.3 Steel - Unprimed

.1 One (1) coat zinc chromate primer

.2 Two (2) coats alkyd enamel semi-gloss

.2 Interior Painting:

.1 Primed Metal Surfaces:

.1 One (1) coat enamel undercoat

.2 Two (2) coats alkyd semi-gloss enamel

.2 Galvanized Metal Surfaces:

.1 One (1) coat galvanized iron primer

.2 Two (2) coats alkyd semi-gloss

.3 Concrete Block and Concrete

.1 One (1) coat latex block filler

.2 Two (2) coats alkyd enamel semi-gloss finish

END OF SECTION

SPECIALTY CHEMICAL RESISTANT COATINGS

1. GENERAL

1.1 Work Included

.1 Provide all labour, equipment and materials to complete supply and install of specialty and coved base coatings.

1.2 Submittals

.1 Prior to commencing work submit manufacturers technical data and installation instructions.

.2 Submit manufacturers certificate of compliance that the materials meet specification requirements.

.3 Submit two 150 x 150 samples of specified item.

1.3 Delivery and Storage

.1 Materials shall be delivered to site in manufacturer's original un-opened containers.

.2 Materials shall be stored indoors protected from damage moisture, direct sunlight and stored in temperatures as per manufacturer's specifications.

2. PRODUCTS

2.1 Manufacturer

.1 Acceptable Manufacturer: KCC Containment linings.

2.2 Materials

.1 Elasti-Liner I & II

3. EXECUTION

3.1 Preparation

.1 Concrete must have sufficient tensile strength (1.7 MPa). The surface must be clean and dry, physically sound and free of contamination. Surfaces must be free of holes, voids or defects. Cracks and abrupt changes in surface profile must not exceed 3.2 mm. Fins and projections must be removed. All curing compounds and sealers must be removed.

.2 Verify that the moisture content of substrate is within the acceptable range to flooring manufacturer.

.3 Contractor must report in writing, surfaces left in improper conditions by other trades. Application will constitute acceptance of surfaces by the applicator.

.4 Prepare all surfaces to receive coating according to contract documents by shot-blast or similar mechanical method as recommended by manufacturer.

.5 Patch all depressions divets honey-comb or scaled concrete with concrete filler as recommended by manufacturer.

3.2 Installation

.1 Comply with manufacturer's recommendations for preparation, priming, and coatings application including mil thicknesses

.2 Prepare surface and apply to all areas as indicated by drawings.

3.3 Protection

.1 Allow drying and curing time and protect finished product as per manufacturers instructions.

END OF SECTION

GENERAL PROCESS PROVISIONS

1. GENERAL

1.1 Intent

.1 Provide complete, fully tested, and operational process systems to meet requirements described herein and in complete accord with applicable codes and ordinances.

.2 Contract Documents and Drawings of this Division are diagrammatic and approximately to scale unless stated otherwise. They establish scope, material, and installation quality, and are not detailed installation instructions.

.3 Follow Manufacturer's recommended installation instructions and procedures for equipment, supplemented by requirements of Contract Documents.

.4 Install equipment generally in locations and routes shown, with minimum interference with other services or free space. Remove and replace improperly installed equipment to satisfaction of the Contract Administrator at no extra cost.

.5 Install equipment to provide access and ease of maintenance.

.6 Connect to equipment specified in other Sections and to equipment supplied and installed by other contractors or by the City. Uncrate equipment, move in place and install complete; start up and test.

1.2 Regulations

.1 All Work carried out under this Division shall be in full accordance with all applicable Codes, Regulations, Bylaws and Ordinances and nothing in the Drawings and Specifications shall remove this responsibility.

1.3 Permits, Fees, and Inspections

.1 Apply for all permits, supply all test certificates and pay all fees to authorities having jurisdiction regarding the installation and inspection of the complete process systems, installed under this Contract.

1.4 Existing Conditions and Other Trades

.1 Visit the Site to determine existing conditions affecting the Work of this Division. Failure to do so shall not remove the responsibility for the effects of such conditions on the Work.

.2 Examine the Mechanical, Structural, Electrical, and Controls and Instrumentation Drawings and become fully familiar with the Work of other trades under this Contract.

.3 Maintain the utmost cooperation with all other trades. Particular attention must be paid to the proximity of the Work to all electrical cables, control conduits, and utilities. Maintain maximum clear ceiling heights throughout. Provide connections of sizes as shown on the Drawings for connection by other trades.

1.5 Materials

.1 Materials and equipment installed shall be new, full weight and of quality specified. Use same brand or Manufacturer for each specific application.

1.6 Scope of Work

.1 Refer to Section 01010 for the Scope of Work. The Work requires the supply and installation of such components as are necessary to construct complete functional and operational systems for all Sections of the Work.

.2 Consideration will not be granted for any alleged misunderstanding of the extent of the Work to be performed. Submitting a Bid shall convey full agreement to all items and conditions specified, indicated on the Drawings, and required by the nature of the Site.

1.7 Discrepancies and Omissions

.1 These Specifications shall be considered as an integral part of the Drawings, which accompany them, and neither the Drawings nor Specifications shall be used alone. Any items or subject omitted from one but which is mentioned or indicated in the other shall be considered as properly and sufficiently specified and shall therefore be provided.

.2 Should the Contractor find discrepancies or omissions in the Contract Documents, or be in doubt as to the intent thereof, he shall immediately obtain clarification from the Contract Administrator.

1.8 Transportation and Hoisting

.1 Assume responsibility for transportation, hoisting, warehousing, and demurrage for all equipment and materials to be furnished and installed under this Division.

1.9 Definitions and Interpretations

.1 Where the term “Provide” is used herein, it shall be understood to include labour, materials, and services necessary to supply, install and make functional the items or Work referenced.

.2 Where the term “Instructions” or “As Instructed” or “Where Instructed”, etc., is used herein, it shall be understood to mean as instructed in writing by the Contract Administrator.

.3 Where the term “Listed” is used herein, it shall be understood to mean that the materials or equipment have been tested in accordance with applicable standards and methods, have been approved and listed for the intended use by a testing authority which itself has been approved by the authorities having jurisdiction.

.4 Where the term “Approved”, “Approval”, etc., is used herein, it shall be understood to mean approved by Authorities having jurisdiction as conforming to Codes, Standards, Bylaws, etc.

.5 Where the term “Acceptable” or “Acceptance”, etc., is used herein, it shall be understood to mean acceptable to the Contract Administrator as conforming to the requirements of the Contract Documents.

.6 Where the term "Submit for Review" is used herein, it shall be understood to mean submit to the Contract Administrator.

.7 Where the term "Subject to Review", etc., is used herein, it shall be understood to mean Work shall be laid out for review by the Contract Administrator. No Work shall proceed until written instructions have been obtained from the Contract Administrator. Submit further information, Shop Drawings, samples, etc., as specified and/or as may be reasonably requested by the Contract Administrator.

.8 Where the term "Accessible" is used herein, it shall be understood to mean readily approachable by person or tools as required and where obstacles may be removed and replaced without cutting or breaking out materials.

.9 Where working pressure or pressure ratings are specified or shown on the Drawings for valves, piping, fittings, equipment, etc., these items shall be suitable for operating at specified pressures and corresponding temperature unless noted otherwise.

1.10 Shop Drawings

.1 Refer to Section 01300 for the general requirements for Shop Drawings.

.2 For specific requirements for Shop Drawings for various pieces of equipment, refer to the relevant specific Sections describing the equipment.

.3 Shop Drawings shall be complete; capable of illustrating fully that the Product to be supplied is in accordance with the Specifications; including design considerations, materials, and accessories and spare parts. Include wiring diagrams for power supply and control schematics for all electrically powered and/or controlled equipment.

.4 Shop Drawings, which are not considered complete, will be returned to the Contractor "Not Reviewed" or "Rejected". It is the responsibility of the Contractor prior to submittal to ensure that they are in accordance with the requirements of the Specifications.

.5 Submit Shop Drawings in an expedient fashion in accordance with the Contract requirements and allowing sufficient time for review and implementation prior to Contract completion.

.6 Shop Drawings of equipment supplied under other Contracts will be made available to the Contractor to assist in the installation.

1.11 Coordination

.1 Coordinate locations of openings, housekeeping pads, and anchor bolts with other Divisions.

.2 Coordinate the connection of the services of other Divisions to the equipment and material supplied under this Division.

1.12 Minor Changes

.1 Equipment and materials shall be located and arranged generally as shown on the Drawings. However, minor changes may be required to suit the precise requirements of the actual equipment or materials supplied, or to avoid conflict between services.

.2 Prior to the installation of the relevant equipment or materials, the Contractor shall advise the Contract Administrator of the requirement for any minor changes (including box-outs and coring) and shall undertake such minor changes as instructed by the Contract Administrator. Such changes shall be undertaken at no extra cost except where the connection or arrangement is modified in length, or alignment, or position, by more than one metre; or if the change involves the addition of more than two fittings greater than 150 mm in diameter.

1.13 Housekeeping Pads

.1 Housekeeping pads are required for all pieces of equipment unless otherwise noted. Dimensions shown on the drawings are for guidance only. Housekeeping pads shall be at least 100 mm larger than the equipment base plates and 100 to 200 mm deep, unless greater or lesser depths are required to support the equipment at the proper elevation. The final housekeeping pad dimensions shall be based on the dimensions of the actual equipment to be installed, and the Manufacturer's recommendations.

.2 The Contractor shall coordinate the location and installation of all the housekeeping pads, to be done by other Divisions.

1.14 Metric Conversion

.1 All units in this division are expressed in SI units.

.2 Submit all Shop Drawings and maintenance manuals in SI units.

.3 On all submittals (Shop Drawings etc.) use the same SI units as stated in the Specifications.

.4 Equivalent Nominal Diameters of Pipes - Metric and Imperial:

mm	inches	mm	inches	mm	inches
3	1/8	65	2-1/2	375	15
6	1/4	75	3	450	18
10	3/8	100	4	500	20
15	1/2	125	5	600	24
20	3/4	150	6	750	30
25	1	200	8	900	36
30	1-1/4	250	10	1050	42
40	1-1/2	300	12	1200	48
50	2				

.1 Where pipes are specified with metric dimensions and Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment, and piping.

.2 When CSA-approved SI metric pipes are provided, the Contractor shall provide at no extra cost adapters to ensure compatible connections between the SI metric pipes and all new and existing pipes, fittings, and equipment.

1.15 Cutting and Patching

.1 Provide holes and sleeves, cutting and fitting required for mechanical Work. Relocate improperly located holes and sleeves.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Obtain written approval from the Contract Administrator before cutting or burning structural members.

.4 Patch building where damaged from equipment installation, improperly located holes, etc. Use matching materials as specified in the respective Section.

1.16 Substantial and Total Performance

.1 Prior to Substantial Performance Inspection, provide complete list of items, which are deficient at the time of the substantial performance inspection.

.2 Perform the following items prior to Substantial Performance Inspection.

.1 Make systems capable of operation with alarm controls functional and automatic controls in operation generally, but not necessarily finally calibrated.

.2 Make necessary tests on equipment including those required by authorities. Obtain certificates of approval.

.3 Complete valve tagging and identify equipment. Paint equipment and piping, and install escutcheons.

.4 Lubricate equipment as per Manufacturer's instructions.

.5 Mail warranty forms to Manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one year.

.6 Submit O&M Manuals as in accordance with Section 01300.

.3 Prior to Total Performance Inspection, provide declaration in writing that deficiencies noted at time of Substantial Performance Inspection have been corrected and the following items completed prior to the Total Performance Inspection:

.1 Complete final calibration of controls.

.4 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until Substantial Performance is declared.

1.17 Equipment Protection and Clean-Up

.1 Protect equipment and materials in storage on-site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 Protect equipment with crates and polyethylene covers.

.3 Thoroughly clean both existing and new piping, ducts and equipment of dirt, cuttings and other foreign substances.

.4 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.18 Temporary Usage

.1 Usage by the City of any process device, apparatus, machinery or equipment prior to Total Performance being issued is not to be construed as acceptance.

1.19 Ductwork Cleaning

.1 Protect all existing supply, exhaust and return air openings with temporary filters (minimum 20 percent filters equal to Farr 20/20, 25 mm thick).

.2 At completion of project, remove all temporary filters and replace all existing air handling unit filters. At the Contract Administrator's discretion, turn the air handling unit filters over to the City, rather than installing in the units.

.3 If, in the Contract Administrator's opinion, the existing ductwork has been made dirty by completion of the project, vacuum duct systems as indicated by the Contract Administrator.

1.20 Painting and Identification

.1 Coordinate colour coding of piping and equipment with that of the existing plant. All piping and equipment is to be painted.

.2 Legend and direction of flow arrows shall consist of adhesive backed labels, yellow colour, with minimum 20 mm high black lettering equal to Brady System B-500, vinyl cloth labels for non-insulated surfaces; and Brady B 946 for insulated surfaces.

.3 Identify piping with labels, colour bands, and flow arrows. Provide identification at 15 m maximum intervals, before and after pipes pass through walls, at all sides of tees, behind access doors and in equipment rooms as required.

1.21 Acceptable Products and Acceptable Manufacturers

.1 The first Product specified in a Product list is considered the "Design Standard" unless noted otherwise. The Design Standard Product has been used as the basis for design. Dimensions, operating protocol, basic materials, etc., of the Design Standard have been incorporated in the design.

.2 Where one or more Acceptable Products or Acceptable Manufacturers have been listed for an item of equipment, these are accepted as equivalent in concept to the Design Standard, if a Design Standard is listed. Incorporation of equipment options to satisfy the intent of the Specifications such that the process system would function as intended with the Design Standard is the responsibility of the Contractor. Modifications to the equipment services, supports, structure, etc., to suit Acceptable Products shall be the responsibility of the Contractor.

.3 It remains the responsibility of the Contractor to ensure the Products supplied are equal to the specified Products in every respect, operate as intended, and meet the performance Specifications and physical dimensions of the specified Product.

.4 The Contractor shall be fully responsible for any additional Work or materials, to accommodate the use of equipment from the acceptable Manufacturers and suppliers' list.

.5 Submit within fourteen (14) days of Contract award a copy of the list underlining the name of the Manufacturer whose price was carried in the Bid. If no Manufacturer's names are submitted, it will be assumed that the price carried in the Bid was that of the specified Manufacturer or, where the specified Product is generic, the first acceptable Manufacturer listed for each item and equipment.

1.22 Delivery Schedule

.1 The Contractor is to coordinate the equipment and material delivery schedule with the suppliers of the equipment and materials supplied under this Contract to suit the construction schedule. The dates for delivery shall be identified within twenty (20) working days of Contract award. These delivery dates may be altered by mutual agreement between the Contractor and the Contract Administrator.

1.23 Delivery

.1 The Contractor shall be responsible for unloading the equipment and materials supplied under this Contract and shall examine all packages on delivery, compare with the shipping list, and inform the supplier, the Contract Administrator and the carrier of any visible damages or defects. The Contractor shall arrange with the supplier to have the supplier replace any damaged or defective items.

1.24 Storage

.1 The Contractor shall provide temporary buildings and covered space for storage at the Site of all equipment prior to installation. The location of such buildings will be subject to acceptance by the Contract Administrator and the City.

.2 Pipe and any other materials shall be stored in a manner which prevents rust, deformation, weathering, or any other physical deterioration. Covered space shall be provided by the Contractor if necessary to provide for this protection.

.3 The Contractor shall adhere to the Manufacturers' storage recommendations.

.4 Heated covered storage space shall be provided by the Contractor for sensitive items of equipment such as motors and pumps, as well as other equipment or supplies specified in this Division or other Divisions.

1.25 Spare Parts and Special Tools

.1 If spare parts or special tools are to be provided with any equipment specified, the specific parts or tools will be listed in the relevant Specification Section and are to be supplied with the equipment.

.2 Where the operation of the equipment for a period of two (2) years would require that some specific spare parts are likely to be required, but are not listed in the Specification, the Contractor shall so inform the Contract Administrator. Costs, delivery periods, and any other information relevant to the procurement of the identified spare parts shall be identified.

.3 Where some specific special tools are required for the maintenance and/or operation of a specific item of equipment, but are not listed, the Contractor shall so inform the Contract Administrator. Costs, delivery periods, and any other information relevant to the procurement of the identified special tools shall be provided.

.4 This clause does not relieve the Contractor of the responsibility to provide, at no cost, any spare parts required during the warranty period to repair malfunctioning or failed equipment. At the end of the maintenance period, the spare parts inventory shall be replenished to allow for the above.

1.26 Bid Price Breakdown

.1 Submit a Bid price breakdown within thirty (30) days of Bid closing and before first progress claim, in the format required by the Contract Administrator.

END OF SECTION

PROCESS EQUIPMENT INSTALLATION

1. GENERAL

1.1 Description

.1 Installation, including the supply of anchor bolts, and testing of equipment supplied by others and supplied under other Sections in Division 11.

1.2 Definitions and Interpretations

.1 Testing: in this Division, testing is defined as the operation of a specific item of equipment under actual or simulated conditions for the purpose of ensuring the equipment satisfies its basic design criteria. Testing shall be conducted by the Contractor. All materials, labour, power and equipment required to conduct the tests shall be the Contractor's responsibility. The Manufacturer is to provide technical assistance to the Contractor for the installation, testing, start-up and commissioning of the equipment supplied. Refer to Section 01650.

.2 Commissioning: in this Division, Commissioning is defined as the operation of equipment systems under actual and/or simulated conditions for the purpose of ensuring the system performs its intended functions. Refer to Section 01670.

1.3 Submissions

.1 Check all the Shop Drawings relative to the equipment and materials, dimensions, measurements, size of members, type of materials, controls, list of equipment being supplied, names of Manufacturers, and other details to affirm that they are correct and conform to the requirements and intent of the Contract.

.2 Where the Shop Drawings are submitted with coordination information missing, such as dimensions of structures, the Contract Administrator will return the submission as soon as practicable marked "Revise and Resubmit."

2. PRODUCTS

2.1 Equipment Schedule

.1 Unless indicated otherwise, supply and install all equipment listed on the Equipment Schedule, detailed on the equipment Specification sheets, or shown on the Drawings.

.2 Determine the extent of equipment to be supplied from the Specifications, list of equipment and materials and Manufacturer's Drawings covering the equipment. Furnish and install all additional materials necessary to complete the installation.

.3 Incorporate all ancillary devices in the installation including those providing for cooling water, seal water, lubricant supply, process drains, electrical connection, and instrumentation and control requirements.

2.2 Mounting Requirements

.1 Provide all supports, anchorage, and mounting of all equipment in accordance with the Manufacturer's recommendations, the National Building Code, and industry standard requirements, unless otherwise specified.

.2 Design and provide all elements required to resist the calculated forces described herein or required by the element Manufacturer.

.3 Design anchorage for all equipment bases, supports, and foundations in accordance with National Building Code for Seismic Zone 0.

.4 For rotating equipment, where specified, submit design notes and calculations for anchorage, signed and sealed by a Professional Engineer registered in the Province of Manitoba.

3. EXECUTION

3.1 Coordination

.1 Coordinate the Work specified under this Section with the Work of other Sections to produce a complete and workmanlike job.

.2 Coordinate the placement of equipment bases and housekeeping pads with Division 3.

.3 Coordinate the routing of ancillary piping with Division 15.

.4 Coordinate the routing of electrical and control wiring and conduit with Division 16.

3.2 Preparation

.1 Before commencing installation of the Work, inspect and take field measurements and ensure that Work conducted previously in the area is not prejudicial to the proper installation of the Work.

.2 Refer to the equipment Specifications and Specification sheets for assistance in determining the form in which equipment is to be shipped and the extent of field assembly required.

.3 Dimensions shown on the Contract Documents for equipment bases, piping connections, etc., are approximate. Correct to suit the exact dimensions of the equipment provided for each application. Arrange any necessary modifications to piping connections, pipework, or other ancillaries at no cost and after acceptance by the Contract Administrator.

.4 Schedule the visits to the site of the Manufacturer's Representative for the times and periods specified in other sections. Cooperate in his supervision of the installation and start-up. Follow all reasonable instructions of the Manufacturer's Representative. Should the Contractor require the Manufacturer' Representative to attend for longer or more frequent periods, he shall arrange this, at his own expense, with the Manufacturer.

3.3 Installation of Equipment

.1 Install all equipment specified in other Sections, detailed on the equipment Specification sheets, and shown on the Drawings.

.2 Dimensions shown on the Contract Documents for equipment bases, piping connections, etc., are approximate. Correct to suit the exact dimensions of the equipment provided for each application. Arrange any necessary modifications to piping connections, pipework, or other ancillaries at no cost and after acceptance by the Contract Administrator.

.3 Supply and install all necessary shims, gaskets, etc., required to complete the installation.

.4 Provide for the use of all necessary lifting and loading equipment and all tools required to complete the installation.

.5 Comply with the specific requirements for installation noted in other Sections of this Specification and with the instructions of the Manufacturer. Where there is a conflict in these requirements, identify the conflict to the Contract Administrator and proceed as directed.

3.4 Equipment Bases and Anchorage

.1 Equipment will be mounted on housekeeping pads that are a minimum of 100 to 200 mm high.

.2 For rotating equipment of 7.5 kW or above and for equipment requiring structural anchoring, set anchor bolts in advance. Where required, set anchor bolts in sleeves to permit minor adjustment during installation. Use machine base templates where shown.

.3 Prepare grout as specified in Division 3 and provide full contact with the equipment bases unless otherwise recommended by the equipment Manufacturer and accepted by the Contract Administrator. Neatly bevel, form, or trim the grout.

.4 Where equipment is supplied with a plate steel base, provide access holes in the top of the plate and use a pour grade, non-shrink, non-metallic grout as specified in the structural concrete Specifications to fill the entire void under the base.

.5 Fixings to concrete structures shall be by adhesive anchors suitably designed for the application.

3.5 Alignment

.1 Set and align all rotating equipment in accordance with the more stringent requirements of either the Manufacturer's requirements or the following:

.1 Level base, use machinists level on all machined bases.

.2 Align couplings to satisfy the following criteria:

Coupling Speed	Allowable Angular Misalignment	Allowable Parallel Misalignment
Under 100 rpm, below 50 hp	4' 00"	0.25 mm
Under 100 rpm, 50 hp and over	3' 00"	0.12 mm
100 to 600 rpm	2' 00"	0.12 mm
600 to 1800 rpm	1' 00"	0.10 mm
1800 to 3600 rpm	0' 35"	0.05 mm

.3 Check for soft foot, maximum permissible 0.002 mm.

.2 Where equipment undergoes a substantial differential temperature rise (30°C between driver and driven unit), provide precision benchmarks in foundation and on equipment and perform alignment at operating temperatures.

.3 Demonstrate to the City, Contract Administrator, and Manufacturer's Representative the final alignment.

3.6 Lubricants

.1 Extend any inaccessible lubrication points and lubricant drains to convenient locations.

.2 Remove storage lubricant and provide the initial fill of new lubricants for the equipment. Lubricant grade to be as recommended by the Manufacturer.

.3 Provide a Lubrication Schedule for all process equipment. Include the following:

.1 Equipment name and number

.2 Date(s) of lubrication

.3 Lubricant type installed

.4 Frequency of lubrication

3.7 Vibration Survey

.1 Conduct a vibration survey under normal operating conditions for all equipment with a motor size exceeding 37 kW and for smaller units where specified.

.2 Use a calibrated vibration sensor, accepted by the Contract Administrator, and capable of measuring unfiltered vibration velocities and peak-to-peak amplitudes. Select a sensor capable of measuring velocities at a precision of 0.1 mm/s and an accuracy of plus or minus 0.2 mm/s.

.3 Monitor vibration in all three dimensions at the head and tail end of both the driver and driven units, at intermediate bearing points, and at other critical locations which may be identified by the Contract Administrator.

.4 Record the vibration velocities for each item of rotating equipment and submit a report to the Contract Administrator detailing the findings. Include a description of the measuring equipment, identification of equipment on which vibration monitoring was completed, description of conditions under which the test was conducted, and a listing of all of the collected data.

.5 Unless specified otherwise, use unfiltered velocities as the vibration criteria. Unfiltered velocities less than 5 mm/s shall be considered acceptable. Undertake corrective action where unfiltered velocities exceed 5 mm/s.

3.8 Noise Survey

.1 Conduct a noise survey for all equipment over 37 kW and for smaller units where specified.

.2 Use a calibrated noise meter, accepted by the Contract Administrator, and capable of measuring noise in the A Scale at a precision of 0.5 dBA and an accuracy of 1.0 dBA.

.3 Measure noise levels at an elevation similar to the major noise emitter from the equipment (bearing housing, muffler, etc.) and at a horizontal distance of 1.0 metre.

.4 Record the noise levels for each item of equipment and submit a report to the Contract Administrator detailing the findings. Include a description of the measuring equipment, identification of equipment on which noise level monitoring was completed, description of conditions under which the test was conducted, and a listing of all of the collected data.

.5 Equipment is to operate at a noise level less than 85 dBA, when measured in free field at 1.0 m. Noise requirements may be more stringent in areas where more than one item of process equipment is intended to operate concurrently. Specific requirements for equipment that differ from 85 dBA are listed in the sections related to those items of equipment.

.6 Noise abatement features (acoustic panels, acoustic insulation, etc.) are specified in other Sections.

.7 In any process area, recommend whatever measures necessary to maintain a composite noise level below 90 dBA. Where directed by the Contract Administrator, undertake those corrective actions.

3.9 Quality Assurance Forms

.1 Test all process equipment to ensure the equipment operates in accordance with the basic design criteria listed in the Specification Sections or equipment Specification sheets. Complete the series of forms that attest to the proper installation and functioning of the equipment. Refer to Section 01650 and 01670 for the Forms.

END OF SECTION

PROCESS PIPING

1. GENERAL

1.1 Description

.1 This section describes the pipe materials, fittings, appurtenances, installation and testing of the process mechanical systems.

.2 Use the general requirements specified in this section integrally with the more specific requirements listed in Section 11055 Detailed Piping Specification Sheets.

.3 Piping supports are generally not shown on the process mechanical layout Drawings. Provide the design of piping supports, pipe guides, expansion joints and anchors based upon final piping layout. Typical support details and structural attachments shown on the Drawings indicate the level of quality that will be considered acceptable.

.4 The Contractor must provide the necessary submittals and ensure the proper registration of piping systems and system components as required by the Manitoba Steam and Pressure Vessels Act.

.5 Standard of Acceptance: Items specified by manufacturers name and/or catalogue number form part of this specification in order to define the standard regarding performance, quality of material and workmanship. When used in conjunction with a referenced standard, shall be deemed to supplement the standard.

1.2 Definitions

.1 Pressure terms used in this and other related sections are defined as follows:

.1 Operating Limits: the minimum and maximum pressure at which the piping system operates for sustained periods of time.

.2 Test Pressure: the hydrostatic pressure used to determine system compliance.

.2 Unless otherwise specified or shown, the interface between piped commodities common to process/mechanical and yard piping is below grade and 0.45 m from the exterior face of a building or tunnel wall.

.3 Pipe and appurtenance location terms used in this and other related sections are defined as:

.1 Tunnels, Pumphouse and Buildings: within an environmentally controlled enclosure where temperature is maintained above 5°C

.2 Exposed, Aboveground: outside or within an enclosure which is not environmentally controlled so that the temperature is maintained above 5°C. For the purpose of defining exterior protection systems, this definition is extended to vertical piping to a point of 0.5 m below finished ground level.

.3 Underground (or buried): placed in soil and not tied to structures.

.4 Below Structures: below concrete slabs such as tanks, channels, buildings, pipe chases, foundation slabs, etc., but not including roadways or walkway structures.

.5 Submerged: regularly or occasionally immersed in liquid; inside tanks or channels, and within 3.0 m above maximum water level of open tankage, including pipe and appurtenances within manholes, vaults, and chambers.

1.3 Reference Standards

.1 Conform to the most recent version of the following reference standards:

.1 ANSI/ASME A13.1, Scheme for the Identification of Piping Systems

.2 ANSI/ASME B1.20.1, Pipe Threads, General Purpose

.3 ANSI/ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800

.4 ANSI/ASME B16.3, Malleable Iron Threaded Fittings Class 150 and 300

.5 ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings

.6 ANSI/ASME B16.9, Factory-Made Wrought Steel Butt Welding Fittings

.7 ANSI/ASME B16.11, Forged Steel Fittings, Socket Welding and Threaded.

.8 ANSI/ASME B16.12, Cast Iron Threaded Drainage Fittings

.9 ANSI/ASME B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250

.10 ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings

.11 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

.12 ANSI/ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes

.13 ANSI/ASME B31.1, Power Piping

.14 ANSI/ASME B31.3, Process Piping

.15 ANSI/ASME B31.9, Building Services Piping

.16 ANSI/ASME B36.10M, Welded and Seamless Wrought Steel Pipe

.17 ANSI/ASME B36.19M, Stainless Steel Pipe

.18 ASME Section IX, Boiler and Pressure Vessel Code, Welding and Brazing Requirements

.19 ASTM A47, Malleable Iron Castings

.20 ASTM A53, Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless

.21 ASTM A74, Cast Iron Soil Pipe and Fittings

.22 ASTM A105/A105M, Forgings, Carbon Steel, for Piping Components

.23 ASTM A106, Seamless Carbon Steel Pipe for High Temperature Service

.24 ASTM A126, Grey-Iron Castings for Valves, Flanges, and Pipe Fittings

.25 ASTM A135, Electric-Resistance-Welded Steel Pipe

.26 ASTM A139, Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and Over)

.27 ASTM A167, Stainless Steel and Heat-Resisting Chromium-Nickel Steel Plate

.28 ASTM A181/181M, Forgings, Carbon Steel, for General Purpose Piping

.29 ASTM A182/182M, Forged or Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service

.30 ASTM A193/193M, Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service

.31 ASTM A194/194M, Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service

.32 ASTM A197, Cupola Malleable Iron

.33 ASTM A234/A234M, Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

.34 ASTM A240, Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels

.35 ASTM A269, Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

.36 ASTM A276, Stainless and Heat-Resisting Steel Bars and Shapes

.37 ASTM A285/A285M, Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength

.38 ASTM A307, Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength

.39 ASTM A312/312M, Seamless and Welded Austenitic Stainless Steel Pipe

.40 ASTM A320/320M, Alloy Steel Bolting Materials for Low-Temperature Service

.41 ASTM A351/A351M, Standard Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts

.42 ASTM A380, Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems

.43 ASTM A403/A403M, Wrought Austenitic Stainless Steel Piping Fittings

.44 ASTM A409/A409M, Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service

.45 ASTM A480/A480M, General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

.46 ASTM A536, Ductile Iron Castings

.47 ASTM A563, Carbon and Alloy Steel Nuts

.48 ASTM A570/A570M, Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality

.49 ASTM A774/A774M, As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures

.50 ASTM A778, Welded, Unannealed Austenitic Stainless Steel Tubular Products

.51 ASTM A967, Standard Specification for Chemical Passivation Treatment for Stainless Steel Parts

.52 ASTM B32, Standard Specification for Solder Metal

.53 ASTM B88, Seamless Copper Water Tube

.54 ASTM C76, Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

.55 ASTM C564, Rubber Gaskets for Cast Iron Soil Pipe and Fittings

.56 ASTM D638, Test Method for Tensile Properties of Plastics

.57 ASTM D792, Test Method for Specific Gravity and Density of Plastics by Displacement

.58 ASTM D1248, Polyethylene Plastics Moulding and Extrusion Materials

.59 ASTM D1457, PTFE Moulding and Extrusion Materials

.60 ASTM D1599, Standard Test Method for Short-Time Hydraulic Failure Pressure or Plastic Pipe, Tubing and Fittings

.61 ASTM D1784, Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

.62 ASTM D1785, Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

.63 ASTM D2105, Standard Test Method for Longitudinal Tensile Properties of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Tube

.64 ASTM D2241, Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)

.65 ASTM D2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

.66 ASTM D2466, Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40

.67 ASTM D2467, Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

.68 ASTM D2513, Thermoplastic Gas Pressure Pipe, Tubing, and Fittings

.69 ASTM D2529, Standard Practice for Measuring Beam Deflection for Reinforced Thermosetting Plastic Pipe Under Full Bore Flow

.70 ASTM D2657, Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings

.71 ASTM D2564, Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings

.72 ASTM D2665, Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

.73 ASTM D2996, Filament-Wound Reinforced Thermosetting Resin Pipe

.74 ASTM D3212, Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals

.75 ASTM D3261, Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Fittings

.76 ASTM D3350, Standard Specification for Polyethylene Plastics Pipe and Fitting Materials

.77 ASTM D4024, Standard Specification for Reinforced Thermosetting Resin (RTR) Flanges

.78 ASTM D4101, Propylene Plastic Injection and Extrusion Materials

.79 ASTM D4174, Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems

.80 ASTM F441, Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

.81 ASTM F714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR). Based on outside Diameter.

.82 ASTM F894, Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

.83 AWWA C105, Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids

.84 AWWA C110, Ductile-Iron and Grey-Iron Fittings, 3 Inch through 48 Inch, for Water and Other Liquids

.85 AWWA C111, Rubber-Gasket Joints for Ductile-Iron and Grey-Iron Pipe and Fittings

.86 AWWA C115, Flanged Ductile-Iron and Grey-Iron Pipe with Threaded Flanges

.87 AWWA C151 (ANSI A21.51), Ductile-Iron Pipe, Centrifugally Cast in Metal Moulds or Sand-Lined Moulds, for Water and Other Liquids

.88 AWWA C200, Steel Water Pipe, 6 Inches and Larger

.89 AWWA C203, Coal Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied

.90 AWWA C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inches through 144 Inches

.91 AWWA C206, Field Welding of Steel Water Pipe

.92 AWWA C207, Steel Pipe Flanges for Waterworks Services - Sizes 4 Inch Through 144 Inch

.93 AWWA C208, Dimensions for Fabricated Steel Water Pipe Fittings

.94 AWWA C209, Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines

.95 AWWA C210, Liquid Epoxy Coating System for the Interior and Exterior of Steel Water Pipe

.96 AWWA C214, Tape Coating Systems for the Exterior of Steel Water Pipelines

.97 AWWA C301, Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids

.98 AWWA C303, Reinforced Concrete Pressure Pipe - Steel Cylinder Type, Pretensioned, for Water and Other Liquids

.99 AWWA C600, Installation of Ductile-Iron Water Mains and their Appurtenances

.100 AWWA C606, Grooved and Shouldered Joints

.101 AWWA C651, Disinfecting Water Mains

.102 AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches through 12 Inches, for Water

.103 AWWA C906, Standard for Polyethylene (PE) Pressure Pipe and Fittings 4 in. Through 63 in., for Water Distribution

.104 AWWA M11, Steel Pipe - A Guide for Design and Installation

.105 CGA, Canadian Gas Association Standards

.106 CAN/CGA B105 - Installation Code for Digester Gas Systems

.107 CAN/CSA B70, Cast Iron Soil Pipe, Fittings and Means of Joining

.108 CISPI 301, Specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings

.109 CAN/CSA B139, Installation Code for Oil Burning Equipment

.110 CAN/CSA B149.1, Natural Gas and Propane Installation Code

.111 CPC, Canadian Plumbing Code

.112 CSA B52, Mechanical Refrigeration Code

.113 CSA B137.1, Polyethylene Pipe, Tubing and Fittings for Cold Water Pressure Services

.114 CSA B137.3, Rigid PVC Pipe for Pressure Applications

.115 CAN/CSA B181.2, PVC Drain, Waste, and Vent Pipe and Pipe Fittings

.116 CAN/CSA B182.2, PVC Sewer Pipe and Fittings (PSM Type)

.117 CSA CAN-Z183, Oil Pipeline Systems

.118 CSA CAN3-Z299.3, Quality Verification Program Requirements

.119 EJMA STDS-93, Standards of Expansion Joint Manufacturers' Association, Edition No. 6

.120 Fluid Sealing Association Technical Handbook, Rubber Expansion Joint Division

.121 FEDSPEC, L-C-530B(1), Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy

.122 MIL-H-13528B, Hydrochloric Acid, Inhibited, Rust Removing

.123 MIL-S-8660C, Silicone Compound

.124 MIL-STD-810C, Environmental Test Methods

.125 MSS SP25, Standard Marking System for Valves, Fittings, Flanges and Unions

.126 MSS SP43, Wrought Stainless Steel Butt Welding Fittings

.127 NACE RP0178, Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to be Lined for Immersion Service.

.128 SAE J1227, Assessing Cleanliness of Hydraulic Fluid Power Components and Systems

.129 SSPC-P3, Canadian Government Standards Board

.130 SSPC-SP6, Canadian Government Standards Board

.131 SSPC-SP10, Canadian Government Standards Board

.132 NPC, National Plumbing Code

.133 Plastics Pipe Institute's PPI Handbook of Polyethylene Piping, chapter " Underground Installation of PE Piping " and chapter "Specifications, Test Methods and Codes for Polyethylene"

.134 TSSA, Technical Standards and Safety Association

.135 Provincial Building Code

.136 Provincial Plumbing Code

1.4 Design Requirements

.1 The design has been completed to the degree necessary for the Contractor to Bid. It is not fully detailed and will require the Contractor to undertake design of and responsibility for minor aspects for the piping systems to be installed.

.2 All process piping shall meet requirements of the Process Piping Code, B31.3, whether or not it falls within the Code scope. The Manitoba Steam and Pressure Plants Act shall be the Code Authority whenever the piping system falls within the Code scope. The Contract Administrator shall be the Code Authority for process piping that does not fall within the Code scope.

.3 Piping and instrumentation Drawings, piping schematics, and piping layout Drawings are contained in the Drawings set. The piping and instrumentation Drawings (P&IDs) indicate all major pipework, valves, and appurtenances (other than cleanouts, purge points, etc.) The layout Drawings indicate the design concepts and are intended to illustrate a constructible method for the piping systems. Some appurtenances, supports, guides and anchors, and

expansion joints are not fully shown. The Contractor's design will complement and detail these Drawings.

.4 It is understood that some conflicts will arise that will require that the Contractor re-route some of his piping to allow for the installation of wiring, ventilation duct, or similar.

.5 The Contractor is required to engage a Professional Engineer registered in the Province of Manitoba to be responsible for the final aspects of the design. The components of the design that will be generated will be as follows:

.1 Final layout, illustrated using layout and isometric drawings.

.2 Piping flexibility and stress analysis proving that the allowable stresses prescribed by the Process Piping Code B31.3 are not exceeded under any prescribed combination of conditions, and indicating the forces and moments in each direction under each condition at each support, guide or anchor.

.3 Piping support system design, including details and spacing of all supports. The support system will ensure that the weight of the pipework and the need for lateral and vertical support are considered fully.

.4 Expansion and contraction design, including the layout and details for all necessary expansion joints needed to compensate for thermal expansion and contraction, structural movement, and the isolation of equipment.

.5 Thrust restraint design, including thrust restraint required due to any forces imposed during construction, pressure testing, normal operation, and/or surging, if applicable. The thrust restraint design shall include a minimum safety factor of 2.0 using the maximum thrust force that will be experienced during construction, pressure testing, normal operation, and/or surging, if applicable. This requirement applies to new piping systems as well as to existing piping systems that may be modified.

.6 The piping system shall have sufficient flexibility to prevent thermal expansion or contraction or movements of piping supports and terminals causing:

.1 Failure of piping or supports from overstress or fatigue

.2 Leakage at joints

.3 Detrimental stresses or distortion in piping and valves or in connected equipment or piping systems not designed by the Contractor, resulting from excessive thrusts and moments in the piping.

.6 Design documentation will be submitted to the Contract Administrator as necessary to indicate compliance with the requirements of the piping systems. The documentation will be signed and sealed by a Professional Engineer registered in the Province of Manitoba, who must provide evidence of experience with such systems.

.7 Note that for large diameter, thin walled (thickness less than 1 percent of diameter) piping comprehensive flexibility and stress analysis is required, even if the design met the exception granted under section 319.4.1(c) of the Process Piping Code B31.3.

1.5 Submittals

.1 For each piping system refer to Section 11055, submit documentation listing pipe, fittings, flexible connectors, expansion joints, linings, coatings, and valving to be used for each pipe size and category.

.2 Radiographic Weld Testing

.1 Submit the name and qualifications of at least two independent firms for the radiographic weld testing to be undertaken by the Contractor if and as required by the applicable Code. The selected firm will be subject to the review and acceptance of the Contract Administrator.

.3 A copy of this specification section and all referenced sections with each paragraph check-marked to show compliance or highlighted to indicate deviation.

.4 For all pipe greater than or equal to 50 mm diameter, submit isometric drawings, to indicate the assembly details, the welds, flanges, valve placement, cathodic protection, expansion joints, guides, anchors, hangers, supports, and the provisions for thrust restraint, as well as any other pertinent details.

.5 Submit piping layout drawings by plant area which indicate location and placement of valves, fittings and other appurtenances for all piping, greater or equal to 150 mm diameter, in that area. Indicate location and clearances from structures and other utilities (ductwork, conduit, electrical tray, etc.)

.6 Submit copies of all original submittals and all related correspondence made as part of the regulatory submission required by the Manitoba Steam and Pressure Plants Act and any submissions required by other regulatory authorities.

.7 Product Samples

.1 Where specified or when directed by the Contract Administrator, provide mill test results or product samples.

.8 Provide hanger, guide, anchor, support system design details including locations, load information, design calculations and illustrative drawings, signed and sealed by a Professional Engineer registered in the Province of Manitoba. Refer to Section 11052.

.9 For expansion joints submit manufacturer's catalogue data, Shop Drawings and assembly drawings confirming general arrangement, dimensions, tolerances, materials of construction, weights, and installation details. Submit calculations to substantiate expansion joint selection and amount of pre-compression, signed and sealed by a Professional Engineer registered in the Province of Manitoba. Refer to Section 11053.

.10 Welding

.1 Prior to commencing any welding of stainless steel pipe, prepare and submit to the Contract Administrator a written description of welding techniques including but not limited to materials, methods, and quality control. Identify differences in shop and field techniques. Written procedures will be signed and sealed by a Professional Engineer registered in the Province of Manitoba and qualified for welding design. For stainless steel welds exposed to process fluids, the weld procedure should provide for maximizing the corrosion resistance of the final weld as well as providing the mechanical strength required.

.11 Radiographic weld test results

.12 Prior to the commencement of welding, submit current and complete documentation of the welder's qualifications.

1.6 Coordination

.1 Process and Utility Piping identification

.1 Refer to Section 11910 for process piping identification.

.2 Process and utility piping is identified in the Drawings by a two component alpha-numeric code, (Line Label) as follows:

.1 The first component of the code indicates the nominal line size.

.2 The second component of the code identifies the process fluid being conveyed (commodity). The commodity codes are defined in the Drawings.

.3 Detailed process pipe Specifications are provided for each commodity in Section 11055.

.4 Routing

.1 Coordinate piping installation routes and elevations with installation of sheet metal, process equipment, HVAC, instrumentation, and electrical work.

.5 Pipe sleeves

.1 Coordinate with other divisions to locate and place sleeves in cast-in-place concrete and in masonry building elements prior to construction.

.6 Coordinate with Division 17 to provide correct piping configuration for primary instrumentation elements. For example, provide required minimum straight run of pipe upstream and downstream of flow meters. Coordinate with Division 17 for meter manufacturer’s requirements.

1.7 Quality Assurance

.1 Welding certification

.1 All welders to be certified under the Manitoba Steam and Pressure Plants Act. As a minimum, welders will hold a Level B Journeyman Welder's Certificate.

.2 All welders who work on this project must provide the correct documentation.

.3 Welders working on stainless steel piping must not work on welding of any other material.

.4 Tools used for stainless steel piping welding must be new and marked for this use. These tools must not be used for any other work. Tools must not be made of materials that could contaminate the stainless steel surface.

.2 Weld tests

.1 All piping welds shall be 100 percnet visually inspected by a registered inspector and any imperfections shall be made good as required by the applicable Code and to the satisfaction of the Contract Administrator.

.2 For piping required by the applicable Code to be subject to radiographic inspection or for welds not found satisfactory during the Contract Administrator's visual inspection provide for one full circumference radiographic inspection for every 20 welded pipe-to-pipe and pipe-to-fitting joints. All sizes and types of pipe welds to be tested at locations identified by the Contract Administrator.

.3 Contractor to provide for one full circumference radiographic inspection for every 20 welded pipe-to-pipe and pipe-to-fitting joints. All sizes and types of pipe welds to be tested at locations identified by the Contract Administrator.

.4 Have radiographic test firm evaluate welds in accordance with ANSI/ASME B31.3 Process Piping Code Normal Service and prepare report summarizing results.

.5 Have radiographic weld test report, complete with results, submitted directly to Contract Administrator.

.6 For each defective weld, three (3) additional radiographic inspections at locations identified by the Contract Administrator will be required plus a radiograph of the repair.

.3 Regulatory submissions

.1 Complete all regulatory submissions as required by the Manitoba Steam and Pressure Plants Act.

.2 Complete all other submissions as required by other regulatory authorities.

1.8 Conflicts

.1 Review the Drawings prior to installation of piping, conduit services, and fixtures by this or any other division. Identify any conflicts and cooperate with the Contract Administrator to determine the adjustments necessary to resolve these conflicts.

.2 Confirm the routing of each section of pipework with other services prior to commencement of installation. Advise the Contract Administrator of any conflicts with existing services or services yet to be installed. Where necessary, amend the routing of pipework to avoid conflict and confirm with the Contract Administrator.

1.9 Shipment, Protection and Storage

.1 Refer to Section 01600 for Shipment and Storage.

.2 Deliver pipe, fittings, and specials to site using loading methods which do not damage pipe or coatings.

.3 Piping materials delivered to site will be clearly marked to indicate size, type, class/schedule and coatings.

.4 Until ready for incorporation in the work, store on site as recommended by the piping materials manufacturer to prevent damage, undue stresses, or weathering.

.5 Store materials at least 200 mm above ground with sufficient supports to prevent undue bending.

.6 Protect non-UV light inhibited plastic from sunlight.

.7 Ship pipe expansion joints, anchors, guides and flexible connectors pre-assembled to the degree which is practical.

.8 Provide shipping devices to maintain the face-to-face dimension of each expansion joint during shipment, storage and installation. Design and place shipping devices so as not to inhibit installation of the joints.

1.10 Warranty

.1 Contractor shall supply new materials and re-do the Work should materials be found to be defective or not in compliance with the Specifications, or should the workmanship be found to be inadequate or the Work was not performed in accordance with the Specifications and referenced standards, codes and regulations. This warranty shall remain in effect for the maximum period of time allowed under Law.

.2 Neither the Contract Administrator’s inspections, checks, or any other tests or subsequent authorization to proceed with the Work, nor the Contract Administrator’s waiving of the Contract Administrator’s right to perform such tests, nor the Contract Administrator’s decision not to solicit submission of material certificates or other quality assurance

documentation relieve the Contractor from any degree of responsibility in regard to the Work or the corresponding warranty above. The Contractor agrees that the Contract Administrator's ability to fully assess the suitability of materials, procedures, worker qualifications and other relevant issues is limited. The Contractor bears full responsibility and is solely liable in these matters.

.3 The use of faulty materials or materials that do not meet the Specifications and referenced standards, codes and regulations shall constitute a hidden defect.

.4 Employment of labour not properly qualified the performance of the work not in accordance with the Specifications and the referenced standards, codes and regulations, and the use of inadequate of sub-standard workmanship shall constitute hidden defects.

2. PRODUCTS

2.1 Function

.1 Provide the pipe materials, fittings, and appurtenances as described below, for the piping systems shown.

2.2 Pipe Materials - General

.1 All pipe materials to be new, free from defects and conforming to the reference standards identified in Section 11055.

.2 Where any standard referenced has been superseded prior to bidding, the Contractor shall comply with the new standard.

2.3 Pipe Sizes

.1 Where the pipe size is not specified, provide pipe with the sizes required by the Manitoba and National Plumbing Codes. For small piping not described by the Manitoba and National Plumbing Codes, use 12 mm nominal diameter.

2.4 Fittings

.1 General

.1 Provide eccentric reducers in horizontal lines with the flat side on top, unless shown otherwise.

.2 Provide concentric reducers in vertical lines unless indicated otherwise.

.3 Provide long radius elbows unless otherwise shown. Provide smooth flow carbon or stainless steel elbows 350 mm and less, to ANSI B16.9. Provide mitred elbows greater than 350 mm, to AWWA C208 unless otherwise shown or specified. Use 3-piece construction unless otherwise shown or specified.

.4 Provide fittings in concrete cylinder pipe fabricated from metal plate, cement lined and coated, and in accordance with AWWA C301. Dimensions to AWWA C208.

.2 Steel Pipelines

.1 75 mm diameter or greater: conform to ANSI B16.9, ANSI B16.11 or ANSI B16.5. Provide fittings with a wall thickness equal to or greater than the pipe.

.2 Less than 75 mm diameter: provide threaded malleable iron fittings, conforming to ANSI B16.3.

.3 Provide long radius steel grooved-joint fittings conforming to ANSI B16.9 in steel grooved-joint pipeline systems. Grooved joint adapters may be welded to fitting ends; dimension and cut the groove of the adapter in accordance with the coupling manufacturer's recommendations; materials and inside diameter to be the same as the pipe; grind the interior weld smooth and meet the lining Manufacturer's recommendations.

.4 For steel grooved-joint pipe of diameters of 150 mm and less, the Contractor may provide ductile iron grooved-joint fittings which have an outside diameter equal to the steel pipe diameter. Provide ductile iron to ASTM A536, dimensioned to 1.5 diameter radius bends, and cut grooving dimensions to AWWA C606 IPS dimensions. The lining and coating of the ductile iron fittings must equal the lining and coating of the steel pipeline system.

.5 Standard radius elbows to dimensions of ANSI B16.5 may be provided on clean water grooved-joint piping systems only.

.3 Stainless steel pipelines

.1 Less than 75 mm diameter: provide fittings of the same class as the pipe, conforming to ASTM A403 and ANSI B16.11.

.2 Equal to or greater than 75 mm diameter: fabricate fittings using similar materials and classes as the pipe and conform to ASTM A774 (scale removed).

.4 Ductile iron pipelines

.1 For flanged piping systems, provide fittings that conform to ANSI B16.1 and in grooved end or mechanical joint ductile iron pipelines to AWWA C110.

.2 For ductile iron grooved-joint pipelines, provide ductile iron grooved-joint fittings which have an outside diameter equal to the pipe diameter. Provide ductile iron to ASTM A536, dimensioned to 1.5 diameter radius bends, and cut grooving dimensions to AWWA C606 IPS dimensions. The lining and coating of the ductile iron fittings must equal the lining and coating of the pipeline system.

.5 PVC pipelines

.1 Provide PVC to CSA B137.3, of the same material and class as the pipe.

.6 FRP pipelines

.1 Provide fittings of the same material and class as the pipe. Provide flanges to meet ANSI B16.5 Class 150 bolt hole patterns.

.2 Provide adhesive kits suitable for the selected FRP material.

.7 Copper pipelines

.1 Provide copper fittings in conforming to ANSI B16.26.

.8 Polyethylene pipelines:

.1 Provide fittings in the same material and class as the pipe.

.2 Thermal butt fusion joints to ASTM D2774.

.9 Buried pipelines

.1 For buried piping and piping inside carrier pipes, refer to Drawings and Division 2.

2.5 Grooved Piping System – IPS Carbon Steel

.1 General:

.1 All grooved components shall be of one manufacture and approved for use by the authorities, agencies, codes and standards named in the Specifications.

.2 All approved manufacturers shall be certified to ISO 9001 standards.

.2 Grooved couplings:

.1 Grooved couplings shall be manufactured from ductile iron conforming to ASTM A536.

.2 All grooved couplings to be designed with angle pads to provide a rigid joint unless otherwise noted. Standard of Acceptance: Victaulic Style 07 (Victaulic Data Sheet 06.02).

.3 Where expansion, contraction, or angular deflection is designed into pipe system flexible couplings shall be used. Standard of Acceptance: Victaulic Style 77 (Victaulic Data Sheet 06.04).

.3 Grooved fittings: All grooved fittings to be manufactured from ductile iron conforming to ASTM A536, forged steel conforming to ASTM A234 or carbon steel conforming to

ASTM A53. Standard of Acceptance: Fittings manufactured by Victaulic (Victaulic Data Sheet 07.01).

.4 Bolted mechanical branch connections: branch connections may be provided by bolted, mechanical branch connections manufactured from ductile iron conforming to ASTM A536 complete with synthetic rubber gaskets approved for line service. Standard of Acceptance: Victaulic Style 920 N (Victaulic Data Sheet 10.01).

.5 Flange adapters: For connection to ANSI Class 125/150 or Class 250/300 flanged components, grooved flange adapters manufactured from ductile iron conforming to ASTM A536 or malleable iron conforming to ASTM A47 may be used. Standard of Acceptance: Victaulic Style 741 and Style 743 (Victaulic Data Sheet 06.06 and 06.07).

.6 Noise and vibration attenuation: Where it is necessary to suppress noise or vibrations in piping system, three (3) Victaulic Flexible Grooved couplings may be installed close to the source of noise or vibration in lieu of Elastomeric Flexible "Arch Type" connectors or Flexible Metal Hose connectors. Standard of Acceptance: Victaulic Style 77 (Victaulic Data Sheet 26.04).

2.6 Grooved Piping System – Stainless Steel – Specify Type 304 or Type 316 SS

.1 General:

.1 All grooved components shall be of one manufacture and approved for use by the authorities, agencies, codes and standards named in the Specifications.

.2 All approved manufacturers shall be certified to ISO 9001 standards.

.2 Grooved Couplings

.1 Grooved couplings shall be manufactured from stainless steel conforming to ASTM A351, ASTM A743 or ASTM A744.

.2 Grooved couplings to be designed with angle pads to provide a rigid joint unless otherwise noted. Standard of Acceptance: Victaulic Style 489 (Victaulic Data Sheet 17.25). Note: In some applications painted or galvanized ductile iron couplings may be used to joint stainless steel pipe. Confirm with Manufacturer.

.3 Where expansion, contraction or angular deflection is designed into piping system flexible couplings shall be used. Standard of Acceptance: Victaulic Style 77S and Victaulic Style 475 (Victaulic Data Sheet 17.03 and 17.14).

.3 Grooved fittings: All grooved fittings to be manufactured from stainless steel conforming to ASTM A312, ASTM A403 or ASTM A774. Standard of Acceptance: Fittings manufactured by Victaulic (Victaulic Data Sheet 17.04).

2.7 Grooved Piping System – AWWA Ductile Iron

.1 General:

.1 All grooved components shall be of one manufacture and approved for use by the authorities, agencies, codes and standards named in the Specifications.

.2 All approved Manufacturers shall be certified to ISO 9001 standards.

.2 Grooved couplings:

.1 Grooved couplings shall be manufactured from ductile iron conforming to ASTM A536. Gaskets shall be Grade "M" FlushSeal Halogenated Butyl for water service. Standard of Acceptance: Victaulic Style 31 (Victaulic Data Sheet 23.02).

.2 For connecting components of IPS dimension to components of AWWA dimension, grooved transition couplings may be used. Gaskets shall be Grade "M" FlushSeal Halogenated Butyl for water service. Standard of Acceptance: Victaulic Style 307 (Victaulic Data Sheet 23.03).

.3 Grooved fittings: Grooved fittings shall be manufactured from ductile iron conforming to ASTM A395, Grade 65-45-12 or ASTM A536, Grade 65-45-12 or cast iron conforming to ASTM A48, Class 30-A. Standard of Acceptance: Fittings manufactured by Victaulic (Victaulic Data Sheet 23.05).

.4 Flanged adapters: For connection to ANSI Class 125 / 150 or Class 250 / 300 flanged components, grooved flange adapters manufactured from ductile iron conforming to ASTM A395 or ASTM A536 may be used. Standard of Acceptance: Victaulic Style 341 (Victaulic Data Sheet 23.04).

2.8 Grooved Piping System – Copper Tubing

.1 General:

.1 All grooved components shall be of one manufacture and approved for use by the authorities, agencies, codes and standards named in the Specifications.

.2 All approved manufacturers shall be certified to ISO 9001 standards.

.2 Grooved Couplings:

.1 Grooved couplings shall be manufactured from ductile iron conforming to ASTM A536.

.2 All grooved couplings to be designed with angle pads to provide a rigid joint unless otherwise noted. Standard of Acceptance: Victaulic Style 606 (Victaulic Data Sheet 22.02).

.3 Couplings shall be complete with FlushSeal gaskets or equivalent.

.3 Grooved fittings: all grooved fittings to be manufactured from wrought copper conforming to ASTM B75, C12200 or ASTM B152, C1100 or cast bronze per ASTM B584. Standard of Acceptance: Fittings manufactured by Victaulic (Victaulic Data Sheet 22.04).

.4 Flanged adapters: for connection to ANSI Class 125/150 or Class 300 flanged components, grooved flange adapters manufactured from ductile iron conforming to ASTM A536. Standard of Acceptance: Victaulic Style 641 (Victaulic Data Sheet 22.03).

2.9 Gaskets

.1 For flat-faced flanges, use full-face gaskets. For Van Stone, lap joint and raised-face flanges, use full face or ring type gaskets. Conform to ASTM B16.21.

.2 Use gasket materials for flanged connections suitable for the temperature, pressure, and corrosivity of the fluid conveyed in the pipeline. Refer to the detailed pipe Specification sheets for the recommended gasket material. Material designations used in the detailed pipe specification sheets are as follows:

.1 EPDM: ethylene-propylene-diene-terpolymer 70 durometer

.2 Bl. Neoprene: neoprene (black) 70 durometer (not acceptable in stainless steel pipe systems)

.3 Nitrile: nitrile (Buna N)

.4 SBR: Styrene-butadiene (red)

.5 Natural rubber: natural rubber

.6 Compressed synthetic fibres (Kevlar): ASTM F104 (F712400), and neoprene binder: 1.7 MPa (ASTM F152), 0.2 mL/h Leakage Fuel A (ASTM F37)

.7 Compressed synthetic fibres (Kevlar): ASTM F104 (F712400) and SBR binder: 1.7 MPa (ASTM F152). 0.1 mL/h Leakage Fuel A (ASTM F37)

.8 Gylon Type 1: Garlock Style 3500. 1.35 MPa (ASTM F152). 0.22 mL/h Leakage Fuel A (ASTM F37)

.9 Gylon Type 2: Garlock Style 3510. 1.35 MPa (ASTM F152). 0.04 mL/h Leakage Fuel A (ASTM F37)

.10 CPE: chlorinated polyethylene

.3 Unless otherwise specified, minimum Gasket Material Thickness for full face gaskets:

.1 Up to 250 mm pipe diameter: 1.6 mm thick

.2 Greater than 250 mm pipe diameter: 3.2 mm thick

.4 Unless otherwise specified, minimum gasket material thickness for raised face ring gaskets:

.1 Up to 100 mm pipe diameter: 1.6 mm thick

.2 Greater than 100 mm pipe diameter: 3.2 mm thick

.5 Grooved type gaskets:

.1 Select material as recommended by the manufacturer for the service conditions indicated.

.2 Unless otherwise specified; for epoxy lined piping systems for solids carrying liquids, provide end-seal type gaskets.

.3 Unless otherwise specified, provide flush seal type gaskets for all other grooved joint systems. Acceptable products: Gustin-Bacon Rigigrip, Victaulic Flush-Seal.

2.10 Bolts and Nuts

.1 Provide hex head bolts and nuts. Threads to be ANSI B1.20.1, standard coarse thread series.

.2 For general indoor service, use bolts conforming to ASTM A307, Grade A; nuts conforming to ASTM A563, Grade A.

.3 Provide stainless steel bolts, nuts and washers for exposed, submerged, buried and concrete encased service; bolts conforming to ASTM A193, Grade B8, C1.1; nuts conforming to ASTM A194, Grade 8. Provide these also for connections above normal water level but which may be subjected to direct contact with splashed water.

.4 Provide hot dip galvanized bolts, nuts and washers for use with hot dip galvanized Van Stone flange back-up rings and Lap-joint flange back-up rings.

.5 Provide hex nuts equal to or less than 25 mm. Greater than 25 mm, provide heavy hex.

2.11 Cathodic Protection

.1 Provide cathodic protection of piping, pipe fittings and appurtenances in accordance with Division 16.

2.12 Structural Element Penetrations

.1 Structural element penetrations are shown and referenced to a detail or Process/Mechanical Standard Detail. Where a structural element penetration is not referenced, conform to the Standard Detail relevant to the type of structure, exposure, and type of pipe.

.2 Provide pipe sleeves capable of supporting the loads applied during placement of concrete or during blockwork erection. Century Line HDPE sleeves with water stop collar may be used where applicable.

.3 Supply wall or floor penetrations into submerged areas, under slab areas, and where shown with a 6 mm thick water stop flange at least 50 mm larger than the pipe or pipe sleeve outside diameter. Continuously weld the water stop flange, both sides, onto the pipe or pipe sleeve. Fill annular space between the sleeve and pipe, where a sleeve is used, with non shrink grout in accordance with Division 3. Form reglets between the grout and the concrete and between the grout and the pipe, on "wet" sides of the wall penetration. Fill reglet with sealant.

.4 For structural concrete wall and floor penetrations of non-insulated pipe between dry areas, furnish a sleeve which has an internal diameter at least 50 mm larger than the outside diameter of the pipe. For pipes 75 mm and less furnish a pipe sleeve 25 mm larger than the outside diameter of the pipe.

.5 For masonry wall penetrations of non-insulated pipe, furnish a sleeve which has an internal dimension of at least 50 mm larger than the pipe outside diameter. For pipes 75 mm and less furnish a pipe sleeve 25 mm larger than the outside diameter of the pipe.

.6 A Standard Detail is shown for segmented modular pipe seals. Where this detail is used for the penetration of a wall separating a dry area from an underground area, tighten the bolts from the inner face and fill the outer annular space with grout. Use stainless steel bolts and nuts in penetrations through walls separating underground or exterior areas from any other area. If seepage occurs during the warranty period, the Contractor is responsible for repair and/or replacement, at no cost to the City. Do not use this type of wall penetration below maximum ground water level elevation.

2.13 Insulation

.1 Provide insulation in accordance with Section 11059. Minimum insulation thickness: 25 mm. Use greater thicknesses as recommended by the manufacturer if more than 25 mm is required to lower the outer skin temperature to below 40°C.

.2 Provide stainless steel bands over the insulation at a maximum of 300 mm centers.

.3 Provide insulation and recovering for all piping where the pipe surface will sweat, where heat retention is required, and at the locations indicated on the Drawings. Conform to Section 11059.

.4 Where pipe runs below ground, continue insulation and recovering to a depth 2.5 m below finished ground surface in grassed areas or 3.0 m below roads, walkways, and access pads.

.5 Do not insulate over expansion joints or flexible hose connectors, in order to permit periodic inspection of connector bolting.

.6 Recover all insulated pipe. Align longitudinal seams in aluminum recovering to shed water. Overlap radial seams a minimum of 50 mm.

.7 Refer to Division 16 for electrical heat tracing.

2.14 Interior Finishes (Linings)

.1 General

.1 Provide products with factory applied linings and finishes unless otherwise noted. Fittings and pipe of any one pipe system to be lined by the same manufacturer.

.2 Do not shop coat the internal surface of stainless steel or plastic piping.

.3 Provide No. 1 or No. 2B standard finish for gauge stainless steel pipe, as specified in ASTM A480. Finish heavier pipe to No. 1 mill finish or better, as specified in ASTM A480.

.4 Unless otherwise specified, finish fittings in the same manner as the pipe run.

.2 Epoxy, E2a, E2b or E2c

.1 Where specified in the detailed pipe specification sheets, apply epoxy to the internal surface of piping in accordance with AWWA C210. Refer to Section 09900.

.3 Asphaltic Varnish

.1 Provide asphaltic varnish as the standard finish for ductile iron and cast iron pipe, in accordance with AWWA C151.

.4 Cement Mortar Lining

.1 Where specified in the detailed pipe specification sheets, apply cement mortar lining and an asphaltic seal to the internal surface of ductile iron piping in accordance with AWWA C104.

.2 Where specified in the detailed pipe specification sheets, apply cement mortar lining and an asphaltic seal to the internal surface of steel piping in accordance with AWWA C205.

.5 Glass Lining

.1 Where specified in the detailed pipe specification sheets, apply glass lining to pipe interior in two coats.

.2 Sandblast interior pipe surfaces prior to lining application to white metal finish in accordance with SSPC-10.

.3 After application of first and each subsequent coat, expose to naturation temperature above 750°C.

.4 Finished lining will be:

.1 250 to 300 microns thick

.2 Density of 2.5 to 3.0 grams per cubic centimetre

.3 Hardness in excess of 5.0 on the MOHS scale

.4 Capable of withstanding 175°C thermal shock without crazing, blistering, or spalling

.5 No visible loss of surface gloss after immersion in 8 percent sulphuric acid solution at 65°C for a period of ten minutes.

.6 No more than 0.01 percent exposure of the base metal due to defects in the glassed surface.

.5 Provide sample to Contract Administrator for use as a comparison guide.

.6 Acceptable products modified to meet this specification are:

.1 Vitco

.2 Waterworks

.7 The glass lining shall provide continuous coverage when tested by a low voltage wet sponge holiday detector, with no isolated voids permitted due to casting anomalies. Testing procedure and acceptance criteria shall be as per "MP-92, Porcelain Enamel Continuity Testing", as listed in Clauses 2.10.5.7.1 – .3.

.1 Purpose: Proper application of the porcelain enamel coating provides beneficial long term characteristics of lubricity, adherence, and resistance to corrosion and high temperature. Currently, there is no test method, either destructive or non-destructive, which directly measures these characteristics. Rather, the industry has developed a testing method utilizing a holiday detector, which determines the continuity of the glass lining and indicates the relative quality of the process. This method is commonly referred to as "spark test".

.2 Test Description

.1 Equipment: The equipment consists of a Tinker & Rasor electronic device or equivalent designed to locate holidays (pinholes, voids, ridges, etc.) in the non-conducting porcelain enamel lining. It functions by applying a 67.5 volt potential across the glass lining. Any pinholes or other holidays in the glass lining will close the circuit and produce an audible signal from the detector for any resistance less than 10,000 ohms. The current is applied through a circular sponge which has been wetted using water containing approximately 1 percent of a wetting agent such as Kodak "Photo Flo".

.2 Procedure: For testing long pipe sections, the diameter of the wetted sponge shall exceed the diameter of the pipe so that the sponge is in full circumferential contact with the porcelain enamel lining of the pipe. The

sponge is attached to a rod which allows the sponge to be pushed through at least 50 percent of the pipe. Any discontinuities will result in an audible signal which will be recorded with regard to position along the pipe. Testing is performed from both ends of the pipe.

.3 Special techniques are required at the exposed pipe ends which are not enameled. If, due to excess water on the sponge, the electric current short circuits to the end of the pipe resulting in an audible signal (typically within 75 mm of the end), a visual inspection shall be made to determine if discontinuities exist.

.3 Acceptance criteria: The pipe or fittings as tested by the procedure shall be rejected from shipment if testing reveals isolated voids and pinholes due to casting irregularities which represent more than 0.01 percent of the total glassed surface. Rejected pipe shall be evaluated for additional coating with porcelain enamel or for total reblasting, reprocessing, and retesting.

.4 Field Procedure:

.1 All handling or lifting of glass lined pipe, valves and fittings shall be done on the exterior only.

.2 Avoid lifting internally with hooks, forks or chains at any time.

.3 Welding on glass lined pipe is not permitted. Wall collars, restrained joint weld ends, tapping connections, etc. to be fabricated by the manufacturer and then glass lining applied.

.4 Glass lined pipe shall not to be cut to length for field closure pieces. No site modification is permitted to the glass lined pipe without specific written instruction from the glass-lining manufacturer.

2.15 Exterior Finishes - (Coatings) Shop Applied

.1 Provide Products with factory applied coatings and finishes as specified in the detailed pipe Specification sheets. If no coating is specified in the detailed pipe Specification sheets, refer to Section 09900 for general painting requirements. Refer to Section 11910 for colour coding requirements.

.2 Yellow Jacket

.1 High density polyethylene (HDPE) jacket extruded over a mastic base.

.2 Manufacture, test, inspect and report procedures to meet or exceed CAN3-Z299.3 (Quality Assurance Program - Category 3).

.3 Prior to mastic application, sandblast pipe in conformance with requirements or SSPC SP6.

.4 Adhesive consists of rubberized asphalt mastic, non-hygroscopic, formulated for use with Yellow Jacket. Apply to prepared surfaces in thickness exceeding 0.175 mm.

.5 HDPE has the following minimum properties: Ultimate tensile strength, 21 MPa; Tensile elongation at break, 600 percent; Shore "D" hardness, 60; and Brittleness temperature -50°C.

.6 Apply HDPE by extruding over adhesive in an even thickness to provide a smooth continuous outer sheath, free of pinholes, bubbles, wrinkles, blisters, cracks, or mechanical damage.

.7 Minimum HDPE thickness will be as follows:

Nominal Pipe Diameter (mm)	**Minimum HDPE Thickness (mm)**
20	0.55
25	0.55
30	0.60
40	0.65
50	0.70
65	0.70
75	0.70
100	0.75
150	0.90
≥200	1.00

.8 All flaws (up to three per pipe) will be repaired by cutting out each damaged area and applying sealant lined 200 mm diameter patch or heat shrink sleeve not exceeding 400 mm in length. Overlap undamaged area by a minimum of 75 mm around cut out section.

.9 Where the number of flaws or damaged areas per pipe exceeds three or any flaw is too large to be repaired with a patch or sleeve, the pipe will be rejected.

.10 Tape wrap: shop applied tape wrap may be used as an alternative to Yellow Jacket. Two or three layer methods can be used, meeting or exceeding the application and performance requirements of AWWA C214.

.3 Epoxy, E2a, E2b or E2c

.1 Apply epoxy (E2a, E2b or E2c) to the exterior of piping in accordance with AWWA C210. Refer to Section 09900 for details.

2.16 Exterior Finishes - (Coatings) Field Applied

.1 General

.1 Use field applied finishes only for

.1 Short lengths of metal pipe in a piping system where the length of pipe which requires coating is less than 3.0 m unless otherwise specified

.2 To repair shop-applied exterior finishes

.3 To make up cutback distances at joints

.4 For fittings, couplings, valves, and other appurtenances

.2 Refer to Section 09900 for painting requirements for aboveground piping and piping located in tunnels, buildings, pump houses, and other structures. Also refer to Section 09900 for painting requirements for exposed piping within insulated systems.

.2 Tape wrap

.1 For welded joints on Yellow Jacketed pipe and as other indicated locations apply tape to buried pipe and fittings. Use Polyken, Tec-Tape or Denso tape, consisting of primer and tape applied to minimum thickness of 0.90 mm in accordance with AWWA C209.

.2 For flanged or coupled joints and for fittings use petrolatum primer, mastic and tape; Polyken, Tec-Wrap or Denso, in accordance with AWWA C217.

.3 Shrink sleeve

.1 As an alternative to tape wrap, shrink sleeves are acceptable if material and method of installation is reviewed and accepted by the Contract Administrator prior to use.

.4 Epoxy, E2a, E2b or E2c

.1 Apply epoxy, E2a, E2b or E2c, to the exterior of piping in accordance with AWWA C210. Refer to Section 09900.

2.17 Galvanizing

.1 Where piping is to be galvanized, hot dip zinc coat to CSA G164 with a minimum coating of 550 g/m^2.

.2 All carbon steel parts, such as elements of flanges, anchors, guides and supports shall be galvanized, hot dip zinc coat to CSA G164 with a minimum coating of 550 g/m^2. Elements welded to components that do not lead themselves to hot dip galvanizing shall be thoroughly cleaned and cold zinc galvanized to similar coat thickness. Surface preparation for cold galvanizing shall meet specifications of the manufacturer of the cold galvanizing product. Product shall meet 2000 hours resistance test to salt spray (ASTM B-117).

2.18 Grout

.1 Non-shrink grout: conform to Section 03300

2.19 Concrete

.1 Provide concrete for concrete surround placed around buried pipe, and fill placed over buried pipe, in accordance with Section 03300 and as shown.

3. EXECUTION

3.1 Preparation

.1 Prior to installation, inspect and field measure to ensure that previous work is not prejudicial to the proper installation of piping.

.2 Make all minor modifications to suit installed equipment and structural element locations and elevations.

.3 Piping arrangements indicated on the Drawings have been established on the basis of the "Design Standard" listed in the specific process equipment sections. If the equipment to be provided is not the Design Standard, modify the piping arrangement as necessary at no additional expense to the City.

.4 Advise the Contract Administrator of all modifications. Do not commence work on the related piping until all modifications have been reviewed by the Contract Administrator.

.5 Include any piping modifications in the Shop Drawings submitted prior to fabrication or installation.

3.2 Pipe Handling

.1 Inspect each pipe and fitting prior to installation. Do not install damaged pipe or pipe with damaged protective coatings. Do not use sections of large diameter, thin walled stainless steel piping that may have been deformed out of roundness or dimpled. Such damaged sections shall be discarded.

.2 Remove all foreign matter from inside of pipe prior to installation.

.3 Repair pipe with damaged protective coatings with material similar to the original in accordance with the Manufacturer's directions and to the satisfaction of the Contract Administrator.

.4 Damaged glass lining cannot be repaired. Damaged pipe must be replaced.

.5 Use proper implements, tools, and facilities for the proper protection of the pipe. Exercise care in the installation so as to avoid damage to pipe or coatings.

.6 When lifting sections of large diameter, thin wall piping onto the supports use methods that will prevent damage or deformation. Lift evenly at several places to ensure that the piping deflection between lifting points does not exceed 6.3 mm.

3.3 Sleeves

.1 Unless otherwise noted or approved by the Contract Administrator, provide sleeves where piping passes through a wall, floor or ceiling.

.2 Locate and place sleeves prior to construction of cast-in-place elements and prior to the construction of concrete and masonry building elements.

3.4 Installation of Pipe Underground/Buried and Below Structures

.1 Trenching and backfill for buried pipe: conform to Division 2

.2 Pipe laying and bedding: conform to Division 2

.3 Unless otherwise shown, protect pipe laid below structures with a concrete surround having a minimum coverage of 100 mm all around the pipe; extend concrete surround to undisturbed ground.

.4 For concrete surround, comply with the following:

.1 Install pipe in straight alignment. Do not exceed 10 mm variance from the true alignment in any direction.

.2 Ensure the pipe alignment stays true during and after placement of concrete surround.

.3 Ensure that the method used to prevent pipe uplift during placement of concrete surround results in a level invert and crown.

.4 Maintain pipe circular cross section.

.5 Provide lean concrete to within 150 mm of the underside of the slab or footing for backfill over pipe laid below structures, except as detailed otherwise.

.6 Place concrete in accordance with Section 03300.

.7 Provide Yellow Jacket or tape wrap on all fittings and flanged, grooved, plain end and welded joints underground and below structures.

.8 Unless otherwise specified or shown, for underground piping provide groove joints or flex coupled joints at 6000 mm on centre.

.9 Use anti-seize compound with all stainless steel nuts and bolts.

.10 Prior to installation provide a Manufacturer's Representative, from the HDPE pipe manufacturer, for a minimum of one day to instruct personnel on installation procedures of HDPE pipe.

3.5 Installation

.1 Fabricate and install process and pressure piping in accordance with the Process Piping Code B31.3 and the Manitoba Steam and Pressure Plants Act. Fabricate and install domestic hot and cold water piping, sanitary piping and storm drainage piping in accordance with the Manitoba and National Plumbing Codes.

.2 Make adequate provision in piping and pipe support systems for expansion, contraction, slope, and anchorage. Supports, bracing, and expansion joints shown in the Drawings are schematic only. The Contractor is responsible for the design, supply, and installation of the piping system in general accordance with the indicated requirements.

.3 Install pipe support system to adequately secure the pipe and to prevent undue vibration, sag or stress.

.4 Install expansion joints where shown and at other locations as necessary to allow for piping expansion and contraction.

.5 Provide temporary supports as necessary during construction to prevent overstressing of equipment, valves, or pipe.

.6 Accurately cut all piping for fabrication to field measurements. Process air piping sections shall be measured and cut at a temperature between 15ºC and 20ºC. If the installation in the field takes place at lower outdoor temperatures, provide circulation of hot air inside the piping to expand the material such that flanges can be bolted. Expansion joints for process air piping shall be blocked at their natural length at 15ºC to 20ºC and such that they will not deflect excessively during handling and installation. These blocks shall be removed prior to pressure testing.

.7 Install pipes in straight alignment. For large diameter (500 mm nominal diameter and greater), thin-walled (6.4 mm and less) stainless steel piping provide laser alignment of all pipe supports. Lateral and vertical misalignment between any three consecutive supports shall not exceed the pipe wall thickness.

.8 For piping other than large diameter, thin-walled stainless steel, do not exceed 10 mm in 10 m variance from the true alignment, in any direction.

.9 Fabricate and assemble pipe runs so that the pipework is not stressed to achieve the desired alignment and that no stresses are transferred to equipment or equipment flanges. The "springing" of pipework to ensure alignment is not permitted. Undo and subsequently remake all pipework connections to ensure that springing does not occur. Take care not to damage equipment, valves or flanges.

.10 Slope instrument air piping to condensate traps. Provide condensate traps as recommended by the manufacturer of the instrument air compressor.

.11 Do not cut or weaken the building structure to facilitate installation.

.12 In parallel pipe runs, offset flanges and grooved joint fittings by a minimum of 200 mm.

.13 In vertical pipe runs of diameter greater than 250 mm, provide 200 mm long spool piece on lower side of each valve.

.14 Provide aluminum watertight drip trays under pipe carrying corrosive commodities crossing over cable trays. The drip trays will be 300 mm wider and 600 mm longer than the piping area over the cable tray.

3.6 Mild Steel Welding

.1 Use manual shielded metallic arc welding (SMAW), submerged arc welding (SAW), or inert gas shield arc welding (GMAW) or gas tungsten arc welding (GTAW).

.2 Welding procedures shall conform to CSA Z183.

.3 Bevel plain pipe ends prior to welding.

.4 Clean and dry welding surfaces thoroughly prior to welding, in an area not less than 0.3 m wide on each side around the welding line.

.5 Do not proceed with welding when metal temperatures fall below minus 18°C. Apply supplemental heat when metal temperatures are below 0°C, to heat the metal to 20°C.

.6 Maintain flanges, pipes, fittings, etc. in alignment during welding. Ensure that no part of the weld is offset by more than 20 percent of the pipe wall thickness.

.7 Make tack welds of material equal to the root pass. Tack welds which have not cracked may be incorporated in the root pass.

.8 Ensure the first bead obtains full root penetration with a minimum of weld material projecting within the pipe.

.9 For butt welds of pipe diameters less than 200 mm use a minimum of two passes. For larger pipe use three passes - minimum.

.10 For lap joints, weld joint in two passes minimum.

.11 Between passes, visually inspect bead for pinholes or other defects. Repair any defects prior to the placement of the next pass.

.12 Clean all flux, slag and other foreign material from the weld prior to applying a successive bead, and on completion of the weld.

.13 Do not start successive passes at the same point.

.14 Completely fill the joint with weld, and have a reinforcement greater than 1.5 mm and less than 3.0 mm, with no undercutting at the weld edges.

.15 Provide a smooth surface for coating application to exterior surfaces of pipe. Grind or buff all welds to a minimum radius of 6 mm on all edges and corners. Adhere to latest edition of NACE RP0178. Refer to Section 09900.

.16 Contractor to provide access to all external welds in fabricated spool pieces for grinding purposes. This will ensure that the coating application on welds can be properly ground to achieve proper coating application. Provide maximum of 400 mm distance from any weld.

.17 Repair linings and coatings after welding.

3.7 Stainless Steel Welding

.1 Conform to reviewed stainless steel pipe welding procedures, which have been signed and sealed by a Professional Engineer registered in the Province of Manitoba, and to Section 05500.

.2 Remove all scale, rust and any other surface deposits from the entire pipe and fittings before welding. Be particularly thorough with the internal surface preparation.

.3 For all stainless steel pipe intended to convey liquids, use inert gas backing for field and shop welds (GMAW or GTAW). For these services, "Solar Flux" and similar products will not be allowed.

.4 Ensure the first bead obtains full root penetration with a minimum of weld material projecting within the pipe.

.5 Grind or buff all welds to a minimum radius of 6 mm on all edges and corners to achieve a smooth surface, eliminate any pockets and eliminate any protruding root passes. Adhere to latest edition of NACE RP0178. If material thickness will not allow 6 mm radius, make radius one half of material thickness.

.6 Ensure the outside diameter weld (weld cap) is free of excessive weld cap and free of discoloration due to welding. Ensure all inside diameter welds (root pass) or outside diameter welds exposed to wastewater or corrosive fluids/environments are ground flush and have no discoloration.

.7 Passivation

.1 Passivate the inside of all stainless steel piping after completion of all piping and supports welding. Any welding after passivation will require passivation of the entire piping section again. A piping section is the length between flanges.

.2 Comply with ASTM A380, Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems, and ASTM A967, Standard Specification for Chemical Passivation Treatment for Stainless Steel Parts, latest edition.

.3 Use fine grit carbide sandpaper to remove any discoloration, such as bluish due to overheating.

.4 Thoroughly clean the interior of the pipe and ensure there are no oil or grease deposits or particulate (such as from the sandpaper) using trisodium phosphate (TSP) solution per manufacturer's recommendation. Thoroughly rinse with tap water.

.5 Acid pickle using a solution of 20 percent nitric acid and 2 percent hydrofluoric acid in chloride-free water. Treat for no less than 2 hours at 20ºC to 40ºC. Do not do the work at less than 20ºC. An equivalent pickling paste shall be used for air piping not designed to be filled with water. Follow the manufacturer's instructions. Rinse thoroughly with chloride-free water (distilled or de-ionized) until the rinse water shows less than 0.1 mg/L of fluoride. Rinse thoroughly with chloride-free water (distilled or de-ionized) brought to pH 10 using ammonia (preferred). Alternatively caustic soda or soda ash may be used to increase the final rinse water pH, but the maximum concentration of chloride allowed in this solution is 1 mg/L. Note that chloride concentration in commercially available caustic soda and soda ash may be too high for this use. Completely drain and leave drying in warm air (not less than 20ºC at the outlet end) overnight.

.6 Collect all acids, caustics and rinses and take all necessary precautions to prevent spills on the ground. Neutralize as needed, for example blending acid and caustic wastes and using pebble or ground limestone, lime or other suitable material. Dispose of the neutralized waste as indicated by the City at the closest primary effluent channel. Note that the City may limit the volume that may be discharged over any period of time. Take measures to prevent freezing.

.7 Process air piping may not be filled with water unless laid flat on the ground or otherwise supported every 5000 mm and on each side of sliding supports.

.8 Pickling and passivating may require the ingress of an individual into the process air pipe. A single individual may do so once the pipe has been installed. Provide adequate ventilation that will blow any fumes away from the worker. This individual shall wear adequate protection per MSDS and clean, thick cloth socks over footwear. Confined entry procedures shall apply. Footwear, other items or tools that could scratch the stainless steel surface shall not be carried into the pipe.

3.8 Grooved Piping System – Installation

.1 All grooved products shall be installed according to manufacturer's installation instructions.

.2 Carbon steel pipe may be either cut grooved or roll grooved as appropriate for pipe and service specified.

.3 Schedule 5 and Schedule 10 stainless steel pipe shall be roll grooved using "RX" rolls in accordance with manufacturer's installation instructions.

.4 Ductile iron pipe shall utilize "radius cut grooves". Grooves shall conform to either "rigid" or "flexible" cut groove dimensions as specified for application. Pipe shall have wall thickness of Class 53 pipe or greater.

.5 Copper piping shall be roll grooved in accordance with manufacturer's installation instructions.

3.9 Insulation

.1 Insulate piping systems in accordance with Sections 11055 and 11059.

3.10 Testing

.1 Give the Contract Administrator 24 hours notice prior to testing.

.2 Do not insulate or conceal work until piping systems are tested and accepted.

.3 Complete any required weld tests.

.4 Interior of stainless steel piping shall be bright metal with no discoloration. Any discoloration, such as bluish tint at welds, will require spot pickling and passivation using paste containing nitric acid and hydrofluoric acid, followed by rinsing and drying as indicated previously.

.5 Spot check the interior of the stainless steel piping and weld areas as indicated by the Contract Administrator. Use 5 percent copper sulphate solution. After ten minutes at not less than 15ºC there shall be no observable deposit of metallic copper. Otherwise, pickling and passivation shall be repeated for the entire piping section. Carefully wipe off copper sulphate solution with several damp pieces of cloth.

.6 Supply all water, air and inert gases required for pressure testing.

.7 Supply all pumps, compressors, gauges, etc. required for testing.

.8 Install air threadolets, air relief valves and line fitting valves as necessary to complete testing. Remove after testing and plug the threadolets.

.9 Cap or plug all lines which are normally open ended. Remove on completion of testing.

.10 Provide all temporary thrust restraints necessary for testing. Remove upon completion of testing.

.11 Test all underground lines prior to backfilling. Do not place concrete surround until lines are tested.

.12 Test all existing piping where it connects to new piping to the first valve in the existing piping. Repair any failures in existing piping which occur as a result of the test after informing the Contract Administrator of such failure.

.13 Isolate all low pressure equipment and appurtenances during testing so as not to place any excess pressure on the operating equipment.

.14 Where defective material or equipment is identified, repair or replace using new material.

.15 Release pressure safely, flush and drain liquid pipes after pressure tests. Release pressure safely and purge if needed all gas pipes after pressure tests.

.16 Dispose of flushing water in manner approved by the Contract Administrator, which causes no damage to buildings or siteworks.

3.11 Pressure Testing of Liquid Lines

.1 Hydrostatically test all lines normally used for the conveyance of liquid using water as the test medium.

.2 Test pressures and durations shall be as specified in the detailed specification sheets.

.3 Ensure all lines are filled with water. Bleed air from all high spots using the taps provided specifically for that purpose.

.4 Zero leakage is permitted throughout the specified test period for all exposed piping, buried insulated piping, and any liquid chemical lines.

.5 Show evidence of leakage rates below 0.01 L/h per mm pipe diameter per 100 m of pipe length for buried piping, unless otherwise specified.

.6 Test drains in accordance with the Manitoba and National Plumbing Codes.

3.12 Pressure Testing of Gas, Air and Vapour Lines

.1 Hydrostatically or pneumatically pressure test, as shown in the table below, all lines normally used for the conveyance of gas, air, or vapour in accordance with Process Piping Code B31.3 procedures for testing pressure piping and CAN/CGA B105 for buried digester gas piping. Pneumatically test all instrument air lines in accordance with ISA-RP7.1.

.2 For gas and air lines to be hydrostatically tested, check support system to ensure it is capable of withstanding loads imparted by test method. Provide any additional supports necessary in a manner acceptable to the Contract Administrator. At the Contract Administrator's request, provide calculations indicating design of temporary support system.

.3 Other than for chlorine and sulphur dioxide piping systems, use the following test media:

Pipe Size	Testing Pressure	Test Medium
50 mm and smaller	500 kPa or less	Air or water
50 mm and smaller	Greater than 500 kPa	Water
Greater than 50 mm	500 kPa or less	Air or Water
Greater than 50 mm	Greater than 500 kPa	Water

.4 Test pressures are identified in the detailed piping specification sheets.

.5 Zero leakage rate for insulated systems, and systems tested with water is required at the specified test pressure through the test period. Prior to commencing test using air, ensure air will be at ambient temperature and specified test pressure.

.6 Do not exceed 5 percent of the specified test pressure as the allowable leakage rate over the test period for other systems tested with air. Provide feed air pressure regulator with gauge and pressure safety valve with ring pressure set at not more that 20 kPag above the test pressure and adequately sized for both the compressor capacity and any condition that could result in pressure increases.

.7 Wet all joints using a mixture of soap and water in systems tested with air. Remake all joints which display leakage and retest. For stainless steel piping, repeat cleaning and passivation procedure indicated above for the entire piping section, then test for adequate passivation in the re-worked area.

.8 Test natural gas piping in accordance with CAN/CGA B139-1.

3.13 Cleaning and Flushing

.1 After installation and prior to testing, perform initial cleaning of process and utility lines. Clean piping greater than 150 mm and less than 600 mm by passing a tightly fitting cleaning ball or swab through the pipeline, unless specified otherwise. Lines greater than 600 mm may be cleaned manually or with a cleaning ball or swab. Give lines smaller or equal to 150 mm an initial flush or purge.

.2 After initial cleaning, connect the piping systems to related process and mechanical equipment. Insert temporary screens, provided with visible locator tabs, in the suction of pumps and compressors in accordance with the following table:

Suction Diameter, mm	Maximum Screen Opening, mm
25 and smaller	1.5
30-75	6.25
80-150	12.5
150 and greater	25

.3 Maintain the screens during testing, flushing/purging, initial startup, and the initial operating phases of the commissioning process. In special cases and with the Contract Administrator's acceptance, screens may be removed for performance tests.

.4 Unless specified otherwise, flush liquid systems after testing, with clean water and screens in place. Maintain flushing for a minimum period of 15 minutes and until no debris is collected in the screens.

.5 Remove the screens and make the final connections after the screens have remained clean for a minimum of 24 consecutive hours of operation. Screens in solids handling systems are exempt; remove prior to placing the system in service.

.6 In air or gas systems with pipe sizes less than or equal to 150 mm, purge with air and/or inert gases before testing. Upon completion of testing and cleaning, drain and dry the piping with a dry air stream. Satisfy ANSI/ISA-S7.3 standards for instrument air systems.

.7 Brush clean steel pipe exterior to SSPC-P3 standard prior to painting. Also refer to Section 09900.

3.14 Disinfection

.1 Disinfect lines intended for potable water service after testing in accordance with AWWA C651.

END OF SECTION

PROCESS PIPE JOINTS AND EQUIPMENT CONNECTIONS

1. GENERAL

1.1 Description

.1 This section describes acceptable methods for jointing and connecting piping to equipment and appurtenances.

.2 Refer to the general piping requirements of Section 11050. Use the general requirements specified in this section and Section 11050 integrally with the more specific requirements listed in Section 11055.

1.2 Submittals

.1 With the submittals required in Section 11050, provide a listing of joining and connecting techniques used in the performance of the work.

1.3 Coordination

.1 Coordinate the jointing techniques with the piping requirements and ensure that the connection techniques match the requirements of the equipment and ancillary devices to which piping must attach.

1.4 Quality Assurance

.1 Refer to Section 11050 for welding quality assurance requirements.

1.5 Shipment, Protection and Storage

.1 Refer to Section 01600 and Section 11050.

2. PRODUCTS

2.1 Function

.1 Provide for the joining of the pipe materials, fittings, and appurtenances as described below, for the piping systems shown.

2.2 General

.1 Connect piping using joints not readily disassembled only where shown and where not otherwise specified. Provide joints which may be disassembled as indicated on the Drawings, and at the minimum, within 1000 mm of any connection to equipment, on both sides of structural penetrations, within 600 mm of all threaded end valves, and at the spacing specified in the detailed piping specification sheets.

.2 Where new pipe crosses a new or existing structural expansion joint and the pipe is supported from each side of the structure, provide a flexible coupling in pipe to allow for differential settlement. Select flexible connection suitable for pipe material.

2.3 Welding Materials

.1 Use welding materials conforming to CSA W48.1.

.2 Provide electrodes compatible with the material welded and which deposit metal with strength and corrosion resistance properties at least equivalent to the base metal.

.3 Provide proper storage for welding rod. Provide rod ovens in cold or inclement weather.

.4 Keep stainless steel rods in marked containers, separate from other materials.

2.4 Dissimilar Metal Connections

.1 Where dissimilar metals are to be connected, furnish dielectric fittings and/or isolating flanges.

2.5 Carbon Steel Piping

.1 Less than 75 mm in diameter: butt-weld or use threaded couplings. Use unions where disassembly is required.

.2 Equal to or greater than 75 mm in diameter: where not specified or shown otherwise, butt-weld according to ASME Boiler and Pressure Vessel Code or furnish flanges, conforming to ANSI B16.5, Class 150. Where disassembly is required, flanges are sufficient.

.3 Companion flanges for connection to cast iron or ductile iron equipment flanges shall be refaced to be flush with the companion flange.

.4 Where grooved joint fittings are shown for use in steel piping systems, meet the following requirements:

.1 Use flexible style couplings for all buried service pipe, all pipe greater than 300 mm in diameter, for pipe less than 300 mm in diameter in rack mounted piping assemblies, and for grooved joints adjacent to pump or blower suction and discharge where grooved joints are used for noise and vibration control. Acceptable products are Gustin-Bacon 100 and Victaulic Style 77.

.2 Use rigid style couplings in all other applications. Acceptable products are Gustin-Bacon 120 Rigi-Grip and Victaulic Style 07 Zero-Flex.

.3 With the Contract Administrator’s prior acceptance, flange assemblies may be substituted for above ground steel piping which is not lined where rigid style couplings are shown or specified. Note any such substitutions in the submittals prior to fabrication.

2.6 Stainless Steel Tubing

.1 Use stainless steel compression fittings.

.2 Furnish compression couplings for stainless steel tubing of the same material as the pipe, capable of withstanding the maximum pressure to which the pipe is subjected.

2.7 Schedule Stainless Steel Pipe

.1 Less than 75 mm in diameter: socket-weld pipe. Where disassembly is required, use threaded unions.

.2 Equal to or greater than 75 mm in diameter: butt-weld pipe; where disassembly is required, use flanges.

.3 Flanged Connections:

.1 Make flanges on stainless steel piping stainless steel slip-on, rolled-angle collar Van-Stone type, with a galvanized steel back-up ring drilled to ANSI B16.1, Class 125. Make the angle ring thickness equal or greater than the pipe or fitting to which it is welded. Stamped (pressed) collars are not acceptable.

.2 For submerged joints, make the backup ring stainless steel.

.3 For digester gas services, make the flanges Lap-joint type with galvanized steel back-up ring and in accordance with CGA B105. For submerged joints, make the back-up ring stainless steel.

.4 Conform to ASTM A182 or ASTM A276, Class 150, for threaded connections to stainless steel pipe, threadolets to be shop welded to the pipe at the locations specified.

2.8 Gauge Stainless Steel Pipe

.1 Less than 75 mm in diameter: socket-weld pipe. Where disassembly is required, use socket weld unions.

.2 Equal to or greater than 75 mm in diameter: butt-weld pipe; where disassembly is required, use flanges.

.3 Flanged Connections:

.1 Make flanges on stainless steel piping stainless steel slip-on, rolled-angle collar Van-Stone type, with a galvanized steel back-up ring drilled to ANSI B16.1, Class 125. Make the angle ring thickness equal or greater than the pipe or fitting to which it is welded. Stamped (pressed) collars are not acceptable.

.2 For submerged joints, make the backup ring stainless steel.

.3 For digester gas services, make the flanges Lap-joint type with galvanized steel back-up ring and in accordance with CGA B105. For submerged joints, make the back-up ring stainless steel.

.4 Conform to ASTM A182 or ASTM A276, Class 150, for threaded connections to stainless steel pipe, threadolets to be shop welded to the pipe at the locations specified.

2.9 Copper or Brass Piping

.1 Use soldered couplings. Where disassembly is required, use compression unions.

.2 Use soldered couplings conforming to ANSI B16.26. Use lead free solder conforming to ASTM B32 and the National Plumbing Code.

.3 In potable water systems, use lead free solder conforming to ASTM B32 and National Plumbing Code.

.4 Solder used in DWV systems will be 50/50 type.

.5 Furnish compression couplings for copper and brass tubing of copper, suitable for the maximum pressure of the pipe, conforming to ANSI B16.26.

2.10 Ductile Iron Piping

.1 For above ground ductile iron piping, where not shown or otherwise specified, use grooved joints in accordance with AWWA C606. Flanges may be used if approved by the Contract Administrator and where needed to connect to equipment or piping appurtenances.

.2 For below ground piping systems use slip-on joints for unrestrained systems. Where shown or indicated, use bolted mechanical joints.

.3 Provide Class 125 flanges on cast or ductile pipe, conforming to ANSI B16.1.

.4 For grooved piping systems, provide pipe with rigid cut grooves for exposed services, and flexible cut grooves for buried services. Acceptable coupling products are Gustin-Bacon 500 series and Victaulic Style 31.

.5 Push-on joints: rubber ring compression, bell and spigot type. Assemble in accordance with AWWA C600 and manufacturers recommendations. Do not use on fittings or other appurtenances.

.6 Bolted mechanical joints: Comply with ANSI A21.10 and ANSI 21.11.

.7 Where restrained mechanical joints are shown or specified, ensure joints can be disassembled after installation. Do not use internal restraints. Factory apply retainer weldments. Do not use joints which employ set screws, retainer glands, or concrete thrust anchors. Acceptable products are Lok-Ring and TR Flex.

.8 When tying into existing ductile iron piping, replace existing ductile iron pipe back to the nearest joints to avoid field cutting.

2.11 Cast Iron Piping

.1 For cast iron drain pipe inside structures or concrete encased, use gasket and retaining clamp type mechanical joint conforming to CSA B70.

2.12 PVC and FRP Piping

.1 Where not shown or otherwise specified, use solvent weld joints for PVC and FRP piping. Provide flanges or unions where disassembly is required.

2.13 Concrete Cylinder Piping

.1 Bell and spigot joint: fabricate to AWWA C301 and/or C303. Provide and assemble rubber gasket joints in accordance with the pipe manufacturer's recommendations. After the joint has been made, verify the position of the gasket. Separate, rejoin and check joints which are not properly positioned.

.2 Welded joint: use only where shown or approved by the Contract Administrator. Weld exterior of joint. Use compatible filler rod as necessary to provide appropriate weld size.

.3 Restrained joints

.1 Type 1: Flanges to AWWA C207. Complete with a reinforcing ring welded to pipe cylinder

.2 Type 2: specially fabricated U-shaped clamps, ductile iron to ASTM A536, which when used with wedge rings to ASTM A36, rubber gaskets and stop rings, minimize pipe movement. Bolt in accordance with manufacturer's recommendations

.3 Type 3: a grooved joint style complete with a reinforcing ring welded to the pipe cylinder and grooved to accept the fitting.

.4 Ensure pipe design can withstand stresses induced by joint design.

.5 Grout each joint after installation with cement mortar in accordance with manufacturer’s directions.

2.14 HDPE Piping

.1 Refer to pipe manufacturer's specifications for product information and installation instruction.

.2 HDPE pipe joined by method of thermal butt fusion should conform to ASTM D 2657.

.3 Provide bell and spigot type joints conforming to ASTM D3212.

.4 Provide pipe, pipe support, and restraints to withstand stresses induced by joint design.

.5 Provide pipe, pipe supports, and restraints to withstand the stresses incurred during placement of concrete surround.

2.15 Flanges

.1 General requirements for flanges are as follows:

.1 Provide compatible flanges for mating to equipment or valves.

.2 Provide flat-faced flanges on each side of butterfly valves.

.3 For steel piping, provide weld neck flanges on both sides of wafer or lug body valves.

.4 A lap joint flange on digester gas services or Van Stone flange on schedule 10S stainless steel piping systems is acceptable.

.2 Do not use slip-on flanges that are attached to a pipe by means of set screws and gaskets (uni-flange, etc.)

2.16 Threaded Couplings

.1 Make screwed joints using American Standard threads to ANSI B1.20.1.

.2 Use Teflon tape as thread lubricant for threaded joints.

.3 Provide threaded-end to flanged-end adapters where required to connect to flanges.

2.17 Grooved Joint Couplings

.1 Fabricate grooved joint couplings of ductile iron to ASTM A536, and in accordance with AWWA C606.

.2 For ductile iron pipe, provide cut grooves in pipe and fittings in accordance with AWWA C606. Rolled grooves and roll-groove type joints are not acceptable.

.3 For steel pipe, provide cut grooves in pipe and fittings in accordance with AWWA C606. Alternatively, rolled grooves and roll-groove type joints may be used on bare steel pipe. Rolled grooves and roll-groove type joints are not acceptable on steel pipe that is internally lined.

.4 Cut or rolled grooved joints are not acceptable in stainless steel piping less than schedule 40S, carbon steel piping less than Schedule 40, and PVC piping less than schedule 80. Provide suitable end pipe piece for grooving as needed if piping wall is thinner.

.5 For all grooved joints, grind or buff edges to a minimum radius of 6 mm. Coordinate with coupling manufacturer to ensure proper fit.

.6 In grooved joint piping systems requiring end-seal type gaskets, provide grooved joint couplings and grooved pipe in accordance with gasket manufacturers recommendations. Acceptable manufacturers: Gustin-Bacon, Victaulic.

.7 Where grooved joint piping systems connect to equipment or to flanged valves, meters, or other sensing devices; use grooved joint flanges or flange adapters. Flange adapters have been used to develop the piping layout shown in the Drawings unless specifically noted otherwise. Acceptable products are Tyler Groove-to-Flange Fittings and Victaulic Flange adapters. Where the Contractor chooses to use grooved joint flanges rather than the indicated adapters, piping modifications required to suit this change are the responsibility of the Contractor. Make full allowance for piping disassembly and access to the face of equipment.

2.18 Flexible Couplings - Type I

.1 Unless specifically shown otherwise, use Type I flexible couplings where a flexible coupling is shown or required.

.2 Type I General Requirements:

.1 Center ring: steel, shop coated for corrosion protection.

.2 Gaskets: fabricated of material suitable to the service conditions.

.3 For submerged, buried or below structure applications, use stainless steel bolts, nuts and washers and provide center ring with epoxy coating.

.4 Provide the necessary amount and appropriate size of restraining rods and gussets as recommended by the manufacturer.

.5 Type 1 Restrained: use a flexible sleeve-type coupling with restraining rods, and gussets welded to the pipe. Provide sufficient restraint to resist pressure equal to twice the system test pressure.

.6 Do not use Type 1 flexible couplings in pipe systems which undergo thermal expansion and contraction; also, do not use these couplings at structural joints.

.3 Flexible Couplings Type IA

.1 Flexible sleeve type couplings: cylindrical centre ring, two follower rings, two resilient gaskets, and connecting bolts.

.2 Acceptable products are:

.1 Dresser Style

.2 Ford Meter Box

.3 Robar

.4 Rockwell

.5 Viking Johnson

.4 Flexible Couplings Type IB

.1 Flanged flexible sleeve type couplings: flanged cylindrical centre ring, a companion flange, one follower ring, one resilient gasket, and connecting bolts.

.2 Acceptable products are:

.1 Dresser

.2 Ford Meter Box

.3 Robar

.4 Rockwell

.5 Viking Johnson

.5 Flexible Couplings Type IC

.1 Transition flexible sleeve type couplings: Cylindrical centre ring, two follower rings two resilient gaskets, and connecting bolts.

.2 Acceptable products are:

.1 Dresser

.2 Robar

2.19 Flexible Couplings Type II

.1 Flexible pipe couplings: progressive sealing, capable of two degrees angular deflection in all directions, leakproof.

.2 Acceptable manufacturers:

.1 Straub

.2 Young Nam Company (YNC)

.3 Casing: 304 or 316 stainless steel.

.4 Lockparts: Steel, shop coated for corrosion protection. 304 stainless steel for buried or submerged services.

.5 Gaskets: fabricated of material suitable to the service conditions.

2.20 Equipment Connections

.1 Unless specified otherwise, comply with the Table at the end of this Section for the pipe connection requirements for various types of equipment ends.

3. EXECUTION

3.1 Mild Steel Welding

.1 Refer to Section 11050 for mild steel welding requirements.

3.2 Stainless Steel Welding

.1 Refer to Section 11050 for stainless steel welding requirements.

3.3 Threaded Joints

.1 Conform to the requirement of ANSI B31.3 Process Piping Code.

.2 Ream the end of all pipes to remove all burrs and cuttings when fabricating threaded joints.

.3 Clean out pipe and repair linings and coatings prior to joining.

.4 Apply Teflon tape to male threads and join pipe. Use both Teflon tape and Teflon sealing compound on stainless steel pipe threads. Do not use extra tape to make up for slack in the joint.

.5 Provide joints at spacings noted in Section 11055 to allow for pipe disassembly.

3.4 Flanged Joints

.1 Clean flanges and gaskets prior to connection.

.2 Lubricate gaskets with soapy water and apply anti-seize compound to the bolts.

.3 Bring flanges into close parallel and lateral alignment.

.4 Tighten bolts progressively. Proceed from side to side of the flange.

.5 Washers may not be used to take up excess bolt length.

.6 Provide approximately two full threads bolt projection beyond nuts.

.7 When joining steel to cast iron flanges, take care to avoid damage to the cast iron flange. Ensure both flanges are flat-faced and use full face gaskets.

.8 Align flanges which connect piping to mechanical equipment to close parallel and lateral alignment prior to tightening bolts. Do not place undue strain on the equipment.

.9 Provide flanges at spacings noted in the Drawings and in Section 11055 to allow for pipe disassembly.

.10 Allow a minimum of 150 mm to face or 200 mm to edge of flange from wall, floor or ceiling unless otherwise shown on the Drawings.

.11 On gauge stainless steel piping, consider the flange assembly weight in the design of the piping supports.

3.5 Grooved Pipe Joints

.1 Groove all pipes to be joined by this method in accordance with the manufacturer's recommendations.

.2 Repair linings and coatings after grooving.

.3 Where connecting grooved joint pipe to flanged equipment or valves, use a transition coupling a minimum of 150 mm in length with a Class 125 FF flange at one end and a grooved joint at the other, unless otherwise specified or shown.

.4 Alternately, use split flanges fabricated specifically for grooved joint pipe to connect to flanged equipment, valves, meters, or sensing devices. Provide restraint on joints to prevent valve body rotation when the operator is torqued.

.5 Provide joints at spacing noted in Section 11055 to allow for pipe disassembly.

.6 Allow a minimum of 150 mm to face or edge of grooved joint coupling from wall, floor or ceiling unless otherwise shown.

.7 On epoxy lined piping systems and in accordance with the coupling manufacturer's recommendations, continue the epoxy lining around the ends of each pipe to the edge of the cut groove; provide the same on each fitting.

.8 On glass lined piping systems and in accordance with the coupling manufacturer's recommendations, continue the lining around the ends of each pipe to the edge of the cut groove; provide the same on each fitting. Alternately a glass lining patch kit or mastic similar to Sikaflex 1A is acceptable on the glass lined pipe ends to the outside groove.

PROCESS PIPE JOINTS AND EQUIPMENT CONNECTIONS

Table - Pipe Connections for Various Equipment End Types

Piping Material	Pipe Type	Diameter Range (mm)	Equipment End								
			Tubing/Various	Brass or Bronze Female Thread	Cast Iron or Steel Female Thread	Cast Iron Flanged	Steel/Stainless Flanged	Steel/Stainless Plain End	Steel or Stainless Welding End	Fibreglass Flanged	PVC Female Thread
Stainless Steel	Tubing	6 to 25	Nut and Double Ferrule Type Connectors or Adapters as required Rating: Class 1000	150mm SS Threaded Nipple and Union Rating: Class 250	150mm SS Threaded Nipple and Union Rating: Class 250						150mm SS Threaded Nipple and Union Rating: Class 250
	Gauge & Schedule 10S	10 to 65		150mm SS Threaded Nipple and Union Rating: Class 250	150mm SS Threaded Nipple and Union Rating: Class 250			Flexible Joint Flanged One End Rating: Class 150 RF or Flange Adaptor and Van Stone Flange Rating: Class 150 RF			150mm SS Threaded Nipple and Union Rating: Class 250
		Greater than 65				Rolled Angle Van Stone Flange Rating: Class 125 FF	Rolled Angle Van Stone Flange Rating: Class 150 RF	Flexible Joint Flanged One End Rating: Class 150 RF or Flange Adaptor and Van Stone Flange Rating: Class 150 RF	Butt Welded (SS Equip. End)	Rolled Angle Van Stone Flange Rating: Class 150 RF	
	Schedule 40S	10 to 65		Socket Weld Nipple and Union Rating: Class 250	Socket Weld Nipple and Union Rating: Class 250			Flexible Joint Flanged One End Rating: Class 150 RF or Flange Adaptor and Van Stone Flange Rating: Class 150 RF			Socket Weld Nipple and Union Rating: Class 250
		Greater than 65				Rolled Angle Van Stone Flange Rating: Class 125 FF	Rolled Angle Van Stone Flange Rating: Class 150 RF	Flexible Joint Flanged One End Rating: Class 150 RF or Flange Adaptor and Van Stone Flange Rating: Class 150 RF	Butt Welded (SS Equip. End)		
Steel	Standard Wt. & Schedule 40	10 to 65		150mm Galvanized Threaded Nipple and Union Rating: Class 250	150mm Galvanized Threaded Nipple and Union Rating: Class 250	Threaded Steel Flange Rating: Class 125 FF	Threaded Steel Flange Rating: Class 150 RF	Flexible Joint Flanged One End Rating: Class 150 RF			150mm galv. Threaded Nipple and Union Rating: Class 250
		Greater than 65				Steel Flange Rating: Class 125 FF	Steel Flange Rating: Class 150 RF	Flexible Joint Flanged One End Rating: Class 150 RF	Butt Welded (Steel Equip. End)		
	Schedule 80	10 to 65		Threaded Nipple and Union Rating: 3000 kPa	Threaded Nipple and Union Rating: 3000 kPa	Threaded Steel Flange Rating: Class 125 FF	Threaded Steel Flange Rating: Class 150 RF	Flexible Joint Flanged One End Rating: Class 150 RF			Threaded Nipple and Union Rating: 3000 kPa
		Greater than 65				Steel Flange Rating: Class 125 FF	Steel Flange Rating: Class 150 RF	Flexible Joint Flanged One End Rating: Class 150 RF	Butt Welded (Steel Equip. End)		

PROCESS PIPE JOINTS AND EQUIPMENT CONNECTIONS

Table - Pipe Connections for Various Equipment End Types (Continued)

Piping Material	Pipe Type	Diameter (mm)	Equipment End								
			Tubing/Various	Brass or Bronze Female Thread	Cast Iron or Steel Female Thread	Cast Iron Flanged	Steel/Stainless Flanged	Steel/Stainless Plain End	Steel or Stainless Welding End	Fibreglass Flanged	PVC Female Thread
Ductile Iron		Greater than 65				Grooved End to Flanged Adaptor Rating: Class 125 FF	Grooved End to Flanged Adaptor Rating: Class 150 RF				
Cast Iron		Greater than 65				Grooved End to Flanged Adaptor Rating: Class 125 FF	Grooved End to Flanged Adaptor Rating: Class 150 RF				
Copper		10 to 65		150mm Copper Threaded Nipple and Union Rating: Class 250	150mm Copper Threaded Nipple and Union Rating: Class 250	Threaded Copper Flange Rating: Class 125 FF	Threaded Copper Flange Rating: Class 150 RF				
PVC	Schedule 40	10 to 65									150mm PVC Nipple and Union Rating: Schedule 80
		Greater than 65				PVC Van Stone Flange Rating: Class 125 FF	PVC Van Stone Flange Rating: Class 150 RF				
	Schedule 80	10 to 65		150mm PVC Nipple and Union Rating: Schedule 80	150mm PVC Nipple and Union Rating: Schedule 80						150mm PVC Nipple and Union Rating: Schedule 80
		Greater than 65				PVC Flange (Sch.80) Rating: Class 125 FF	PVC Flange (Sch.80) Rating: Class 150 RF				
HDPE		10 to 65		150mm Galvanized Steel Nipple and Grooved Joint, Transition Coupling	150mm Galvanized Steel Nipple and Grooved Joint, Transition Coupling						
		Greater than 65				Stub End and Ductile Iron Backup Ring Rating: Class 125 FF	Stub End and Steel Backup Ring Rating: Class 150 RF				

END OF SECTION

PROCESS PIPE GUIDES AND ANCHORS

1. GENERAL

1.1 Description

.1 This section describes process pipeline guides and anchors to be installed integrally with the piping. These items are an integral component of the piping support system for which other requirements are described in Section 11050.

.2 Refer to the general piping requirements of Section 11050. Use the general requirements specified in this Section and Section 11050 integrally with the more specific requirements listed in Section 11055.

1.2 Submittals

.1 Provide Shop Drawings, signed and sealed by a Professional Engineer registered in the Province of Manitoba, for each type of pipeline support and anchor in accordance with the requirements of Section 01300 and 15050.

.2 Show the materials of construction and illustrations of the method of installation.

.3 Refer to Section 11050 for requirements for submittals for the support system that incorporates the pipe guides and anchors.

.4 Provide evidence that the Manufacturer has at least five installations of similar size and type in satisfactory service for a period of not less than five years.

1.3 Coordination

.1 Coordinate the guides and supports with the pipe support system. Ensure that the guides and supports are mounted in locations suitable for their intended function.

1.4 Quality Assurance

.1 Welding Requirements: refer to Section 11050 for welding quality assurance requirements.

.2 Alignment: for large diameter (500 mm and larger), thin walled (6.4 mm and less) stainless steel piping supports laser align such that lateral and vertical misalignments between three consecutive supports do not exceed the wall thickness.

1.5 Process Air Pipe Anchors and Guides

.1 The process air pipe anchor and guide manufacturer will be regularly engaged in the business of designing and fabricating pipe anchors and guides of the size and type specified and shown on the Drawings.

1.6 Shipment, Protection, and Storage

.1 Refer to Section 01600 and Section 11050.

2. PRODUCTS

2.1 Function

.1 Provide the pipe guides and anchors as described below, for the piping systems shown.

2.2 Pipe Guides and Anchors

.1 Pipe guides

.1 Unless otherwise shown or specified, provide spider type. After fabrication hot dip galvanize. Provide AISI 304 stainless steel for submerged locations. Refer to the following pages and the Drawings for location.

.2 Acceptable manufacturers

.1 Grinnell Fig. 256

.2 B-Line Series B3281

.2 Anchors

.1 Unless otherwise shown or specified, provide steel to Section 05120, hot dip galvanized to Section 05120; concrete to Section 03300, reinforcement to Section 03200; and anchor bolts to Section 05120.

.2 Provide AISI type 304 stainless steel materials in submerged locations.

.3 Provide AISI Type 304 stainless steel nuts, bolts, and washers.

2.3 Process Air Pipe Guides and Anchors

.1 Provide PTFE lower bearing surfaces not less than 2.4 mm (3/32 inch) thick of 100 percent virgin material in accordance with ASTM D1457 and with a 25 percent content of glass fiber filling.

.2 Provide PTFE lower bearing surfaces mechanically secured and bonded to a substrate made of 10 gauge or 3.2 mm (1/8 inch) thick type 304 stainless steel with a 6.4 mm (1/4 inch) welding lip all around.

.3 Provide PTFE with minimum 20 MPa tensile strength, tested in accordance with ASTM D638; 200 percent elongation minimum, tested in accordance with ASTM D638; and 216 ± 0.03 relative density, tested in accordance with ASTM D792.

.4 Provide stainless steel components to ASTM A167; type 304.

.5 Provide stainless steel upper bearing surfaces with an annealed mirror finish in accordance with ASTM A480 and having a maximum surface roughness of 0.15 microns.

.6 Provide these filled Teflon to stainless steel slide bearings as manufactured by Amscot Structural Products, Piping Technology and Products, or approved equal, and with the dimensions shown on the Drawings.

.7 Use welding procedures which minimize distortion of the pipe guides and anchors, and avoid damage to the finished work or bonded materials. Stitch weld thin stainless steel.

.8 Finish members true to line, free from twists, bends, open joints, sharp corners, and sharp edges.

.9 Fabrication tolerances

.1 Overall dimensions to within 3 mm

.2 Machined surfaces to within 0.4 mm

.3 Backing plates for sliding surfaces to within 0.8 mm

.4 Deviation from flatness of PTFE surfaces to 0.2 mm maximum

.5 Deviation from flatness of stainless steel surfaces intended for contact with PTFE to 0.0003 LH maximu.

.6 PTFE thickness to ±10 percent of the specified thickness

.7 Parallelism of one sliding surface with respect to the mating sliding surface, as datum, to 0.2 percent of the longer side, maximum

.8 Matching holes for bolts to register so that a gauge 2 mm smaller in diameter than the holes will pass freely through the assembled members at right angles to such members

.9 Finished bolt holes to not more than 2 mm in diameter larger than the bolt diameter

.10 Center-to-centrer distances between bolt holes to within 1 mm of the dimensioned distance

.10 Drill or ream bolt holes

.11 Provide vibration resistant type fasteners

.12 Provide stainless steel sliding surfaces intended for contact with PTFE of one piece continuously welded around the perimeter to the back plate to prevent ingress of moisture. Provide the weld clean, sound, smooth, uniform, without overlaps, properly fused, and located outside the area of contact with PTFE.

.13 Machine or fine grind metal-to-metal contact surfaces. Machine sliding metal contact surfaces in the principal direction of movement. Machine after welding whenever possible.

.14 Provide metal surfaces in contact with PTFE with no openings or discontinuities, and a maximum surface roughness of 3 microns.

.15 Remove abrasive materials from finished surfaces and clean with a degreasing agent.

.16 Protect finished surfaces from contamination and mechanical damage.

3. EXECUTION

3.1 Process Air Pipe Guides and Anchors

.1 The Contractor shall, at his own cost, employ a Professional Engineer to design pipe anchors to control piping expansion and contraction for the foul air and process air piping systems. Refer to Section 11050.

.2 Unless written permission has been obtained from the Manufacturer and from the Contract Administrator, do not dismantle the pipe guides after they have left the Manufacturer's shop, in order to prevent contamination of the sliding surfaces.

.3 Use stainless steel shims to laser-align supports before installing the piping. Tighten J-bolts and grout using liquid, non-shrink, epoxy grout. Prevent ingress of grout into the annular space between the J-bolts and their pipe casing (the use of flexible sealant is allowed). Concrete base foundations for anchors and sliding supports shall be built with the top surface approximately 25 mm below aligned bottom of support plate. Allow for this much epoxy grout at each location. Preparation and grouting to be done according to structural specifications in Division 3.

.4 Construct of fabricate as indicated in the Drawings or use approved commercial systems as indicated above.

END OF SECTION

PROCESS PIPE EXPANSION JOINTS

1. GENERAL

1.1 Description

.1 This section describes process expansion joint supply and methods for installation.

.2 Refer to the general piping requirements of Section 11050. Use the general requirements specified in this Section and Section 11050 integrally with the more specific requirements listed in Section 11055.

.3 The number and location of expansion joints detailed on Drawings is indicative only. Contractor to provide a complete piping system design as described in Section 11050.

1.2 Submittals

.1 With the submittals required in Section 11050, provide a listing of the expansion joints used in the performance of the Work.

.2 Provide Shop Drawings showing expansion joint details including maximum allowable temperature and pressure rating, overall face-to-face length measured at 15ºC, wall thickness, number of convolutions per joint, spring rate, maximum allowable axial, lateral and angular movement and materials of construction.

1.3 Coordination

.1 Coordinate the expansion joints with the piping requirements and ensure that the connection techniques match.

1.4 Quality Assurance

.1 Comply with the requirements of EJMA.

1.5 Shipment, Protection, and Storage

.1 Refer to Section 01600 and Section 11050 for Shipment and Storage.

.2 Provide shipping and installation blocking to prevent over-extension and deflection. Remove blocks prior to leak testing.

2. PRODUCTS

2.1 Function

.1 Expansion joints are used to compensate for thermal expansion and contraction in piping systems; to isolate equipment from stresses and vibration transmitted from the piping system; and to allow for seismic or long term settlement which could cause differential movement in adjacent piping or equipment.

.2 Design and fabricate expansion joints in accordance with EJMA standards and to meet the requirements of this Section.

.3 Provide expansion joints as necessary to allow for pipe expansion and contraction. Unless otherwise specified provide elastomer, spherical moulded type expansion joints.

2.2 Elastomer Expansion Joints

.1 Select materials suitable for service commodity, temperature and pressure. Conform to the requirements of the Fluid Sealing Association, Rubber Expansion Joint Division. Process air may contain up to 20 ppm hydrogen sulphide.

.2 Provide control rods on expansion joint connectors to prevent excessive axial elongation and to accept the static pressure thrust in the piping system. Manufacturer to determine number and sizes of control rods.

.3 Provide elastomer cover of the same material as the elastomer tube liner.

.1 For service temperatures between -40°C and 120°C, use EPDM for the elastomer tube.

.4 Elastomer, Spool Type

.1 Unless otherwise specified, provide spool, resilient arch type expansion joints.

.2 Construct of multiple plies of woven fabric impregnated with elastomer and reinforced with steel rings or wire embedded in the body.

.3 Provide backup or retaining rings of galvanized steel construction. Make retaining rings a nominal 10 mm thick, split type.

.4 Use filled-arch type expansion joints on all piping systems conveying fluids containing solids.

.5 Acceptable manufacturers:

.1 Senior Flexonics

.2 Garlock

.3 Mercer

.4 Techniquip

.5 Elastomer, Spherical Moulded Type

.1 Construct of multiple plies of nylon tire cord fabric and elastomer suitable for specified commodity, temperature and pressure.

.2 Provide steel floating flanges, such that no metal parts come in contact with the fluid.

.3 Acceptable manufacturers:

.1 Senior Flexonics

.2 Garlock

.3 Mercer

.4 Techniquip

.5 Proco

2.3 Sliding Joints - Liquid Service

.1 Provide single end type sliding expansion joints able to allow longitudinal movement and radial stresses while maintaining pipe alignment. Provide through rods where necessary to maintain alignment.

.2 Limit longitudinal separation of the two pipe sections to 50 percent of the Manufacturer's recommended maximum by a restraining flange affixed to the slip pipe with the bolts extending through this flange.

.3 Use packing material suitable for the service conditions.

.4 Acceptable manufacturers:

.1 Dresser

.2 Ford Meter Box

.3 Robar

.4 Rockwell

2.4 Flexible Hose Connectors

.1 Where other types of flexible expansion joints are not shown or specified, provide flexible hose connectors within 2 m pipe length of rotating equipment suction, discharge and ancillary service connection. Do not provide flexible connectors on sump pump connection piping.

.2 Provide flexible hose connectors with live lengths suitable for a line pressure equal to the test pressure of the pipe and for 12.5 mm lateral movement each side of the pipe centerline.

.3 Provide one union for pipe diameters less than 65 mm, or floating flange for pipe diameter greater than 65 mm, per flexible connector as appropriate to minimize the possibility of torque damage during installation.

.4 Provide flexible hose connectors capable of minimum of 10,000 cycles at the manufacturer's published minimum intermittent centerline bend radius and maximum working pressure.

.5 The design standard for flexible hose connectors on piping systems up to and including 75 mm diameter is Senior Flexonics Type UFBX annular corrugated hose connectors.

.6 Acceptable manufacturers for flexible hose connectors on piping systems up to and including 75 mm diameter are:

.1 American BOA

.2 Flex-Weld

.3 Senior Flexonics

.7 The design standard for flexible hose connectors on piping systems larger than 75 mm diameter is Senior Flexonics Type OF301 corrugated flexible metal hose connectors.

.8 Acceptable manufacturers for flexible connectors on piping systems larger than 75 mm diameter are:

.1 American BOA

.2 Flex-Weld

.3 Senior Flexonics

3. EXECUTION

3.1 Expansion Joints

.1 Accurately align pipelines to receive expansion joints before installing the joint. Do not stretch, compress or offset the joint to fit the piping.

.2 Align and install each expansion joint in accordance with EJMA standards and with the manufacturer's written instruction; properly guide and anchor all expansion joints. No lateral movement is permitted on compensator type expansion joints.

.3 Pre-compress expansion joint as required depending on installation temperature.

.4 On rubber expansion joints, check bolt tightness, and tighten where necessary one week after commissioning.

3.2 Flexible Hose Connectors

.1 Accurately align pipelines to receive flexible connectors before installing the connectors. Do not stretch, compress, misalign, or offset the connectors.

.2 Align and install each flexible connector in accordance with the Manufacturer's instructions.

.3 Support, anchor, and guide the piping so that the flexible connectors are not required to absorb any axial compression or elongation.

.4 Do not torque or twist the flexible connectors.

.5 Check bolt tightness and tighten where necessary, a maximum of one week after commissioning and periodically thereafter.

END OF SECTION

DETAILED PROCESS PIPING SPECIFICATION SHEETS

1. GENERAL

1.1 Work Included

.1 The piping specification sheets on the following pages detail the requirements for each type of process pipe included in the Work.

.2 The piping materials are listed on the Specification sheets.

2. PRODUCTS

2.1 Process Fluids and Piping Materials Summary

Commodity		Dia (mm)	Exposure	Specification
AL	Alum	10-60	Pumphouses, Tunnels, Exterior, Submerged	PVC3
AL	Alum	75-100	Pumphouses, Tunnels, Exterior, Submerged	PVC3
CA	Compressed (service) air	10-65	Pumphouses, Tunnels,	CU1
CA	Compressed (service) air	>65	Pumphouses, Tunnels,	MS3
DCW	Domestic cold water	20-100	Pumphouses, Tunnels	CU1
DCW	Domestic cold water	100-350	Pumphouses, Tunnels	MS1
DHW	Domestic hot water	20-100	Pumphouses, Tunnels	CU1
DHW	Domestic hot water	100-350	Pumphouses, Tunnels	MS1
DR	Drain, miscellaneous	<60	Pumphouses, Tunnels, Exterior, Submerge Below structures, Buried	MS4
DR	Drain, miscellaneous	60-1050	Pumphouses, Tunnels, Exterior, Submerge Below structures, Buried	Di1/MS3
FA	Foul air	>75	Pumphouses, Tunnels	ALUM1
FA	Foul air	150-1500	Below structures, Buried, Exterior	PE1
FA	Foul air	150-1500	Exterior	FRP1
FC	Ferric Chloride	<65	Pumphouses, Tunnels, Exterior, Submerged Buried	PVC3/PE2
FC	Ferric Chloride	75-200	Pumphouses, Tunnels, Exterior	PVC4/PE2
FW	Fire Water	100-350	Pumphouses, Tunnels	MS5

Commodity		Dia (mm)	Exposure	Specification
GLYR	Glycol return	<75	Pumphouses, Tunnels	MS1
GLYR	Glycol return	100-350	Pumphouses, Tunnels	MS1
GLYS	Glycol supply	<75	Pumphouses, Tunnels	MS1
GLYS	Glycol supply	100-350	Pumphouses, Tunnels	MS1
HWR	Hot water return	<75	Pumphouses, Tunnels	MS1
HWS	Hot water supply	20-350	Pumphouses, Tunnels	MS1
IA	Instrument air	<20	Pumphouses, Tunnels, Exterior, Submerge	SS4
IA	Instrument Air	20-65	Tunnels, Pumphouses	SS3
IA	Instrument Air	75-100	Tunnels, Pumphouses	SS5
NG	Natural gas	<60	Pumphouses, Tunnels, Buried	MS2
PSW	Process Service Water	10-100	Pumphouses, Tunnels	CU1
PV	Process vent, miscellaneous	<60	Pumphouses, Tunnels, Exterior, Submerge	MS4
PV	Process vent, miscellaneous	60-1050	Pumphouses, Tunnels, Exterior, Submerge	MS3
PW	Potable water	<65	Pumphouses, Tunnels	CU1
PW	Potable water	65-300	Pumphouses, Tunnels	MS3
PW	Potable water	65-300	Buried	PVC4
RW	Recycle water	<60	Pumphouses, Tunnels, Exterior, Submerge Buried, Below structures	MS4
RW	Recycle water	60-1050	Pumphouses, Tunnels, Exterior, Submerge, Buried, Below structures	MS3
SAN	Sanitary	75-150	Pumphouses, Tunnels, Exterior	CI1
SAN	Sanitary	75-150	Below structures	CI1
ST	Storm water	75-150	Pumphouses, Tunnels, Exterior	CI1
ST	Storm water	75-150	Below structures, Buried	PVC4
SW	Seal Water	<65	Pumphouses, Tunnels,	CU1

2.2 Schedule

.1 Pages 3 to 38 following.

ALUM1

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (kPa)	TEST PRESS. (kPa)
FA	10-1500	Pumphouses, Tunnels, Exterior	1000	2500

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Pumphouses, Tunnels, Exterior	150-600 650 – 850 900 – 1100 1200 – 1350 >1400	Aluminum Alloy 3003-414	1.27 mm 1.60 mm 2.03 mm 2.29 mm 2.54 mm	ASTM B209	Spiral wound to SMACNA Note 1

COATINGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS
All	All	None			

LININGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS
All	All	None			

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS
Pumphouses, Tunnels, Exterior	≥ 150	Angle Iron Flange Slip Joint		SMACNA	

ALUM1 (cont'd)

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
Van-Stone Flanges	≥ 150	Same as pipe, Galvanized Steel Back-Up Ring	Class 150	Pipe Material: ASTM A240 Fabrication: MSS SP43 Pattern: ANSI B16.5	
Elbow-Short Radius Elbow-Long Radius Tees, Reducers, Reducing outlets, Laterals	≥ 150	Same as pipe	Same as pipe	Dimensions: ANSI B16.5 (SR)	
5 Piece Elbow	100 – 600 650 – 850 900 – 1100 1200 – 1350 >1400	Aluminum Alloy 3003-414	1.60 mm 2.03 mm 2.29 mm 2.54 mm 3.18 mm	ASTM B209	
Cap	≥ 150	Same as pipe	Same as pipe		
Flex Connections	≥ 150	Stainless Steel 321	Class 150		Note 2
Flexible Couplings	≥ 150	Neoprene with SST Clamps: 50 mm wide	Class 150		Note 3
Flange Gaskets	100 – 250 ≥300	Compressed Kevlar with Neoprene Binder	1.6 mm thick 3.2 mm thick		Note 2

INSPECTION AND TESTING

As per the SMACNA "Accepted Industry Practice for Industrial Duct Construction "
See section 11050 for other testing requirements.

CLEANING AND CONDITIONING

As per the SMACNA "Accepted Industry Practice for Industrial Duct Construction "
See section 11050 for other cleaning and conditioning requirements.

NOTES

1. Construct FA duct to SMACNA Round Industrial Duct Standards.
2. Also refer to Section 11053.
3. Rubber Boot type.

DETAILED PROCESS PIPING SPECIFICATION SHEETS

CI1

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (kPa)	TEST PRESS. (kPa)
SAN	75 – 150	Tunnels, Pumphouses, Exterior, Below Structures	Atm.	50

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses Exterior, Below Structures	75 – 150	Cast Iron		CSA CAN3-B70-M	

COATINGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses Exterior, Below Structures	75 – 150 75 – 150	Paint Concrete Surround		Refer to Section 09902	

LININGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses Exterior, Below Structures	75 – 150	Standard Asphaltic Varnish	Factory		

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses Exterior, Below Structures	75 – 150	Mechanical Joint Couplings	N/A	CSA CAN3 B602	Note 1

CI1 (cont'd)

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
Elbow-Short Radius Elbow-Long Radius Tees, Reducers Reducing Outlets, Laterals	75 – 150	Cast Iron	Class 125	ANSI B16.3, ASTM A197, CSA CAN3-B70-M	Note 2
Plug	75 – 150	Cast Iron	Class 125 Grooved	CSA CAN3 B70 CSA CAN 3 B242	
Flanged Adapters	75 – 150	Mild Steel	Std. Wt. Class 125	Flange: ANSI B16.1 ASTM A-105	

INSPECTION AND TESTING

Pressure testing as per CSA B70
See Section 11050 for additional testing requirements.

CLEANING AND CONDITIONING

As per CSA B70
See Section 11050 for other cleaning requirements.

NOTES

1. Mechanical joint constructed of corrugated stainless steel, lined with neoprene and banded with a minimum of two adjustable stainless steel straps.
2. Refer to Section 11430 for plumbing fixtures and trim.

DETAILED PROCESS PIPING SPECIFICATION SHEETS

CU1

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (kPa)	TEST PRESS. (kPa)
PW	<65	Tunnels, Pumphouses	700	1000
PSW	10-100	Tunnels, Pumphouses		
SW	<65	Tunnels, Pumphouses, Exterior		
DCW	20-100	Tunnels, Pumphouses		
DHW	20-100	Tunnels, Pumphouses		

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses and Exterior	<100	Copper	Type L, Hard	ASTM B88	

COATINGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses and Exterior	<100	Paint (Note 3)	Field	Refer to Section 9902	

LININGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses	<100	Soldered Couplings	N/A	ANSI B16.22	
and Exterior	<100	Unions	6 m	ANSI B16.22	Note 1

EQUIPMENT CONNECTIONS

EQUIPMENT END	SIZE (mm)	PIPE END	RATING	SPECIFICATION	REMARKS
Brass, Bronze, or Cast Iron Female Thread	<65	150 mm Threaded Copper Nipple with Union	Class 150	ANSI B16.15 ANSI B16.1	Note 2

CU1 (cont'd)

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
Couplings, Unions Elbow-Short Radius Elbow-Long Radius Tees, Reducers Reducing Outlets, Y	<65	Brass or Copper, Socket Welded	Class 250	ANSI B16.22	

INSPECTION AND TESTING

Test potable water systems with potable water for 4 hours without leakage.
Test and disinfect potable water systems as per the Manitoba Plumbing Code, and the City of Winnipeg Standards.

CLEANING AND CONDITIONING

Remove debris and flush with potable water at minimum velocity of 1.0 m/s.

NOTES

1. Provide unions at noted spacings to allow for pipe disassembly.
2. Provide unions at equipment connections.
3. Insulation shall be a minimum 25 mm thickness where indicated on the drawings. See Section 11261.

DETAILED PROCESS PIPING SPECIFICATION SHEETS

DI1

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (kPa)	TEST PRESS. (kPa)
DR	150	Buried, below structures	100	250

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses, Exterior, Buried, below structures	75 – 600	Ductile Iron	Class 53	AWWA C151	

COATINGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses	75 - 600				
Exterior	75 – 600	Paint	Field	See Section 09902	
Buried,	75 – 600	Concrete Surround	Field	Section 03300	
Below Structures	75 – 600	Epoxy	Field	AWWA C210	

LININGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses, Exterior, Buried, below structures	75 - 600	Cement Mortar	Factory	AWWA C205	

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses, Exterior	75 – 600	Grooved Joint, Flexible couplings, Flanged/grooved adapter	6 m	AWWA C606	
Buried, Below Structures	75 – 750	Groove Jt. or Bell/spigot	6 m	AWWA C606/C110	Note 4

EQUIPMENT CONNECTIONS

EQUIPMENT END	SIZE (mm)	PIPE END	RATING	SPECIFICATION	REMARKS
Cast Iron, Flanged	75 – 600	Ductile Iron, grooved end to flange adaptor	Cl 125	FF Flange to ANSI B16.1 Grooved end to AWWA C606	
Steel, Flanged	75 – 600	Mild Steel, grooved end to flange adaptor	Cl 150	RF Flange to ANSI B16.1 Grooved end to AWWA C606	

DETAILED PROCESS PIPING SPECIFICATION SHEETS

DI1 (cont'd)

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
Elbow-Short Radius Elbow-Long Radius Tees, Reducers, wyes, Reducing Outlets,	75 – 600	Ductile Iron	Class 125	Material: ASTM A606 Dimensions: ANSI B16.3	
Bolts, above ground			Hex. Head	ASTM A307 Gr. A	
Nuts, above ground	≤ 25 mm		Hex	ASTM A563 Gr. A	
	>25		Heavy Hex.		
Flange Gaskets	75 – 250	White Neoprene	1.6 mm thick		
Flange Gaskets	>300	White Neoprene	3.2 mm thick		
Flange Gaskets	500 – 600	White Neoprene			
Vic. Gaskets	75 – 600			AWWA C606	Note 2

INSPECTION AND TESTING

Hydrostatic test with clean water.

CLEANING AND CONDITIONING

Remove debris and flush with water at minimum velocity of 1.0 m/s.

NOTES

1. Joints shown at specific spacing shall be provided for pipe disassembly.
2. Comply with manufacturer's recommendations for grooved joint gaskets.
3. Provide full faced gaskets for flat face flanges and ring gaskets for raised face flanges.
4. Provide joints at noted spacing for pipe disassembly or as per lengths provided, nominal 6m spacing.

FRP1

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (kPa)	TEST PRESS. (kPa)
FA	>550	Exterior	100	

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses	>75	Fibre Reinforced Plastic	Glass 150	ASTM D2996	

COATINGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

LININGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS

EQUIPMENT CONNECTIONS

EQUIPMENT END	SIZE (mm)	PIPE END	RATING	SPECIFICATION	REMARKS

FRP1 (cont'd)

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
90° Elbow, 45° Elbow Tee, Cap, Coupling, conc. Reducer, ecc. Reducer, Lateral	>75	FRP Epoxy, Female Ends			
Flanges, FF	>75	FRP Epoxy, male	Class 150	ANSI B16.5	
	>75	FRP Epoxy, female	Class 150	ANSI B16.5	
	>75	FRP Epoxy, blind	Class 150		
Gaskets	>75	FF, Neoprene, shore A60	3.2 mm thick		Garlock 7986
	>75	Ring, Neoprene, shore A60	3.2 mm thick		
Bolts		Stud/bolt nuts w/carbon steel washers	Hex. Head	ASTM A307 Gr. B	
Cement	Epoxy adhesive for FRP				
Strainer, RF, FF	>75	Startup Strainer, 316 SS	Class 150		

INSPECTION AND TESTING

CLEANING AND CONDITIONING

NOTES

1. Elbows shall be long-radius type unless shown otherwise.
2. Pressure and temperature restrictions apply to ball and butterfly valves.
3. All valves to have non-asbestos graphite or reinforced Teflon packing and gaskets.
4. Use ring gasket only when connecting to raised face flanges.
5. Use Bondstrand RP-34 epoxy adhesive or similar.
6. Refer to 13200 Fiberglass Reinforced Plastic Fabrication.
7. Refer to 15261 for insulation and jacketing.

DETAILED PROCESS PIPING SPECIFICATION SHEETS

MS1

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (kPa)	TEST PRESS. (kPa)
DCW	100 – 350	Pumphouses Tunnels	207	1033
DHW	100 – 350	Pumphouses Tunnels	207	1033
GLYR	20-350	Pumphouses, Tunnels	207	1033
GLYS	20-350	Pumphouses, Tunnels	207	1033
HWS	20-350	Pumphouses, Tunnels	207 (at 110 deg C)	1033
HWR	20-350	Pumphouses, Tunnels	207 (at 110 deg C)	1033

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses	75-600	Mild Steel, CW, ERW or Seamless	Sch. 40	ASTM A53, Gr. B	

COATINGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses	<75	Insulation and recovering	Field		Note 1
	75 – 600	Insulation and recovering	Field		Note 1

LININGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses	<75	Threaded couplings, malleable iron	N/A	ASTM A197 ANSI B16.3, Cl 150	
	<75	Unions, malleable iron	12 m		
	75 – 600	Butt Weld	N/A		
	75 – 600	Flanges	18 m	ANSI B16.5	

DETAILED PROCESS PIPING SPECIFICATION SHEETS

MS1 (cont'd)

EQUIPMENT CONNECTIONS

EQUIPMENT END	SIZE (mm)	PIPE END	RATING	SPECIFICATION	REMARKS
Cast Iron Flange	150 – 600	Steel Flange	Cl 125, FF	ANSI B16.1	
Steel Flange	150 – 600	Steel Flange	Cl 150, RF	ANSI B16.5	
Steel, Plain End	150 – 600	Flexible Joint, Flanged one end	Cl 150	Flange – ANSI B16.5	

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
Flanges, FF or RF	75 – 600	Mild Steel	Class 150	Material: ASTM A234 Dimensions: ANSI B16.5	
Elbow-Short Radius Elbow-Long Radius	60 – 75	Malleable Iron, Banded	Class 150	Material: ASTM A197 Dimensions: ANSI B16.3	Note 6
Tees, Reducers, Reducing Outlets, Laterals and Caps	75 – 600	Mild Steel, Seamless	Same as Pipe	Material: ASTM A234, WPB Dimensions: ANSI B16.5, ANSI B16.9	
3-Piece Elbow	350 – 600	Mild Steel, ERW or Seamless	Same as Pipe	Material: Same as Pipe Dimensions: AWWA C208	
Plug	>60	Mild Steel	Class 150, Blind Flange	Material: ASTM A181 Dimensions: ANSI B16.5	
Nuts, Submerged or Below Ground	>60		Heavy Hex.	ASTM A194 Gr. 8	
Bolts, Submerged or Below Ground			Hex. Head	ASTM A193, Gr. B8, Cl.1	
Flanged Adaptors	75 – 600	Same as Pipe	Same as Pipe	Flange: ANSI B16.5	
Flanged Gaskets	150 – 250	Neoprene	1.6 mm thick		Note 4
Flanged Gaskets	>300	Neoprene	3.2 mm thick		Note 4
Vic. Gaskets	150 – 600			AWWA C606	Note 5

INSPECTION AND TESTING

Refer to Section 11050 for other requirements

CLEANING AND CONDITIONING

Remove debris and flush with water at a minimum velocity of 1.0 m/s.

DETAILED PROCESS PIPING SPECIFICATION SHEETS

MS1 (cont'd)

NOTES

1. Insulation shall be a minimum 50 mm thickness and as required for personnel protection at the design temperature of the pipe ensuring the surface temperature is below 40°C. Also, ensuring the pipe surface does not sweat. See Section 11261.
2. Tapewrap butt welded joints after welding. Plain end or grooved joints and valves shall be protected with a polyethylene sheath or a shrink sleeve attached to the pipe with tapewrap.
3. Finish fittings, etc. in same manner as pipe.
4. Provide full faced gaskets for flat face flanges and ring gaskets for raised face flanges.
5. Comply with manufacturer's recommendations for grooved joint gaskets.
6. Provide beveled edges for all welded fittings.
7. Underground joints at 6.0 m on center or as shown on the drawings shall be groove jointed or flex coupled.
8. Field touch up linings and coatings after welding.
9. Underground fittings shall be yellow jacketed or tape wrapped.

DETAILED PROCESS PIPING SPECIFICATION SHEETS

MS 2

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (kPa)	TEST PRESS. (kPa)
NG			150	300

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses	<60	Mild Steel, Seamless	Sch. 80	ASTM A53	

COATINGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

LININGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses	<60	Treaded Cplgs, Forged Steel	N/A	ANSI B16.5, Cl 3000 ANSI B16.11	
	<60	Unions, Forged Steel	12 m	ANSI B16.5, Cl 3000	Note 3

EQUIPMENT CONNECTIONS

EQUIPMENT END	SIZE (mm)	PIPE END	RATING	SPECIFICATION	REMARKS
Brass, Bronze, Cast Iron, or Steel, Female Thread	<60	150 mm Threaded Nipple and Union	Cl 3000	ANSI B16.5 ASTM A105	

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
Couplings, Unions Elbow – Short Radius Elbow – Long Radius Tees, Reducers, Reducing Outlets, Y	<60	Forged Steel Socket Weld	Cl 3000	ANSI B16.11 ASTM A106	
Bolts			Hex. Head	ASTM A307, Gr. A	
Nuts			Hex.	ASTM A563, Gr. A	

MS 2 (cont'd)

INSPECTION AND TESTING

Test NG piping as per CGS Propane and Natural Gas Code

CLEANING AND CONDITIONING

Remove debris and purge with dry nitrogen for 24 hours minimum.

NOTES

1. Finish valves, fittings, etc., in the same manner as pipe.
2. Brush clean steel pipe to SSPC-P3 standard prior to painting.
3. Provide unions at noted spacings to allow for pipe disassembly.

DETAILED PROCESS PIPING SPECIFICATION SHEETS

MS3

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (kPa)	TEST PRESS. (kPa)
CA			750	500
DR			100	1000
PV			100	500
PW			650	-
RW			100	500

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses, Buried,	65 – 1050	Mild Steel, CW or ERW	Standard wt.	ASTM A53	
Below Structure, Exterior	65 – 150	Mild Steel, CW or ERW	Standard wt.	ASTM A53	
Submerged	65 – 150	Mild Steel, CW or ERW	Standard wt.	ASTM A53	

COATINGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses,	65 - 1050				Refer to Division 09
Buried, Below Structure,	65 – 1050	Yellow Jacket or Tapewrap	Factory	Section 11050	
Exterior, Submerged	65 – 1050	Epoxy	Factory	AWWA C210	

LININGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses,	65 – 1050	Epoxy	Factory	AWWA C210	
Buried, Below Structure,	65 – 1050	Epoxy	Factory	AWWA C210	
Exterior, Submerged	65 – 1050	Epoxy	Factory	AWWA C210	

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses	60-1050	Butt Welded	N/A	ANSI B16.9	Notes 3,4
		Grooved	18 m	AWWA C606	Notes 7,9
		Flexible Couplings	As Shown		
		Flanged	N/A	ANSI B16.5	Notes 3,4,5

DETAILED PROCESS PIPING SPECIFICATION SHEETS

MS3 (cont'd)

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
Steel Flange	60 – 1050	Steel Flange	Cl 150, FF	ANSI B16.5	
Steel, Plain End	60 – 1050	Flexible Joint	Cl 150	ANSI B16.5	
Flanges, FF or RF	60 – 1050	Mild Steel	Class 150	ASTM A234, WPB ANSI B16.5	Note 5
Elbow-Short Radius Elbow-Long Radius Tees, Reducers, Reducing Outlets, Y	60 – 1050	Mild Steel, Seamless	Same as Pipe	Material: ASTM A234, WPB Dimensions: ANSI B16.5	Note 5
Plug	60 – 1050	Mild Steel Blind Flange	Class 150	Material: ASTM A181, Gr. 1 Dimensions: ANSI B16.5	
Flanged Adapters Grooved Joint to Flange	60 – 1050	Same as Pipe	Same as Pipe	Flange – ANSI B16.5	
Bolts, Submerged or Below Ground			Hex. Head	ASTM A193, Gr. B8, Cl 1	
Nuts, Submerged or Below Ground	<25 mm >25 mm		Hex. Heavy Hex.	ASTM A194, Gr. 8	
Flange Gaskets	60 – 300	Bl. Neoprene	1.6 mm thick		Note 3
Flange Gaskets	>300	Bl. Neoprene	3.2 mm thick		Note 3
Grooved Joint Gaskets	60 – 1050			AWWA C606	Note 4

INSPECTION AND TESTING

Test sample lines at 1000 kPa (operating pressure of 400-600 kPa)

CLEANING AND CONDITIONING

Remove debris and flush with water at minimum velocity of 1.0 m/s.

NOTES

1. Finish valves, fittings, etc., in same manner as pipe.
2. Provide full-faced gaskets for flat face flanges and ring gaskets for raised face flanges.
3. Comply with manufacturer's recommendations for grooved joint gaskets.
4. Provide beveled edges for all welded fittings and connections.
5. Field touch-up linings and coatings after welding. Do not weld piping where access for touch-ups is restricted.
6. Slip-on flanges shall be provided except where noted otherwise herein or in the drawings. Provide weldneck flanges (mild steel pipe) on each side of fittings and wafer body valves.
7. Brush clean steel pipe to SSPC-P3 standard prior to painting.
8. Joints at noted spacing for pipe disassembly.

MS4

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (kPa)	TEST PRESS. (kPa)
DR	<60	Tunnels, Pumphouses, Exterior, Buried Submerged, Below Structure	100	250
PV			400	750
PW			400	750
RW			400	750

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses, Buried, Below Structure , Exterior, Submerged	<60	Mild Steel, Seamless	Schedule 80	ASTM A53	

COATINGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses,					(Note 7)
Buried, Below	<60	Yellow Jacket or	Factory	Section 11040	
Structure,		Tapewrap			
Exterior, Submerged	<60	Epoxy	Field	AWWA C210	

LININGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS
Tunnels,	<60	Epoxy	Factory	AWWA C210	
Pumphouses					
Buried, Exterior	<60	Epoxy	Factory	AWWA C210	
Below Structures	<60	Epoxy	Factory	AWWA C210	
Submerged					

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS
Tunnels,	<60	Threaded Cplgs,	N/A	ANSI B16.5, Cl 3000	
Pumphouses,		Forged Steel,		ANSI B16.11	
Buried Exterior,					
Below Structures	<60	Unions, Forged Steel	12 m	ANSI B16.5, Cl 3000	Note 2
Submerged					

MS4 (cont'd)

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
Couplings, Unions Elbow–Short Radius Elbow–Long Radius Tees, Reducers Reducing Outlets, Y	<60	Forged Steel Socket Weld	Cl 3000	ANSI B16.11 ASTM A106	
Bolts			Hex. Head	ASTM A307, Gr. A	
Nuts			Hex.	ASTM A563, Gr. A	

INSPECTION AND TESTING

CLEANING AND CONDITIONING

Remove debris and flush with water at minimum velocity of 1.0 m/s.

NOTES

1. Finish valves, fittings, etc., in same manner as pipe.
2. Joints shown for pipe disassembly.
3. Comply with manufacturer's recommendations for grooved joint gaskets.
4. Field touch-up linings and coatings after welding. Do not weld piping where access for touch-ups is restricted.
5. Brush clean steel pipe to SSPC-P3 standard prior to painting.
6. Joints at noted spacing for pipe disassembly.
7. Exterior coating is not required on PE sample lines, imbedded in concrete.

DETAILED PROCESS PIPING SPECIFICATION SHEETS

MS5

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (KPa)	TEST PRESS. (kPa)
FW			207	1033

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses,	100 – 350	Mild Steel, CW or ERW	Standard wt.	ASTM A53	

COATINGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses	65 – 1050				Refer to Division 09
Buried, Below Structure	65 - 1050	Yellow Jacket or Tapewrap	Factory	Section 11050	
Exterior, Submerged	65 - 1050	Epoxy	Factory	AWWA C210	

LININGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses	60-1050	Butt Welded	N/A	ANSI B16.9	Notes 3,4
		Grooved	18 m	AWWA C606	Notes 7
		Flexible Couplings	As Shown		
		Flanged	N/A	ANSI B16.5	Notes 3,4,5

DETAILED PROCESS PIPING SPECIFICATION SHEETS

MS5 (cont'd)

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
Steel Flange	60 – 1050	Steel Flange	Cl 150, FF	ANSI B16.5	
Steel, Plain End	60 – 1050	Flexible Joint	Cl 150	ANSI B16.5	
Flanges, FF or RF	60 – 1050	Mild Steel	Class 150	ASTM A234, WPB ANSI B16.5	Note 5
Elbow–Short Radius Elbow–Long Radius Tees, Reducers, Reducing Outlets, Y	100 – 1050	Mild Steel, Seamless	Same as Pipe	Material: ASTM A234, WPB Dimensions: ANSI B16.5	Note 5
Plug	100 – 1050	Mild Steel Blind Flange	Class 150	Material: ASTM A181, Gr. 1 Dimensions: ANSI B16.5	
Flanged Adapters Grooved Joint to Flange	100 – 1050	Same as Pipe	Same as Pipe	Flange – ANSI B16.5	
Bolts, Submerged or Below Ground			Hex. Head	ASTM A193, Gr. B8, Cl 1	
Nuts, Submerged or Below Ground	<25 mm >25 mm		Hex. Heavy Hex.	ASTM A194, Gr. 8	
Flange Gaskets	100 – 300	White Neoprene	1.6 mm thick		Note 3
Flange Gaskets	>300	White Neoprene	3.2 mm thick		Note 3
Grooved Joint Gaskets	100 – 350			AWWA C606	Note 4

INSPECTION AND TESTING

CLEANING AND CONDITIONING

Remove debris and flush with water at minimum velocity of 1.0 m/s.

NOTES

1. Finish valves, fittings, etc., in same manner as pipe.
2. Provide full-faced gaskets for flat face flanges and ring gaskets for raised face flanges.
3. Comply with manufacturer's recommendations for grooved joint gaskets.
4. Provide beveled edges for all welded fittings and connections.
5. Field touch-up linings and coatings after welding. Do not weld piping where access for touch-ups is restricted.
6. Slip-on flanges shall be provided except where noted otherwise herein or in the drawings. Provide weldneck flanges (mild steel pipe) on each side of fittings and wafer body valves.
7. Brush clean steel pipe to SSPC-P3 standard prior to painting.
8. Joints at noted spacing for pipe disassembly.
9. Insulation shall be a minimum 50 mm thickness and as required for personnel protection at the design temperature of the pipe ensuring the surface temperature is below 40 degC. See Section 11261

DETAILED PROCESS PIPING SPECIFICATION SHEETS

PE1

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (KPa)	TEST PRESS. (kPa)
FA	150 – 1500	Below Structures, Buried, Exposed	100	250

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Below Structures, Buried	150 – 300 400 – 450 500 600 ≥ 650	HDPE	SDR 21 SDR 32.5 RSC 160 RSC 160 RSC 150	ASTM F714 CSA B137.1 ASTM F894	Note 1

COATINGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS
Below Structures	≥ 150	Concrete Encased			Note 1

LININGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS
Underground, Below Structures and Submerged	150 – 400 ≥ 450	Heat Fusion Bell and Spigot/Thermal	N/A 12 m	ASTM F714 ASTM F894	

DETAILED PROCESS PIPING SPECIFICATION SHEETS

PE1 (cont'd)

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
Van-Stone Flanges, Rolled Angle, FF or RF	≥ 150	Same as pipe, Galvanized Steel back-up ring	Class 150	Pipe Material: ASTM A240 Fabrication: MSS SP43 Pattern: ANSI B16.5 Dimensions: ANSI B16.5 (SR)	
Tees, Reducers, Reducing Outlets, Laterals	≥ 150	HDPE	Same as Pipe	ANSI B16.9 ASTM D 3261	Note 4
3 Piece Elbow	400 – 600	Same as Pipe	Same as Pipe	Material: Same as Pipe Dimensions: AWWA C208	
4 Piece Elbow	> 600	Same as Pipe	Same as Pipe	Material: Same as Pipe Dimensions: AWWA C208	
Cap	≥ 150	Same as Pipe	Same as Pipe		
Flex Connections	≥ 150	Stainless Steel 304L	Same as Pipe		
Flexible Couplings	≥ 150	Neoprene with SST Clamps; 50 mm thick	Same as Pipe		
Flange Gaskets	100 – 250 300 – 450 ≥ 500	Compressed Kevlar with Neoprene Binder	1.6 mm thick 3.2 mm thick 6.4 mm		
Bell and Spigot Joint Gaskets		EPDM			

INSPECTION AND TESTING

CLEANING AND CONDITIONING

NOTES

1. Comply with HDPE pipe manufacturer's recommendations to eliminate stress when placing concrete encasement around HDPE pipe.
2. Provide piping suitable for 1.25 kPa vacuum.
3. Avoid overloading pipe, maximum allowable wheel load of 70 kPa; or hand place backfill to 1000 mm depth of cover.
4. Fabricate inlet tees with a male bell and spigot connection on one side of the tee and a female bell and spigot connection on the other side of the tee.

DETAILED PROCESS PIPING SPECIFICATION SHEETS

PE2

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (KPa)	TEST PRESS. (kPa)
AL	10 – 65	Tunnels, Pumphouses, Exterior, Submerged	400	850
FC	10-75	Tunnels, Pumphouses, Exterior, Submerged buried	400	850

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses, Submerged, Exterior	6-12 12 – 50 75 - up	HDPE tubing	 Series 200 DR 13.5	 CSA B173.1	Note 5 Note 1 Note 1

LOCATION	SIZE (mm)	RATING MATERIAL	TYPE	MATERIAL SPECIFICATION	REMARKS
Flanges	40 and up	160 psig 150 LB	BW LJF	PE Stub End ASTM A105 Flange	
Gaskets	All	Viton or PTFE	3.2 mm		

LOCATION	SIZE (mm)	MATERIAL	TYPE	MATERIAL SPECIFICATION	REMARKS
Compression fittings	12-25		Swagelok	Plastic fitting	

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses, Exterior, Submerged	10 – 25 40 and up	SS Clamped BW, LJF	30 m 12 m	SS, Brass or Plastic Fitting	Note 2 Note 3

NOTES

1. Resin compound to be Type III, Category 5, Class C, Grade p34 per ASTM D-1248, with a Long Term Hydrostatic Strength of at least 1600 psi per ASTm D-2837
   Minimum cell classification to be PE 345434C for PE 3408 materials per ASTM D-3350
2. No lubricants allowed for inserting fittings into end of pipe 50 mm and less. Immerse end in warm water.
3. Thermal Butt Fusion,

PE2 (cont'd)

EQUIPMENT CONNECTIONS

WELDING	SIZE (mm)	WELD TYPE	PROCESS	MATERIALS	REMARKS
Piping, fitting	75 and up	Thermal Butt Fusion	ASTM D-2657		
Flanges	75 and up	Thermal Butt Fusion	ASTM D-2657	Lap Joint PE Stub-End fusion Welded Class 150 flange to ANSI B16.5	
Piping, fittings, flanges	75 and up	Thermal Butt Fusion	ASTM D-2657	Max. fusion temp. 210° C Max. fusion press. 25 psi	

PVC3

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (KPa)	TEST PRESS. (kPa)
AL	10 – 65	Tunnels, Pumphouses, Exterior, Submerged	400	850
FC	<65	Tunnels, Pumphouses, Exterior, Submerged buried		

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses, Submerged, Exterior	10 – 65	PVC	Schedule 80	CAS 137.3 ASTM D1785 ASTM D1784	

COATINGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

LININGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses, Exterior, Submerged	10 – 65	Solvent Weld w/unions unions	N/A 12 m	ASTM D2467, D2564	Note 1

PVC3 (cont'd)

EQUIPMENT CONNECTIONS

EQUIPMENT END	SIZE (mm)	PIPE END	RATING	SPECIFICATION	REMARKS
Brass or Bronze, Female Thread	10 – 65	150 mm PVC threaded nipple and union	Sch. 80	ASTM D2467 ANSI B16.15	
Cast Iron, Female Thread	10 – 65	150 mm PVC threaded nipple and union	Sch. 80	ANSI B16.3	
Steel, Female Thread	10 – 65	150 mm PVC threaded nipple and union	Sch. 80	ASTM D2467 ANSI B16.11	
PVC Female Thread	10 – 65	150 mm PVC threaded nipple and union	Sch. 80	ASTM D2467	
Couplings Elbow–Short Radius Elbow–Long Radius Tees, Reducers, Reducing Outlets, Y	10 - 65	PVC	Sch. 80	ASTM D2467	

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
Bolts			Hex. Head	ASTM A193 Gr. B Cl. 1	
Nuts			Hex. Head	ASTM A194 Gr. B	
PVC Solvent				ASTM D2564	

INSPECTION AND TESTING

CLEANING AND CONDITIONING

Remove debris and flush with water at minimum velocity of 1.0 m/s.

NOTES

1. Provide unions at noted spacings to allow for pipe disassembly. Spacing for solvent weld joints as required.

DETAILED PROCESS PIPING SPECIFICATION SHEETS

PVC4

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (KPa)	TEST PRESS. (kPa)
PW	60 - 600	Buried		
ST	75-150	Buried, Below structures		
FC	75-200	Pumphouse, Tunnels, Exterior		

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses Submerged, Exterior Buildings, Buried	75 – 200	PVC	Schedule 40	CSA 137.3 ASTM D1785	

COATINGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

LININGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses and Buildings	75 – 200 75 – 200	Solvent Weld Flange	N/A 12 m	ASTM D2466, D2564 ASTM D2466	Note 2
Buried	75 – 200	Bell and Spigot	6 m	ASTM D2466	

PVC4 (cont'd)

EQUIPMENT CONNECTIONS

EQUIPMENT END	SIZE (mm)	PIPE END	RATING	SPECIFICATION	REMARKS
Cast Iron, Flange	75 – 100	PVC Flange	Sch. 80, FF Cl 150	ASTM D2467 ANSI B16.1	
Cast Iron, Flange	125 – 200	PVC Flange Van Stone Flange	Cl 150, FF	ASTM A181, Gr. 1 ANSI B16.1	
Steel Flange	75 – 300	PVC Flange Van Stone Flange	C1 150, FF	ASTM A181, Gr. 1 ANSI B16.5	

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
Flanges, FF	75 – 100	PVC	Sch. 80	Material: ASTM D2467 Dimensions: ANSI B16.5	
Van Stone Flanges, FF	150 – 200	PVC Aluminum Ring	Sch. 80 Cl 150	Material: ASTM D2467 Dimensions: ANSI B16.5	
Elbow–Short Radius Elbow–Long Radius Rees, Reducers Reducing Outlets, Y	75 – 200	PVC	Sch. 80	ASTM D2466	
Bolts, Above Ground			Hex. Head	ASTM A307 Gr. A	
Bolts, Submerged or below ground			Hex. Head	ASTM A193 Gr. B8, Gl.1	
Nuts, Above Ground	≤ 25 mm >25 mm		Hex.	ASTM A563 Gr. A	
Nuts, Submerged or below ground	≤ 25 mm >25 mm		Hex.	ASTM A194 Gr. 8	
Flange Gaskets	75 – 300	White Neoprene	1.6 mm thick		Note 1
PVC Solvent				ASTM D2564	

INSPECTION AND TESTING

Hydrostatic at 700 kPag with clean water.

CLEANING AND CONDITIONING

Remove debris and flush with water at minimum velocity of 1.0 m/s.

NOTES

1. Provide full faced gaskets for flat face flanges and ring gaskets for raised face flanges.
2. Joints shown at specific spacings shall be provided for pipe disassembly.

SS3

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (KPa)	TEST PRESS. (kPa)
DCW	<60	Tunnels, Pumphouses, Exterior	600	1000
DHWR	<60	Tunnels, Pumphouses	600	1000
IA	20 – 65	Tunnels, Pumphouses	750	1000

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses, Buildings and Submerged	20 – 65	304L Stainless Steel	Sch. 10S	Material: ASTM A240 Fabrication: ANSI B36.19; ASTM A778	

COATINGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

LININGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses and Buildings	30 – 65 30 – 65	Threaded Couplings Unions, St. Steel (Note 4)	N/A 18 m	ANSI B120.1 ASTM A774	Note 1

EQUIPMENT CONNECTIONS

EQUIPMENT END	SIZE (mm)	PIPE END	RATING	SPECIFICATION	REMARKS
Brass or Bronze, Female Thread	10 – 65	150 mm SS Threaded nipple and coupling	Cl 250	ANSI B16.15	
Cast Iron, Female Thread	10 – 65	150 mm SS Threaded nipple and coupling	Cl 250	ANSI B16.15	

SS3 (cont'd)

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
Couplings Elbow – Short Radius Elbow – Long Radius Tees, Reducers Reducing Outlets, Y	30 – 65	304L Stainless Steel, Socket Weld	Cl 300	Material: ASTM A403 Dimensions: ANSI B16.3	
Threadolet	10 – 40	304L St. Steel			
Expansion Couplings	30 – 65	Synthetic Rubber Galvanized Steel	Same as Pipe		
Nuts	≤ 25 mm >25 mm		Hex. Heavy Hex.	ASTM A194 Gr. B	
Bolts		Stainless Steel	Hex	ASTM A193 Gr. B8, Cl 1	

INSPECTION AND TESTING

Visual and random nondestructive testing for welds.

CLEANING AND CONDITIONING

Remove debris and flush with water at minimum velocity of 1.0 m/s.
IA – Purge with dried air for a minimum of 24 hours or until air meets ISA spec.

NOTES

1. Joints at specific spacings for pipe disassembly.
2. Provide beveled edges for all welded fittings and connections.
3. Passivate all welds after completion.
4. IA pipe couplings shall be socket welded, not threaded.

DETAILED PROCESS PIPING SPECIFICATION SHEETS

SS4

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (KPa)	TEST PRESS. (kPa)
IA	<20	Tunnels, Pumphouses, Exterior,	700	1000

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Tunnels Pumphouses, Exterior and Submerged	12 20	304L Stainless Steel 304L Stainless Steel	1.24 mm 1.65 mm	ASTM 269 Fully annealed hydraulic tubing Hardness Rb 80 or Less. Tubing to be free of scratches.	13 mm OD 19 mm OD

COATINGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

LININGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses, Buildings and Submerged	<20	Nut and double ferrule type union, stainless steel	Tubing lengths	ANSI A276	

EQUIPMENT CONNECTIONS

EQUIPMENT END	SIZE (mm)	PIPE END	RATING	SPECIFICATION	REMARKS
Various	<20	Nut and ferrule type connectors or adapters as required	7,000 kPa	ASTM A276	

SS4 (cont'd)

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
Couplings Elbow – Short Radius Tees, Reducers, Cap, Plug	<20	Stainless steel, nut and double ferrule type	7,000 kPa	ASTM A276	
Bolts			Hex. Head	ASTM A193 Gr. B, Cl.1	
Nuts			Hex.	ASTM A194 Gr. B	

INSPECTION AND TESTING

Hydrostatic at 1000 kPag with clean water.

CLEANING AND CONDITIONING

Flush with water at minimum velocity of 1.0 m/s. Purge with dried air for 24 hours minimum.

DETAILED PROCESS PIPING SPECIFICATION SHEETS

SS5

COMMODITY CODE	PIPE SIZE (mm)	EXPOSURE	OPERATING PRESSURE (KPa)	TEST PRESS. (kPa)
IA	75 – 100	Tunnels, Pumphouses	750	1000

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses,	75 – 100	304L Stainless Steel	Sch. 20S	Material: ASTM A240 Fabrication: ANSI B36.19; ASTM A778	

COATINGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

LININGS

LOCATION	SIZE (mm)	MATERIAL	FACTORY/ FIELD	MATERIAL SPECIFICATION	REMARKS

JOINTS

LOCATION	SIZE (mm)	TYPE	SPACING	MATERIAL SPECIFICATION	REMARKS
Tunnels, Pumphouses	75-100	RFWN Flanged	18 m		Note 1

EQUIPMENT CONEECTIONS

EQUIPMENT END	SIZE (mm)	PIPE END	RATING	SPECIFICATION	REMARKS
Cast Iron Flange	75 – 100	Rolled Angle or Weld Neck Flange	Cl 150	ANSI B16.5 ASTM A774	Note 3
Steel Flange	75 – 100	Rolled Angle or Weld Neck Flange	Cl 150	ANSI B16.5 ASTM A774	Note 3

SS5 (cont'd)

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
Elbow - Short radius Elbow - Long Radius Tees, Reducers Reducing Outlets, Y	75 – 100	316L Stainless Steel, Single Longitudinal Weld Seam	Sch 20S	Material: Same as pipe ASTM A774/A240 Dimensions: ANSI B16.9	
Threadolet	10 – 40	304L St. Steel	Cl 300	Material: ASTM A403 Dimensions: ANSI B16.3	
Nuts	≤ 25 mm >25 mm		Hex.	ASTM A194 Gr. B	
Bolts		Stainless Steel	Heavy Hex.	ASTM A193 Gr. B, Cl.1	

INSPECTION AND TESTING

Visual and random nondestructive testing for welds.

CLEANING AND CONDITIONING

Remove debris and flush with water at minimum velocity of 1.0 m/s.
IA – Purge with dried air for a minimum of 24 hours or until air meets ISA spec.

NOTES

1. Joints at specific spacings for pipe disassembly.
2. Provide beveled edges for all welded fittings and connections.
3. Passivate all welds after completion.

END OF SECTION

PROCESS PIPELINE APPURTENANCES

1. GENERAL

1.1 Description

.1 This Section describes process pipeline appurtenances to be installed integrally with the piping.

.2 Refer to the general piping requirements of Section 11050. Use the general requirements specified in this section and Section 11050 integrally with the more specific requirements listed in Section 11055.

1.2 Submittals

.1 Provide Shop Drawings for each type of pipeline appurtenance in accordance with the requirements of Section 01300 and 11050.

.2 Show the materials of construction, a cutout indicating the interior workings of the unit, and illustrations of the method of installation.

1.3 Coordination

.1 Coordinate the appurtenances with the piping layout and arrangement. Ensure that the appurtenances are mounted in locations suitable for their intended function and where they are accessible for maintenance personnel.

1.4 Quality Assurance

.1 Refer to Section 11050 for welding quality assurance requirements.

1.5 Shipment, Protection and Storage

.1 Refer to Section 01600 and Section 11050.

2. PRODUCTS

2.1 Function

.1 Provide the pipe appurtenances as described below, for the piping systems shown.

2.2 Instrument Air Connections

.1 Provide instrument air connections to each instrument with a run of 12 mm stainless steel tubing from the nearest instrument air header to within close proximity of each device requiring instrument air.

.2 Terminate each tubing run with a 12 mm ball valve (stainless steel) within 1500 mm horizontal distance of the device and 1500 mm off the floor. Group multiple valves neatly together with a common orientation.

.3 Refer to Section 17421 for connection from that termination to the device from the downstream side of the valve. A list of devices requiring instrument air is provided in the Instrument Specification Sheets.

.4 Provide a vertical riser connection at the header to avoid condensate entrainment. From the top of the riser, slope the tubing generally down to the device.

2.3 Strainers

.1 Air and Gas Strainers

.1 Provide strainers with Y-pattern, cast iron body, with 40 mesh Moel screens packed with Everdur wool. For copper piping, provide bronze bodies.

.2 Fit air line strainers with a brass blowoff cock.

.3 Acceptable manufacturers are:

.1 Armstrong

.2 Mueller

.2 Steam and Water Strainers

.1 Provide steam and water strainers with Y-pattern unless otherwise specified.

.2 Provide carbon steel body for steam strainers, cast iron body for water strainers, and bronze bodies for copper piping systems.

.3 Provide 304 stainless steel screens and tapped and plugged blowoff connections. Screen perforations shall be 0.5 mm for steam service and 1.15 mm for water service.

.4 Acceptable manufacturers are:

.1 Armstrong

.2 Mueller

.3 Ferric Chloride Strainers

.1 Provide Y-pattern sodium hypochlorite strainers with a PVC body.

.2 Provide PVC Filter Screen with 0.8mm screen perforations.

.3 Provide tapped and plugged blowoff connections.

2.4 Quick Disconnects

.1 Provide quick disconnects which are not disconnectable under pressure. Unless otherwise shown or specified, provide products listed below.

.2 For air service, acceptable products are:

.1 Dixon Air King

.2 Tomco, 12 mm diameter

.3 For water service, provide products to Owner standard; two lug, malleable iron, female NPT. Sizes as shown. Acceptable products are: For water service, provide products to Owner standard. Sizes as shown. Acceptable products are:

.1 For hose 25 mm or less in diameter, two lug, malleable iron, female NPT: Dixon Air King

.2 For 38 mm and 50 mm diameter hose, two lug, malleable iron, female NPT: New Line

.3 For 75 mm and 100 mm diameter; quick-acting, dual clip: Rite-pro, Dixon.

.4 For ferric chloride service, acceptable products are:

.1 Bay Seal

.2 Dixon Boss Lock

.3 PT Couplings

2.5 Flushing Connections

.1 Provide flushing connections on all piping for the conveyance of sludge, scum, grit or other liquid containing solids greater than 0.5 percent.

.2 Locate flushing connections adjacent to all isolation valves, on dead end branches, at tees and 90 degree elbows, and at intermediate locations which limit the distance between flushing connections to less than 30 m.

.3 Show flushing connections on piping submittals.

2.6 Purge Connections

.1 Provide purge connections on all gas lines.

.2 Locate adjacent to both sides of all isolation valves and spectacle flanges, and at any other locations shown in the Drawings.

.3 Purge points shall be a minimum of 20 mm NPS pipe, fitted with a shut-off valve, which shall be capped.

2.7 Mechanical Branch Connections

.1 Provide mechanical branch connections as required for flushing connections and pipe tappings as shown in the Standard Details.

.2 Provide branch connection recommended by the manufacturer for the service and pipe installed.

.3 Acceptable products

.1 Gruvlock Clamp T

.2 Ford Service Saddles (F/FS)

.3 Victaulic Mechanical T

.4 Robar 2706 Service Saddles

2.8 Hoses

.1 Provide hoses rated for 600 kPa, complete with quick connect fittings as per standard details and as called for on the Drawings.

3. EXECUTION

3.1 Pipeline Appurtenances

.1 Provide manual air vents at the high points of each reach of pipeline and where shown, consisting of a ball valve and copper tubing return. Take air vents to the nearest floor with the valve mounted in a location accessible from floor level and no greater than 1200 mm above the floor. For piping systems conveying fluids containing solids, use 25 mm line with a non-lubricated ball valve fitted with quick disconnects. For a high point vent required on an extended run of constant elevation pipe, locate the vent at the downstream end of the run close to the downward elbow.

.2 Provide manual drains at the low point of each reach of pipeline and where shown. Pipe drains to a sump, gutter, floor drain, or other collection point with a valve mounted in a location accessible from floor level and no greater than 1200 mm above the floor. Provide threaded ball valves for drain valves of the size shown. When drains cannot be run to collection points, route them to a point of easy access and attach quick disconnects of the size specified. For pumps that do not come with integral drains, provide 25 mm drain connections with threaded manual ball valves inside pump isolation valves.

.3 Unless otherwise shown or specified, install gauge taps on the suction and discharge of all pumps, fans, blowers, compressors, and vacuum pumps. Attach gauge taps with a threaded nipple and valve, as shown, attached by a threaded nipple to the pipeline, duct or equipment.

.4 Install flushing and purge connections as described in Part 2 and as shown. Install sample lines and connections as shown.

END OF SECTION

PROCESS PIPE HANGERS AND SUPPORTS

1. GENERAL

1.1 Work Included

.1 Supply and installation of hangers and supports for all process piping systems specified in Section 11050. This section does not include pipe support for fire sprinkling systems, pipe anchors, guides or seismic restraints.

.2 Engage a Professional Engineer to be responsible for the final aspects of the piping support system design, including details and spacing of all supports. The support system will ensure that the weight of the pipework and the need for lateral and vertical support are considered fully. Contractor to provide a complete piping system design as described in Section 11050.

1.2 Submissions

.1 Submit the following for information in accordance with Section 01300:

.1 In piping layout drawings specified in Section 11050, indicate hanger and support locations and provide legend summarizing load information and hanger and support component selection at each location.

1.3 Service Conditions

.1 The intent of the Drawings has been to indicate general arrangements and typical spacings for pipe systems, but does not relieve the Contractor of the responsibility for the design and supply of a complete and adequate support system.

.2 Provide hangers and supports specified in this Section to resist pipe loads occurring primarily in the downward (gravity) direction. For the purpose of pipe hanger and support selection, this Section established pipe support classifications based on the operating temperature of the piping contents.

.3 Pipe support classifications:

.1 Hot Systems:

.1 A-1: 40°C to 230°C

.2 A-2: 230°C to 400°C

.3 A-3: Over 400°C.

.2 Ambient systems:

.1 B-1: 15°C to 49°C.

.3 Cold systems:

.1 C-1: 0.5°C to 15°C

.2 C-2: -40°C to 0°C.

1.4 Hanger and Support Selection

.1 Piping supports are generally not shown on the process mechanical layout Drawings. Therefore, select pipe hangers and supports as specified in this Section. Typical support details and structural attachments shown on the Drawings indicate the level of quality that will be considered acceptable. Where specific supports are illustrated on the process mechanical or structural Drawings or where a specific standard detail is noted on the Drawings, provide that type of support for that particular pipeline.

.2 Piping insulation thickness is specified in Section 11059.

.3 Review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the type of support to be used at each hanger point.

.4 Hangers and supports shall withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consideration shall be given to following conditions:

.1 Weights of pipe, valves, fitting, insulating materials, suspended hanger components, and normal fluid contents.

.2 Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.

.3 Reaction forces due to the operation of safety or relief valves.

.4 Wind, snow or ice loadings on outdoor piping.

.5 Size hangers and supports to fit the outside diameter of pipe, tubing, or where specified, the outside diameter of insulation.

.6 Where negligible movement occurs at hanger locations, use rod hangers for suspended lines, whenever practical. Use bases, brackets or structural cross members for piping supported from below.

.7 Hangers for the suspension of pipe and tubing sizes, 65 mm and larger shall be capable of vertical hanger component adjustment under load.

.8 Provide the supporting systems to allow for free or intended movement of the piping including its movement in relation to that of connected equipment.

.9 Design the system to support the operating loads with a safety factor of 4.0.

.10 Where there is horizontal movement at a suspended type hanger location, select hanger components to allow for swing. The vertical angle of the hanger rod shall not, at any time, exceed 4 degrees.

.11 No contact is allowed between a pipe and hanger or support components of dissimilar metals. Prevent contact between dissimilar metals when supporting copper tubing with copper-plated, rubber, plastic or vinyl coated, or stainless steel hanger and support components.

.12 Do not support piping from masonry wall construction.

.13 Do not use existing pipes and supports to support new piping unless otherwise specified.

.14 Do not attach pipe support components to equipment or pressure vessels unless otherwise specified.

.15 Use stock hanger and support components wherever practical.

.16 Provide supplementary structural members, where structural bearings are not in suitable locations.

.1 Make provision for expansion, contraction, slope and anchorage.

.2 Where necessary, pipe support systems shall withstand the additional load of electrical or instrumentation trays. Coordinate with other divisions. Design and provide support system accordingly.

2. PRODUCTS

2.1 Acceptable Manufacturers

.1 The following manufacturers products to provide the specified features and to meet specified operating conditions:

.1 B-Line

.2 Grinnell

.3 Powerstrut

.4 Superstrut

.5 Unistrut

2.2 Support Spacing

.1 Maximum support spacing shall be as listed in the following table:

	Max Spacing (in m) for Pipe made of:		
Pipe Size Nominal (mm)	Iron	PVC	Steel or SS
30 and under	2.1	1.4	2.1
30 to 40	2.7	1.5	2.1
40 to 50	3.0	1.6	2.1
60 to 75	3.6	1.8	3.0
100	4.2	2.5	3.7
150	5.2	3.0	4.3
200	5.8	3.5	4.6
250	6.4	4.0	4.9
300	6.7	4.2	5.2
350	6.7	-	5.8
400	6.7	-	6.1
500	6.7	-	6.7
600 and greater	6.7	-	6.7

.2 For pipes that convey material with a specific gravity greater than 1.0, use specific gravity correction factor for maximum spacing, based on supplier's recommendation

.3 Provide additional supports at any valves or other heavy piping elements.

2.3 Materials

.1 Non-Corrosive Environments (Tunnels and Buildings):

.1 Unless otherwise specified, pipe hangers and supports, structural attachments, fittings and accessories are hot-dipped galvanized after fabrication.

.2 Provide cadmium plated hardware (nuts, bolts, washers, threaded rods).

.3 Touch up cadmium and galvanized material with zinc rich coating where the material has been cut. Exposed bare steel is not acceptable.

.2 Exterior, Submerged or Corrosive Environments:

.1 Pipe hangers, supports, structural attachments, fittings, accessories and hardware are all stainless steel.

.2 Any areas that may be considered corrosive and are in question should be reviewed with the Contract Administrator in advance of securing the materials.

.3 Provide AISI, Type 304 stainless steel concrete inserts.

2.4 Pipe Hangers and Supports

.1 Type 1 - Clevis Pipe Hanger: Provide carbon steel clevis hangers with configuration and components as follows:

.1 Steel pipe (insulated) - B-Line B3100, Grinnell Figure 260, Superstrut C-710 or Unistrut No. 24 with insulation shield.

.2 Steel pipe (uninsulated) - B-Line B3100, Grinnell Figure 260, Superstrut C-710 or Unistrut No. 24.

.3 Cast and ductile iron pipe - B-Line B3102, Grinnell Figure 590, Superstrut C-710 or Unistrut No. 24.

.4 Copper pipe (uninsulated) - shall be B-Line B3104 CT, Grinnell Figure CT-65, Superstrut C-710 or Unistrut No. 51.

.5 Copper pipe (insulated) - B-Line B3100, Grinnell Figure 260, Superstrut C-710 or Unistrut No. 24, with insulation shield.

.6 Plastic pipe - B-Line B3100, Grinnell Figure 260 or Unistrut No. 56.

.2 Type 2 - "J" Pipe Hanger: Provide carbon steel hangers with configuration and components equivalent to MSS Type 5. Use only on uninsulated pipe, with configuration and components as follows:

.1 Steel pipe - B-Line B3690, Grinnell Figure 67, Superstrut C-711 or Unistrut J1205-J1280 Series.

.2 Copper and plastic pipe - B-Line B3690 (Plasticoat) Grinnell Figure 67 (plastic coated), Superstrut C-711P or Unistrut J 1205N-J1280N series.

.3 Type 3 - Double Bolt Pipe Clamp: Provide carbon steel pipe clamps, with configuration and components as follows:

.1 Steel pipe (insulated) - B-Line B3144 or Grinnell Figure 295, with insulation shield. Insulation shield is optional for hot and ambient systems.

.2 Steel pipe (uninsulated - B-Line B3144 or Grinnell Figure 295.

.3 Copper pipe (insulated only) - B-Line 3144 or Grinnell Figure 295, with insulation shield.

.4 Type 4 - Adjustable Roller Hanger: Provide cast iron rollers, carbon steel yoke and cross bolt with configuration and components as follows:

.1 Steel pipe (insulated) - B-Line B3110, Grinnell Figure 181 or Superstrut C-729, with insulation shield.

.2 Steel pipe (uninsulated) - B-Line B3110, Grinnell Figure 181 or Superstrut C-729.

.3 Copper pipe (insulated only) - B-Line B3110, Grinnell Figure 181 or Superstrut C-729, with insulation shield.

.4 Plastic pipe - B-Line B3110, Grinnell Figure 181 or Superstrut C-729.

.5 Type 5 - Single Pipe Roll: Provide cast iron rollers and sockets, and steel cross rods with configuration and components as follows:

.1 Steel pipe (insulated) - B-Line B3114, Grinnell Figure 171 with insulation shield.

.2 Steel pipe (uninsulated) - B-Line B3114, Grinnell Figure 171.

.3 Plastic pipe - B-Line B3114, Grinnell Figure 171.

.6 Type 6 - Framing Channel Pipe Clamp: Provide steel pipe clamps with hot dipped galvanized finish and material thickness as listed below:

.1 Steel pipe (uninsulated) - B-Line 2007, Powerstrut PS1100, or Unistrut P1009 Series:

Pipe Diameter (mm)	Thickness (mm)
10 to 12	1.6
20 to 32	2.0
38 to 75	2.8
90 to 125	3.2
150 to 200	3.6

.2 Steel pipe (insulated); as per 2.4.6.1 with insulation shield.

.3 Copper (uninsulated) and plastic pipe, B-Line B2033 Series, Powerstrut PS1200 or Unistrut P2024C and P2024PC Series B-Line. Provide a copper-plated, plastic coated or lined with a dielectric material on pipe clamps.

Pipe Diameter (mm)	Thickness (mm)
10 to 25	1.6
32 to 38	2.0
50 to 75	2.8
100	3.2

.4 Copper (insulated); as per 2.4.6.3 with insulation shield.

.7 Type 7 - U-Bolt: Provide carbon steel U-bolts with configuration as follows:

.1 Steel pipe (uninsulated) - Grinnell Figure B-Line B3188 or Superstrut H-115.

.2 Steel pipe (insulated) - Grinnell Figure 137, B-Line B3188 or Superstrut H-115 with insulation shield.

.3 Cast and ductile iron pipe - Grinnell Figure 137, B-Line B3188 or Superstrut H-115.

.4 Copper pipe (uninsulated) - B-Line B3501 CT, Grinnell Figure 137C, Superstrut H-115 (with plastic coating) or Unistrut No. 13 (with plastic coating).

.5 Copper pipe (insulated) - Grinnell Figure 137 or B-Line B3188, Superstrut H-115 with insulation shield.

.6 Plastic pipe - Grinnell Figure 137C, B-Line B3188 or Superstrut H-115 (with plastic coating).

.8 Type 8 - Adjustable Pipe Roll Support: Provide cast iron rollers and sockets, and carbon steel cross rod and support rods with configuration and components as follows:

.1 Steel pipe (insulated) - B-Line B3122 or Grinnell Figure 177 with insulation shield.

.2 Steel pipe (uninsulated) - B-Line B3122 or Grinnell Figure 177.

.3 Copper pipe (insulated only) - B-Line B3122 or Grinnell Figure 177 with insulation shield.

.4 Plastic pipe - B-Line B3122 or Grinnell Figure 177.

.9 Type 9 - Welded Pipe Stanchion: Provide a carbon steel, standard schedule pipe stanchion, cut pipe to match contour of pipe elbow. Use only for ambient commodity systems.

.10 Type 10 - Pipe Stanchion saddle: Provide carbon steel saddles and yokes as follows:

.1 Steel pipe (insulated) - B-Line B3900 or Grinnell Figure 259 with insulation shield.

.2 Steel pipe (uninsulated) - B-Line 3090 or Grinnell Figure 259.

.3 Cast and ductile iron pipe - B-Line 3090 NS or Grinnell Figure 259.

.4 Copper pipe (uninsulated) - B-Line B3090 or Grinnell Figure 259 with insulation shield or lined with dielectric material.

.5 Copper pipe (insulated) - B-Line B3090 or Grinnell Figure 259 with insulation shield.

.6 Plastic pipe - B-Line B3090 or Grinnell Figure 259.

.11 Type 11 - Offset Pipe Clamp: Provide carbon steel pipe clamps with con-figuration and components as specified and to the most standard design manufactured by a pipe hanger component manufacturer:

.1 Steel pipe (insulated) - B-Line B3148 or Grinnell Figure 103 or with insulation shield.

.2 Steel pipe (uninsulated) - B-Line B3148 or Grinnell Figure 103.

.3 Cast and ductile iron pipe - B-Line B3148 NS or Grinnell Figure 103.

.4 Copper pipe (insulated) - B-Line B3148 or Grinnell Figure 103 or with insulation shield.

.5 Copper pipe (uninsulated) - B-Line B3148 or Grinnell Figure 103 lined with dielectric material.

.6 Plastic pipe - B-Line B3148 or Grinnell Figure 103.

.12 Type 12 - Riser Clamp: Provide carbon steel riser clamps with configuration and components as follows:

.1 Steel pipe (insulated) - B-Line B3373 or Grinnell Figure 261, Superstrut C-720 or Unistrut No. 82.

.2 Steel pipe (uninsulated) - B-Line B3373 or Grinnell Figure 261, Superstrut C-720 or Unistrut No. 82.

.3 Cast and ductile iron pipe - B-Line B3373 or Grinnell Figure 261, Superstrut C-720 or Unistrut No. 82

.4 Copper pipe (insulated) - B-Line B3373 CT, Grinnell Figure 261, Superstrut C-720 or Unistrut No. 82.

.5 Copper pipe (uninsulated) - B-Line B3373 CT, Grinnell Figure CT-261, Superstrut C-720 or Unistrut No. 84.

.6 Plastic pipe - B-Line B3373, Grinnell Figure 261C, or Superstrut C-720 or Unistrut No. 82.

.13 Type 13 - Framing Channel Pipe Strap: Provide carbon steel pipe strap with configuration as follows:

.1 Steel pipe (uninsulated) - B-Line B2400 Series, Powerstrut PS3126, Superstrut C-708-U or Unistrut P2008 Series.

.2 Steel pipe (insulated) - B-Line B2400 Series, Powerstrut PS3126, Superstrut C-708-U or Unistrut P2008 Series with insulation shield.

.3 Copper pipe (uninsulated) - B-Line B2400 Series, Powerstrut PS3126, Superstrut C-708-U or Unistrut P2008 Series with insulation shield.

.4 Copper pipe (insulated) - B-Line B2400 Series, Powerstrut PS3126, Superstrut C-708-U or Unistrut P2008 Series with insulation shield.

.5 Plastic pipe - B-Line B2400 Series, Powerstrut PS3126, Superstrut C-708-U or Unistrut P2008 Series.

.14 Rack and Trapeze Supports:

.1 Unless otherwise specified, provide steel trapeze and pipe rack components having a minimum thickness of 2.8 mm with a maximum deflection 1/240 of the span. Framing channel as specified in 2.4.16.5.

.2 Type 20 - Trapeze Pipe Support: Trapeze pipe support cross members as specified in 2.4.16.5. Provide 41 mm square carbon steel flat plate fittings of stranded design manufactured by framing channel manufacturer, B-Line B202-2, Powerstrut PS619 or Unistrut P1062 Series.

.3 Type 21 - Pipe Rack Support: Post and cross member framing channels, as specified in 2.4.16.5. Provide carbon steel pipe rack fittings of standard design manufactured by framing channel manufacturer. Provide gusset type, 90-degree fittings, B-Line B844, Grinnell PS3373 or Unistrut P2484. Post base fittings as specified in 2.4.15.14.

.15 Structural Attachments:

.1 Type A - Malleable Iron Concrete Insert: Provide malleable iron concrete inserts; B-Line B3014, Grinnell Figure 282 or Unistrut M2808.

.2 Type B - Side Beam Bracket: Provide malleable iron bracket Grinnell Figure 202 or B-Line B3062.

.3 Type C - Malleable Beam Clamp With Extension Piece: Provide malleable iron clamp and extension pieces with steel tie rods; Grinnell Figure 218 with Figure 157 extension piece or B-Line B3054.

.4 Type D - Steel Beam Clamp With Eye Nut: Provide forged steel beam clamps and eye nuts; Grinnell Figure 292, B-Line B3291 series.

.5 Type E - Steel channel clamp: Provide malleable iron clamp and heel plates, and steel bolts and nuts; Grinnell Figure 226.

.6 Type F - Welded Beam Attachment: Provide carbon steel beam attachments; B-Line B3083 or Grinnell Figure 66.

.7 Type G - Adjustable Beam Attachment: Provide carbon steel beam attachments, B-Line B3082, Unistrut P1737 or Powerstrut PS2648.

.8 Type H - Double Channel Bracket: Provide single channel attachment as specified in 2.4.16.5. Provide a carbon steel double framing channel cantilever bracket assembly; B-Line B297-12 through B297-36, Powerstrut PS809 or Unistrut P2542 series.

.9 Type J - Single Channel Bracket: Provide single channel attachment as specified in 2.4.16.5. Provide a carbon steel single framing channel cantilever bracket assembly; B-Line B198-6 through B198-24, Powerstrut PS661 or Unistrut P2231 through P2234.

.10 Type K - Wall Mounted Channel: Provide 41 mm x 62 mm carbon steel framing channel; B-Line B12 or Unistrut P5500.

.11 Type L - Pipe Stanchion Attachment: Provide minimum 12 mm thick carbon steel baseplate. Anchor bolt holes: 1.6 mm larger than bolt diameter. Provide non-shrink grout between the baseplate and upstand.

.12 Type M - Welded Steel Bracket: Provide carbon steel brackets which comply with MSS Type 32 and FEDSPEC Type 33 for medium welded bracket: Grinnell Figure 195. Heavy welded bracket to comply with MSS Type 33 and FEDSPEC Type 34; Grinnell Figure 199.

.13 Type N - Cast Iron Bracket: Provide cast iron brackets; Grinnell Figure 213.

.14 Type P - Framing Channel Post Base: Provide carbon steel post bases of stranded design manufactured by framing channel manufacture. Single channel: Unistrut P2072A, B-Line B280 Powerstrut PS3025. Double channel: Unistrut P2073A, B-Line B281 or Powerstrut PS3064.

.15 Type Q - Continuous Concrete Inserts: Provide 300 mm long carbon steel concrete inserts; Unistrut P3253.

.16 Accessories:

.1 Weldless Eye Nut: Provide forged steel eye nuts and comply with MSS and FEDSPEC Type 17; Grinnell Figure 290 or B-Line B3200.

.2 Welded Eye Rod: Provide carbon steel eye rods with eye welded closed. Inside diameter of eye to accommodate a bolt diameter 3.2 mm larger than the rod diameter; Grinnell Figure 278 or B-Line B3211.

.3 Turnbuckle: Provide forged steel turnbuckles; Grinnell Figure 230 or B-Line B3202.

.4 Framing Channels: Provide 41mm x 62mm roll formed carbon steel framed channel, having a thickness of 2.7 mm. Channel to have a continuous slot along one side with in-turned clamping ridges. Single Channel: Unistrut P5500. Double Channel: Unistrut P5501.

.5 Anchor bolts to Section 05500.

2.5 Hanger Rods

.1 Rod material shall conform to ASTM A307 as a minimum, and shall be cadmium plated in non-corrosive interior spaces, stainless steel in exterior, submerged or corrosive applications, threaded on both ends or continuous threaded and sized as specified.

.2 Hanger rod sizing, as a minimum shall be as follows:

Pipe Size Nominal (mm)	Hanger Rod Diameter (mm)
100	10
150	12
200	16
250	20
300	22
350	25
400	25
500	38
600	44

2.6 Base Elbows

.1 Where elbows change the run of a horizontal pipe to a vertical direction, supports shall be secured to the elbow.

.2 Dimensions for the supports shall be as follows:

Pipe Size Nominal (mm)	Support Pipe Diameter (mm)	Base Plate Dimension (mm x mm)
100	50 Schedule 40	100 x 6
150	75 Schedule 40	125 x 6
200	100 Schedule 40	150 x 6
250	100 Schedule 40	150 x 6
300	150 Schedule 40	200 x 10
350	200 Schedule 40	250 x 10
400	200 Schedule 40	250 x 10
500	250 Standard Weight	300 x 10
600	300 Standard Weight	350 x 10
750	350 Standard Weight	400 x 10
1050	350 Standard Weight	400 x 10

.3 Gauge piping: In general, support elbow stanchions for gauge stainless steel piping shall be of the same diameter as the pipe.

2.7 Thermal Pipe Hanger Shield

.1 Provide thermal shields at hanger, support and guide locations on pipe requiring insulation. The shield consists of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer. The thermal shield is the same thickness as the piping system insulation. Use standard shield for hot systems and vapour barrier shield for cold systems. Use stainless steel band clamps to ensure against slippage between the pipe wall and the thermal shield.

.2 Standard Shield:

.1 Insulation:

.1 Hydrous calcium silicate, high density, waterproof.

.2 Compressive strength: 700 kPa average.

.3 Flexural strength: 500 kPa average.

.4 R value: 2.16 at 37.8°C mean.

.5 Temperature range: -7°C to 260°C.

.6 Steel Jacket: Galvanized steel, thickness as per manufacturer's standards, supplied for the given pipe size.

.7 Connection: Provide butt connection shield to pipe insulation. Steel jacket and insulation to be flush with end.

.2 Vapour Barrier Shield:

.1 Insulation:

.1 Hydrous calcium silicate, high density, waterproof.

.2 Compressive strength: 700 kPa average.

.3 Flexural strength: 500 kPa average.

.4 R value: 2.16 at 37.8°C mean.

.5 Temperature range: -7°C to 260°C.

.2 Steel Jacket: Galvanized steel, thickness as per manufacturer's standards, supplied for the given pipe size.

.3 Connection: Provide butt connection shield to pipe insulation. Insulation to extend 25mm each side of steel jacket for vapourtight connection to pipe insulation vapour barrier.

3. EXECUTION

3.1 Hanger and Support Location

.1 Locate hangers and supports as near as possible to concentrated loads such as valve, flanges, etc. Locate hangers, supports and accessories within the maximum span lengths specified on Drawings to support continuous pipeline runs unaffected by concentrated loads.

.2 Provide hangers or base supports within 1000 mm of each change in direction on each leg, on one side of each valve, and on the first spool piece or fitting extending from a piece of equipment.

.3 Locate hangers and supports to ensure that connections to equipment, tanks, etc. are substantially free from loads transmitted by the piping.

.4 Ensure that where piping is connected to equipment, a valve, piping assembly etc. that will require removal for maintenance, the piping will be supported in such a manner that temporary supports will not be necessary for this procedure.

.5 Support piping so that no pockets will be formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

.6 Install spring hangers where required to offset expansion in horizontal runs which follow long vertical risers.

3.2 Installation

.1 Welded and bolted attachments to the building structural steel to be in accordance with the requirements of Section 05500. Unless otherwise specified, do not drill or burn holes in the building structural steel.

.2 Do not use hanger components for purposes other than for which they were designed. Do not use hanger components for rigging and erection purposes.

.3 Install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

.4 Aluminum or galvanized steel clips shall be used to support piping from aluminum or steel structural members. Where metals of different type are to be connected, provide isolation to prevent galvanic corrosion.

.5 Use embedded anchor bolts instead of concrete inserts for support installation in areas below water surface or normally subjected to submerging.

.6 Install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Butt joint connections to pipe insulation shall be made at the tie of insulation installation in accordance with the manufacturer's recommendation.

.7 All minor modifications to accommodate installed equipment and structural components are subject to review. Do not commence Work on related piping until written acceptance has been received.

.8 Include any piping support modifications on the Shop Drawings submitted prior to fabrication or installation.

.9 Prior to installation, inspect and field measure to ensure that previous Work is not prejudicial to the proper installation of piping.

.10 Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.

.11 Rollers shall roll freely without binding.

.12 Finished floor beneath Type L structural attachments and framing channel post bases shall be roughed prior to grouting. Grout between base plate and floor shall be free of void of foreign material.

.13 Cut and drill baseplates to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

.14 Provide plastic or rubber end caps at the exposed ends of all framing channels that are located up to 2100 mm above the floor.

.15 Review the Drawings prior to installation of piping, conduit, and fixtures by this or any other division. Identify any conflicts and confirm the routing of each section of pipe prior to commencement of installation. Advise of any conflicts with existing services. Where necessary, amend the routing of pipework to avoid conflict and provide Shop Drawings showing proposed routing.

3.3 Adjustment

.1 Adjust hangers and supports to obtain required pipe slope and elevation. Use shims made of material that is compatible with the piping material. Adjust stanchions prior to grouting of baseplates.

END OF SECTION

PROCESS PIPING AND EQUIPMENT INSULATION

1. GENERAL

1.1 Scope

.1 Process piping and equipment insulation

.2 Adhesives, tie wires, tapes

.3 Recovering

.4 Refer to Division 2 if buried insulated pipe is required

1.2 Quality Assurance

.1 Install insulation employing skilled workmen regularly engaged in this type of work.

.2 Materials shall meet or exceed fire and smoke hazard ratings as stated in this section and defined in applicable building codes.

1.3 Submittals

.1 Submit Shop Drawings which indicate complete material data, "K" value temperature rating, density, finish, recovery jacket of materials proposed for this project and indicate thickness of material for individual services.

1.4 Job Conditions

.1 Deliver material to Site in original non-broken factory packaging, labelled with Manufacturer's density and thickness.

.2 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

2. PRODUCTS

2.1 General

.1 Insulation Materials, Recovery Jackets, Vapour Barrier Facings, Tapes and Adhesives

.1 Composite fire and smoke hazard ratings shall not exceed 25 for flame spread and 50 for smoke developed rating when tested in accordance with CAN4-S102, NFPA 255 or ASTM E84.

.2 Provide insulating materials and accessories that withstand service temperatures without smoldering, glowing, smoking or flaming when tested in accordance with ASTM C441.

.3 All insulation materials shall meet current Building Code Standards, and packages or containers of such materials shall be appropriately labelled.

.4 Insulate fittings and valve bodies with preformed removable insulated fittings.

2.2 Materials

.1 Cold piping interior: Semi-rigid, pre-formed fibreglass or formed rigid mineral fibre pipe insulation, with factory applied paintable canvas vapour barrier jacket, factory moulded to conform with piping, "K" value: maximum 0.035 W/m°C at 24°C. Service temperature: -40°C to 150°C.

.2 Hot piping interior: Semi-rigid, pre-formed fibreglass or rigid mineral fibre pipe insulation, with factory applied paintable canvas general purpose jacket, factory moulded to conform to piping, "K" value: maximum 0.035 W/m°C at 24°C. Service temperature: up to 200°C.

.3 Cold piping exterior: Foamglass insulation with factory applied aluminum vapour barrier jacket, factory moulded to conform with piping. “K” value: maximum 0.035 W/m°C at 24°C. Service temperature: -40°C to 150°C.

.4 Hot piping exterior: Foamglass insulation with factory applied aluminum vapour barrier jacket, factory moulded to conform with piping. “K” value: maximum 0.035 W/m°C at 24°C. Service temperature: -40°C to 150°C.

.5 Buried piping: Refer to Division 2, if applicable.

.6 Hot equipment flat surfaces: Rigid mineral fibre insulation with factory applied paintable canvas general purpose jacket, factory moulded to conform to equipment. “K” value: maximum 0.035 W/m°C at 24°C. Service temperature: 20°C to 200°C.

.7 Hot equipment curved surfaces: Mineral fibre blanket with factory applied paintable canvas general purpose jacket, factory moulded to conform to equipment?. “K” value: maximum 0.035 W/m°C at 24°C. Service temperature: 20°C to 200°C.

.8 Recovery jackets: 0.9 mm smooth aluminum sheet or paintable canvas for all new insulated piping.

.9 Cold and hot water piping up to 115ºC: As an alternate to formed fibreglass pipe insulation, rigid phenolic closed cell foam insulation equal to Kingspan Koolphen K CFC-free rigid phenolic insulation may be used. Product shall meet ASTM-E-84 and ASTM-C-585-90 and ULC burn and smoke spread rating for non-combustible installations (ULC-S102, S127).

2.3 Buried Piping

.1 Provide insulation for all buried piping with a soil cover of less than 2500 mm in grassed areas or less than 3000 mm below roads, walkways and access pads in accordance with Division 2, if applicable.

2.4 Above Ground Piping

.1 Provide insulation for all pipe and equipment with an operating surface temperature in excess of 50 °C. Use a minimum thickness of 25 mm. Use greater thicknesses as required to lower the outer skin temperature to below 40 °C.

.2 Provide insulation for all piping where heat retention is required, at the locations indicated on the drawings and for other piping systems where insulation is indicated on the process mechanical drawings.

.3 Provide insulation at pipe hangers and supports with factory applied vapour jacket and a self sealing lap, manufactured specifically for use at support locations. It shall be a minimum of 200 mm long and of the same thickness as adjacent pipe insulation.

.4 Provide a suitable bonding agent to joint the preformed sections.

.5 On exterior piping, provide aluminum jacketing with a minimum thickness of 0.9 mm, unless indicated otherwise.

.6 Provide aluminum banding, 12 mm wide by a minimum of 0.5 mm thick with matching seals.

.7 Provide polypropylene jacketing at elbows, tees or other changes of direction and where indicated. Use the heat-shrink type jacketing, with a minimal thickness of 0.1 mm.

.8 On interior piping, provide paintable canvas jacketing, ULC listed, 0.27 kg/m^2 minimum.

3. EXECUTION

3.1 Preparation

.1 Do not install insulation and recovering before piping and equipment has been tested and approved.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.2 Installation

.1 Ensure insulation is continuous through inside walls and floor penetrations. Pack around pipes with fire proof self-supporting insulation material, properly sealed.

.2 Insulate piping and fittings as noted in the schedule below. Insulate valves unless otherwise noted. Do not insulate unions, flanges (except on flanged valves if valve must be insulated), Victaulic couplings, strainers, (except on chilled water lines), flexible connections and expansion joints. Terminate insulation neatly with plastic material trowelled on a bevel.

.3 Provide insulation on all process air pipes located in the building and tunnel areas. Use 50 mm thick fibreglass insulation over the entire length of the pipe run except over couplings, valves and meters. Provide stainless steel bands over the insulation at a maximum of 300 mm centres.

.4 Unless indicated otherwise, do not insulate water body valves.

.5 Terminate insulation 100 mm on each side of all flanges and grooved joint couplings.

.6 Finish insulation neatly on hangers, supports and other protrusions.

.7 Locate insulation or cover seams in least visible locations. Locate seams on piping in ceiling spaces on the underside of the pipe.

.8 Cover all insulated piping throughout with aluminum or paintable canvas recovery jacket secured with aluminum bands on 200 mm centres or screws on 150 mm centres, unless otherwise noted. Lap the joints a minimum of 75 mm. Align longitudinal seams in aluminum recovering to shed water. All bands and screws are to be accessible for service and removal.

.9 Cold piping: seal lap joints with 100 percent coverage of vapour barrier adhesive. Seal butt joints with 50 mm wide strips of vapour barrier sealed with vapour barrier adhesive. For fittings and valves, apply hydraulic insulating cement; or apply factory fabricated insulation half shells, seal all laps and joints.

.10 Flare out staples may be used to secure jacket laps on hot systems. Staples are to be applied on 100 mm centres.

.11 Hot piping: for fittings and valves, apply hydraulic insulating cement, or apply factory fabricated insulation half shells.

3.3 Process Pipe Insulation Installation Thickness Schedule

	Piping or Equipment	**Pipe Sizes mm**	**Insulation Thickness (fibreglass) mm**	**Insulation Thickness (closed cell phenolic) mm**	**Recovery Jacket**
1.	Insulated Process Piping, as shown on drawings	15 to 50 Over 50	25 * 50 *	25 * 25 *	As noted in 2.2
2.	Process Air Piping: Blower Building Basement PRA Tunnel	 All All	 50 50	 50 50	 Aluminum Canvas

* Unless stated otherwise elsewhere in Sections 11050, 11055, 11100 or 11105, or on drawings.

END OF SECTION

1. GENERAL

1.1 Description

.1 This Section specifies the supply, installation and testing of valves used for isolation, manual throttling, and bypass.

1.2 Definitions

.1 Valve Identification: valves are identified in the drawings by valve symbols. Refer to the Drawings for lists of valve symbols and labels.

.2 Actuators: valves are supplied with their standard operators as detailed in Part 2 unless otherwise noted in Section 11105 or Instrumentation Specification Sheets.

.3 Detailed Valve Specification Sheets:

.1 Detailed valve specification sheets are provided in Section 11105 for each type of valve which is identified in the Drawings with a valve symbol or described in Part 2 of this specification section.

.2 Where there is a conflict between valves described in this Section and other valves described in Division 11 and Division 17, conform to the most stringent requirements.

.4 Instrument Data Sheets for modulating control valves: Division 17 specifies and takes responsibility for the supply and installation of electric and pneumatic control valves, complete with valve body, actuator, position indicator, and other ancillaries. Valve bodies for these products will comply with the requirements as specified in Section 11105 and this Section.

1.3 Submittals for Review

.1 Shop Drawings: submit the following information in accordance with Section 01300:

.1 Catalogue cuts and Shop Drawings for each type of valve indicating the valve number, materials of construction, dimensions, head loss characteristics through the valve, operating torque and valve end configuration.

.2 An amended Detailed Valve Specification Sheet for all valves. Indicate with check marks where the valve supplied meets the requirements specified and with written amendments where the Product differs from the Specification.

.2 Operating and Maintenance data for incorporation in Operation and Maintenance Manual, as specified in Division 1. Include complete description of operation together with detailed drawings, a complete list of replacement and repair parts, and parts Manufacturer's identifying numbers.

.3 Affidavits and registration numbers described below in Quality Assurance.

1.4 Quality Assurance

.1 Provide CRN designated by the Province of Manitoba for each valve type.

.2 Provide affidavits of compliance, as required by AWWA C500 for gate valves.

.3 For butterfly valves to be installed below ground, provide affidavits of compliance with AWWA C504.

.4 Valves are to be marked in accordance with MSS SP-25.

1.5 Shipment, Protection and Storage

.1 Deliver valves to site in accordance with Division 1 and using loading methods which do not damage casings or coatings.

.2 Clearly tag valves stating size, type, coatings and mating parts.

.3 Store on-site until ready for incorporation in the Work using methods recommended by the Manufacturer to prevent damage, undue stresses, or weathering.

2. PRODUCTS

2.1 General

.1 Provide valves of the same type, size range and service from a single manufacturer.

.2 Provide new, unused valves.

.3 Valve materials to be free from defects or flaws, with true alignment and bores.

.4 Unless otherwise indicated on the Process and Instrumentation Drawings or specified in Division 17, valves shall be the same size as the pipe run in which they are to be installed.

.5 Clearly mark valve bodies in raised lettering to indicate the valve type, rating, and where applicable, the direction of flow. Conform to MSS SP25.

.6 Provide padlockable lockout feature on all sizes of the following valve types:

.1 Automated Control Valves (electric and pneumatic); FCV, LCV, PCV and XV only. Refer to the Drawings for abbreviation definitions.

.2 Specialty Valves; FV and PRV only. Refer to the Drawings for abbreviation definitions.

.3 Manual Isolation and Shut-off Valves; BF, BV, GL, GV, KV and PV only. Refer to Section 11105 for abbreviation definitions.

.7 Specific requirements for the materials, ratings and service conditions for each valve are listed in Section 11105.

.8 Valves to open counter-clockwise.

2.2 Drawings

.1 The process schematics indicate major process valves required for the process to operate as intended.

.2 The detailed process drawings and process standard drawings indicate the valves on the process schematics plus other valves required for isolation.

.3 In pipe runs less than 100 mm diameter, in addition to the valves indicated on the P&IDs, detailed drawings and standard drawings, provide isolation valves in straight pipe runs at intervals no greater than 60 m and at takeoffs to individual services. Provide ball isolation valves in pipe of 65 mm diameter and less, or in pipe of less than 100 mm diameter and carrying solids. Provide butterfly isolation valves in pipe of 75 mm diameter and greater and not carrying solids.

.4 In pipe runs carrying sludge or scum tap bottom of pipe at low point of runs and install short nipple and isolation valve.

.5 Provide valves and taps on top of pipe at high point in all liquid pipe runs greater than 60m length where the change in slope exceeds 4 percent.

.6 Provide flushing connections and valves as shown in standard details, at 30 m intervals on any primary sludge, primary and thickener scum and thickened secondary sludge lines.

.7 Unless otherwise specified, provide gate valves 400 mm and larger with a bypass valve sized in accordance with AWWA C500.

.8 Where a valve may be required for the process to function correctly or is required to satisfy fire and safety codes but it is not shown in the drawings, inform the Contract Administrator and provide details and suggestions for remedial action. Do not commence piping in the related pipe run until obtaining the Contract Administrator's approval.

2.3 Valve Ends

.1 In pipe runs less than 75 mm diameter provide valves with female threaded ends, unless indicated otherwise. Threads to conform to ANSI B1.20.1.

.2 Valves in pipe runs equal to or greater than 75 mm diameter to be flanged unless indicated otherwise.

.3 For cast iron body valves, drill flanges to Class 125 pattern conforming to ANSI B16.1. For steel body valves, flanges to be Class 150 pattern or Class 300 pattern conforming to ANSI B16.5 or as noted in Section 11105.

.4 Do not use grooved joint valve ends.

.5 Use flanged joints for buried and exterior valves. The flanges are to be compatible with the pipe and jointing technique used.

.6 Use flanged joints for buried butterfly valves.

.7 Lug style wafer body valves shall have tapped holes, suitable for the bolt spacing of the pipe flanges placed on either side.

.8 Wafer body valves shall have positioning holes, suitable for the bolt spacing of the pipe flanges placed on either side.

.9 For gate valves, end flanges shall be integral with the gate valve body and be faced and drilled in accordance with ANSI B16.1, Class 125 flanges.

2.4 Manual Operators

.1 Provide valves with manual operators unless specifically indicated otherwise on the process schematic drawings, mechanical drawings, in Section 11105, Division 17 or the Instrumentation Specification sheets.

.2 For hand wheels, clearly show the direction of opening in raised lettering and symbols.

.3 Hand wheel diameter to conform to the following:

Nominal Valve Diameter (mm)	**Minimum Handwheel Diameter (mm)**
12	50
20	50
25	60
38	75
50	85
65	105
75	200
100	250
150	300
200	350
250	400
300	450
350	450
400	550
450	600
500	600
600	600

.4 The maximum rim pull on a hand wheel not to exceed 300 N when one side of the valve is at test pressure and the other side is at atmospheric pressure. Where a shaft mounted hand wheel would require greater than this force to operate, provide a gear operator. Unless different operators are scheduled or shown in the drawings, conform to the following minimum requirements:

.1 Gate Valves: less than 300 mm, hand wheel; equal to or greater than 300 mm, gear operator.

.2 Knife Gate Valves: less than 300 mm, hand wheel; equal to or greater than 300 mm, gear operator.

.3 Globe and Needle Valves: less than 200 mm, hand wheel; equal to or greater than 200 mm, gear operator.

.5 Match existing operating nuts. Provide two eight-point operating wrenches.

.6 Supply stem extensions and valve boxes for buried valves specified in the Drawings, Sections 11105, and in Clause 2.5 of this Section. Provide two operating tees.

.7 Lever operators to conform to the following dimensions:

Nominal Valve Diameter (mm)	**Minimum Lever Length (mm)**
6	80
12	80
20	100
38	150
50	150
65	150
75	175
100	225
150	250
200	300
250	450
300	450

.8 Quarter-turn lever operators to be perpendicular to the pipe run when the valve is closed.

.9 Lever operators on ball valves to be two position. Provide butterfly valves with 10 position latching levers except where used to balance air flows. Where used to balance air flows provide infinite position, screw down levers.

.10 The maximum pull at the end of the lever arm not to exceed 300 N when one side of the valve is at test pressure and one side is at atmospheric pressure. Where greater than this force would be required to operate the valve with a lever, provide a gear operator. Unless different operators are scheduled or shown in the drawings, conform to the following minimum requirements:

.1 Plug Valves and Ball Valves: less than 150 mm, lever operator; greater than or equal to 150 mm, gear operator.

.2 Butterfly Valves: less than 250 mm, lever operator; greater than or equal to 250 mm, gear operator.

.11 Gear operator to be worm gear type, equipped with a hand wheel and a visual indicator of the valve position. Equip operators with adjustable mechanical stop-limiting devices to prevent overtravel of the disc or ball in the open and closed positions and which are self-locking and designed to hold the valve in any intermediate position between full open and full closed. Gear operators shall be grease lubricated. Where gear operators are intended for direct bury or submergence, seal units with long life lubricant.

.12 Manual operators for butterfly and gate valves for buried service to include an AWWA operating nut and be gasketed and grease packed for submerged operation at water pressures to 700 kPa. Operators for exposed service shall be gasketed for weatherproof service. Place gear boxes above ground and liquid surfaces.

.13 Gear and manual operators for submerged service to be permanently lubricated and sealed for operation at water pressures to 700 kPa.

.14 For manual valves on lines 75 mm and greater, mounted over 2.0 m above the operating floor, provide chain wheel gear operators. Design the operator so that a force of 150 N is sufficient to open the valve when one side of the valve is at test pressure and the other side is at atmospheric pressure. The chain pulley to mesh positively with the chain. Extend the chain from the valve operator to operating height 1.2 m above the floor or as directed by the Contract Administrator. The exact dimensions shall be field determined. Provide approved chain hooks where required to prevent chain from hanging within traffic paths.

2.5 Valve Stem Extensions

.1 Provide valve stem extensions where additional clearance is required for pipe insulation, where valve operation without the extension is difficult, and in manholes.

.2 Where angle valve stem extensions are employed, they shall be angle geared. Universal joint types are not permitted.

2.6 Insulation

.1 In insulated pipe runs, insulate valves in accordance with Section 11059.

.2 Preform insulation in a shape suitable for the valve, of the same material specified in Section 11059.

.3 Recovering to be as specified in Section 11059, with transition sections for the joints between the valve insulation and the pipe insulation.

.4 Insulation to be removable and reusable without destroying insulation or recovering.

2.7 Protective Coatings

.1 Unless otherwise specified, provide valves coated in accordance with Section 11900.

2.8 Cathodic Protection

.1 Unless otherwise specified, provide cathodic protection to underground valves.

2.9 Spare Parts

.1 Provide one spare valve including the appropriate operator for each valve type and size.

.2 Provide a list of all spare parts which would be expected to be required under normal conditions for a period of five years. At the Contract Administrator's request, provide a price for these parts.

3. EXECUTION

3.1 Preparation

.1 The valve and piping arrangement indicated in the drawings is based on typical dimensions for valves of the specified type. Make the necessary modifications in the piping to allow for discrepancies between the valve dimensions shown and those supplied for the Work.

.2 Prior to the installation of the valves, field measure and check all equipment locations, pipe alignments, and structural installation. Ensure that the valve location and orientation provides suitable access to manual operators and that sufficient space and accessibility is available for pneumatic and electric actuators.

.3 Where conflicts are identified, inform the Contract Administrator and initiate the necessary piping modifications at no cost to the City.

3.2 Valve Installation

.1 Install valves in conjunction with the piping described in Sections 11050 and with control valves and their appurtenances described in Division 17.

.2 In horizontal pipe runs other than in locations where space does not permit, mount all valves except for butterfly valves and trunnion ball valves with a vertical operating shaft with the actuator at the top. In no case install a valve with the operator shaft pointing down.

.3 Mount butterfly valves and trunnion ball valves with the shaft in a horizontal orientation.

.4 When joining valves to pipe or fittings, do not over torque bolts to correct for misalignment.

.5 Support valves in position using temporary supports until valves are fixed in place.

.6 Permanently support valves to prevent transmission of loads to adjacent pipework and/or equipment.

.7 Where valves are installed in PVC pipework greater than 100 mm diameter, support valves independently and brace against operating loads and torque to prevent transmission of stresses to the adjacent pipework.

.8 Generally pipe supports and hangers are not shown unless for indication purposes only.

.9 Install gate valves in the closed position.

.10 Install valves which are bubble tight in one direction to seal in a direction opposite to normal flow unless otherwise noted or directed by the Contract Administrator.

.11 Unless otherwise specified, install single seated ball valves and knife gate valves with the seat downstream. Install at tank connections with seat away from tank. Install on pump discharge and suction lines with seat adjacent to the pump.

.12 Install all valves in accordance with the Manufacturer's recommendations.

.13 Protect valves installed below grade with a shrink sleeve or polyethylene sheath attached to the pipe with tapewrap.

3.3 Valve Extensions

.1 Install valve stem extensions where necessary to provide clearance from insulation.

3.4 Insulation

.1 Install insulation and recovering as specified in Section 11059.

3.5 Valve Testing

.1 Operate valves under simulated and/or real process conditions to ensure they operate as intended.

.2 Pressure test the valves in conjunction with the pipes in which the valves are installed as specified in Section 11050.

END OF SECTION

VALVE SPECIFICATION SHEETS

1. GENERAL

1.1 Description

.1 The following pages provide a summary of the valve body materials, valve performances and reference specifications for use in the Work and should be read in conjunction with Sections 11050, 11055 and 11100. Furnish all valves in accordance with the requirements of this section and those requirements of Sections 11050, 11055, and 11100. Where there is a conflict, conform to the most stringent requirements.

.2 Table 1, below, provides a reference table of commodities and valves acceptable for use with these commodities, unless otherwise specified. The valve abbreviation on Table 1 indicates the Detailed Valve Specification Sheet to be referenced. Provide the valve type as indicated in the drawings by the valve symbol shown. Match the symbol, commodity and line size to the Detailed Valve Specification Sheet.

.3 Valves identified in the drawings with an equipment identification symbol or instrument identification symbol are specified in Sections 11100 and 17213, respectively. Detailed Valve Specification Sheets referenced by other sections are independent of Table 1.

.4 Named Acceptable Products are shown to define basic materials and performance criteria required for each valve type. Modify valves as specified to meet the service requirements of the system and detailed specifications.

1.2 Definitions

.1 Abbreviations used in Detailed Valve Specification Sheets:

AV - Angle Valve
BC - Balancing Cock Valve
BD - Butterfly Damper
BF - Butterfly Valve
BV - Ball Valve
CB - Circuit Balancing Valve
CV - Check Valve
DV - Diaphragm Valve
GA - Gate/Root Valve
GL - Globe Valve
GV - Gate Valve
KV - Knife Valve
MV - Mud Valve
NV - Needle Valve
PD - Pump Discharge Valve
PV - Plug Valve
TW - Two Way/Three Way Multiport Valve

2. PRODUCTS

.1 Detailed Valve Specification Sheets follow.

3. EXECUTION

.1 Not used

VALVE SPECIFICATION SHEETS

BF01

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Butterfly Valve	**BF01**	Air	75	5-120	850	120

TYPICAL SERVICE
On/Off valve for low pressure air.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Cast Iron	Size Range	50 mm to 600 mm
Disc	Ductile Iron	Rating	Class 125
Disc Trim	Bronze or Nickel (Note 1)	Body/Valve Ends	Lugged (Note 2)
Seats	EPDM	Type of Disc	
Shaft	Stainless Steel (416)	Operator	Note 3
		Actuator	Note 4
		Lining	
		Coating	

NOTES

1. Full bronze disc for valves below 300 mm.
2. Full lug, wafer style body for placement between two Class 125 flanges.
3. See Section 11100.
4. See Division 17.

ACCEPTABLE PRODUCTS

Keystone F1020	Bray Series 31	DeZurik Fig. 632	Center Line Series 200
Toyo 918	Grinnell Series 8000	Lunkenheimer 507	Crane Series 44
Apollo Series 143			

VALVE SPECIFICATION SHEETS

BF02

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Butterfly Valve	**BF02**	Liquid	600	5-30	850	50

TYPICAL SERVICE
On/Off or Modulating Control Valve for Liquid Service without Stringy Material.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	API 609
Body	Cast Iron	Size Range	50 mm to 600 mm
Disc	Ductile Iron	Rating	Class 125
Disc Trim	Bronze or Nickel (Note 1)	Body/Valve Ends	Lug Wafer (Note 2)
Seats	Buna-N	Type of Disc	
Shaft	Stainless Steel (416)	Operator	Note 3
		Actuator	
		Lining	
		Coating	

NOTES

1. Full bronze disc for valves below 200 mm.
2. Full lug, wafer style body for placement between two Class 125 flanges. In steel piping provide weldneck flanges on each side of valve.
3. See Section 11100.

ACCEPTABLE PRODUCTS

Keystone F1020	Bray Series 31	DeZurik Fig. 632	Center Line Series 200
Toyo 918	Grinnell Series 8000	Lunkenheimer 507	Crane Series 44
Apollo Series 143			

VALVE SPECIFICATION SHEETS

BF03

GENERAL

TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Butterfly Valve	**BF03**	Liquid/Air	100 – 900	5 – 115	1000	120

TYPICAL SERVICE

On/Off or Modulating Valve for Liquid/Air

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Cast Iron (Note 6)	Size Range	50 mm to 600 mm
Disc	Ductile Iron (Note 6)	Rating	CWP 1000 kPag (Note 5)
Disc Trim	(Nylon 11) Bronze or Nickel (Note 1)	Body/Valve Ends	Lugged (Note 2)
Seats	EPDM (Note 7)	Type of Disc	
Shaft	Stainless Steel (316)	Operator	Note 3
		Actuator	Note 4

NOTES

1. Full bronze disc for valves below 300 mm. Nylon 11 trim is not acceptable for services operating above 90°C.
2. Full lug, wafer style body for placement between two Class 125 flanges.
3. See Section 11100.
4. See Division 17.
5. Provide valves for CWP 1400 kPag on AA service.
6. Provide valves with 304 stainless steel body and disc for PA system submerged locations.
7. Provide valves with seats bonded to a rigid reinforcing ring.

ACCEPTABLE PRODUCTS

Keystone F1020 (only to 100°C and 1000 kPag)	Bray Series 31 (only to 1000 kPag)	DeZurik Fig. 632	Watts BF-03 (only to 1000 kPag)
Grinnell LC8201/LC8202	Apollo Series 143		

VALVE SPECIFICATION SHEETS

BF04

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Butterfly Valve	**BF04**	Gas	600	50 – 110	850	120

TYPICAL SERVICE
LSG, MSG, NG

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	CGA B105 (Note1, Note2)
Body	Stainless Steel (316)	Size Range	75 mm to 300 mm
Disc	Stainless Steel (316)	Rating	Class 150
Disc Trim	Stainless Steel (316)	Body/Valve Ends	Lugged
Seats	Reinforced PTFE	Type of Disc	Eccentric mount
Shaft	Stainless Steel (316)	Operator	Note 2
		Actuator	

NOTES

1. When this valve is installed into a gas service it must comply with the applicable requirements: also refer to Section 11100.
2. See Section 11100.

ACCEPTABLE PRODUCTS

Keystone	Watts	DeZurik	

VALVE SPECIFICATION SHEETS

BF07

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Butterfly Valve	**BF07**	Air	75	5-120	850	120

TYPICAL SERVICE
Modulating control valve for low pressure air.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Cast Iron	Size Range	75 mm to 600 mm
Disc	Steel or Ductile Iron	Rating	Class 125
Disc Trim	N/A	Body/Valve Ends	Wafer
Seats	None	Type of Disc	Damper Style
Shaft	Stainless Steel (316)	Operator	Gear Operator (Note 1)
		Actuator	(Note 2)
		Lining	
		Coating	

NOTES

1. See Section 11100.
2. Refer to Division 17

ACCEPTABLE PRODUCTS

Fisher 8560	Newles Jamesbury L1C	Masoneilan Dresser 37002	Center Line Series 400

VALVE SPECIFICATION SHEETS

BF11

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Butterfly Valve	**BF11**	Gas	600	50 – 110	850	120

TYPICAL SERVICE
Flow control service only - LSG, MSG

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	CGA B105 (Note1)
Body	Stainless Steel (316 or 317)	Size Range	75 mm to 600 mm
Disc	Stainless Steel (316 or 317)	Rating	CWP 1000 kPag
Disc Trim	Stainless Steel (316 or 317)	Body/Valve Ends	Wafer (Note 3)
Seats	Reinforced PTFE	Type of Disc	Eccentric mount
Shaft	Nitronic 50 or Stainless Steel (316)	Operator	Note 2
Packing	PTFE – V ring	Actuator	Note 2
Bearings	PTFE/Composition Lined 316	Rangeability	100 to 1

NOTES

1. When this valve is installed into a gas service it must comply with the applicable requirements: also refer to Section 11100.
2. See Section 11100.

ACCEPTABLE PRODUCTS

Fisher	Neles	Maoneilan Dresser	

VALVE SPECIFICATION SHEETS

BV01

GENERAL

TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Valve	**BV01**	Liquid/Air	600	5-120	850	120

TYPICAL SERVICE

On/Off valve for utility water and chemical solution lines.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	Note 2
Body	Bronze or Forged Brass	Size Range	10 mm to 65 mm
Ball	Bronze or Chrome plated brass - floating	Rating	Class 125
Seats	PTFE	Body/Valve Ends	Female Threaded (Note 3)
Shaft	Bronze or Stainless Steel (Note 1)	Pattern	Compact, Regular Port
		Operator	Lever
		Actuator	

NOTES

1. Blowout-proof stem.
2. When this valve is installed into a gas service it must comply with the applicable requirements: also refer to Section 11100.
3. Provide threaded end cap and chain when used for drain service.

ACCEPTABLE PRODUCTS

Newman Hattersley Fig. 1969	Crane 9302	Nibco 560/580	Watts B6100/B6000
Kitz Fig 58	Toyo Fig 5044A		

VALVE SPECIFICATION SHEETS

BV02

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Valve	**BV02**	Liquid/Gas	910	5-120	1400	120

TYPICAL SERVICE
General service valve for process lines.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	Body Material: ASTM A351 (Note 2)
Body	Stainless Steel (Note 3)	Size Range	10 mm to 65 mm
Ball	Stainless Steel – floating	Rating	CWP 1000 kPag
Packing	Reinforced PTFE	Body/Valve Ends	Female Threaded
Seats	Reinforced PTFE	Pattern	Compact, Full Port
Shaft	Stainless Steel (Note 1)	Operator	
		Actuator	Lever
		Lining	
		Coating	

NOTES

1. Blowout-proof stem.
2. When this valve is installed into a gas service it must comply with the applicable requirements: also refer to Section 11100.
3. For NG service stainless steel body not required.

ACCEPTABLE PRODUCTS			
Crane 9501	Kitz Type 600 UTKM	Neles Jamesbury 3000M	Watts

VALVE SPECIFICATION SHEETS

BV03

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Valve	**BV03**	Water and wastewater	600	0-60	1400	100

TYPICAL SERVICE
General service wastewater valve.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Carbon Steel	Size Range	75 mm to 450 mm
Ball	Stainless Steel	Rating	Class 150
Seats	PTFE (Note 1)	Body/Valve Ends	Flanged
Shaft	Stainless Steel (Note 3)	Pattern	Split Body,
		Operator	(Note 2, 4)
		Actuator	(Note 4)
		Lining	
		Coating	

NOTES

1. Stainless steel seats for scum service.
2. See Section 11100.
3. Blowout-proof stem.
4. See Section 17213.

ACCEPTABLE PRODUCTS			
Kitz K150 SCTBZM	Watts CF-1500	Velan F-01402-SS	Crane KF943S
American Valve Model 4000D			

VALVE SPECIFICATION SHEETS

BV04

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Valve	**BV04**	Liquid	1000	5 to 30	1400	50

TYPICAL SERVICE
General Service Valve for Process Lines

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Carbon Steel or Stainless Steel	Size Range	10 mm to 64 mm (Note 2)
Ball	Stainless Steel (304)	Rating	CWP 1400 kPag
Seats	PTFE or RTFE	Body/Valve Ends	Female Threaded
Shaft	Stainless Steel (304 or 315)	Pattern	Compact, Full Port
	(Note 2)	Operator	
		Actuator	Lever

NOTES

1. Blowout proof stem.
2. Isolation valve for flushing connections.
3. For valves in PVC piping use BV06

ACCEPTABLE PRODUCTS			
Velan M1113 or M1102	Watts C-FBV/S-FBV	Trueline N620	

VALVE SPECIFICATION SHEETS

BV05

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Valve	**BV05**	Liquid	100 – 900	5 to 30	1000 (Note 6)	50

TYPICAL SERVICE
On/Off or Modulating Valve for Process Lines

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	MSS-SP72 (Note 4)
Body	Cast Steel or Cast Iron or Steel	Size Range	75 mm to 450 mm (Note 5)
Ball	Stainless Steel (304 or 316)	Rating	CWP 1400 kPag
Packing	Reinforced PTFE or AFE	Body/Valve Ends	Split Body, Flanged (Note 4)
Seats	Reinforced PTFE	Pattern	Full Port
Shaft	Stainless Steel (304 or 315)	Operator	Notes 1, 3
	(Note 2)	Actuator	Note 3

NOTES

1. See Section 11100.
2. Blowout proof stem.
3. See Division 17.
4. Provide Class 125 to suit cast or ductile iron piping systems and Class 150 for steel systems.
5. Provide trunnion mounted ball on all valves 250 mm diameter and greater.

ACCEPTABLE PRODUCTS			
Kitz 150 SCTBZM	Watts G4000/G4000T	Velan F-10402-SSGA	Neles Jamesbury 6150
American Valve Model 4000			

VALVE SPECIFICATION SHEETS

BV06

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Valve	**BV06**	Liquid	100 – 750	5 to 40	1000	60

TYPICAL SERVICE
Chemical Lines

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	Material: ASTM D1784 (Grade A) Threads: ASTM D2464
Body	PVC	Size Range	10 mm to 65 mm
Ball	PVC – floating ball	Rating	CWP 1000 kPag
Packing	O-Ring, EPDM or Viton (Note 4)	Body/Valve Ends	Schedule 80, Female Threaded, True Union
Seats	PTFE	Pattern	Full Port (Note 2)
Shaft	PVC (Note 1)	Operator	Lever
		Actuator	

NOTES

1. Blowout proof ball and stem required.
2. Bi-directional.
3. This valve is for use in PVC piping systems only; also refer to BV02.
4. Do not provide BV05 valves with Viton rings on CHS services.

ACCEPTABLE PRODUCTS			
Chemline CTU, Safe Bloc	Hayward Safe-Block	Nibco Tru-Block PVC	Fabco Superbloc

VALVE SPECIFICATION SHEETS

BV07

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Valve	**BV07**	Liquid	600	5 to 40	850	60

TYPICAL SERVICE
Chemical Lines

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	ASTM D1784 (Grade A)
Body	PVC	Size Range	75 mm to 100 mm
Ball	PVC – floating ball	Rating	CWP 1000 kPag
Packing	O-Ring, EPDM or Viton	Body/Valve Ends	Schedule 80, Flanged, True Union
Seats	PTFE	Pattern	Full Port (Note 2)
Shaft	PVC (Note 1)	Operator	Lever
		Actuator	

NOTES

1. Blowout proof ball and stem required.
2. Bi-directional.
3. For SHS services provided valves with CPE packing.

ACCEPTABLE PRODUCTS			
Chemline CTU, Safe Bloc	Hayward Safe-Block	Nibco Tru-Block PVC	Fabco Superbloc

VALVE SPECIFICATION SHEETS

BV08

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Valve	**BV02**	Gas	910	5-120	1300	120

TYPICAL SERVICE
General service valve for process lines.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	MSS-SP072 (Note1, Note4)
Body	Stainless Steel (316)	Size Range	50 mm to 400 mm (Note 5)
Ball	Stainless Steel (316)	Rating	Class 150
Packing	Reinforced PTFE	Body/Valve Ends	Split body, Flanged
Seats	Reinforced PTFE or Hypatite	Pattern	Full Port
Shaft	Stainless Steel (316) (Note 2)	Operator	(Note1, Note3)
		Actuator	(Note3)

NOTES

1. See Section 11100
2. Blowout-proof stem.
3. See Division 17.
4.. When this valve is installed into a gas service it must comply with the applicable requirements: also refer to Section 11100.
5. Provide trunnion mounted ball on all valves 250 mm diameter and larger.

ACCEPTABLE PRODUCTS

Velan	Kitz	Neles Jamesbury	Watts
Trueline			

VALVE SPECIFICATION SHEETS

BV12

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Valve	**BV02**	Gas	910	5-120	1300	120

TYPICAL SERVICE
Flow control service only – LSG, MSG.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	CGA B105 (Note3)
Body	Stainless Steel (316 or 317)	Size Range	25 mm to 250 mm
Ball	Stainless Steel (316 or 317)	Rating	Class 150
Packing	V ring, PTFE	Body/Valve Ends	Wafer (Note1)
Seats	Metal	Pattern	Segmented Ball or Vnotch
Shaft	Nitronic 50 or Stainless Steel 316	Operator	(Note2)
Seal	Manufacturer's Standard	Actuator	(Note2)
Bearings	Poly-Ether-Ether-Ketone or Reinforced PTFE		

NOTES

1. Wafer style body for placement between two Class 150 valves
2. See Division 17
3. When this valve is installed into a gas service it must comply with the applicable requirements: also refer to Section 11100.

ACCEPTABLE PRODUCTS			
Fisher	Masoneilan Dresser	Neles Jamesbury	

VALVE SPECIFICATION SHEETS

CV01

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Check Valve	**CV01**	Liquid	600	5-30	850	50

TYPICAL SERVICE
Check valve for utility water or wastewater.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	Body Material: ASTM B62
Body	Bronze	Size Range	10 mm to 65 mm (Note 1)
Disc	Bronze	Rating	Class 125
Seats	Bronze	Valve Ends	Female Threads
Hinge pin, trim	Bronze	Type of Disc	Swing Check Regular Port
Spring		Operator	
		Actuator	
		Lining	
		Coating	

NOTES
1. FM approval required for valves in FPS systems and valves in systems connected to FPS systems.

ACCEPTABLE PRODUCTS			
Crane 37	Newman Hattersley A60	Kitz No. 22	Jenkins 4092
Toyo 236	Powell 560Y	Lunkenheimer 554	

VALVE SPECIFICATION SHEETS

CV02

GENERAL

TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Check Valve	**CV02**	Liquid	600	5-30	850	50

TYPICAL SERVICE

Check valve for utility water, scum, sludge or wastewater (Note 1).

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	AWWA C508
Body	Cast Iron	Size Range	75 mm to 600 mm
Disc	Cast or Ductile Iron	Rating	Class 125
Seats	Bronze	Valve Ends	Flanged
Hinge pin, trim	Stainless steel	Type of Disc	Swing Check (Note 1)
		Operator	(Note 1)
		Actuator	
		Lining	
		Coating	

NOTES

1. For all check valves on pump discharges, provide weighted lever arm.

ACCEPTABLE PRODUCTS

Crane 370 series; 147XU	APCO Series 6000- Convertible	Newman Hattersley 651	Terminal City
Jenkins 587	Powell 559	Lunkenheimer 1790	Toyo Fig 435A
Kitz Fig 78			

VALVE SPECIFICATION SHEETS

CV03

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Check Valve	**CV03**	Liquid	600	5-30	850	50

TYPICAL SERVICE
Check valve for sludge lines.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Cast Iron	Size Range	75 mm to 400 mm
Disc	(Note 1)	Rating	Class 125
		Valve Ends	Flanged
		Type of Disc	Ball Check (Note 1)
		Operator	
		Actuator	
		Lining	
		Coating	

NOTES
1. Hollow steel ball with elastomeric coating.

ACCEPTABLE PRODUCTS			
Flygt HDL 2016			

VALVE SPECIFICATION SHEETS

CV04

GENERAL

TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Check Valve	**CV04**	Air	100	5-100	400	150

TYPICAL SERVICE

Check valve for low and medium pressure air and sludge gas.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	Note 3
Body	Cast Iron	Size Range	75 mm to 750 mm
Disc	Stainless Steel	Rating	Class 125
Seats	Bronze	Valve Ends	(Note 1)
Hinge pin, trim	Stainless Steel	Type of Disc	Split Disk/Double Leaf
Spring	Stainless Steel	Operator	
		Actuator	
		Lining	
		Coating	
		Specials	(Note 2)

NOTES

1. Wafer Body for mounting between Class 150 flanges.
2. Provide lifting lugs on valve greater than 50kg.
3. When this valve is installed into a gas service it must comply with the applicable requirements: also refer to Section 11100.

ACCEPTABLE PRODUCTS

APCO 9000	Val-Matic 8000	Proquip Twin Flapper	Mission 12 HMP
Gulf MB12-5-0-9-1-5-F	Center Line Series 800		

VALVE SPECIFICATION SHEETS

CV05

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Check Valve	**CV05**	Air	700	5-100	1400	120

TYPICAL SERVICE
Check valve for compressed air.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	Body Material: ASTM B62 MSS SP-80
Body	Bronze	Size Range	10 mm to 65 mm
Disc	Bronze	Rating	Class 150
Seats	Bronze	Valve Ends	Female Threads
Hinge pin, trim	Stainless Steel	Type of Disc	Swing Check Regular Port
Spring		Operator	
		Actuator	
		Lining	
		Coating	

NOTES

ACCEPTABLE PRODUCTS			
Newman Hattersley 47	Crane 137	Kitz No. 29	Jenkins 4475
Toyo Fig 236			

VALVE SPECIFICATION SHEETS

CV06

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Check Valve	**CV06**	Liquid	800	-5 to 115	1400	120

TYPICAL SERVICE
RFL, GLS, GLR

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Cast Iron	Size Range	75 mm to 250 mm
Disc	Bronze	Rating	Class 125
Seats	Bronze	Valve Ends	Wafer (Note 2)
Screw	Stainless Steel (304 or 316)	Type of Disc	Plug, Silent Check
Spring	Stainless Steel (304 or 316)	Operator	
Bushing	Bronze	Actuator	

NOTES

1. Provide Class 250 valves for services having operating temperatures above 60 degrees C
2. Provide wafer style valves to be installed between Class 125 flanges

ACCEPTABLE PRODUCTS			
ValMatic	APCO	Stream Flo	

VALVE SPECIFICATION SHEETS

CV07

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Check Valve	**CV07**	Air	700	50	1000	100

TYPICAL SERVICE
Swing check valve for low to high pressure air.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	ANSI B2.1
Body	316 Stainless Steel	Size Range	15 mm to 65 mm
Disc	316 Stainless Steel	Rating	Class 200
Disc Trim	316 Stainless Steel	Valve Ends	Female threaded
Seats	316 Stainless Steel	Type of Disc	Swing
Pin	316 Stainless Steel	Operator	
		Actuator	
		Lining	
		Coating	

NOTES

ACCEPTABLE PRODUCTS			
Kitz AK200UOM	Crane 61600	Jenkins 1328	

VALVE SPECIFICATION SHEETS

GL01

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Globe Valve	**GL01**	Liquid	600	5-30	1000	50

TYPICAL SERVICE
On/Off valve for Clean Water.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	MSS SP-080
Body	Cast Iron (Note 1)	Size Range	10 mm to 150 mm (Note 1)
Disc	294-s renewable composition	Rating	Class 150
Seats	Stainless Steel (316)	Valve Ends	Flanged (Note 1)
Seals		Type of Disc	
Shaft	Copper Alloy 864	Operator	OS&Y (Note 1)
		Actuator	
		Lining	
		Coating	

NOTES
1. For valves less than 65mm diameter: RS, union bonnet, threaded (ANSI B2.1) bronze body.

ACCEPTABLE PRODUCTS	
Jenkins Fig. 142	Newman Hattersley 731 CD
Kitz Fig 76	Toyo Fig 400A

VALVE SPECIFICATION SHEETS

GL02

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Globe Valve	**GL02**	Liquid	750	-5 to 115	1000	120

TYPICAL SERVICE
RFL

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	MSS SP-080
Body	Bronze	Size Range	<=65 mm
Disc	Polyurethane or PTFE	Rating	Class 125
Seats	Bronze	Valve Ends	Female threaded
Seals		Type of Disc	
Shaft	Stainless Steel 316 or Bronze ASTM B505	Operator	Handwheel rising stem
		Actuator	

NOTES

ACCEPTABLE PRODUCTS	
Kitz	Newman Hattersley
Grinnell	

VALVE SPECIFICATION SHEETS

GV01

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Gate Valve	**GV01**	Liquid	600	5-100	850	120

TYPICAL SERVICE
Isolation valve for utility water and wastewater.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	Body Material: ASTM B62 MSS SP-080
Body	Bronze	Size Range	10 mm to 65 mm
Disc	Bronze	Rating	Class 125
Seats	Bronze	Valve Ends	Female Threaded
Seals/Packing	O-Rings, Buna-N	Type of Disc	Solid Wedge
Shaft	Bronze	Operator	RS, Handwheel
		Actuator	
		Lining	
		Coating	

NOTES

ACCEPTABLE PRODUCTS			
Crane 428	Nibco T-111	Newman Hattersley T607	Kitz No. 24
Jenkins 810	Powell 500 SW	Toyo 293	Lunkenheimer 2127

VALVE SPECIFICATION SHEETS

GV02

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Gate Valve	**GV02**	Liquid	600	5-30	850	50

TYPICAL SERVICE
Isolation valve for chemical lines.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	PVC	Size Range	10 mm to 200 mm
Disc	Polypropylene	Rating	Class 150
Shaft O-Ring	EPDM	Valve Ends	Flanged
		Type of Disc	Solid Wedge
Shaft	PVC	Operator	Handwheel, NRS
Handwheel	Polypropylene	Actuator	
		Lining	
		Coating	

NOTES

ACCEPTABLE PRODUCTS			
Fabco GT500	Chemline CGA		

VALVE SPECIFICATION SHEETS

GV03

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Gate Valve	**GV03**	Liquid	350	90	700	105

TYPICAL SERVICE
Isolation valve for water services.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	ANSI B16.5
Body	Cast Iron	Size Range	75 mm to 300 mm
Disc	Cast Iron	Rating	Class 125
Disc Trim	Bronze	Valve Ends	F.F. Flanged
Seats	Steel	Type of Disc	Solid Wedge
Packing	Graphite	Operator	Rising Stem
		Actuator	Handwheel
		Lining	
		Coating	

NOTES

ACCEPTABLE PRODUCTS			
Jenkins Fig. 454	Toyo Fig. 421A	Crane No. 965 1/2	Walworth No. 1793
Lukenheimer No. 1430			

VALVE SPECIFICATION SHEETS

KV01

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Knife Gate Valve	**KV01**	Liquid	600	5-30	850	50

TYPICAL SERVICE

Isolation valve for wastewater service.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Cast Iron	Size Range	75 mm to 1000 mm
Disc	Stainless Steel	Rating	Class 125
Seats	Buna-N	Valve Ends	Lugged
Seals	Buna-N	Type of Disc	
Shaft	Stainless Steel	Operator	RS, Bonnetless (Note 1, 2), Handwheel
Wiper Ring	Reinforced PTFE	Actuator	
Pillars	Stainless Steel	Lining	
		Coating	

NOTES

1. See Section 11100.
2. Provide bonnet with stainless steel (304) stem extension for below grade and submerged services.

ACCEPTABLE PRODUCTS

DeZurik Series L	Fabri-Valve Fig. 37R	Red Valve Series G, D	Orbe 10

VALVE SPECIFICATION SHEETS

MV01

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Mud Valve	**MV01**	Liquid	100	5-30	150	50

TYPICAL SERVICE
Basin drain valve for wastewater service.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	ASTM A 276, ASTM D2000 Gr. 2
Frame	Stainless Steel	Size Range	100 mm to 400 mm
Disc	Stainless Steel	Rating	Class 125
Flange and Yoke	Stainless Steel	Valve Ends	Flanged
Seals	Neoprene	Type of Seats	Tapered
Stem	Stainless Steel	Operator	Handwheel, NRS
		Actuator	
		Lining	
		Coating	

NOTES

ACCEPTABLE PRODUCTS			
Fontaine Series 85	Clow	Armtec	

VALVE SPECIFICATION SHEETS

NV01

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Needle Valve	**NV01**	Liquid/Air	800	5-100	1000	140

TYPICAL SERVICE
Isolation valve for utility service.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	(Note 1)
Body	Stainless Steel	Size Range	10 mm to 65 mm
Stem	Stainless Steel	Rating	Class 150, 600 psi
Seats	Stainless Steel	Valve Ends	Female threaded (Note 1)
Seals/Packing	PTFE	Type of Disc	Needle
Handle	Stainless Steel or Phenolic	Operator	Screwed Bonnet, Handwheel
		Actuator	
		Lining	
		Coating	

NOTES
1. Female threads to suit commodity piping.

ACCEPTABLE PRODUCTS			
Nupro JN Series	Anderson, Greenwood H Series	Lukenheimer 1733T	Parker FC-V12LNSS
ECI Series 2000 FFG	Century CM2-IF44BT		

VALVE SPECIFICATION SHEETS

PV01

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Plug Valve	**PV01**	Liquid	600	5-30	850	50

TYPICAL SERVICE
On/Off valve for wastewater sludge/scum.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	API 593, MSS SP-078 - (Note 1)
Body	Cast Iron	Size Range	75 mm to 600 mm
Plug	Cast Iron (see plug coating)	Rating	Class 150
Seats	Nickel	Valve Ends	FF Flanges
Seals	O-Rings, Buna-N	Type of Plug	Eccentric
Shaft	Steel	Operator	Square nut (Note 1)
Bearings	Stainless Steel	Actuator	
		Lining	Abrasion Resistant
		Plug Coating	Buna-N, Al-Clad, or Hycar
		Coating	

NOTES
1. See Section 11100.

ACCEPTABLE PRODUCTS			
DeZurik Series 100 Eccentric	Dresser MH Series 820 X-Centric	Val-Matic Series 5800 Cam-Centric	Pratt Eccentric Plug
Clow Ful-Flo	Keystone Ballcentric		

VALVE SPECIFICATION SHEETS

PV02

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Plug Valve	**PV02**	Gas	15-240	5-120	500	150

TYPICAL SERVICE
On/Off control and isolation valve for low and medium pressure gas.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	CGA Standard - (Note 3)
Body	Stainless Steel	Size Range	75 mm to 400 mm
Plug	Stainless Steel	Rating	Class 125
Seats	Stainless Steel	Valve Ends	FF Flanges (Note 4)
Seals	O-Rings, PTFE	Type of Plug	Parallel
Shaft	Stainless Steel	Operator	Gear Operator (Note 1)
Bearings	Stainless Steel	Actuator	(Note 2)
		Lining	
		Plug Coating	Nickel Plated, PTFE coating
		Coating	
		Lubrication	330 White

NOTES

1. See Section 11100.
2. See Division 17.
3. 2. When this valve is installed into a gas service it must comply with the applicable requirements: also refer to Section 11100.
4. Valve ends threaded for sizes 10 to 65 mm.

ACCEPTABLE PRODUCTS	
NEO Model #1-AS-80118	Newman Millikan 200M

VALVE SPECIFICATION SHEETS

TW01

GENERAL

TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
2 Way Multiport	**TW01**	Liquid	300	-5 to 115	1720	120

TYPICAL SERVICE

GLR, GLS, RFL

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Bronze (Note 2)	Size Range	10 mm to 200 mm
Disc	Bronze (Note 4)	Rating	CWP 1720 kPag
Packing	PTFE	Valve Ends	(Note 1)
Seats	(Note 6)	Pattern	Two way
Shaft	Stainless Steel 304	Operator	
Plug	(Note 5)	Actuator	(Note 3)
		Control Characteristics	Linear, equal percentage
		Rangeability	1 to 50

NOTES

1. Valves less than or equal to 50mm threade; greater than 50mm flanged
2. Flanged bodies to be cast iron
3. Refer to Division 17 and Drawings for actuator specification; thermostatically controlled valve.
4. Provide valves with threaded bodies with removable teflon discs and brass disc holder
5. Provide valves with threaded bodies with contoured brass plug; flanged bodies with cast iron plug
6. Provide valves with threaded bodies with replaceable brass seats; flanged bodoes with replaceable bronze seats

ACCEPTABLE PRODUCTS

Honeywell	

VALVE SPECIFICATION SHEETS

TW02

GENERAL

TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
3 Way Multiport	**TW02**	Liquid	300	-5 to 115	1720	120

TYPICAL SERVICE

GLR, GLS, RFL

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Bronze (Note 2)	Size Range	10 mm to 200 mm
Disc	Bronze (Note 4)	Rating	CWP 1720 kPag
Packing	PTFE	Valve Ends	(Note 1)
Seats	(Note 6)	Pattern	Three way
Shaft	Stainless Steel 304	Operator	
Plug	(Note 5)	Actuator	(Note 3)
		Control Characteristics	Linear, equal percentage
		Rangeability	1 to 50

NOTES

1. Valves less than or equal to 50mm threade; greater than 50mm flanged
2. Flanged bodies to be cast iron
3. Refer to Division 17 and Drawings for actuator specification; thermostatically controlled valve.
4. Provide valves with threaded bodies with removable teflon discs and brass disc holder
5. Provide valves with threaded bodies with contoured brass plug; flanged bodies with cast iron plug
6. Provide valves with threaded bodies with replaceable brass seats; flanged bodoes with replaceable bronze seats

ACCEPTABLE PRODUCTS

Honeywell	

VALVE SPECIFICATION SHEETS

TW03

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
3 Way Multiport	**TW03**	Gas	15-240	5-120	500	150

TYPICAL SERVICE
LSG, MSG, NG.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	CGA B105 - (Note 3) API 599, 60
Body	Stainless Steel (316) (Note4)	Size Range	75 mm to 400 mm
Plug	Stainless Steel (316)	Rating	Class 125
Seats	Stainless Steel (304)	Valve Ends	FF Flanges
Seals	O-Rings, PTFE	Type of Plug	Parallel
Shaft	Same as Plug	Operator	Gear Operator (Note 1)
		Actuator	(Note 2)
		Body Style	T-Port, Rectangular Port, Regular Pattern
		Plug Coating	Nickel Plated, PTFE coating
		Lubrication	330 White

NOTES

1. See Section 11100.
2. See Division 17.
3. 2. When this valve is installed into a gas service it must comply with the applicable requirements: also refer to Section 11100.
4. Stainless steel body not required for NG service

ACCEPTABLE PRODUCTS	
NEO Model #1-AS-80118	Newman Millikan 200M

END OF SECTION

VALVE AND GATE ACTUATORS

1. GENERAL

1.1 Work Included

.1 Supply, delivery, and supervision of installation, and testing of process electric and pneumatic actuators.

1.2 Submissions

.1 Shop Drawings: submit shop drawings for all actuators in accordance with Section 01300 and Section 11005. In addition to the information requirements of Section 11005, include the following:

.1 Calculations indicating the operating torque of the valve or gate for which the actuator is to be supplied.

.2 The torque rating of the actuator.

.2 Operating and Maintenance Data: provide for incorporation in O&M manual as specified in Section 01735.

1.3 Delivery and Storage

.1 Deliver actuators to site using unloading methods which do not damage casings or coatings.

.2 Clearly tag actuators indicating size, type, model number, coatings, and mating parts.

.3 Store on-site for incorporation in the work using methods recommended by the manufacturer to prevent damage, undue stresses, or weathering.

1.4 Process Valve and Actuator Detailed Specification Sheets and Schedules

.1 Process Valves are identified in the Drawings by an alpha-numeric code.

.2 Create a valve schedule listing the critical valves required for process operation. The schedule lists the valves and actuators by type, and the function and location of the valve in the process. Ensure all valves and actuators are in compliance with the Section 11100. Do not commence work on any piping runs until review of valve and actuator selection has been received from the Contract Administrator.

2. PRODUCTS

2.1 General

.1 Provide new, unused actuators for the work.

.2 Use materials for actuators that are free from defects or flaws.

.3 Tag actuators to indicate operating characteristics and inlet and outlet ports for electric or pneumatic services.

.4 Standard of acceptance for all on/off electric actuators shall be Rotork.

.5 Provide actuators with mechanical position indicators

2.2 Drawings

.1 Review and verify piping and instrumentation drawings (P&IDs), ensuring that they indicate all valves and automatic actuators that are critical to proper process operation. Where valves or actuators are not indicated, inform Contract Administrator.

2.3 Manual Actuators

.1 Provide valves with manual actuators unless indicated otherwise in other specification sections or shown on the process and instrumentation drawings.

.2 For manual actuators located more than 1830 mm above the floor, provide chain operators.

2.4 Pneumatic Diaphragm Actuators - General

.1 Provide diaphragm quarter turn and linear actuators capable of continuous duty over the full operating range.

.2 Unless specified otherwise the actuators shall fail to the open position when the control function fails or when pressure is removed from the actuator diaphragm.

.3 Each actuator to be capable of operating in any horizontal or vertical orientation.

.4 When manual actuation is specified fit each actuator with a hand wheel, mounted in line with the valve shaft, which will enable manual override control of the valve.

.5 House all internal components in a cast iron enclosure, drip-proof, and corrosion-proof.

.6 Provide one (1) complete rebuild kit for each size of pneumatic actuator.

2.5 Pneumatic Diaphragm Quarter Turn Actuators, Modulating Type (PDQM)

.1 Diaphragm operators to be suitable for mounting on quarter turn valves intended for modulating service.

2.6 Pneumatic Diaphragm Linear Actuators, Modulating-Type (PDLM)

.1 Diaphragm operators to be suitable for mounting on sliding-stem valves and dampers requiring linear actuation, and intended for modulating service.

2.7 Pneumatic Diaphragm Quarter Turn Actuators, Open/Close-Type (PDQO)

.1 Diaphragm operators to be suitable for mounting on quarter turn valves intended for on/off service.

.2 Provide a solenoid valve, an air set and accessories as detailed on the instrument specification sheets for each actuator.

.3 Provide two needle valves (snubbers) for each actuator. The needle valves control instrument air flows such that the actuator travels a full stroke within a time range adjustable from 1 to 30 seconds with separate adjustments for each direction of travel.

2.8 Pneumatic Piston Actuators - General

.1 Provide piston actuators of the type specified on the instrument specification sheets. Two types of quarter-turn pneumatic piston actuators are available: rack and pinion or linkage. Actuators to be capable of continuous duty over the full operating range.

.2 Unless specified otherwise on the instrument specification sheets, the actuators will fail to the open position when the control function fails or when pressure is removed from the actuator piston.

.3 Each actuator to be capable of operating in any horizontal or vertical orientation.

.4 House internal components in a cast iron enclosure, drip-proof, and corrosion proof.

.5 Where valves are intended to fail open or closed, provide spring loaded actuators. Where they are intended to fail to last operating position, provide double acting actuators. The Instrument Specification Sheets indicate the fail position of each actuator.

.6 Provide one (1) complete rebuild kit for each size of pneumatic actuator

2.9 Pneumatic Piston Quarter Turn Actuator, Modulating Type (PPQM)

.1 Piston actuators to be suitable for mounting on quarter turn valves or dampers intended for modulating service.

2.10 Pneumatic Piston Quarter Turn Actuator, Open/Close Type (PPQO)

.1 Piston operators to be suitable for mounting on quarter turn valves or dampers intended for on/off service. Sector types are not permitted.

.2 Provide actuator accessories such as limit switches and position switches as described in the instrument specification sheets and in Division 17.

.3 Provide two needle valves (snubbers) for each actuator. The needle valves to control instrument air flows such that the actuator travels a full stroke within a time range of 1 to 30 seconds with separate adjustments for each direction.

2.11 Electric Actuators, Open/Close, Quarter Turn, Less than 1,000 N-m Torque

.1 Use electric operators that are suitable for mounting on quarter turn valves intended for on/off service.

.2 For actuators rated at less than or equal to 100 Nm, incorporate a 120 V, 1 phase, 60 Hz motor. For actuators rated at greater than 500 Nm and less than or equal to 1,000 Nm, use a 208 V, 3 phase, 60 Hz motor. In each case, use motors that are high torque, reversible.

.3 Use motors that are rated for continuous duty, as defined in the appropriate NEMA standard.

.4 Incorporate thermal overload devices in motor windings to protect the motor against overheating.

.5 Unless noted otherwise, design the actuators to fail to the last position when the control function or power fails.

.6 Fit each actuator with a hand wheel that will enable manual override control of the valve. Incorporate a method of ensuring that when the manual override is engaged, motor driven operation is precluded.

.7 Make each actuator capable of operating in any horizontal or vertical orientation.

.8 Provide external mechanical indication of valve position.

.9 House internal components in a NEMA 4X enclosure, waterproof and moisture resistant and corrosion-resistant, and permanently lubricated. Use stainless steel connectors for all exposed connections.

.10 For actuator drive train, use steel or aluminum gears arranged with worm gears or compound gear assembly. Design gears in accordance with AGMA standards for heavy duty, intermittent service. Ensure that geared drive train can withstand locked rotor conditions. Incorporate bearings designed with an ABFMA B10 life in excess of 40,000 hours.

.11 Use gears and bearings that are non-lubricated or permanently lubricated.

.12 In each actuator, incorporate two SPDT travel limit switches, 10 A, 120 VAC, CSA listed. The travel limit switches shall each be adjustable.

.13 In each actuator, incorporate two SPDT torque limit switches, 10 A, 120 VAC. Make the torque limit switches factory pre-set and field adjustable.

.14 Provide mechanical limit stops, adjustable, to ensure over-turning of the valve door does not occur.

.15 Protect exterior mounted actuators against high temperature and condensation.

.16 Design the actuator so that the opening and closing speed is field adjustable.

.17 Provide a terminal board for field wiring. Include contacts to indicate the open/closed status of the valve, overheating alarm, and overtorque alarms.

2.12 Electric Actuators, Open/Close, Quarter Turn, Greater or Equal to 1,000 kN-m Torque

.1 Use electric operators that are suitable for mounting on quarter turn valves intended for open/close service.

.2 Incorporate a 600V/3 phase/60 Hz motor. Use motors that are high torque, reversible. Select motor that is capable of at least ten starts per hour. Size motor to open valve within 60 seconds maximum.

.3 Use motors that are rated for continuous duty, as defined in IEC Standard 34-1.

.4 Incorporate thermal overload devices in motor windings to protect the motor against overheating.

.5 Unless noted otherwise, design the actuators to fail to the last position when the control function or power fails.

.6 Fit each actuator with a handwheel that will enable manual override control of the valve. Incorporate a method of ensuring that when the manual override is engaged, motor driven operation is precluded.

.7 Provide external mechanical indication of valve position.

.8 House internal components in a NEMA 4X enclosure, waterproof and moisture resistant and corrosion-resistant, and permanently lubricated. Use stainless steel connectors for all exposed connections.

.9 For actuator drive train, use stainless steel or machine steel gears and shafts. Design gears in accordance with AGMA standards for heavy duty, intermittent service. Ensure that geared drive train can withstand locked rotor conditions. Incorporate bearings designed with an ABFMA B10 life in excess of 40,000 hours.

.10 Use oil lubricated gearbox. Seal using o-rings or gaskets. Provide a minimum of two filling points.

.11 In each actuator, incorporate two SPDT travel limit switches, 10 A, 120 VAC, CSA listed. The travel limit switches shall each be adjustable.

.12 In each actuator, incorporate two SPDT torque limit switches, 10 A, 120 VAC. Make the torque limit switches factory pre-set and field adjustable.

.13 Provide mechanical limit stops, adjustable, to ensure over-turning of the valve door does not occur.

.14 Protect exterior mounted actuators against high temperature and condensation.

.15 Design the actuator so that the opening and closing speed is field adjustable.

.16 Provide a terminal board for field wiring. Include contacts to indicate the open/closed status of the valve, overheating alarm, and overtorque alarms.

2.13 Electric Actuators, Open/Close, Multi-Turn

.1 Use electric operators that are suitable for mounting on non-rising stem valves or gates that are intended for open/close service.

.2 Incorporate a 600V 3 phase 60 Hz motor. Use motors that are high torque, reversible. Select motor that is capable of at least ten starts per hour. Size motor to provide a minimum of 30 rpm or sufficiently high to open or close gate within ten minutes, whichever requires greater motor size.

.3 Use motors that are rated for continuous duty, as defined in IEC Standard 34-1.

.4 Incorporate thermal overload devices in motor windings to protect the motor against overheating.

.5 Unless noted otherwise, design the actuators to fail to the last position when the control function or power fails.

.6 Fit each actuator with a hand wheel that will enable manual override control of the valve or gate. Incorporate a method of ensuring that when the manual override is engaged, motor driven operation is precluded.

.7 Provide external mechanical indication of valve or gate position.

.8 House internal components in a NEMA 4X enclosure, waterproof and moisture resistant and corrosion-resistant, and permanently lubricated. Use stainless steel connectors for all exposed connections.

.9 For actuator drive train, use stainless steel or machine steel gears and shafts. Design gears in accordance with AGMA standards for heavy duty, intermittent service. Provide method that allows higher shock loads to valves or gates at the beginning of operation so that they unseat. Ensure that geared drive train can withstand locked rotor conditions. Incorporate bearings designed with an ABFMA B10 life in excess of 40,000 hours.

.10 Use oil lubricated gearbox. Seal using o-rings or gaskets. Provide a minimum of two filling points.

.11 Design so that motor can be disconnected without draining the lubricant from the actuator gear case.

.12 In each actuator, incorporate two SPDT travel limit switches, 10 A, 120 VAC, CSA listed. The travel limit switches shall each be adjustable.

.13 In each actuator, incorporate two SPDT torque limit switches, 10 A, 120 VAC. Make the torque limit switches factory pre-set and field adjustable.

.14 Provide mechanical limit stops, adjustable, to ensure over-turning of the valve door does not occur.

.15 Protect exterior mounted actuators against high temperature and condensation.

.16 Design the actuator so that the opening and closing speed is field adjustable.

.17 Provide a terminal board for field wiring. Include contacts to indicate the open/closed status of the valve, overheating alarm, and overtorque alarms.

2.14 Electric Actuators, Modulating

.1 Select actuators for modulating duty that are generally as described in Clause 2.6, but that modulate in response to a 4-20 mA control signal. For modulating actuators, incorporate a servo drive system suitable for continuous modulation.

.2 For modulating service, select motors that are capable of 1200 starts per hour.

.3 Fit actuators for modulating duty with a position retransmit module (4-20 mA) for remote indication.

2.15 Current-to-Pneumatic (I/P) Converters

.1 Provide I/P converters where required.

.2 Supply all required hardware for mounting the I/P converter on the controlled device.

.3 I/P converter to be of EEMAC 4, minimum.

.4 I/P converter to operate with instrument quality control air at an operating pressure range of 20 to 200 kPa.

2.16 Valve Positioners

.1 When specified on the instrument specification sheets supply compatible positioners pre-mounted to each actuator. Do not mount the positioner upside down.

.2 Each positioner to service the entire operating range of the actuator. The equipment position shall be fed back to the positioner through a mechanical linkage.

.3 Positioner to operate with instrument quality, oil-free control air.

.4 Provide three independent, interchangeable cams for each positioner-linear function, square function, and square root function.

.5 Mount a pressure gauge on the positioner to measure air output.

2.17 Position Switches and Indicators

.1 When specified on the Instrument Specification Sheets, supply actuator assemblies pre-mounted with external position monitors which include two (2) cam actuated "GO" Form C rated proximity switches, a 5-pole male receptacle, a polycarbonate dome beacon and an EEMAC 4 (minimum) enclosure.

.2 Cams to be fastened to a splined shaft and adjustable without set screws.

.3 Provide a visual indicator with beacon type display showing red when the controlled device is in the closed position, and green in the open position.

.4 Supply all required hardware for mounting of position monitor in accordance with the specified valve and actuator orientation.

.5 Diaphragm actuated valves to have external position monitor actuated through linkages.

.6 Enclosures to be suitable for environment to which they are exposed.

2.18 Manual Loading Station

.1 Manual loading station shall consist of a manually adjustable loading regulator, changeover valve (manual/automatic), a gauge for manual signal pressure indication, a gauge for automatic signal pressure indication, an air set, and air supply isolation valve.

.2 Mount loading station on a galvanized plate attached to a floor stand. Locate station within 2 m of the controlled device.

2.19 Finishes

.1 Actuators shall be shop finished in accordance with Section 11901.

3. EXECUTION

3.1 Preparation

.1 Prior to the installation of the actuators, field measure and check all equipment locations, pipe alignments, and structural installations. Ensure that the valve location and orientation provides suitable access to manual actuators and that sufficient space and accessibility is available for maintenance and to allow unobstructed view of operation and position of pneumatic and electric actuators.

.2 Where conflicts are identified, inform the Contract Administrator and initiate the necessary piping modifications.

3.2 Installation Training

.1 Inform the installer of all procedures and requirements necessary for the successful installation of the equipment. Attest to the installer's understanding by completing Form 101 as shown in Section 01650.

3.3 Installation

.1 Ensure the equipment is installed as required to provide satisfactory service.

.2 Cooperate with the installer to fulfill the requirements for a successful installation, as documented by Form 102, illustrated in Section 01650.

3.4 Testing

.1 Ensure the equipment, including all component parts, operates as intended. Testing includes field verification of operating speed and torque outputs at rated operating conditions.

.2 Cooperate with the installer to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650.

3.5 Commissioning

.1 Attend during commissioning of the process system which includes the equipment specified in this section and to ensure the equipment functions as intended in the process system.

END OF SECTION

PROCESS MOTORS

1. GENERAL

1.1 Description

.1 This Section specifies alternating current induction motors, 150 kW or less, to be provided with the driven equipment.

.2 This Section does not specify medium voltage (2300 V and greater) and specialty motors such as submersible motors, valve operator motors or torque rated motors.

.3 Unless specified otherwise, electric motors to be provided by the manufacturer of the driven equipment, as an integral component of the driven equipment, as specified in Section 11005.

.4 Motors suitable for driving centrifugal pumps, fans, blowers, compressors, gears, progressive cavity pumps or other loads fed via the variable frequency drive or connected across-the-line.

1.2 Reference Standards

.1 Conform to the following reference standards:

.1 CSA C22.2 No. 100, Motors and Generators

.2 CSA C22.2 No. 145, Motors and Generators for Use in Hazardous Locations

.3 CSA C390, Energy Efficient Test Methods for Three Phase Induction Motors

.4 EEMAC M1-7, Motors and Generators

.5 IEEE 112, Standard Test Procedure for Polyphase Induction Motors and Generators

.6 IEEE 114, Standard Test Procedure for Single Phase Induction Motors

.7 IEEE 841, Standard for the Petroleum and Chemical Industry - Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 500 hp (370 kW)

.8 NEMA MG1, Motors and Generators

1.3 Submittals

.1 Shop Drawings: submit with the related items of equipment in accordance with Section 01300 and Section 11005. In addition, submit the following details: provide the specified information for each typical size or type of motor driven equipment.

.1 Shop drawings and product data in accordance with Division 16

.2 Overall dimensions of motor

.3 Shaft centerline to base dimension

.4 Shaft extension diameter and keyway, coupling dimensions and details

.5 Fixing support dimensions

.6 Terminal box location and size of terminals

.7 Arrangement and dimensions of accessories

.8 Diagram of connections

.9 Speed and torque characteristics

.10 Weight of motor

.11 Installation data.

.12 Rotation direction

.13 Starting restrictions (time between starts)

.14 Terminal leads marking

.15 Bearing data (including part numbers)

.16 Recommended lubricant

.17 Design ambient temperature and temperature rise ratings

.18 Torque characteristics including rated starting torque and breakdown torque

.19 The ABFMA L-10 rated life for the motor bearings

.20 The nominal efficiency for all motors

.21 Class, division, group and UL frame temperature limit code for explosion-proof motors

1.4 Service Conditions

.1 Unless specified otherwise, provide motors suitable for continuous operation at an elevation of 230 m above sea level.

.2 Provide motors suitable for continuous operation in a 40°C ambient temperature.

1.5 Coordination

.1 For motors fed via variable frequency drives, communicate motor requirements to and comply with drive requirements of the manufacturer of the VFD in accordance with Division 16.

1.6 Quality Assurance

.1 Build motors in accordance with CSA C22.2 No. 100, CSA C22.2 No. 145, NEMA Standard MG1, IEEE 841 and to the requirements specified.

1.7 Shipment, Protection and Storage

.1 Ship, protect, and store equipment in a manner that prevents damage or premature aging.

.2 Handle motors with suitable lifting equipment.

.3 Store motors in heated, dry, weather-protected enclosure.

2. PRODUCTS

2.1 Acceptable Manufacturers

.1 Baldor Electric Company

.2 GEC Alsthom

.3 Reliance Electric

.4 Siemens Energy and Automation

.5 Toshiba International Corporation

.6 US Motors (Emerson)

.7 TECO-Westinghouse

2.2 Materials

.1 Motors: to EEMAC M1-6.

.2 Lead markings: to EEMAC M2-1.

.3 Unless specified otherwise, provide all motors with:

.1 Cast iron frame

.2 Non metallic corrosion-resistant fan blades and shrouds

.3 Stainless steel hardware

.4 Non-hygroscopic windings

2.3 Motor Efficiency

.1 Use premium efficiency motors with efficiencies that comply with the minimum requirements of US Energy Policy Act (EPAct) and Natural Resources Canada (NRCan).

.2 Use vertical motors with efficiency within 0.5 percent of minimum values stated for horizontal motors.

.3 Test motor efficiency in accordance with CSA C390 and NEMA MG1, accounting for stray load losses, measured indirectly based on the IEEE method.

.4 Stamp efficiency on the motor nameplate.

2.4 Horizontal and Vertical Motors, 0.25 kW to 150 kW

.1 General

.1 Unless otherwise specified, motors 0.25 kW to 150 kW to be 3-phase, squirrel cage, full voltage start, high efficiency induction type with copper windings.

.2 Squirrel cage induction type, with a service factor of 1.15 at 40°C ambient, and non-hygroscopic windings unless otherwise specified.

.3 Make all motors TEFC, unless otherwise specified.

.4 Rated for 600 V, 3 phase 60 Hz AC service unless otherwise specified.

.5 Design motors for full voltage starting, capable of running successfully when terminal voltage is from +10 percent to -10 percent of nameplate voltage.

.6 Capacity sufficient to operate the driven load and associated devices under all conditions of operation without overloading.

.2 Torque Requirements

.1 Provide motors capable of developing 150 percent of NEMA Design B locked rotor and pull-up torques with 100 percent of rated voltage applied and capable of developing in excess of NEMA locked rotor torque values at 90 percent of rated voltage.

.3 Inertia Loading

.1 Design motors to be capable of 200 percent of inertia loading values indicated in MG1-12.50, Table 12.3.

.4 Insulation

.1 Use Class F insulation

.2 Design motor for temperature rise less than 90°C at 1.15 service factor loading.

.3 Insulation to be non-hygroscopic.

.5 Varnish

.1 Dip and bake in class H varnish a minimum of two times. For 284T and larger frames, dip and bake a minimum of three times.

.6 Current Imbalance

.1 Do not exceed the values tabulated below when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system:

.1 Under 37.5 kW: 25 percent

.2 37.5 kW and above: 10 percent

.2 Base imbalance criteria upon the lowest value measured.

.7 Winding Over-temperature Protection

.1 Provide stator winding over-temperature protection on all motors rated 45 kW and larger. Motors rated less than 45 kW to have stator winding over-temperature protection when required by the specific equipment specification section or if recommended by the driven equipment manufacturer.

.2 Over-temperature protection for motors rated 45 kW and larger and other motors, where specified, to be NEMA MG1-12.53, Type 1, winding running and locked rotor over-temperature protection. One detector to be provided per phase. Detectors to be positive thermal protection (PTC) thermistor type, with leads brought out to a terminal strip in a NEMA 4 enclosure in Type 2 motors and a NEMA 7C or 9 enclosure for Type 3 motors.

.8 Bearings

.1 Provide sealed ball or cylindrical roller bearing type on motors less than 37.5 kW.

.2 Bearings on 37.5 kW motors or larger to be greasable ball bearing type, rated for a minimum L-10 life of 100,000 hours at the ambient temperature specified herein.

.3 Design bearings to have a maximum 45°C temperature rise at rated horsepower for 4 pole and greater motors and 50°C for 2 pole motors.

.4 Provide features to minimize the entrance of moisture and contaminants into the bearing chamber

.9 Frame

.1 Use a minimum of grade 25 cast iron, aluminum, or steel for frame, end brackets, fan cover, and conduit box. Refer to motor classifications.

.2 Provide two bronze automatic breather drains at the lowest point in the motor frame.

.3 On frames sizes greater than 180, provide lifting bolts with a design safety factor greater than ten.

.4 Use stainless steel hardware.

.10 Motor Classifications:

.1 Type 1 (General Duty): TEFC enclosures with Class F insulation, unless specified otherwise.

.2 Type 2 (Process): TEFC, with Class F insulation, suitable for moist and corrosive environment. All internal surfaces to be coated with an epoxy paint. Aluminum frame motors are permitted. Steel frame motors are permitted for motors with frames 184 and smaller.

.3 Type 3 (Explosion-proof): Motors to be rated for operation in a Class 1, Division 1, Group D hazardous location in accordance with CSA C22.1. The motor to have a Class F insulation. Steel frame motors are not permitted. Provide an approved breather/drain device to be provided in the motor drain hole.

.11 Cooling Fans

.1 Fabricate external cooling fans of non sparking, corrosion resistant material.

.12 Terminal Box

.1 Incorporate a terminal box with a volume greater than NEMA requirements, rotatable in 90 degree increments. Provide gaskets between the terminal box and frame and between the terminal box and cover.

.2 Provide diagonally split, gasketted, EEMAC 4 terminal boxes complete with threaded hub for conduit entry for ODP and TEFC motors and adequately sized, diagonally split, gasketted EEMAC 7 terminal boxes complete with threaded hub for conduit entry for explosion-proof motors.

.3 Provide a ground connection and lifting eyes or lugs in the terminal box.

.13 Motors are to be aligned and balanced with the related equipment in the shop to minimize vibration and undue stresses. Maximum vibration of motor at the bearing housing is 12.5 microns peak to peak. As necessary, provide stainless steel balance washers.

.14 Sound pressure levels at 1000 mm, free field:

.1 93 kW and larger 2 pole motors: 90 dBA

.2 All other motors: 85 dBA

.15 Where specified, equip motors with anti-condensation heaters suitable for connection to 120 V, single phase, 60 Hz.

.16 Finishes

.1 Factory prime and paint in accordance with Section 11901.

.2 On interior of motor, apply rust inhibiting coating on all exposed machined surfaces.

2.5 Motors Smaller Than 0.25 kW

.1 General

.1 Unless otherwise specified, motors 0.25 kW and smaller to be squirrel cage, single phase, capacitor start, induction run type with copper windings.

.2 Construction features listed in this section may be as normally supplied by the equipment manufacturer.

.3 Single phase motors to have Class F insulation.

.4 Small fan motors may be split-phase or shaded pole type.

.5 Provide copper windings.

.2 Rating

.1 Unless specified otherwise, motors to be rated for operation at 115 V, 1 phase, 60 Hz AC, and continuous-time rated in conformance with NEMA Standard MG1, paragraph 10.35.

.3 Enclosures

.1 Unless otherwise specified, provide motors with totally enclosed fan cooled or totally enclosed non-ventilated enclosures.

.2 Provide explosion-proof motors bearing the UL label for Class I, Division 1, Group D hazardous locations.

.3 Provide an over-temperature device in the enclosure to detect and automatically de-energize the motor.

2.6 Motors for Variable Frequency Drives

.1 Comply with the characteristics of the intended variable frequency drives. Ensure that the variable frequency drives are rated for 690 V 3 phase 60 Hz AC service.

.2 Select premium efficiency units, inverter duty rated, in conformance with NEMA MG1.

.3 Use Type 2 or Type 3 motors.

.4 Insulation: Class F insulation with Class B temperature rise, suitable for moist and corrosive environments and in accordance with NEMA MG1 Part 30 and Part 31.

.5 Design motors for variable frequency systems so that they are not required to deliver more than 80 percent of the motor's power rating by any load imposed by the driven machine at any specified operating condition or any condition imposed by the driven machine's performance curve at maximum operating speed.

.6 Ensure motors have adequate cooling capacity when operating through the entire speed range capacity of the drive.

.7 Enclosure and other insulation requirements are the same as required for constant speed motors.

2.7 Vertical Motors

.1 Provide full voltage vertical motors with a Type P base specifically designed for vertical installation, Unless specified otherwise.

.2 Universal position motors are not acceptable.

.3 Provide vertical motors with solid shafts, unless specified otherwise.

.4 Provide thrust bearing rating compatible with the loads imposed by the driven equipment.

2.8 Two Speed Motors

.1 Provide two-speed motors with separate windings. Single-winding two-speed motors are not acceptable.

2.9 Power Factor Correction Capacitor Sizing

.1 The motor vendor to confirm the maximum capacitor size which may be connected to motors 7.5 kW and larger, on constant speed drives.

2.10 Motor Mounting

.1 Where equipment is specified to include C-Flange mounting, make motors compatible with this joining and alignment technique.

2.11 Finishes

.1 In accordance with Division 16.

2.12 Equipment Identification

.1 Provide equipment identification in accordance with Division 11 and Division 16.

.2 Nameplates

.1 Provide motor nameplates on engraved or stamped stainless steel. Include information enumerated in NEMA Standard MG1, paragraph 10.37, 10.38 or 20.60, as applicable.

.2 Additionally, indicate:

.1 The ABFMA L-10 rated life for the motor bearings for motors 37.5 kW and larger.

.2 The nominal efficiency for all motors.

.3 Class, division, group and UL frame temperature limit code for explosion-proof motors.

.4 Permanently fasten nameplates to the motor frame and position to be easily visible for inspection.

2.13 Spare Parts

.1 Provide maintenance materials and spare parts in accordance with Division 1.

3. EXECUTION

3.1 Installation

.1 Dry motor if dampness present, in accordance with manufacturer's recommendations.

.2 Install or ensure the motor is properly installed to provide satisfactory service.

.3 Make connections as indicated. Use liquid-tight PVC jacketed flexible conduit between rigid conduit and motor.

.4 Make flexible conduit long enough to permit movement of motor over entire length of slide rails, when applicable.

.5 Check for correct direction of rotation, with motor uncoupled from driven equipment.

.6 Align and couple motor to driven machinery to manufacturers instructions, using only correct parts such as couplings, belts, sheaves, as provided by manufacturer.

.7 Install anchor devices and setting templates in accordance with Division 3.

3.2 Testing

.1 Perform tests and document results in accordance with Division 16.

END OF SECTION

PROCESS PUMPS – GENERAL REQUIREMENTS

1. GENERAL

1.1 Description

.1 This section defines the general requirements for the supply and supervision of installation and commissioning of all pumps required for this project.

1.2 Definitions

.1 The terms in the specification generally comply with the definitions of the Hydraulic Institute.

.2 Definitions:

.1 Efficiency: pump efficiency shall be calculated as the delivered hydraulic power divided by the electrical power at the inlet box of the pump. It shall take full account of mechanical and electrical losses.

.2 Performance Curve: the performance curve is a graph of the flow delivered (L/s, x-axis) in relation to the discharge head (metres, y-axis). It generally denotes efficiencies as isopleths and may include NPSH requirements as a function of the flow.

.3 Best Efficiency Point: the best efficiency point is the point in the pump performance curve where the pump operates at its highest efficiency.

.4 Rating Point: the pump rating point is the combination of discharge head an flow which the pump must satisfy. It typically is determined on the basis of all duty pumps (one or more, depending on the service) operating simultaneously against the worst system conditions (typically maximum headloss, minimum suction head, maximum discharge head, etc.) This condition is listed in the detailed pump specification and must be satisfied by the pump supplied.

.5 Low Head Point: the low head point is the combination of head and flow which corresponds to the least head the pump might operate against. It is determined on the basis of only one duty pump operating against the system conditions which would produce the least discharge pressure (typically minimum headloss, maximum suction head, minimum discharge head, etc.) The minimum system head is shown or described for each pump. The manufacturer must ensure that the pump can operate satisfactorily, without cavitation in the pump casing or over-stressing of the motor, at the intersection of the pump curve and the minimum head curve, or low head point.

.6 Low Speed Point: the minimum flow and head conditions against which a variable speed pump is expected to operate.

.7 NPSH (Net Positive Suction Head): the total pressure (atmospheric) at the pump suction. The available NPSH is the pressure available at the pump suction and is a function of site atmospheric pressure and suction piping losses. Required NPSH is the pressure required at the pump suction to ensure cavitation due to water column separation does not occur. Required NPSH shall be defined by the pump supplier at the

pump inlet connection whether that be at the casing or at the face of a suction reducer/elbow supplied as an integral part of the pump.

.8 Minimum Diameter Passing: solids-handling pumps have listed a minimum diameter passing. A sphere of this size must be capable of passing from the pump intake to the discharge.

1.3 Submissions

.1 Shop Drawings: submit in accordance with Section 01300 and Section 11005. For all pump shop drawings, in addition to the requirements of Section 11005, include the following specific details:

.1 Performance curve for the pumping unit(s) superimposed on the system curve for the particular pumping application. Where the system curve is not included in the specifications, request this information from the Contract Administrator when required. With the performance curve, include efficiency isopleths and NPSHR variation with flow. Where required in the specific pump sections, the performance curve should be certified in accordance with Hydraulic Standards.

.2 Motor operating data, including motor and insulation ratings, start-up and operating current ratings, operating voltage and amperage tolerances, description of construction complete with illustrative drawings, and any other pertinent information.

.3 List of materials of construction, detailing the component parts of the pump(s), their materials of construction, and reference specifications for those materials.

.4 Required ancillary services including, but not limited to electrical, seal water, and drains. The sizes, ratings, and any other pertinent information related to these services.

.5 Installation instructions indicating assembly and mounting requirements, alignment and assembly tolerances, and points of connection for ancillary services (electrical, seal water, drains, etc.)

.6 Start-up instructions including lubricant requirements, electrical requirements, etc.

.2 Operating and Maintenance Data: provide for incorporation in operation and maintenance manual as specified in Division 1. Include the following:

.1 Complete description of operation

.2 General arrangement and detailed drawings

.3 Wiring diagrams for power and control schematics

.4 Parts catalogues with complete list of repair and replacement parts with section drawings, illustrating the connection and the parts manufacturer’s identifying numbers.

.3 Number of weeks prior to shipment that Contract Administrator will be required to supply final conditions of flow and head for trimming the impeller. Manufacture casings to the

conditions given on the system head curves, but complete final trim of the impellers according to the flow and head supplied for this pump on or before a date agreed on between Contractor and the Contract Administrator.

1.4 Delivery and Storage

.1 Ship pre-assembled to the degree that is possible. Inform installer of any site assembly requirements.

.2 Securely fasten heavy wood blanks to the pump flanges. Use blanks that are larger diameter than the flange. Protect machined surfaces against rusting. Protect threaded connections with threaded plugs or caps. Protect open, plain pipe ends with caps.

.3 Where pumps are to be stored on-site for any period of time exceeding on week, instruct site staff of specific requirements to ensure there is no uneven wear or distortion of pump component parts.

.4 Identify any special storage requirements.

1.5 Coordination

.1 Coordinate with other Divisions to ensure there are no conflicts in the work.

2. PRODUCTS

2.1 Pump Performance Requirements

.1 Provide pumps that are suitable for continuous duty.

.2 Select impellers for fixed speed pumps that permit operation at an efficiency within 5 percent of the efficiency at the Best Efficiency Point.

.3 For variable speed pumps, select pump speed and impeller diameter which allow operation from the Rating Point to the Low Speed Point at efficiencies with 10 percent of efficiency at the Best Efficiency Point.

.4 Ensure that motors are sufficiency sized to drive pumps at a maximum speed when the head is as defined for the low head point.

.5 Provide pumps capable of operating at 30 percent of the flow at the rated capacity with good efficiency without exceeding the motor horsepower, and capable of operating at any point on its characteristic curve, to where that curve intersects the low head point, without exceeding motor power rating.

2.2 Pressure Sensing

.1 Supply a means of measuring inlet and outlet pressure with each pump, except as noted.

.2 For centrifugal pumps handling clean water, provide gauges for the inlet and outlet of each pump. Mount on the connections described for equipment in Section 11005.

.3 For submersible pumps, provide only one gauge for mounting on the discharge of the pump on a weldolet installed outside, but within 2 metres of the wetwell.

.4 For centrifugal pumps handling sewage, sludge, grit, or effluent water, provide one pressure sensor and one gauge for each pump. Refer to standard details for mounting requirements.

.5 For positive displacement pumps (diaphragm, piston, etc.), provide full pipe diameter annular ring pressure sensor for both the suction and discharge, complete with gauges and connections for instrumentation devices.

.6 Gauges:

.1 Supply gauges that are 75 mm diameter, 6.35 mm bottom connection, complete with shut off cock with stainless steel movement and Bourdon tube.

.2 Use metric units of measurement (kPa or Pa), clearly indicated on the face of the gauge.

.3 Calibrate the gauges to read pressure ranges approximately as follows:

	Actual Pressure	**Gauge Pressure Range**
Suction	-50 kPa to 50 kPa	-50 kPa to 350 kPa
	50 kPa to 200 kPa	0 kPa to 350 kPa
	200 kPa to 700 kPa	0 kPa to 1000 kPa
Discharge	50 kPa to 350 kPa	0 kPa to 700 kPa
	350 kPa to 700 kPa	0 kPa to 1000 kPa
	700 kPa to 1500 kPa	0 kPa to 2000 kPa

.4 Acceptable manufacturers: Ashcroft, H.O. Trerice.

.7 Pressure Sensors

.1 Provide annular ring, flow through type pressure sensors, with stainless steel body, a sensing element compatible with the corrosive and abrasive nature of the fluid being measured, 25 mm diameter.

.2 Acceptable products: Red Valve Series 42 or Robbins and Myers RKL Series W.

.3 Provide stainless steel nipples extending to a tee from the pressure sensor. Mount the gauge on one leg of the tee. If a pressure indicator/transmitter/switch is shown on the drawings, mount on the other side of the tee. Otherwise, plug the tee.

.4 Supply annular type pressure sensors with their initial fill of fluid.

2.3 Pump Seals

.1 Provide cartridge type, single mechanical seals, externally mounted.

.2 Provide non-destructive, self-aligning seals of the stationary design with require no wearing sleeve for the shaft.

.3 Material of construction:

Type of Service	Metal Parts	Spring(s)	O-Rings	Faces
Potable water	316 or 317L Stainless Steel	316 or Hastelloy C	Buna-N or Viton	Silicon Carbide on Carbon
Sewage	316 or 317L Stainless Steel	316 or Hastelloy C	Viton	Sintered Silicon Carbide on Carbon
Secondary Sludge and Scum	316 or 317L Stainless Steel	316 or Hastelloy C	Viton	Tungsten Carbide on Sintered Silicon Carbide
Primary Sludge, Digested Sludge, and Grit	316 or 317L Stainless Steel	316 or Hastelloy C	Viton	Tungsten Carbide on Sintered Silicon Carbide

.4 Approved manufacturers are:

.1 Durametalic

.2 John Crane

.3 Chesterton

2.4 Bearings

.1 Refer to Section 11005.

.2 For all pumps other than submersible and where otherwise noted in the detailed specifications, provide a bearing shield, complete with labyrinth seals, to prevent the ingress of water.

2.5 Protective Guards

.1 Provide a protective guard for all couplings and keys, drive belts, or other exposed rotating devices. As a minimum, conform to the requirements of Section 11005.

2.6 Couplings

.1 For all pumps other than submersible and where noted otherwise in the detailed specifications, provide flexible, double disc, spacer type couplings conforming with Section 11005.

.2 Design couplings so that the pump unit can be disassembled without disturbing face piping.

.3 Acceptable Products: Wood Sureflex, Rex Omega

2.7 Shafts

.1 Design shafts to absorb 1.15 times the rated power of the motors required to drive the pumps when the pump is fitted with maximum size impellers.

.2 Use stainless steel shafts, without any allowance for shaft sleeves.

2.8 V-Belt Drives

.1 Do not use V-belt drives unless specified or shown on the drawings.

.2 Conform to the requirements of Section 11005.

2.9 Seal Water Connection

.1 For each pump handling fluids with abrasive or corrosive components, including wastewater flows of any type, provide seal water connections to the pump seals.

.2 For seal water piping and fittings, unless otherwise specified, use 12 mm diameter.

.3 Seal water connections consist of the following:

.1 Isolating valve: ball valve type BV01. Refer to Section 11105.

.2 Filter strainer, copper and brass with stainless steel screen basket.

.3 Pressure regulator, copper and brass

.4 Solenoid valve, copper, power to open

.5 Rotameter, 0 to 10 L/min, rated for 1000 kPa

.6 Needle valve, separate or integral with the rotameter. For separate, use NV01.

.7 Flow switch, Rosemount or Foxboro

2.10 Spare Parts

.1 For each pump, provide for one spare mechanical seal or packing kit (as applicable) and one set of pump bearings.

.2 For each size of seal water connection, one rotameter.

.3 For each centrifugal pump type and size, provide a single impeller, wear plate, suction ring (if replaceable), one pumps shaft, and nut.

2.11 Factory Performance Testing

.1 Where required for specific pumps, as noted in the sections related to those pumps, factory performance test all pumps.

.2 Conduct factory performance testing in compliance with the Hydraulic Institute Standards.

.3 Inform the Contract Administrator at least three weeks prior to the factory testing to allow for his attendance.

.4 Certify test results and summarize findings in a short report. Submit report within three weeks of completing factory tests.

.5 Where a pump does not satisfy the specified performance requirements within the tolerances specified by the Hydraulics Institute, redesign, modify, and retest the pump, all at no additional cost.

.6 Do no ship the pump until the test result report has been submitted to the Contract Administrator.

2.12 Finishes

.1 Factory prime and paint all pumps in accordance with Section 11901.

3. EXECUTION

3.1 General

.1 Comply with the requirements of the specific sections for the pumps to be provided.

3.2 Installation

.1 Comply with the requirements of Section 11020 and any special requirements listed in the specific sections related to each pump.

3.3 Testing

.1 Field test all pumps greater than or equal to 3.7 kW, and smaller units where noted, to verify performance.

.2 Provide temporary connections, flow monitoring, pressure monitoring, ammeters, and temporary tankage required for the performance of the tests.

.3 Flow Metering

.1 Where possible, use fill and draw techniques to determine the amount of flow conveyed during the test period. Ensure that the volumes are sufficient for at least 5 minutes of pump operation at the flows that are to be tested, other than run-out.

.2 Where permanent flow meters are installed on the downstream piping, they may be used to measure the flow during testing when accepted by the Contract Administrator. Ensure that the permanent flow meters are calibrated to within five percent of the rated flow of the pump to be tested prior to testing.

.3 Temporary metering may be used if accepted by the Contract Administrator. Temporary meters must have an accuracy of plus or minus 5 percent, at the rated flow of the pump, to be acceptable.

.4 Where other methods are not possible or where directed, use dye testing to determine the flow during the test periods. Dye testing is to be conducted by an agency acceptable to the Contract Administrator. Measured flows during the testing will be certified by a qualified Professional Engineer to be within five percent of the actual flows.

.4 Pressure Monitoring

.1 Do not use permanent gauges for pressure monitoring during tests. Temporary test gauges can be connected to the permanent gauge taps.

.2 Use gauges with sufficient accuracy to measure anticipated pressures on pump discharges within 2.5 percent. Where pump suction draws from an open tank or wet well, test gauge must be capable of measuring pressure at pump suction within 1.0 kPa.

.3 Provide evidence of pressure gauge calibration within 3 months of conducting tests.

.5 Test pump at a minimum of three flow conditions, typically corresponding to the rating point flow, 75 percent of that flow, and 120 percent of that flow. At each test point, measure flow, pressure, and amperage. In addition, verify run-out conditions.

.6 For variable speed pumps, conduct the tests at two speeds, typically 100 percent of the design speed and 30 percent of the design speed.

.7 Field Test Report

.1 Compile field test results into a report for submittal to the Contract Administrator.

.2 Describe test set-up and measurement devices used to conduct the tests.

.3 For each pump, list the specified performance requirements and field test results. Show field test results (flow, pressure, power draw) superimposed on the performance curve provided with the submission.

.8 Where field tests to not verify compliance with specified performance requirements, investigate cause for noncompliance, undertake remedial work as required to bring pump into compliance, or replace the pump and all necessary ancillaries, and retest to prove compliance. All work required to bring the pump into compliance is the responsibility of the Contractor.

END OF SECTION

GEAR PUMPS, SKID-MOUNTED

1. GENERAL

1.1 Work Included

.1 Supply and supervision of installation, testing and commissioning of a skid-mounted, pre-piped, pre-wired and pressure tested, complete and functional external gear pumps for designated chemicals dosing application.

1.2 Submittals

.1 Submit shop drawings in accordance with Section 01300 and Section 11005.

.2 Operation and maintenance data: provide for incorporation in Operation and Maintenance Manual as specified in Section 01735. Include complete description of operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, parts catalogue with complete list of repair and replacement parts with section drawings illustrating the connections and identifying numbers.

1.3 Coordination

.1 Coordinate with other Sections of Division 11 to ensure there are no conflicts in the Work.

.2 Coordinate with other Divisions to ensure there are no conflicts in the Work, including the following:

.1 Division 16, Electrical

.2 Division 17, Instrumentation and Controls

1.4 Shipment, Protection, and Storage

.1 Ship pre-assembled to the degree possible.

.2 Provide storage instructions indicating specific requirements to ensure there is no uneven wear, distortion or weathering of components.

.3 Identify all other special storage requirements.

2. PRODUCTS

2.1 Description

.1 Equipment to be capable of pumping ferric chloride, ferrous chloride, ferric sulphate, ferrous sulphate, and aluminum sulphate. Only one of these chemicals will be fed to the dosing pump skid at any one time.

.2 The system includes metering pumps, strainers, controls, calibration column, backpressure valves, pressure relief valves, ball valves, pressure gauges, high pressure switches, check valves, magnetic flow meters, and all associated piping and fittings, in accordance with the Drawings.

.3 The whole system shall take into account the specific gravity, viscosity, corrosivity and temperature of the fluid being pumped.

2.2 Tag Numbers

.1 W-740

.2 W-750

.3 W-760

2.3 Design Standard

.1 Micropump

2.4 Acceptable Manufacturers

.1 Liquiflo

.2 Pulsafeeder (Isochem)

.3 Tuthill

2.5 Capacities and Performance

.1 Ferric chloride: 8 to 14 percent Fe, density of 1.26 kg/L to 1.48 kg/L (at 20°C), viscosity of 12 cps.

.2 Ferrous chloride: 7 to 12 percent Fe, density of 1.18 kg/L to 1.32 kg/L (at 20°C), viscosity of 15 cps.

.3 Ferric sulphate: 9 to 12 percent Fe, density of 1.40 kg/L to 1.54 kg/L (at 20°C), viscosity of 25 cps.

.4 Aluminum sulphate (alum): 2.6 to 4.0 percent Al, density of 1.20 kg/L to 1.35 kg/L (at 20°C), viscosity of 25 cps.

.5 Design pumps to handle abrasive crystals that may form in the solution.

.6 Fluid temperature: 5 ^{o}C to 35 ^{o}C

.7 Gear Pumps

.1 Number of pumps: 3

.2 Minimum capacity, each: 8 L/hr.

.3 Maximum capacity, each: 400 L/hr.

.4 Maximum backpressure: 400 kPa

.5 Maximum positive suction pressure: 65 kPa (chemical storage tank full).

.6 Maximum negative suction pressure: 50 kPa (chemical storage tank empty).

.7 Maximum differential pressure: 450 kPa

2.6 Materials

.1 Fabricate pumps of titanium

.2 Fabricate pipes and valves of PVC

.3 Fabricate skid of fibre reinforced plastic (FRP) or black PVC

2.7 Strainers

.1 Provide an inline suction strainer for each metering pump. Use material appropriate for the chemicals being pumped.

.2 Provide flanged Y-type strainers complete with removable plastic 1.5 mm screen and Teflon seals.

2.8 Calibration Chamber

.1 Provide 4000 mL calibration cylinder suitable for the chemicals with scale in mL on the side and ball isolation valve for connection to the suction line of each metering

pump. Provide column of clear PVC or a translucent material suitable for the chemical application. Do not provide glass cylinders.

2.9 Gear Pumps

.1 Provide positive displacement seal-less magnetically driven external gear type metering pumps designed to meet the specified flow ranges when pumping the specified materials. Pumping rate change shall be accomplished by varying the pump operating speed.

.2 Include hydraulic relief valves to protect pumps against overpressure. Set valves according to Manufacturer's recommendations. Fabricate of materials resistant to corrosive chemicals used.

.3 Provide high pressure switches on the discharge of each pump.

.4 The pumps shall provide a constant flow rate for a particular drive speed and provide linear pulsation-free output flow at all chemical liquid level in storage tanks.

.5 The driven magnet shall be an encapsulated assembly mounted on the end of the pump shaft. The drive magnet assembly shall rotate around the containment can as a result of the magnetic force.

.6 The pumps shall have a pumping accuracy of +5 percent of the full range.

.7 Combined pump, motor and variable frequency controller system shall be capable of providing a 100:1 turndown ratio.

.8 Construct the pump parts in contact with the chemical being pumped from materials suitable for the chemical application. Construct the pump of the following materials:

.1 Pumps: hardened titanium construction

.2 Wear plates: ceramic

.3 Shafts: ceramic

.4 Gears: Teflon or Ryton

.9 Provide pressure relief valve and backpressure regulating valve for each pump discharge, sized for the maximum pump flow with an adjustable pressure range. Valve material to be compatible with the chemical being pumped.

.10 Provide pumps suitable for connection to variable speed drive.

.11 Provide motors suitable for variable speed operation refer to Section 11205. Motors shall include position feedback encoder for closed loop speed control, compatible with supplied variable frequency drive.

.12 Motors to be designated IEEE Chemical Industry - Severe Duty TEFC (CISD-TEFC).

.13 Provide local control for each pump, complete with speed indicator, manual speed control, computer-off-hand, selector, lock-off-stop pushbutton, start/stop switch, and power disconnect switch.

.14 Provide variable speed drives, in accordance with Section 16815, capable of producing the required torque and power to operate the pumps over the entire speed range required to match specified dose rates.

.15 Provide drives suitable for 208 V/3 phase/60 Hz power supply.

.16 Provide drives suitable for local fixed speed or remote variable speed control, from remote 4-20 mA DC input signals.

.17 Provide a floor-mounted support frame for the skid assembly. Fabricate support frame of chemically resistant fibre reinforced plastic (FRP) or chemically resistant black PVC. Provide sufficient strength to allow the support frame to carry the full weight of all of the skid components when full of chemical.

2.10 Piping and Valves

.1 Provide Schedule 80 PVC piping and flanges in accordance with Sections 11050, 11051 and 11055. Provide flanges on the inlet and outlets to the skid.

.2 Provide valves and appurtenances of material suitable for the specified chemicals, in accordance with Sections 11056, 11100, and 11105.

.3 Provide instrumentation and flow meters in accordance with Section 17701.

.4 Isolation valves to be ball valves. Refer to Section 11105, BV06 for details.

.5 Check valves to be PVC ball check valves with Viton seats, rated for 150 psi. Valves to be Chemline, Hayward “True Check”, or equivalent.

.6 Pressure relief valves to be PVC with Viton seals, with no external metal fastners and have corrosion resistant coated internal spring to cover the valve’s entire set pressure range. Valves to be hand adjustable without tools. Valve to relieve pressure in the range 5 to 75 psi. Valves to be Chemline, Hayward, or equivalent.

.7 Back-pressure regulating valves to have Viton seals. Provide Chemline SB12 or equivalent.

2.11 Control Panel

.1 Provide remotely-mounted variable frequency drive control panels and remotely-mounted control stations for the pump skid. The panels and control stations are to include pump speed controls and all features necessary for the system to operate as described and to permit the system to operate on remote automatic control or on local or remote manual control.

.2 Each control panel to include the following:

.1 Variable frequency drives, transformer, relays, line reactors, fused disconnect, wireway-lamacoid nameplates, etc.

.2 Each panel to be suitable for 208 V, 3 phase, 60 Hz power supply.

.3 Factory finished NEMA 4X, 316 stainless steel enclosures to house all required components. Provide enclosure with a hinged, lockable front face. Provide accessories to mount the panel at a suitable operating height. Mount all indicators, hand switches, contacts, etc, on the panel face.

.4 Provide the following for each pump:

.1 One Computer-Off-Hand switch

.2 One Lock-Off-Stop switch

.3 One Speed Controller (key pad)

.4 One Alarm Reset push-button

.5 One RED-ON/GREEN-OFF light.

.5 Provide voltage free form C contacts for all digital points and optically isolated connections for all analogue points in accordance with the Drawings.

.6 Terminate all connections to external wiring inside the panel at 208 V terminal strip for connection to wiring by Division 16 and Division 17.

2.12 Control Description

.1 When required, the gear pump system is turned on manually. The pumps are switched on through a power disconnect switch in the local panel. Each injection point has a dedicated metering pump system.

.2 Automatic control sets the chemical dose in response to a 4-20 mA signal, which is used to vary the pump drive speed.

.3 The three lines from the metering pumps cross connect to discharge to injection points.

2.13 Painting

.1 Shop prime and paint equipment in accordance with Section 11901.

.2 All metal surface including frames shall be coated with chemical-resistant coating.

2.14 Spare Parts and Maintenance Materials

.1 Provide one complete spare pump including motor for use as a shelf standby.

.2 Provide the following spare parts:

.1 Three (3) service sets (including gears, shoes, bearings (if required) and O–rings).

.2 Three (3) sets of ceramic wear parts.

.3 Three (3) backpressure valve diaphragms.

.4 Three (3) pressure relief valve diaphragms.

.5 Three (3) strainers

.3 Provide a list of spare parts which would be expected to be required over a period of five years under normal conditions. At the Contract Administrator’s request, provide a price for the listed parts.

3. EXECUTION

3.1 Manufacturer's Representative

.1 To ensure the equipment is installed, operated, and maintained in accordance with the manufacturer's recommended procedures, arrange for a technically qualified Manufacturer's Representative to witness the installation work, certify correct installation, train operating and maintenance staff, and undertake system testing.

3.2 Installation

.1 Ensure the equipment is installed as required to provide satisfactory service.

.2 Instruct installer in the methods and precautions to be followed in the installation of the equipment. Certify the installer's understanding by completing Form 101, included in Section 01650.

.3 Cooperate with the installer to fulfill the requirements for a successful installation by completing Form 102, included in Section 01650.

3.3 Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.2 Cooperate with the installer to fulfill the requirements for successful testing of the equipment byu completing Form 103, included in Section 01650.

3.4 Commissioning

.1 Attend during commissioning of the process system which includes the equipment specified in this section and to ensure the equipment functions as intended in the process system.

END OF SECTION

FIELD APPLIED CORROSION PROTECTIVE AND MAINTENANCE COATINGS

1. GENERAL

1.1 Work Included

.1 Provide, apply, and maintain the specified field applied protective and maintenance coating systems. Coatings are required on all process and mechanical equipment, vessels and pipes unless specifically excepted.

.2 Refer to Drawings and Schedules for the type, location, and extent of coatings required and included for all field coating necessary to complete all the Work shown, specified, or scheduled.

1.2 Delivery and Storage

.1 Deliver all coating materials to the Site in sealed containers properly labelled to indicate the Manufacturer's name, type and colour of contents, date of manufacture, batch number, and storage requirements.

.2 Provide adequately heated and ventilated storage for all materials and ensure compliance with fire prevention regulations.

2. PRODUCTS

2.1 Manufacturers

.1 All constituents of each coating system are to be provided by the same Manufacturer.

.2 Acceptable Manufacturers: Valspar, Sherwin Williams, Benjamin Moore

2.2 Schedule of Surface Treatments

.1 The Schedule of Surface Treatments defines the components of the protective coating system.

Schedule of Surface Treatments

Ref.	Description	Surface Treatments
A	Solvent Cleaning	As SSPC-SP1
B	Hand Tool Cleaning	As SSPC-SP2
C	Power Tool Cleaning	As SSPC-SP3
D	Brush Blast	As SSPC-SP7
E	Near White Metal Blast	As SSPC-SP10
F	White Metal Blast	As SSPC-SP5 (NACE #1)
G	Abrasion	Lightly abrade surface using steel wool or abrasive cloth to provide a key for the next coat, to remove runs or excessive brush marks.
H	Vinyl Wash Primer	DFT 13 microns. Over-coat within 24 hours
I	Zinc Chromate Primer	Nominal DFT 40 microns
J	Inorganic Zinc Primer	Zinc in ethyl silicate vehicle. Minimum DFT 40 microns
K	Industrial Enamel (to 100ºC)	To 1-GP-61M Alkyd Enamel. Minimum DFT 30 microns
L	High Build Epoxy	To AWWA C210 and certified by an appropriate testing agency (NSF Std. 61, CSA, etc.) for use on wastewater applications. Minimum DFT 200 microns
M	Bituminous Paint	To AWWA C230, MIL-P-151470
N	Silicone Alkyd (100ºC to 150ºC)	Min. 60% solids by weight. Nominal DFT 40 microns
O	Silicone Enamel (150ºC to 400ºC)	To 1-GP-143M, DFT 40 microns
P	Fast Drying Aluminum Sealer	To 1-GP-69M, Nominal DFT 25 microns
Q	Canvas Insulation Sealer	Acrylic or PVA latex
R	Epoxy Gloss Enamel	To 1-GP-146, nominal DFT 50 microns

2.3 Schedule of Protective Systems

.1 The schedule of protective systems defines the combination of surface treatments required in each system and the sections of the plant to which it is to be applied. The systems have been grouped into three (3) categories as follows:

.1 Category A: Immersed Service, equipment or material fully, partially or intermittently immersed in water during routine plant operation.

.2 Category B: Exposed Service, equipment or material exposed to the normal range of atmospheric conditions and conditions common to wastewater treatment facilities (high humidity, etc.)

.3 Category C: Indoor Service, equipment or materials inside buildings or other ventilated spaces.

2.4 Category A

.1 All Category A systems will be tested by the Contract Administrator using a wet sponge holiday detector set at 67.5 V. Touch up will be required at points where the detector is grounded.

.2 Schedule:

Schedule of Systems

System	Surface Treatments	Typical Applications
A1	A, D, L, L	Equipment or piping delivered with inorganic zinc primer, i.e., clarifier mechanics, mixers, etc.
A2	A, F, J, L, L	Equipment or piping delivered uncoated or with coatings not compatible with epoxy, i.e., ductile iron, cast iron or steel pipe and pipe sleeves inside treatment units. External Surfaces at valves, fabricated pipe supports, brackets, etc.
A3	A, G, M	Aluminum surfaces in contact with concrete, i.e., access cover frames
A4	A, E	Ferrous metal surface cast into concrete, i.e., penstocks, pipe sleeves
A5	A	Stainless steels, plastics, and fibreglass products

2.5 Category B

.1 Schedule:

Schedule of Systems

System	Surface Treatments	Typical Applications
B1	A, B, R, R	Equipment or piping delivered with inorganic zinc primer, i.e., motors, flocculator gearbox & motor, valve headstocks, piping above ground & outside treatment units, hydrants, etc.
B2	A, B, J, R, R	Equipment or piping delivered but not applied with an inorganic zinc prime coat or with a prime coat not compatible with an inorganic zinc overcoat.
B3	A, B, H, R, R	Galvanized or cadmium plated goods, i.e., pipe supports or brackets, mountings for electrical or control equipment (Unistrut, etc.)
B4	A	Stainless steel or aluminum products, i.e., insulation recovering

2.6 Category C

.1 Schedule

Schedule of Systems

System	Surface Treatments	Typical Applications
C1	A, B, K, K	Equipment or piping delivered c/w factory finished coatings. Coated for system identification and maintenance. Surface temperature during operation not exceeding 100ºC, i.e., pumps, air handling units, valves, etc.
C2	A, G, K, K	Equipment or accessories fully primed. Surface temperatures not exceeding 100ºC, i.e., pumps, steel piping
C3	A, C, I, N, N	Equipment or accessories as C1 or C2 but with operating surface temperatures between 100ºC and 150ºC, i.e., air compressors, blowers
C4	E, J, O	Equipment or accessories as C1 or C2 but with operating surface temperatures between 150ºC and 400ºC, i.e., boiler fittings
C5	B, P, K, K	Piping or valves with bituminous or tar coatings. Surface temperatures not exceeding 100ºC, i.e., cast iron & ductile iron pipe, valves.
C6	A, K, K	PVC pipe, fittings or accessories coated for identification only.
C7	A, H, K, K	Aluminum insulation recovering coated for identification only.
C8	A, Q, G, N, N	Canvas insulation recovering.

Notes 1 Surface preparation G-abrasion has not been fully scheduled but is to be carried out between all coatings.

2 No bare ferrous metal surfaces are permitted. Pipe hanger rods etc., unless zinc or cadmium plated, are to be at least prime coated. Cut ends of plated surfaces (Uni-strut, etc.) are to be spot primed.

2.7 Colour Coding

.1 Not Used

3. EXECUTION

3.1 Quality Assurance

.1 Apply all paints and coatings strictly in accordance with the Manufacturer's directions.

.2 Pay particular attention to ensure the compatibility of each surface treatment with the preceding and subsequent surface treatments and coatings. Ensure the compatibility of all surface treatments and coatings.

.3 Coatings exhibiting visible defects such as drips and runs will not be accepted.

3.2 Environmental Conditions

.1 Do not apply a coating when the ambient or surface temperature is below 10°C or less than 3°C above the dew point.

.2 Provide adequate ventilation and sufficient heating to maintain temperatures above 7°C for 24 hours before coatings are applied. Continue heating to maintain 10°C during application and for 48 hours after application.

.3 Provide a minimum of 300 lux illumination on surface to be treated.

.4 Do not apply coatings where dust is being generated.

3.3 Protection

.1 Provide sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted. Make good any damage resulting from inadequate or unsuitable protection.

.2 Maintain all coated surfaces until completion of the Works. Damage to coatings, occurring at any time, shall be made good within seven days.

.3 Place cotton waste, cloths and material which may constitute a fire hazard in closed metal containers and remove from the Site at suitable intervals.

.4 Remove and, after painting, replace or adequately mask all grease nipples, bright metal surfaces, identification plates and other items not to be painted. Do not use solvent that may remove permanent lacquer finishes.

3.4 Condition of Surfaces

.1 Thoroughly examine all surfaces to be treated or coated prior to commencement of Work. Report, in writing, to the Contract Administrator, any condition or defect that may affect the integrity or quality of the finished coating. Do not commence Work on any section until all such defects in that section have been corrected.

.2 On all factory primed or coated equipment, touch up defects prior to the application of subsequent coatings.

.3 Be responsible for the condition of surfaces and for correcting defects and deficiencies in the surface.

END OF SECTION

FACTORY APPLIED CORROSION PROTECTIVE AND MAINTENANCE COATINGS

1. GENERAL

1.1 Work Included

.1 Supply and application of all factory applied prime coats or factory applied finish coats.

1.2 Submissions

.1 With the equipment Shop Drawings, submit details of the coating systems to be applied.

1.3 Quality Assurance

.1 This Specification is intended to be a minimum standard. Alternative coating systems may be submitted for review, for specific items of equipment, which provide equal or better corrosion protection and maintenance service than those specified herein.

2. PRODUCTS

2.1 Surface Preparation

.1 Immersion service: For ferrous components, degrease and dry blast to a white metal finish in accordance with SSPC-SP5 to a degree of cleanliness in accordance with NACE No. 1. Obtain a 50 micron blast profile.

.2 Non-immersion service: After degreasing, as a minimum, hand tool clean all surfaces in accordance with SSPC-SS2 or power tool clean in accordance with SSPC-SS3.

2.2 Prime Coating

.1 Coat all ferrous surfaces before the blasted surfaces deteriorate.

.2 To ferrous surfaces apply inorganic zinc primer, containing a minimum of 50 percent solids by volume, to a minimum dry film thickness of 75 microns.

2.3 Finish Coats

.1 Apply finish coats in conformance with Section 11900 for service, coating types and application rates.

2.4 Assembly

.1 Before the parts are assembled, clean and coat surfaces of items that are to be bolted together before shipment.

.2 Make all welded connections continuous weld, sealing the mating surface completely. On completion of the welding and fettling, treat all weld seams with phosphoric acid solution, then rinse and thoroughly dry before the primer is supplied.

.3 Where dissimilar metals are mated, insulate the surfaces from one another to provide protection against galvanic or other corrosion.

.4 For immersion service, use 316 stainless steel nuts, bolts, washers and similar fittings. For non-immersion service use 304 stainless nuts, bolts, washers, and similar fittings. Clean and coat the inner face of bolt holes, not threaded, as required for other surfaces.

3. EXECUTION

3.1 Inspection

.1 Notify the Contract Administrator two (2) weeks before commencing the protective coating in order to facilitate the inspection by the Contract Administrator of the surface preparation and protective coating application.

3.2 Protection

.1 Adequately protect all coated equipment against damage, dust, moisture and scratching during shipment, off-loading and storage on-site. If, in the opinion of the Contract Administrator, the coating is damaged during shipment to the extent that touch up would not be satisfactory, return the equipment and recoat at no cost to the City.

END OF SECTION

IDENTIFICATION

1. GENERAL

1.1 Work Included

.1 Identification of equipment, motors, vessels, valves, ferrous, non-ferrous, and insulated piping.

2. PRODUCTS

2.1 Equipment Manufacturer's Nameplates

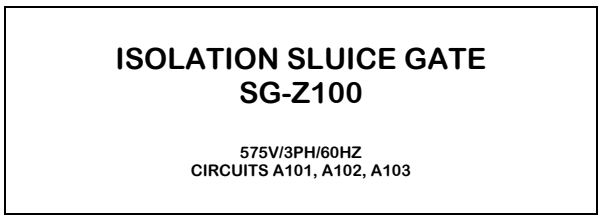
.1 Provide metal nameplate on each piece of equipment, mechanically fastened with raised or recessed letters.

.2 Provide Underwriters' Laboratories or CSA registration plates, as required by respective agency.

.3 Manufacturer's nameplates to indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase, and power of motors.

2.2 Equipment - Project Identification Nameplates

.1 Supply and install white lamicoid identification plates, with black lettering, for all equipment installed under this contract. Provide identification plates that are engraved with the unit name and equipment number in 12 mm high lettering and electrical characteristics, if applicable, in 6 mm high lettering, as shown in the following example:



.2 Submit list of plates for review prior to engraving.

2.3 Valves

.1 Provide all valves with a white lamicoid tag, with 12 mm black engraved names and numbers.

.2 Number valves as directed by the Contract Administrator or as shown on the drawings.

.3 Attach tags to valves using fasteners. Adhesive mounts are not acceptable.

2.4 Piping

.1 For all piping installed under this Contract, use pipe markers designating the pipe service and the direction of flow.

.2 Use pre-printed pipe markers. For pre-printed pipe markers, use self-adhesive, plastic coated cloth labels. In addition to its adhesive, secure each label with a full tape band at each end of the label.

.3 Make direction arrows 150 mm long by 50 mm wide for piping with an outer diameter 75 mm or larger, including insulation. Use 100 mm long by 20 mm wide arrows for smaller diameter piping. Provide double headed arrows where appropriate.

.4 Use block capital letters for names, 50 mm high for piping with an outer diameter 75 mm or larger, including insulation. Use 20 mm high letters for smaller diameters. Identify the pipe commodity using the full names detailed on Drawing 1-0101A-D-A0001.

.5 Use stainless steel tags for pipes and tubing with an outer diameter 20 mm and smaller.

2.5 Colour Coding

.1 Use a colour coded identification system on the following items:

.1 All piping and valves: paint or band the piping with the colours agreed prior to the work, paint the valves in the colour of the system, other than valves on fire protection systems. Paint the valves on fire protection systems red.

.2 All pumps: paint pumps in the colour identifying the material being pumped

.2 Identification shall consist of the following:

.1 Coating or banding of pipes and coating of valves to the colour of the medium being conveyed

.2 Coat non-submerged process equipment to match the colour requirement of the material being processed.

.3 Finish valve handles and similar appurtenances in black.

.3 Select identification colours in accordance with the City standardc colours in the following table:

	Colour	**Colour Code**
Utility Fluids		
Potable Water	Sky Blue	SW 3021
Well Water Supply	Violet	SW 3022
Well Water Return	Violet	SW 3022
Flushing Water	Blue	SW 3023
Hot Water Supply	Green	SW 3024
Hot Water Return	Aqua Green	SW 3025
Glycol Supply	Medium Fuschia	SW 3026
Glycol Return	Light Fuschia	SW 3027
Rain Water Leaders	Grey	SW 3028
Process Fluids		
Primary Effluent	Mint Yellow	SW 3030
Primary Sludge	Charcoal Grey	SW 3031
Return Activated Sludge	Orange	SW 3032
Waste Activated Sludge	Yellow	SW 3033
Sludge Mixing System	Pumpkin	SW 3034
Scum/Degreasing	Blue-Grey	SW 3035
Process Drain	White	SW 3036
Mix Age Polymer Tanks	Med. Orange	SW 3040
Polymer Feed Tanks	Teal Blue	SW 3041
Dry Polymer Storage	Light Green	SW 3042
Liquid Polymer Storage	Medium Green	SW 3043
Sludge Feed/Transfer	Dark Yellow	SW 3044
Sludge Cake Line	Medium Yellow	SW 3045
Thin Sludge	Light Yellow	SW 3046
Centrate	Very Light Yellow	SW 3047
Sludge Cake Storage	Medium Yellow	SW 3045
Sludge (Trucked)	Rich Tan	SW 3048
Sludge Cake Hopper	White	SW 3049
Sludge Cake Pump Drive	Dark Green	SW 3050
Ferric Chloride	Bright Yellow	SW 3063
Gases		
Instrument Air	Forest Green	SW 3060
Process Air	Terrace Green	SW 3061
Oxygen	Purple	SW 3062
Chlorine	Bright Yellow	SW 3063
Natural Gas	Safety Yellow	SW 3064
Digester Gas	Red	SW 3065

	Colour	**Colour Code**
Equipment and Misc Metals		
Duct Work	Warm Grey	SW 3070
Steel Pipe Supports	Ansi Light Grey	SW 3071
Bollards	Red	SW 3065
Exterior Pedestals/Panels	Lemon Yellow	SW 3071
Handrails (Painted)	Aluminum	B 59S2
Motors	Red	SW 3065
Motor Bases	Carmine Red	SW 3072
Valves and Pumps	Match conduit	
Valve Hand- and Chain-wheels	Red	SW 3065
Other		
Boilers	Heat Resistant Aluminum	B 59S3
Concrete and Blockwork	Platinum Grey	SW 4012
Note: SW codes are Sherwin Williams		

3. EXECUTION

3.1 Equipment Manufacturer's Nameplates

.1 Locate nameplates so that they are easily read. Do not insulate or paint over plates.

3.2 Equipment Project Identification Nameplates

.1 Attach plates to the equipment with rivets, sheet metal screws, or nuts and bolts (adhesive will not be accepted).

.2 Fasten plates in conspicuous locations. Where plates cannot be mounted on hot or cold surfaces, provide standoffs.

3.3 Valves

.1 Attach tags to all valves with sheet metal screws or nuts and bolts. Ensure tags are easily accessible from operator location and do not conflict with valve operation.

3.4 Piping

.1 On completion of protective coatings or finish painting, neatly stencil direction flow arrows and the commodity abbreviation on the pipe. Alternatively, attach pre-printed labels.

.2 Stencil or attach pipe markers in readily visible locations. Identify piping at the following locations:

.1 At each valve

.2 On both sides of wall penetrations

.3 At floor and roof penetrations

.4 On each leg of branches

.5 Every 15 m along continuous runs, except ferric chloride pipe which shall be every 5 m.

END OF SECTION

DESIGN AND OPERATING DESCRIPTION

1. GENERAL

.1 This Section is included for reference, to provide the Contractor with an understanding of the project.

2. INTRODUCTION

.1 The Phosphorus Removal Facility is required to meet the requirements of Environment Act Licence No. 2684 R issued by Manitoba Conservation on August 17, 2005. The Licence stipulates that the centrate from the sludge dewatering facility should have a total phosphorus (TP) load that does not exceed 119 kg/d, as determined by a 30-day rolling average.

.2 Phosphorus removal is achieved by the dosing of chemicals into the sludge and centrate piping.

.3 Provisions for both railcar unloading and road truck unloading are provided. A new rail spur and railcar shelter is installed for chemical unloading. A new chemical storage building, adjacent to the existing Dewatering Building, houses two chemical storage tanks. Compressed air is used for padding of the railcars during unloading.

.4 The chemical is pumped to three injection points by gear pumps.

3. DESIGN DESCRIPTION

3.1 Chemical Delivery and Unloading Description

.1 Four chemicals may be used, although only one is used at any one time. The four chemicals that could be used are:

.1 Ferric chloride

.2 Ferrous chloride

.3 Ferric sulphate

.4 Alum

.2 The design documentation focuses on the use of ferric chloride, with provision made for compatibility with the other chemicals. The preferred delivery method is by 86-tonne railcars. Provision will be made to accommodate delivery by truck on a standby or emergency basis.

.3 All four chemicals are acidic and very corrosive. The properties of these chemicals are summarized in Table 1.

Table 1: Chemical Properties

	Ferric Chloride	**Ferrous Chloride**	**Ferric Sulphate**	**Alum**
Concentration, %Fe or %Al	8 to 14	7 to 12	9 to 12	2.6 to 4.0
Viscosity, cps	12	15	25	25
Specific Gravity	1.26 to 1.48	1.18 to 1.32	1.40 to 1.54	1.20 to 1.35

.4 At an average dose rate of 336 mg/L Fe and an average digested sludge flow of 2.05 ML/d, the average daily ferric chloride consumption is estimated to be 5.3 tonnes/day, or 3.8 m^3/d, for a 38 percent $FeCl_3$ solution.

.5 The railcar unloading description is as follows:

.1 An insulated and heated shelter is provided for operator comfort and to minimize the potential for freezing.

.2 A new rail spur is installed to access the railcar shelter.

.3 The railcar is directed into the railcar shelter in accordance with CP Rail's spotting procedures. Once the railcar has arrived, the railcar shelter door is opened, and the railcar is safely brought into the shelter. The door is then closed.

.4 Railcar unloading is undertaken through the top connection on the railcar. An unloading platform is provided for access to the top of the railcar and to the compressed air and chemical unloading connections.

.5 Compressed air is used to pad the railcar, and transfer of the ferric chloride to the storage tanks. The compressed air is supplied from the existing air compressors in the Dewatering Building.

.6 Ferric chloride can be transferred to one of the two storage tanks by opening and closing the appropriate valves.

.7 Chemical unloading can be automatically or manually controlled. A control panel, located next to the unloading platform stairs, contains the unloading controls.

.8 A strainer in the transfer line from the railcar to the storage tanks traps particulate matter in the chemical. Rapid blockage of the strainer during unloading indicates a contaminated load, and the load should be rejected. Regular cleaning of the strainer is required.

.9 A chemical spillage collection system is provided, consisting of three fiberglass reinforced plastic (FRP) pans installed under the centre of the railcar and on both

sides of the track. Each pan has a 100 mm diameter drain in the centre. These drains direct the flow to the containment area in the chemical storage building.

.10 Emergency shower and eyewash stations are provided on the platform and the main floor.

.11 The ferric chloride is transferred to the storage tanks via a 75 mm diameter HDPE flexible pipe under the road. A 150 mm diameter PVC pipe is provided for containment. A drain valve on the 150 mm sleeve in the chemical storage building is periodically opened to inspect for leakage of the 75 mm pipe.

.6 The truck unloading description is as follows:

.1 Ferric chloride can also be delivered and transferred to the storage tanks from a road tanker using the truck's own compressed air system.

.2 Ferric chloride can be transferred to either storage tank by opening and closing of the appropriate valves.

.3 A strainer in the transfer line from the truck to the storage tanks traps particulate matter in the chemical. Rapid blockage of the strainer during unloading indicates a contaminated load, and the load should be rejected. Regular cleaning of the strainer is required.

.4 A spill sump with a bottom drain is provided below the unloading for spill collection. Spills flow into the containment area in the chemical storage building. A removable cover is provided for the top of the spill sump to prevent rain water and snow from building up in the pit. Before the road tanker unloads, the cover is removed

.5 An isolation valve is installed in the land drainage sewer downstream of a catch basin.

.6 Two bags of lime (25 kg) are stored in the facility; one in the railcar shelter and one in the chemical storage building. If a small spill or leak occurs external to the spill collection system, the lime is manually applied, to neutralize the chemical. The residue needs to be properly disposed of.

3.2 Chemical Storage Description

.1 Two storage tanks are provided for chemical storage. Both tanks are located in the chemical storage building adjacent to the existing Dewatering Building. Each tank has a nominal capacity of 70 m^3 which is approximately 113 percent of the volume of one railcar. The total storage volume is 140 m^3.

.2 Both tanks are placed in the lower level of the chemical storage building, 2.7 m below the main floor level. This lower level functions as a chemical containment area in case of spills. The containment area is designed to contain 110 percent of the contents of one chemical

storage tank. The 110 percent volume corresponds to a level of 1.1 m above the basement floor level.

.3 The main floor of the chemical storage building is made of FRP gratings which is resistant to ferric chloride. All leaks and spills are able to pass through the grating into the containment area.

.4 The floor of the containment area slopes towards a sump located in the south east corner. A float switch is installed in the sump pit. Once the liquid level in the sump pit reaches the float switch an alarm is activated.

.5 A manually operated butterfly valve (WV-731D) is installed in the sump pit, with the stem extended to the main floor level. A removable handwheel and stem are provided. The valve operator nut is set at the same level as the main floor. When the valve requires opening, the hand wheel and stem assembly is inserted into the nut. When in the open position, the valve directs flow into the existing sanitary sewer line. Generally, the liquid collected in the sump pit is flushing water and it can be discharged to the sewer without concern. Small amounts of chemical can also be discharged into the sewer. For a large leak, the valve position would have to be adjusted to control the rate of discharge. Alternatively, a waste disposal firm could be hired to remove the contents of the containment area.

.6 Although ferric chloride is stored in two tanks, it is normally dosed from only one tank at a time. The tank from which the ferric chloride is being pumped can be selected automatically, or by manually opening and closing the appropriate valves.

.7 Inter-connection piping and isolation valves are provided at the lower level, so that both tanks can be operated as a single unit, if required.

.8 Each tank is equipped with an observation hatch and an access port. A high-level overflow is installed in each tank. The tanks share a common overflow pipe: this means that a tank initially overflows into the other, until both tanks are full, whereupon the overflow is directed to the containment area.

.9 Each tank is also equipped with an ultrasonic level sensor. At low level, an alarm is activated and the dosing pumps stop. At high level, an alarm is activated and ferric chloride unloading stops, by the operation of the three-way valve (WV-695) and the subsequent venting of compressed air from the railcar. This automatic operation of valve WV-695 is included as an emergency safety precaution. Under normal unloading conditions valve WV-695 does not operate, as the unloading procedure is managed by the operators.

.10 A submersible level transmitter is also provided for each tank as a backup to the ultrasonic level sensor. When the high level is reached an alarm is activated and the three-way valve WV-695 vents compressed air from the railcar to the atmosphere.

.11 Each tank has an insulated and heat traced 250 mm diameter vent line to the outside of the building. If entry is required to the tank, a portable suction fan can be connected to the vent end to draw out any fumes in the tank.

.12 The tanks should be drained once each year, as a minimum, and washed down with water to flush out any sediment. Access to the tank may be required, depending on the amount of sediment and the ease with which it is flushed away. Inspections of the tank walls should be undertaken in accordance with the tank manufacturer's recommended schedule and methods.

3.3 Chemical Dosing Description

.1 Four chemical metering pumps are provided, each with a maximum capacity of 360 L/hr. Three pumps are duty units, and are skid mounted. The fourth pump is a shelf standby. The pumps are magnetically driven external gear pumps with variable speed drives.

.2 Each duty pump transfers the ferric chloride to one injection point. However, inter-connections in the discharge lines allow flexibility in the choice of dosing locations for each pump. Adjustment of the dose rate is done manually, either local to the pump or remotely from the Distributed Control System (DCS).

.3 Adjustment of the pump speed is required to comply with the Licence limits for centrate phosphorus load. Manual adjustment is undertaken following review of laboratory analytical results.

.4 The operation of the gear pumps is interlocked with existing equipment as follows:

.1 The pump that doses to the raw sludge piping is interlocked with magnetic flowmeter FE-P700, to ensure that chemical is not dosed into the sludge piping when there is no sludge flow.

.2 The pump that doses to the digested sludge is interlocked with Pumps W350-DSP and W360-DSP, to ensure that chemical is not dosed into the sludge piping when there is no sludge flow.

.3 The pump that doses to the centrate is interlocked with Centrifuges W112-CE, W122-CE, W132-CE, W142-CE, W152-CE, and W162-CE, to ensure that chemical is not dosed into the centrate piping when there is no centrate flow.

.5 Each injection line has a strainer located in the suction line upstream of the pump. The strainer removes any particles large enough to damage the pumps. The strainer requires regular claeaning.

.6 A high pressure switch on the pump discharge shuts down the dosing pumps when the pressure increases above the set-point.

.7 A pressure relief valve is provided in the discharge line for high pressure relief. Activation of the pressure relief valve diverts flow back to the tank.

.8 Back pressure valves (WV-740L, WV-750L, and WV-760L) are provided on the discharge line of each pump, to ensure that the check valves (WV-740F, WV-750F, and WV-760F) function properly.

.9 A flow meter (FE-740, FE-750, and FE-760) is provided on each line, with output to the DCS.

.10 The pumps transfer the ferric chloride solution to three injection points in 25 mm diameter HDPE tubing. A 50 mm diameter PVC containment pipe surrounds the 25 mm diameter tubing.

.11 Chemical is fed to three different injection points:

.1 A 150 mm diameter branch line off the 200 mm diameter primary sludge line in Gallery No. 3 that transfers raw sludge to the digesters. A plug valve is included in the 200 mm line, to allow adjustment of the flow to the branch line.

.2 A 250 mm diameter digested sludge line in the Dewatering Building that transfers sludge to the centrifuges

.3 A 300 mm diameter centrate line in the Dewatering Building that transfers centrate to the sewer.

.12 If a dosing lines is not used, it should be flushed with water.

.13 Chemical fed into the primary sludge provides the added benefit of struvite control in the downstream processes. The use of ferric chloride in this location may help in the control of hydrogen sulphide in the biogas. The dose-response relationship for phosphorus removal is relatively long due to the large retention time in the digesters.

.14 Chemical fed to digested sludge, upstream of the centrifuges, also provides the benefit of struvite control in the downstream processes. The dose-response relationship for this location is relatively rapid.

.15 Chemical fed into the centrate allows the phosphorus precipitate to be removed in the primary clarifiers. This in turn provides some control on struvite in the sludge system, although the dose-response relationship is relatively long. This dosing point allows dilution of the chloride ions (from the ferric chloride) with the mainstream wastewater, minimizing the risk of corrosion caused by high chloride concentrations.

.16 Pump components should be checked, maintained and replaced in accordance with the manufacturer’s recommendations.

.17 All chemical piping should be regularly inspected for leaks, and repaired when necessary.

4. OPERATING DESCRIPTIONS

4.1 Control Devices

	Location	Qty	Function
Unloading start pushbutton	Local	2	Starts the railcar or truck unloading procedure
Unloading emergency stop pushbutton	Local	4	Stops railcar or truck unloading
Alarm reset pushbutton	Local	2	Resets the railcar or truck unloading procedure after an alarm condition.
Three-way valve O/C/R switch	Local	1	Select valve control from OPEN to CLOSE to REMOTE
Motorized valve LOR switch	Local	4	Select valve control from LOCAL to OFF to REMOTE
Motorized valve open/close switch	Local	4	Opens and closes valve
Speed adjuster	Local	3	Adjusts speed of pump
COH Switch	Local	3	Select pump control from COMPUTER (automatic) to OFF to HAND (local)
LOS Switch	Local	3	Select pump control from LOCK to OFF to STOP
Alarm reset pushbutton	Local	3	Resets the pump after an alarm condition

4.2 Chemical Unloading Operation

.1 Railcar unloading

.1 The chemical unloading system is basically a manual operation assisted by some automatic control elements for quick response and easy controlling.

.2 Before starting the unloading process, the operator must first check that the railcar is properly spotted, following the standard spot procedures outlined by CP Rail. The operator must also follow any and all procedures outlined by the chemical supplier.

.3 Check to ensure the blue flag is in place and that the track is locked out as required.

.4 Check the railcar ID numbers and placards for accuracy.

.5 Inspect the railcar and make sure the brakes are set and wheels are chocked.

.6 Inspect the 250 mm diameter vents at the chemical storage building and the 25 mm diameter vent at the railcar shelter for blockages. Remove any blockages.

.7 The chemical unloading control system monitors liquid levels in the storage tanks (LE-W710 and LE-W720), valve status (for WV-705 and WV-706), unloading air pressure (W695), and unloading flow rate (FE-W701). The tank levels and liquid flow rate are also displayed on the local unloading control panels.

.8 The system allows for simultaneous filling of both storage tanks; when one tank is full, its inlet valve closes and the other tank continues to fill.

.9 The control system turns on the "READY TO UNLOAD" indicator when the total available spare capacity in both storage tanks is greater than a preset volume (enough to accommodate a full railcar volume plus a safety margin).

.10 The operator manually verifies the tank liquid level readings on the unloading control panel.

.11 The operator manually opens the tank railcar lid and performs a volt test if required on the railcar following the established procedure outlined by the chemical supplier.

.12 If needed, the operator takes a sample of the chemical.

.13 The operator closes and secure the hatch bolts evenly.

.14 The operator removes the blind caps from the air inlet port and the chemical discharge port on the railcar.

.15 The operator winches the chemical hose down to the railcar. The operator manually connects the liquid discharge hose to the railcar.

.16 The operator manually connects the air padding hose to the railcar.

.17 The operator opens the liquid line isolation valve, ensuring that there is no pressure in the railcar.

.18 The operator then goes downstairs to the unloading control panel to check and adjust the pressure regulator setting. For the first unloading the pressure can be set at 120 kPa. For subsequent unloading the pressure can be adjusted as desired. The pressure setting must not exceed 240 kPa.

.19 A high air pressure in the railcar is not desired. The railcar should be unloaded in 4 to 6 hours with a chemical flow rate of 10 to 15 m^3/hr. The chemical flow rate is normally high at the beginning and low at the end of the unloading procedure.

.20 The operator initiates the unloading procedure by pressing the START button on the control panel.

.21 When unloading starts the operator must monitor the tank liquid level readings on the unloading control panel.

.22 The control system starts by opening the tank inlet valve (WV-705) for the filling of tank W-710 (or valve WV-706 for tank W-720).

.23 When the valve (WV-705 or WV-706) is confirmed open, the control system operates the three-way air inlet valve (W695) so that compressed air is directed to the railcar.

.24 The operator opens the air flow control valve (WV-695H) slowly and begins to pressurize the railcar. A bypass air control valve (WV-695J) and can be used in case WV-695 is out of order.

.25 When the chemical begins to flow, the operator checks the whole piping line for leakage.

.26 The system allows for simultaneous filling of both storage tanks. When one tank becomes full, its inlet valve (WV-705 or WV-706) closes and filling continues in the other tank.

.27 The operator must stay in attendance with the railcar at all times when the unloading connections are attached. Railcars are not allowed to stand with unloading connections attached after unloading is completed.

.28 Unloading normally continues until the railcar is empty.

.29 When the railcar is empty, the air pressure blows out the transfer lines resulting in the flow reading on FE-W701 dropping to zero together with a drop in unloading air pressure (measured and transmitted on PIT-W695). Either the flow meter reading or the pressure reading indicates to the control system that the railcar is empty. After a time delay, the control system then stops air flow by turning the three-way valve (WV-695) to the vent position and vent the railcar pressure to atmosphere. The time delay is required to purge the railcar atmosphere of corrosive gas. The tank inlet valves (WV-705 and WV-706) are closed after operation of the three-way valve.

.30 Unloading can be manually stopped in progress or when complete by pressing the emergency stop device (ESD) at the railcar unloading panel, truck unloading panel, railcar platform, or in the chemical storage building. This action immediately stops the air flow by venting the compressed air to atmosphere via valve WV-695. In addition, the storage tank valves (WV-705 and WV-706) close, and an alarm initiated. This emergency operation may cause an acidic mist to pass from the railcar to the three-way valve. After an emergency stop, it is necessary for the operator to flush the air piping with water. Water is added into the air piping at the platform for draining through the three-way valve to the spill sump. Draining to the spill sump requires closure of valve WV-696B and opening of valve WV-696D. After flushing, the operator uses compressed air to dry the piping.

.31 The control system, on detecting high unloading air pressure (PIT-W695) assumes failure, pipe blockage, or incorrect setting of the pressure regulating valve (WV-695B) and initiate alarm and shutdown.

.32 The control system, on detecting high level in either of the storage tanks initiates alarm and shutdown.

.33 The control system, on detecting failure or non-responsiveness of a control valve initiates alarm and shutdown.

.34 If leakage is observed in the chemical transfer line, the operator must stop unloading using the ESD. Once the pressure reading (PIT-W695) reaches zero, valve WV-707B must be opened to drain chemicals into the sump pit. If leakage occurs in the transfer line ahead of the strainer, open valve WV-701K to drain chemical into a container. If the strainer clogs, open both valves WV-701H and WV-701K to drain chemical before replacing or cleaning the strainer.

.35 The compressed air venting lines are directed both inside and outside of the railcar shelter. The inside venting line terminates at the sump pit with a 25 to 50 mm diameter increaser; the outside venting line terminates at approximately 1000 mm above ground level with bird and insect screen. Valve WV-696B is for venting to outside and is normally open. Valve WV-695D is only used in cold weather when there is a risk of freezing.

.36 To stop unloading a railcar for any reason, all connections must be disconnected. All valves must be tightly closed, and all other openings securely closed.

.37 Resuming unloading after an ESD or safety shutdown may require bypassing of the "READY TO UNLOAD" interlock. The control system does not turn on the "READY TO UNLOAD" light because the tank level(s) may no longer be low enough. In this case, the DCS operator is provided with a non-latching override for the "READY TO UNLOAD" permissive. Restart of unloading is initiated by pressing the local START button again.

.38 Once unloading is complete the operator isolates and disconnects the liquid and air lines, ensuring that the system is fully vented prior to disconnecting by checking the local pressure gauge PIT-W695. The operator removes the flexible air piping and hangs it on the rack on the platform.

.39 The operator disconnects the flexible chemical piping from the railcar, and put the end of the piping into a barrel. The operator attaches the pipe and barrel to the pulley system and winches them away from the railcar.

.40 The operator reinstalls the blind caps on the railcar using well-lubricated Teflon coated bolts. The operator securely fastens all bolts making sure one flat washer is on the top and the bottom. As soon as the railcar is completely unloaded, all valves must be tightened with a wrench or other suitable tool. The unloading connections must be removed and all other closures made tight.

.41 WV-695E is provided so that compressed air can blow out residual chemical from the transfer line. Opening valve WV-695E requires one of the chemical storage tank inlet valves (either WV-705 or WV-706) be in the OPEN position. The operator opens WV-695E slowly for a few minutes.

.42 The operator removes all other equipment from the railcar.

.43 The operator raises the access walkway and secures it in place with a chain.

.44 The operator descends from the platform and closes air valve WV-695H.

.45 The operator performs an outbound inspection on the railcar by following the established procedures provided by the chemical supplier and railway authorities.

.46 In addition to the procedures described above, the operator follows procedures provided by the railway authorities and chemical supplier.

.2 Truck unloading

.1 Truck unloading is essentially the same process as railcar unloading except that the truck is equipped with its own unloading system (typically air padding) which is manually controlled by the driver.

.2 The operator needs to first close the valve on the outlet of the catch basin in the land drainage sewer.

.3 The operator removes the cover over the spill sump under the unloading connection outside the railcar shelter.

.4 The control system turns on the "READY TO UNLOAD" indicator when the total available spare capacity in both storage tanks is greater than a preset volume (enough to accommodate full truck/trailer volume plus safety margin).

.5 The operator manually verifies the tank liquid level readings on the unloading control panel.

.6 The driver manually vents any built-up pressure or vacuum from the truck using the chemical supplier’s procedure.

.7 The driver manually connects the liquid discharge hose to the truck.

.8 The driver manually opens the isolation valve (WV-702) for the liquid line.

.9 The operator initiates unloading by pressing the START button.

.10 The control system opens the valve (WV-705 or WV-706) for the tank(s) to be filled.

.11 The driver starts the truck-mounted unloading compressed air system.

.12 The system allows simultaneous filling of both storage tanks. When one tank is full, its inlet valve closes and filling continues in the other tank.

.13 Unloading normally continues until the truck is empty. The driver then manually stops the compressed air system.

.14 When the truck is empty, air pressure blows out the transfer lines resulting in the flow reading (FE-W701) dropping to zero together with a drop in unloading air pressure (monitored on the truck). At this time, the control system detects the empty truck and closes the tank inlet valve(s).

.15 Unloading can be manually stopped in progress, or when complete, by pressing the ESD button at either of the local panels, at the platform, or in the railcar building. This action immediately closes the storage tank inlet valve(s) and initiates an alarm.

.16 The control system, upon detecting high level in either of the storage tanks, initiates alarm and shutdown.

.17 The control system detecting failure or non-responsiveness of a control valve initiates alarm and shutdown.

.18 Resuming unloading after an emergency stop or safety shutdown may require bypassing of the "READY TO UNLOAD" interlock. The control system does not turn on the "READY TO UNLOAD" light because the tank level(s) may no longer be low enough. In this case, the DCS operator is provided with a non-latching override for the "READY TO UNLOAD" permissive. Unloading is resumed by pressing the local start button again and restarting the blower if it was stopped.

.19 The driver isolates and disconnects the liquid and air lines at this time, ensuring that the system is fully vented prior to disconnecting.

.20 The driver closes the isolation valve (WV-702) and disconnects the chemical line.

.21 The driver locks out or isolates the truck-mounted compressed air system.

.22 Once unloading is completed, the driver opens the gate valve in the LDS line from the catch basin.

.23 If there are any chemical drips or leaks the driver flushes it to the spill sump with water. In the winter, flushing water is not used: lime is applied to the spill.

.24 The driver replaces and tightens the spill sump cover.

.25 In addition to the procedures described above, the operator and driver are required to follow procedures provided by the chemical supplier.

4.3 Chemical Storage Operation

.1 The outlet valves (WV-710B and WV-720B) on the tanks are normally be open.

.2 The tank drain valves (WV-710D and WV-720D) on the tanks are normally closed.

.3 Liquid can be transferred from one tank to the other tank by opening the two drain valves (WV-710D and WV-720D) and closing the interconnecting valve (WV-731B).

.4 Normally, one of the two actuated valves (WV-715 or WV-725) is in the OPEN position to direct chemical from one of the storage tanks to the pump skid.

.5 Piping is arranged such that it is combined into a common header with isolation valves. Chemical can be withdrawn from either of the two storage tanks (T-710 or T-720) or directly from the railcar if needed, by opening valve WV-707.

4.4 Chemical Dosing Operation

.1 At initial start-up the pumps require priming. If the duty tank is full, priming occurs naturally due to the head. If the duty tank level is low, and the standby tank is full, valve WV-715C is opened to provide priming head to the pumps. If the piping to the pump skid contains fluid, priming of the pumps is not necessary, irrespective of the tank levels.

.2 In normal operation the COH switch is in the COMPUTER position, and the pump speed is controlled from the DCS.

.3 Local speed control can be undertaken with the COH switch in the HAND position.

.4 The three pumps (P-740, P-750, and P-760) transfer the ferric chloride to the three injection points, as appropriate. It is likely that, under most conditions, only one or two pumps operate.

.5 Pressure relief valves (WV-704G, WV-750G, WV-760G) on the pump discharge prevent over-pressure of the discharge piping. When activated, the valves direct excess flow to the chemical storage tank(s) through the vent line. Valves WV-741H and WV-741J control which tank receives the flow.

.6 Back pressure valves (WV-740L, WV-750L, and WV-760L) are used to adjust the discharge pressure.

.7 Pressure switches (PSH-W740, PSH-W750, and PSH-W760) are used to detect high pressure and shut the pumps down.

.8 The ultrasonic level sensors (LE-W710, LE-W720) monitors the chemical level in the tanks and automatically stops the pumps on low-level and activated an alarm.

.9 Pump status is output to the DCS.

.10 A calibration column is provided for calibration of the pumps. The column is normally filled by gravity when the chemical level in the storage tanks is high enough. If the chemical level in both tanks is low, the calibration column can be filled by the pump by opening valve WV-741D and closing valve WV-741F.

.11 A water supply line is provided for flushing of the pump. Flushing water is fed to the pumps by opening valve WV-716B and valves WV-740E, WV-750E, and WV-760E. Valves WV-740E, WV-750E, and WV-760E can also be used for draining of the suction lines, but requires opening of WV-716D.

.12 The pump discharges are interconnected; flow can be directed as desired via of valves WV-740M and WV-760M.

.13 Pumps are drained via valves WV-740Q, WV-750Q, and WV-760Q.

END OF SECTION

1. GENERAL

1.1 Description

.1 This section specifies the requirements for fibreglass reinforced plastic fabrications and equipment including items fabricated with resins but employing glass and other fibre filaments for structural reinforcement.

.2 Conform to the general requirements of Section 11005, unless otherwise specified.

1.2 Reference Standards

.1 AMCA 500-D, Laboratory Methods of Testing Dampers for Rating

.2 ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

.3 ANSI B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24

.4 ANSI/AWWA C950, AWWA Standard for Fiberglass Pressure Pipe

.5 ASME/AINSI RTP-1, Reinforced Thermoset Plastic Corrosion Resistant Equipment

.6 ASTM C581, Standard Method of Determining for Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures Intended for Liquid Service

.7 ASTM C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment

.8 ASTM D570, Standard Test Method for Water Absorption of Plastics

.9 ASTM D638, Standard Test Method for Tensile Properties of Plastics

.10 ASTM D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

.11 ASTM D883, Standard Terminology Relating to Plastics

.12 ASTM D2563, Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts

.13 ASTM D2583, Standard Test for Indentation of Plastic by Means of a Barcol Impressor

.14 ASTM D2584, Standard Test Method for Ignition Loss of Cured Reinforced Resins

.15 ASTM D3299, Standard Specification for Filament-Wound Glass-Fiber Reinforced Thermoset Resin Corrosion-Resistant Tanks

.16 ASTM D3567, Standard Practice for Determining Dimensions of Reinforced Thermosetting Resin Pipe and Fittings

.17 ASTM D3982, Standard Specification for Contact Molded Fiberglass (Glass Fiber Reinforced Thermosetting Resin) Duct and Hoods

.18 ASTM D4097, Standard Specifications for Molded Glass-Fiber Reinforced Thermoset Resin Corrosion-Resistant Tanks

.19 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials

.20 The Society of the Plastics Industry, Inc., Recommended Practice for Shipping and Installation of Reinforced Plastic Pipe, Duct, and Tanks

.21 NFPA No. 30, and Combustible Liquids Code

.22 CAN/CGBS-41-22 Standard for Process Equipment: Reinforced Polyester, Chemical Resistant, Custom Contract Moulded

.23 CAN/ULC-5118-M86, Standard Methods of Test for Air Ducts

.24 The Manitoba Building Code

.25 Abide by the current bylaws and regulations of the Province of Manitoba, the regulations of the Occupational Health and Safety Act, the Worker's Compensation Board, and other applicable acts administered by the authority having jurisdiction in the Province of Manitoba that apply to the work described herein.

1.3 Definitions

.1 The definitions sent forth in CAN/CGSB-41-22 apply to this work.

1.4 Submittals

.1 Provide shop drawings in accordance with the requirements of Section 01300 and Section 11005. In addition, provide the following information:

.1 Manufacturer and method of fabrication

.2 Materials selected for laminates to be furnished for this project

.3 Installation procedures, including field jointing techniques

.2 Quality Control Submittals

.1 Qualifications

.1 Fabricator qualifications: minimum 5 years of experience

.2 Installer qualifications: minimum 5 years of experience

.2 Allowable visual defects

.1 Visual defects as defined in ASTM D2563 and in ASME/ANSI RTP-1 Table 6-1.

.2 Minimize the amount of defects in all laminates. Visual defects in any area of the equipment is not to exceed the maximum allowable levels of visual defects indicated in RTP-1, Section 940 and Table 6-2, level 1.

.3 Presence of visual defects in excess of the allowable levels of RTP-1 Table 6-1 shall be grounds for rejection of the equipment. Listed quantities apply to small localized areas and are not to be averaged over larger areas.

1.5 Other Submittals

.1 In addition to the submittals specified in Section 11005, provide the following for information only in accordance with Section 01300:

.1 Special shipping, storage and protection, and handling instructions.

.2 Manufacturer's written installation instructions, including

.1 Installation instructions indicating assembly, mounting and anchorage requirements, alignment and assembly tolerances, and points of connection for ancillary services.

.2 Manufacturer’s Certificate of Compliance.

.3 Manufacturer’s Certificate of Proper Installation.

.3 Test reports

1.6 Quality Assurance

.1 Fabricator is to be responsible for implementation of a quality assurance procedure, with the following minimum requirements:

.1 Designate personnel to inspect equipment while in-process and after completion to assure compliance to all aspects of the specification and design drawings. Inspection to include, as a minimum; checks for visual defects, laminate thickness and sequence, glass content, Barcol hardness, dimensional tolerances, adherence to construction details, surface preparation, and environmental conditions. Complete a report of the findings including method of measurement for each separate assembly.

.2 Inspect all glass reinforcement prior to use in fabrication and shall not use any glass that does not meet the manufacturer’s acceptance standards. Glass material that is wet or has been wet shall not be used. For each type and glass and lot number used, fabricator shall record the manufacturer, product code, production date, and lot number.

.3 Retain all nozzle cutouts and other excess laminate, clearly marking each piece to identify its original location. These laminate samples become the property of the City. For areas where valid laminate samples are not available, sample plugs shall be taken at

the Contract Administrator's request. Repair of subsequent holes will be performed in a manner approved by the Contract Administrator.

.4 Verify glass content on available samples in accordance with ASTM D2584 at the rate of one test per 100 square metres of surface area. This test to be completed, and the results reported for each major component where samples are available.

.5 Prior to final shipment of the equipment, submit fabricator control report, consisting of copies of all records maintained for compliance with this section.

.2 Test tolerances.

.1 Barcol hardnesses to be 90 percent of Manufacturer's recommended hardness.

.2 Glass contents to be within the range shown on the Manufacturer's Shop Drawings for each type of laminate.

.3 Product tolerances.

.1 General: reject any FRP specialty item which does not satisfy the tolerances specified in this section.

.2 Tolerances

.1 Section uniformity: uniform wall, flange and edge thicknesses to within plus or minus 1 mm in 300 mm.

.2 Colour: items of a similar nature or subassemblies of a single unit will be similar in colour.

.3 Unless otherwise specified, the out-of-round tolerance for cylindrical sections 300 mm in diameter and greater is one-half that listed in ASTM D4097 for ductwork.

.4 The out-or-round tolerance for cylindrical sections smaller than 300 mm in diameter is as listed in American ASTM D4097.

.5 Out-of-parallel tolerance for rectangular and square sections is as specified for out-of-round.

.6 Flanges: flange faces are flat and true to a tolerance of plus or minus 1 mm for tanks and vessels and 1 percent of the nominal diameter of 3 mm for ducts, whichever is less.

.7 Variation in manhole flange thicknesses is within plus or minus 2 mm. Variations in all other flanges are within plus or minus 1 mm.

.8 Tolerance in bolt hole locations and in bolt circle diameter is within plus or minus 2 mm.

.9 Thicknesses shown on the manufacturer's Shop Drawings are construction minimums.

1.7 Factory Inspection

.1 Provide factory access to the Contract Administrator or its designated representative during fabrication and upon completion for the purpose of verifying compliance to the contract documents. The inspection is not intended to replace the fabricator's own quality control procedures.

.2 In no respect does inspection of any equipment by the Contract Administrator or designated representative relieve the fabricator of compliance with the contract documents. A final inspection will be performed by the Contract Administrator or its designated representative when the fabricator certifies that all the terms and requirements of the contract documents have been satisfied. Give at least five days notice prior to this inspection.

.3 Notify the Contract Administrator or its designated representative at the completion of particular milestones during fabrication. Give at least 48 hours notice prior to occurrence of these milestones. The milestones are as follows:

.1 View tooling prior to fabrication

.2 Beginning application of corrosion liner for each part

.3 Extraction of each part prior to beginning assembly.

.4 Completion of each separate assembly

.4 The Contract Administrator reserves the right to include additional milestones.

.5 In the event the equipment is not to the stage of completion designated for a milestone inspection or is not complete as required for a final inspection at the time specified by the fabricator, the fabricator will assume the cost of the inspector's time and expenses and deduct such charges from the cost of the equipment.

.6 Allow the Contract Administrator or its designated representative to photograph the equipment while in-process and upon completion.

.7 The Contract Administrator retains the right to employ the use of magnification or other special viewing or measurement devices during inspection.

.8 Assure that at the time of final inspection, the equipment is cleaned of all foreign material and workings which might block the view. Position the equipment to allow for easy access and viewing and, at the request of the Contract Administrator, move the equipment to allow viewing of all parts.

.9 Evidence of poor Workmanship or lack of compliance with any aspect of the Contract Documents will be grounds for rejection of the equipment.

.10 Subsequent repair of rejected equipment may, at the Contract Administrator's option, be undertaken in an attempt to bring the equipment to an acceptable state. Repair procedures must be approved by the Contract Administrator prior to implementation.

.11 The Contract Administrator may employ destructive testing, such as ultimate tensile of flexural strength tests or glass content ignition tests, on available samples or use other non-destructive test methods, such as acoustic emission or ultrasonic polygauge thickness measurement, on the completed equipment for verification of compliance to the Contract Documents.

.12 Testing performed by the Contract Administrator will be accomplished through use of applicable ASTM test methods when appropriate.

.13 Make hardness tests for acceptance by the Contract Administrator on the liner surface using the Barcol impressor, Model GYZJ 934-1, calibrated at two points in accordance with ASTM D2583. Take ten readings in a localised area, deleting the two highest and two lowest, and averaging the remaining six. Minimum acceptable Barcol hardness will be a reading of 30 unless otherwise specified in the pertinent equipment section.

.14 An acetone sensitivity test may also be performed by the Contract Administrator as acceptance criteria. Evidence of a sticky or tacky surface following rubbing with an acetone-saturated cloth will be grounds for rejection of the equipment.

1.8 Coordination

.1 Refer to Section 11005 for general coordination requirements of the equipment supplied with piping, structures, structural supports, drainage, ventilation and cooling, and other ancillaries specified in other Divisions.

1.9 Guarantee

.1 Provide thermal, mechanical, and hydraulic guarantees from the manufacturer.

2. PRODUCTS

2.1 Materials

.1 Resins

.1 Resins used for FRP specialties exposed to view will contain a minimum of 3 percent antimony trioxide or other fire retardant agent and will have flame spread of 25 or less based on ASTM E84. Add agents to structural wall only, not to the corrosion layer.

.2 Resin to be selected by fabricator, subject to approval of the Contract Administrator and suitable for intended service.

.3 Liner resin: premium grade and corrosion resistant

.4 Structural wall resin may be of different chemical resistance, subject to conditions of service and approval of Contract Administrator.

.5 The Contract Administrator will review the fabricator's choice of resin/catalyst before fabrication begins to verify compliance to the resin manufacturer's recommended procedures.

.6 Add UV absorbers to surfacing resin to improve weather resistance for externally installed ducting and equipment.

.7 Add no thixotropic agent to resins used for a corrosion barrier. Thixotropic agent in the proportion and of the type recommended by the resin manufacturer may be added for viscosity control of resins not used for a corrosion barrier.

.1 The quantity of thixotropic agent added must not interfere with visual inspection of the laminate.

.8 Fabricate components using the resins specified in the pertinent section. Unless specified otherwise, use the same resin throughout all laminates of that component.

.9 Resins must meet flame spread requirements.

.10 No other fillers, including pigments, dyes and colorants, are permitted, unless reviewed and approved in writing by the Contract Administrator.

.11 Repair any damage to the paint coat occurring during installation promptly, restoring the paint coat to the original condition.

.2 Reinforcement

.1 Use commercial grade corrosion-resistant borosilicate glass for reinforcement.

.2 Unless otherwise specified, provide Type C glass 0.25 mm thick protective veil surfacing mat with silane finish and styrene-soluble barrier for interior and exterior surfaces.

.3 Surfacing veils for applications where the glass may be attacked by compounds in the process is a suitable spun-laced synthetic organic entangled fibre fabric, such as Nexus, not less than 500 microns in thickness, backed by chopped strand in a Type A resin.

.4 Unless otherwise specified, provide Type E glass, 0.45 kg/m^2 with silane finish and a styrene-soluble binder for chopped strand mat.

.5 Use Type E glass with chrome finish or silane coupling agent for continuous roving used in chopper guns for spray-up.

.6 Use Type E glass with silane-type finish for continuous roving used for filament winding.

.7 Woven roving is Type E glass, 0.80 kg/m^2, 5 by 4 weave, with silane-type finish.

.8 Woven cloth is Type E glass with silane-type finish.

2.2 Fabrication

.1 General

.1 Physical properties: meet or exceed requirements of ASTM D3982 and ASTM C582.

.2 Squareness of ends, fittings, elbows, and butt joints shall meet or exceed requirements of ASTM D3982.

.3 Keep use of flanges to a minimum; butt joints are preferred method of joining sections of duct, unless otherwise indicated on drawings.

.4 Butt joints shall only be permitted in duct sections that are accessible for inside overlay. Internal overlay to consist of two layers of 0.45 kg per square metre of fiberglass mat followed by one layer of surfacing veil, as a minimum.

.5 Flanges for duct-to-duct connections and duct wall thicknesses: ASTM D3982, rated for specified pressure and vacuum.

.6 Flange dimensions (except thickness) and drilling patterns for flanges that connect to equipment, valves, or dampers are to correspond to ANSI B16.5, Class 150 or ANSI B16.1, Class 125.

.7 Furnish gussets on flanged nozzles from ducts.

.8 Back face of flanges: spot-faced, flat and parallel to flange face, and of sufficient diameter to accept ANSI metal washer under bolt head or nut.

.9 Fabricate FRP items by contact moulding, or filament winding.

.10 Ensure that moulds conform to the following:

.1 Moulds constructed of Masonite, wood, or other porous material must be completely covered with mylar or other suitable material to produce a smooth and glossy inner surface on the FRP equipment.

.2 Moulds and mandrels must be hard-surfaced such that working the wet laminate will not cause local displacement of the material or air entrapment. Covering of mandrels with cardboard is not advised and must be reviewed by the Contract Administrator prior to start of fabrication.

.3 Certain construction details shown on the Manufacturer's Shop Drawings assume the availability of specific tooling and/or moulds. Alternate mould configurations may be considered by the Contract Administrator in the interest of cost savings or betterment. Any deviations from the dimensions shown on the manufacturer's shop drawings must be reviewed by the Contract Administrator prior to the start of fabrication.

.11 Fabricate laminates in accordance with the following:

.1 Reinforce inner surface of ducts with resin-rich surfacing veil 0.254 mm to 0.508 mm thick.

.2 Construct interior layer of resin reinforced with at least 2 plies of chopped strand mat; thickness at least 2.54 mm.

.3 Glass content of combined inner surface and interior layer shall be 27 percent plus or minus 5 percent.

.4 Use positive methods to assure uniform total thickness of the laminate and uniform glass-to-resin ratio without surplus resin or unsaturated glass. Ensure specified glass content is in accordance with ASTM D2584.

.5 Interruptions in laminating sequence must only occur after exotherm plies (E or e). If an exotherm interruption becomes otherwise necessary, ensure it follows the application of a ply of mat and is succeeded by a ply of mat.

.6 Do not exceed 24 hours during laminating sequence interruptions. Retain acetone of the in-process surface until laminating is resumed. Lack of compliance with these procedures, or any indication that contamination of the surface has occurred, will require that surface preparation be accomplished before resuming. Before resuming lamination, touch-ground any rough areas or projections to allow full contact of the succeeding wet laminate.

.7 An exotherm interruption is specifically prohibited within the corrosion liner. Limit an exotherm interruption between the corrosion liner and the structural layers to a maximum of four hours.

.8 Chopped strand glass applied by chopper gun is allowed in lieu of mat layers in the structural laminates only. Mechanically control the application in order to assure uniform thickness and glass-to-resin ratio. The specific methodology must be reviewed by the Contract Administrator prior to fabrication. Chopper gun application of the corrosion liner is not allowed unless specified in Part 2 of the pertinent equipment section.

.9 Coat all non-mould surfaces with resin containing wax additive in the amount necessary to allow full cure of the surface. In the case of interior primary corrosion surfaces such as interior overlays, apply this wax coat within 24 hours of original lamination. In the case of exterior surfaces, ensure this wax coat also contains a UV stabilizer in the type and amount recommended by the resin manufacturer.

.10 Ensure that the exterior surface of all equipment is resin rich and reinforced with one layer c-glass surfacing veil, except as otherwise specified.

.11 When specified in Part 2 of the pertinent equipment section, apply the exterior coat as an opaque pigmented surface coat, apply only after Contract Administrator’s inspection. Colour will be selected by the Contract Administrator.

.12 Do not perform saturation of reinforcement prior to application to equipment on waxed paper or other contaminated material. Saturation of reinforcement of clean paper or cardboard is allowed.

.13 Thoroughly coat all cut edges with resin so that no glass fibers are exposed. Seal cut edges exposed to the corrosive service with a liner laminate. Fill all voids with resin putty.

.12 Fabricate the corrosion liner laminates in accordance with the following:

.1 Fabricate the inner (corrosion service) surface of all laminates resin-rich and reinforced with surfacing veil of the type and number of layers specified.

.2 The interior layer of the corrosion liner of 0.459 kg/m^2 mat in the number of layers specified in Part 2 of the pertinent equipment section. Roll each ply separately to remove entrapped air.

.3 Chopped glass applied by chopper gun is not allowed in the corrosion liner except as specified in Part 2 of the pertinent equipment section.

.4 All plies of the inner surface and interior layer are to gel completely before proceeding with the structural laminates, but in no case exceed four hours interruption. The surface must retain acetone sensitivity until the structural laminate is applied. Lack of compliance to either of these will cause rejection of the corrosion liner.

.5 Do not use a separately cured unreinforced gel coat.

.2 Contact moulding

.1 Unless otherwise specified or approved, contact moulding fabrication is in conformance with ASTM D4097.

.2 Sequence of lay-up

.1 Provide an interior surface corrosion barrier consisting of the specified laminate. Laminate thickness is 2.5 mm minimum. Do not use a separately cured unreinforced gel coat.

.2 Unless otherwise specified, provide an interior surface resin rich, smooth and reinforced with a 0.25 to 0.50 mm Type C glass surfacing veil saturated with resin.

.3 Cover the interior surface layer with a minimum of 0.90 kg/m2 of chopped strand mat and resin in two plies of 0.05 kg/m2 mat saturated with resin.

.4 Allow corrosion liner laminate consisting of the layers specified to gel.

.5 For laminates 5 mm nominal thickness, mat plies or spray-up continue as required with adequate rollout between the application of each chopped pass or mat.

.6 For laminates 5 mm nominal and thicker, mat (0.05 kg/m^2) or spray-up and woven roving (0.80 kg/m^2 4 by 5 weave) is applied to the total required to achieve the desired nominal thickness. Two adjacent plies of woven roving will not be permitted. Each ply or pass is separately rolled out. Reinforcement for laminates having a nominal thickness of 5 mm will include at least one ply of woven roving.

.7 If interruption of laminate buildup is required for exotherm, such interruption is permitted only after every third ply of woven roving has been laid.

.8 Unless otherwise specified, provide an exterior surface corrosion barrier of 2.5 mm minimum thickness for buried FRP storage tanks and for FRP specialties exposed to corrosive exterior environments. Corrosion barrier consists of a two-pass chop, Type C glass veil and resin as specified in paragraphs 2 and 3. Exterior surfaces of FRP specialties not exposed to corrosive environments is Type C glass veil and resin, 0.40 mm minimum thickness.

.9 Ensure that the outer surface of the fabricated product is relatively smooth and has no exposed glass fibres exposed.

.10 Incorporate paraffin for full cure in the final coat of resin.

.11 Lap all edges of reinforcement material 25 mm minimum for mat and 50 mm minimum for woven roving. Stagger lapped edges of adjacent layers.

.12 Seal all cut edges on parts which will make up a secondary joint or be incorporated into a finished product first with at least two coats of lay-up resin.

.3 Filament Winding

.1 Unless otherwise specified, perform filament winding fabrication to conform with ASTM D3299. Sequence of laminate construction as follows:

.1 Provide and interior surface corrosion barrier consisting of the specified laminate. Laminate thickness is 2.5 mm. Do not use a separately cured unreinforced gel coat.

.2 Surfaces exposed to the fluids to be encountered is resin rich, smooth, and reinforced with a 0.25 to 0.5 mm thick Type C glass veil mat saturated with resin.

.3 The inner surfacing layer is followed with a minimum of 0.90 kg/m2, or more of chopped strand mat and resin in a minimum of two plies saturated with resin. Glass content of this portion of the laminate is 25 to 30 percent by weight. For laminates 12 mm and thicker, the nominal 2.5 mm layer is a thickness of at least 2.2 after curing.

.4 Subsequent reinforcing is resin-saturated, continuous roving, as may be required to satisfy all other requirements of this specification.

.5 Additional chopped roving and/or unidirectional roving resin may be sprayed up between winding cycles to provide improved resistance to interlaminar shear. This will result in a wall thickness greater than specified.

.6 For each complete cycle of filament winding, form a closed pattern of winding bands which completely covers the surface with two bi-directional layers. For each layer use a maximum of one roving in thickness. For singular cycles do not exceed a thickness of 1.3 mm, unless otherwise specified in the pertinent equipment sections.

.7 Unless otherwise specified or approved, provide a 55 degree helix angle of winding as measured from the centerline of revolution of the component shell. Tolerance on helix angle is +2 degrees, unless otherwise noted in the pertinent equipment sections.

.8 If for any reason, winding is interrupted to the point where the outer surface is gelled or exotherm temperatures are excessive, stop production and allow the laminate to cure. Grind smooth any prominent ridges left on the cured surface. Following the grinding, apply a bedding layer of 0.23 kg/m2 mat or chopped glass and thoroughly roll to remove air. Winding with continuous strand may be resumed before this layer gels. The additional mat layer is extra material and will result in a wall thickness greater than that specified.

.9 Ensure no glass fibres are exposed on the outer surface

.10 Incorporate a paraffin for full cure in the final coat of resin.

.11 Ensure that cut edges exposed to the chemical environment have a chemical resistant liner consisting of two mats and a veil. No cloth or woven roving are permitted for this purpose.

.12 Seal all cut edges on parts which will make up a secondary joint to be incorporated into a finished product first with at least two coats of lay-up resin.

.4 Surface preparation

.1 Prior to starting secondary overlays, ensure adequate surface abrasion with no surface contamination. Take every precaution to assure adequate surface preparation and a good bond of the secondary overlays.

.2 Prior to making all overlays, thoroughly roughen the cured or wax coated surfaces of the area to be overlaid by grinding. Ensure the roughened area extends 25 mm minimum beyond the proposed overlay edge. Completely coat the roughened area with wax coat at the completion of the joint.

.3 Ensure that grinding is sufficiently deep so that all traces of glossy resin coat are removed and that glass fibre is exposed over the entire abraded surface.

.4 Ensure the edges of the abraded surface are "feathered" out such that no sharp discontinuities exist.

.5 For surface abrasion by grinding, ensure that grinding disks are new and not contaminated, with a grit size of 16 to 24.

.6 FRP joint application must begin within four hours of surface abrasion, or else abrasion must be repeated.

.7 Within 15 minutes prior to beginning FRP joint application, remove dust from the abraded area by vacuuming or brushing with clean non-metallic brushes, or wiping with clean dry rags.

.8 Solvent wiping the abraded area is not allowed.

.9 Air blowing the abraded area is not allowed.

.10 If any indication of contamination is present after this final surface preparation, the abraded area shall be scrubbed with solvent and allowed to evaporate to verify removal of the contaminant. Repeat this solvent wash if necessary. Surface abrasion must be repeated after solvent washing.

.5 Joining laminates

.1 FRP joining laminates are subject to all applicable requirements specified in other sections for laminates.

.2 Reinforce FRP joints with an overlay of glass reinforcement and resin which extends equally within +12 mm on each side of the joint. A smooth contour is required. All FRP joints to have a total width at least 1.25 times that required by standards.

.3 Tolerance on width of joint reinforcement plies is +25 mm, -0 mm. For woven roving plies do not exceed the width of the mat ply below them.

.4 Restrain parts to be joined until completion and cure of the joint to prevent movement overlay.

.5 Fit up parts, and verify that all tolerances and assembly requirements of sections are satisfied. Completely fill the void between component parts with resin putty, taking care not to extrude an excessive amount of putty into the interior.

.6 Grind the puttied area to a smooth contour and repeat this final surface preparation.

.7 Resin coat the abraded area to be overlaid immediately prior to applying glass reinforcement, using a stiff brush to work resin into the rough surface. Supply the resin coat only to an area as wide (+25 mm, -0 mm) as the next exotherm stage of the joint sequence and repeat prior to each exotherm stage. Use no thixotropic material in this resin.

.8 Environment: maintain conditions in the FRP laminate Work during all times when the final surface preparation and FRP laminate application are in process in order to not jeopardise the reliability of the laminate or secondary bond. As a minimum, include the following controls:

.1 Maintain all surfaces to be overlaid and all materials within a range of 16ºC to 35ºC. No further lamination may proceed until the exotherm has completed and the

laminate has cooled to 35ºC or less. Do not attempt to cool the curing laminate prematurely.

.2 Protect prepared surfaces and materials from blowing dust and other contaminants.

.3 If any of the above conditions are violated while the final surface preparation or FRP laminate application are in-process, stop work immediately and begin the process again with surface abrasion.

.4 Store materials in a dry area and within the temperature and humidity limits recommended by the manufacturers.

.6 Vessel Assembly

.1 Assemble vessels in accordance with the following:

.1 Mark and retain all cutouts from the equipment, indicating their original location. All cutouts become the property of the City.

.2 Do not remove centerlines marked on the equipment for use in assembly until after inspection by the Contract Administrator.

.3 Install flanged nozzles with boltholes straddling principle centrelines of the vessel. For tank tops, nozzle boltholes straddle radial centrelines. Other layouts take precedence when detailed on the design drawings.

.4 When requested, fabricator must supply to the Contractor, at the earliest possible time, a template which locates anchor bolt holes within +3 mm for each vessel.

.5 When specified, or indicated on the design drawings or construction details of the pertinent equipment section, provide a non-skid surface on the exterior surface of domed covers. Silica grit may be applied in conjunction with the final resin coat, or other methods employed if reviewed by the Contract Administrator.

.6 Furnish and overlay on the outside of the equipment a plastic nameplate showing the following information:

.1 Name of manufacturer

.2 Date of manufacture

.3 Equipment name and tag number

.4 Resin number and manufacturer

.5 Design pressure and temperature

.6 Vessel diameter, height and weight

.7 Provide butt joints or shell joints in the number and location (s) as shown on the design drawings. Additional joints are not allowed except as reviewed by the Contract Administrator. Slip joints, "mod joints", or other methods not conforming to the design drawings are not allowed. If joint locations are not indicated on the design drawings, fabricator must propose number and location for approval by the Contract Administrator.

.8 Manufacture to tolerances listed in ASTM D3299, except as modified herein or as shown.

.9 When joining components, limit gaps at mating edges to 6 mm maximum, and misalignment of inside surfaces to one-third of the lesser wall thickness.

.10 Ensure that the outside surface of vessel flat bottoms after assembly is flat within +12 mm and localized indentations or protrusions do not exceed +6 mm within 600 mm.

.11 Apply nozzle cut-out reinforcement as specified on the design drawings.

.12 When reinforcing materials are cut to facilitate placement around an installed nozzle or opening, stagger joints in successive reinforcing layers to avoid overlapping and place so that the joints are parallel to the axis of the tank. Ensure that the principle fibre direction of the woven roving reinforcement is parallel to the tank axis.

2.3 Factory Tests

.1 Inspect fabrications for required construction, intended function and conformance with referenced standards.

.2 Inspection of products is required prior to shipment, unless specifically waived in writing by the Contract Administrator.

.3 Notify the Contract Administrator one week prior to estimate date of inspection.

.4 Repairs authorised by the Contract Administrator shall be re-inspected before final acceptance, unless specifically waived.

.5 Hydrostatic tests at temperatures required for normal operation. Conduct a leakage test on the Tanks prior to shipment to the job site. No leaks are allowed.

.6 Submit a report detailing date and time of tests, step-by-step test procedures, test results, and any corrective action taken by the manufacturer, if required.

3. EXECUTION

3.1 Manufacturer's Representative

.1 Provide a technically qualified Manufacturer's Representative to install and initiate operation of each FRP specialty in accordance with the manufacturer's written instructions, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the manufacturer's recommended procedures and in accordance with Division 1.

3.2 Preparation

.1 Verify dimensions and conditions in field

.2 Ducts: layout routing in straight lines parallel to building lines.

.3 Coordinate support locations with layout and joints.

3.3 Installation

.1 Ship, install, join and erect under the direction of factory-trained specialists.

.2 Where jointing is required, ensure that workmen employed for these efforts have been trained in proper jointing techniques by the FRP manufacturer's representative.

.3 Ensure that fabricated equipment has the warning; "Plastic Equipment Handle with Care" stencilled on two sides in letters a minimum of 50 mm high.

3.4 Assembly and erection plans.

.1 Prior to assembly and erection of FRP towers, tanks, stacks and similar structures, provide to the Contract Administrator assembly and erection plans prepared by the FRP manufacturer.

.2 Provide to the Contract Administrator prior to assembly, details on handling, field connections and final installation.

.3 Field joints

.1 Field joining laminates and procedures are subject to all applicable requirements specified in other sections of this document.

.2 Butt-strap joints have a thickness not less than 1.5 times the longest cross-sectional dimension of the FRP specialty and develop at least 200 percent of the strength of the parent laminate.

.3 Notwithstanding this requirement, comprise butt-strap joints of at least two layers of surfacing veil plus sufficient reinforcing glass impregnated in the specified barrier resin.

.4 Surface preparation, methods of curing, and ultraviolet light protection as specified for the parent laminate.

3.5 Cleaning

.1 Blow ductwork clean using system fans; purged continuously for not less than 48 hours at a flow rate no less than design flow rate. If required, system fan shall be throttled on inlet side to prevent motor overload. Temporary screen shall be installed on system fan inlet to protect fan from entering debris.

3.6 Testing

.1 Conduct testing in accordance with Section 01650 and Section 01670 to prove operation, performance, and function.

3.7 Functional Testing

.1 Alignment: test complete assemblies for proper alignment and connection, leakage.

.2 Hydrostatic test: after painting is complete, fill tank with water at a pressure of 150 percent of maximum working pressure for a period of 4 hours. No leakage is acceptable.

.3 Ducts: field test ductwork after installation and before concealment or burying, with air test to 150 percent of maximum working pressure for a period of 4 hours. Leaks shall be corrected and duct re-tested until no further leaks appear.

.4 Operational Testing

.1 Perform under actual or approved simulated operating conditions.

.2 Test for a continuous 8 hour period without malfunction or leakage.

.3 During the guarantee period, the City may, its cost, inspect or retest the system for conformance to these specifications. The Contractor will be notified of these tests, and he may witness the test and inspections. If the system fails to meet the performance requirements, the guarantee provisions of these specifications shall apply.

3.8 Commissioning

.1 Attend during commissioning of the process systems, which includes the equipment specified in this section and to ensure the equipment functions as intended in the process system.

END OF SECTION

CHEMICAL STORAGE TANKS

1. GENERAL

1.1 Section Includes

.1 This section specifies the design, manufacture, supply, factory testing, delivery, and supervision of installation, testing and commissioning of fibreglass reinforced plastic (FRP) tanks.

1.2 Reference Standards

.1 Conform to the following reference standards:

.1 CAN/CGSB-41.22 Fiberglass-Reinforced Plastic Corrosion-Resistant Equipment

.2 ANSI B16.5 Pipe Flanges and Flanged Fittings

.3 ASTM C581 Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service

.4 ASTM C582 Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment

.5 ASTM D2563 Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts

.6 ASTM D2583 Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor

.7 ASTM D2584 Standard Test Method for Ignition Loss of Cured Reinforced Resins

.8 ASTM D3299 Standard Specification for Filament Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks

.9 ASTM D4097 Standard Specification for Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks

.10 ASTM E1067 Standard Practice for Acoustic Emission Testing of Fiberglass Reinforced Plastic Resin (FRP) Tanks/Vessels

1.3 Design Requirements

.1 Design tank, including resin selection, wall thickness, methods and locations of support, and stiffener requirements. Design shall be signed and sealed by a Professional Engineer registered in the Province of Manitoba.

.2 Conform with the requirements of Section 13200.

1.4 Shop Drawings

.1 Provide the following information for shop drawings in accordance with the requirements of Section 01330, Section 11010, and Section 13200.

.1 Detailed fabrication drawings showing connections and termination of equipment for connection by others.

.2 Installation instructions indicating mounting requirements, alignment and assembly tolerances and points of connection for ancillary services.

.3 List of materials of construction, detailing the component parts and reference specifications (ASTM, CSA, ANSI, etc.) Include complete resin system information.

.4 Tank data indicating equipment number, pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, corrosion barrier thickness, and details of nozzle designs.

.5 Tank capacity chart indicating liters for each 10 cm of depth and cumulative total from bottom.

.6 Fabricator's detailed requirements for tank foundations.

.7 Recommended bolt torque for all bolted FRP connections.

1.5 Submittals for Review

.1 Submit the following for review in accordance with Section 01330 and Section 13200:

.1 Complete design calculations for tanks, supports and accessories.

.2 Detailed description of the laminate and the type of reinforcing to be used indicating:

.1 The laminate and reinforcing material used will provide chemical resistance at least equal to the published chemical resistance for the resin for the intended application.

.2 The resin will meet the performance requirements stated and is suitable for the service conditions specified herein and the fabrication technique proposed.

.3 Laminate sample representative of production quality of surface finish and visual imperfections.

.4 Certified test results on physical property, chemical resistance, and quality control test data.

.5 Evidence of installer's qualifications and experience for similar installations; and results of factory testing prior to commencement of work.

1.6 Quality Control Submittals

.1 Provide the following information for quality control in accordance with Section 01330:

.1 Manufacturer's Certificate of Compliance with fabrication requirements.

.2 Qualifications of Acoustic Emission Testing Agency.

.3 Qualifications of Manufacturer 's Quality Assurance Supervisor.

.4 Copy of the Manufacturer 's Quality Assurance Program.

.5 Quality Assurance Inspection:

.1 Qualifications of Independent FRP Quality Assurance Inspector.

.2 Initial QA Inspection Report.

.3 Certification of Factory Testing.

.6 Certification that the access nozzles have been coordinated with the actual equipment being furnished.

.7 Special shipping, storage and protection, and handling instructions.

.8 Manufacturer 's written installation and tank support instructions.

.9 Acoustic emissions test results showing that tank conforms with ASTM E1067.

1.7 Closeout Submittals

.1 Provide the following operating and maintenance data in addition to requirements of Section 01780:

.1 Detailed fabrication drawings indicating equipment number, pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, corrosion barrier thickness, and details of nozzle designs.

.2 Installation instructions indicating mounting requirements, alignment and assembly tolerances and points of connection for ancillary services.

.3 Fabricators catalog information, descriptive literature, specifications, and identification of materials of construction. Include complete resin system information.

1.8 Quality Assurance

.1 Fabricator's Quality Assurance Supervisor: minimum of 5 years of experience in the fabrication of fiberglass structures.

.2 Designer: Professional Engineer registered in the Province of Manitoba.

.3 Independent FRP Quality Assurance Inspector:

.1 Minimum 5 years of experience as an FRP inspector.

.2 Representing a corporately and financially independent organization which can function as an unbiased inspection authority.

.3 Professionally independent of manufacturer's, suppliers, and installers of systems being inspected.

.4 Acoustic Emission Testing Agency: Minimum 5 years of experience in acoustic emission testing of fiberglass structures.

1.9 Coordination

.1 Refer to Section 11010 for general coordinate requirements of the equipment supplied with piping, structures, structural supports, drainage, ventilation and cooling, and other ancillaries specified in other Divisions.

1.10 Shipment, Protection, and Storage

.1 Ship, unload, protect, and store tanks in accordance with Section 01650 and Section 11010.

.1 Mount tanks on padded cradles if shipped horizontally or on a suitable skid if shipped vertically.

.2 Protect all flanged nozzles with wooden blinds bolted to the flange and having a diameter of 50 mm greater than the outside diameter of the flange.

.3 Provide either rigid plugs inside the ends to prevent deflection or wooden boxes for all unflanged components. Brace the open ends of tanks with a suitable stiffening member to prevent deflection.

.4 Do not ship components or other pieces loose inside the tanks.

.5 Load tanks with at least 50 mm clearance between the tank (including fittings) and the bulkheads or bed of the vehicle.

.6 Regardless of the mode of transportation, firmly fasten and pad all components to prevent shifting of the load or flexing of components while in transit.

2. PRODUCTS

2.1 Function

.1 Provide FRP tanks for above ground vertical installation to contain aggressive chemicals at atmospheric pressure.

.2 Supply products modified as necessary by the manufacturer to provide the specified features and to meet the specified operating conditions.

2.2 Design Standard

.1 Structural Glass Ltd

2.3 Acceptable Manufacturers

.1 Augusta Fiberglass

.2 Plas-tanks Industries Inc

2.4 Design Parameters

.1 Design tanks suitable for the storage of:

.1 Ferric chloride: 8 to 14 percent Fe, density of 1.26 kg/L to 1.48 kg/L (at 20°C), viscosity of 12 cps.

.2 Ferrous chloride: 7 to 12 percent Fe, density of 1.18 kg/L to 1.32 kg/L (at 20°C), viscosity of 15 cps.

.3 Ferric sulphate: 9 to 12 percent Fe, density of 1.40 kg/L to 1.54 kg/L (at 20°C), viscosity of 25 cps.

.4 Aluminum sulphate (alum): 2.6 to 4.0 percent Al, density of 1.20 kg/L to 1.35 kg/L (at 20°C), viscosity of 25 cps.

.2 Design the tanks to the following criteria:

.1 Number of tanks: 2

.2 Total volume, each: 80,000 L

.3 Minimum working volume, each: 70,000 L

.4 Internal diameter: 4000 mm

.5 Overall height: 6400 mm

.6 Bottom slope: 0.3 degrees to drain

.7 Design maximum liquid specific gravity: 1.6

.8 Fluid temperature of 5 to 35 ^{o}C.

.9 Lifting lugs, each: 4

.10 Sight glass with protective FRP cage, each: 1

.3 Provide the following heavy-duty FRP bulkhead connections, located as shown on the Drawings

.1 Fill: one 75 mm FF flange

.2 Instrumentation: two 150 mm FF flanges

.3 Vent: one 250 mm FF flange

.4 Manway: one 600 mm FF flange

.5 Outlet: one 50 mm FF flange

.6 Overflow: one 100 mm FF flange

.7 Process vent: one 20 mm FF flange

.8 Site glass connections: two 50 mm FF flanged

.9 Viewing hatch: one 300 mm hinged

.4 Provide FRP drain pipes and flanges for complete tank drainage, 50 mm diameter. Drain pipe centreline shall not be higher than the lowest point on the tank bottom.

.5 Provide 6 mm thick neoprene blanket pad for each tank suitable for tank bottom.

2.5 Fabrication

.1 Fabricate tanks as spiral wound, hand layered or contact molded conforming to the following appropriate ASTM specifications:

.1 Filament wound tanks: design and fabricate in accordance with ASTM D-3299.

.2 Contact moulded tanks: design and fabricate in accordance with ASTM D-4097.

2.6 Resin

.1 Selected by Manufacturer, suitable for intended service and subject to approval by the Contract Administrator.

.2 Premium grade and corrosion resistant, such as chlorendic polyester, vinyl ester, or bisphenol A fumarate polyester that has either been evaluated in a laminate by test in

accordance with ASTM C-581 or that has been determined by previous documented service to be acceptable for the service conditions

.3 Use same resin throughout the entire tank shell.

.4 No dyes, pigments, or colorants except in the exterior gel coat.

.5 No fillers or thixotropic agents contained in the resin.

.6 Curing system

.1 As recommended by resin manufacturer or as specified herein.

.2 Apply color coat after inspection of the laminate has been completed. Exterior color to be Manufacturer's standard, unless specifically requested otherwise by the Contract Administrator.

.3 Cure all products as specified in ASTM D3299 or ASTM D4097.

.4 Measure Barcol hardness according to ASTM D2583.

.7 Post-cure the tank and appurtenances in accordance with resin manufacturer's recommendation for time and temperature. Complete post-curing with warm-to-hot dry air, free of combustion products. Avoid hot spots.

.8 For hypochlorite service, MEKP cobalt catalyst system is allowed in the liner. Cure liner with benzoyl peroxide-dimethyl aniline throughout. The structural layer may be cured with either catalyst system.

.9 Complete any internal repairs or rework prior to post-curing. If repairs are made following post-cure, an additional post-cure cycle is required.

2.7 Reinforcement

.1 Chemical surfacing mat constructed from commercial grade E-type glass strands bonded together using a binder. Treat strands with a sizing that is chemically compatible with the lay-up resin used.

2.8 Laminate

.1 For the laminate comprising the structural tank (bottom, cylindrical shell, top head) use a corrosion-resistant barrier comprised of an inner surface (corrosion barrier), interior layer, and exterior layer (structural layer).

.2 Meet requirements of the mechanical properties and visual acceptance criteria in ASTM C582 for contact-molded laminates or ASTM D2563 for others to Level II for interior surfaces and Level III for exterior surfaces.

.3 Reinforce inner surface with a resin-rich surfacing veil.

2.9 Identification

.1 Identify each tank with Manufacturer's name, capacity in litres, maximum temperature, design pressure and vacuum, specific gravity, pH, resin, minimum thickness, tank number, tank name, and date of manufacture.

.2 Provide permanent marking decals and labels, sealed into the laminate exterior with clear resin.

2.10 Nozzles

.1 Provide all flanged nozzles of hand lay-up construction with the pipe stub moulded integrally with the pipe flange. Compression-moulded or cemented-on flanges are prohibited.

.2 Nozzles 100 mm diameter and smaller shall be be gusseted with conical- or plate-type gussets. Plate gussets to be suitably laminated to the flange back side, hub, pipe neck, and tank wall. Nozzles larger then 100 mm in diameter to be gusseted only where noted.

.3 Provide nozzles with a 150 mm projection as measured from the face of the flange to the inside wall of the tank.

.4 Shell nozzles to be mounted radially, perpendicular to the side shell. Top nozzles to be mounted parallel to the vertical axis of the tank.

.5 Finish nozzles flush with the inside surface of the tank unless otherwise indicated.

.6 The back face of all flanges to be spot-faced, flat and parallel to the flange face of sufficient diameter to accept an SAE metal washer under the bolthead or nut.

.7 Tank manway to be Manufacturer’s standard vapour-tight flanged and bolted.

.8 Gaskets

.1 Provide two gaskets per nozzle, 3 mm thick full-face elastomeric material having a hardness of Shore A60 plus or minus 5.

.2 Gasket material to be suitable for the intended service.

.9 All flanged nozzles shall be rated at 1000 kPa minimum with outer dimensions and drilling corresponding to ANSI B16.5.

.10 Provide nozzles and manways as listed in Clause 2.4 of this Section at locations shown on the Contract Drawings.

2.11 Ancillary components

.1 Pipe Supports

.1 Provide for all tank overflow pipes, loading pipes and recirculation pipes.

.2 Spacing of supports to be as recommended by the fabricator, but not greater than 1200 mm on center.

.3 Design support to allow removal of the pipe.

.4 Provide supports of Type 316 stainless steel complete with necessary bolts, nuts and washers.

.2 Provide suitably attached lifting lugs for all tanks weighing over 45 kg.

.3 Provide anchor connections and anchor bolts of Type 316 stainless steel suitably sized by the manufacturer and according to requirements of Section 11050.

2.12 Quality Control and Factory Tests

.1 Provide services of an Independent FRP Testing Inspector to be present at the point of manufacture at the time fabrication is started, to perform the following:

.1 Observe manufacturing methods, machinery, and techniques to assure compliance with industry standards and these specifications.

.2 Observe initial fabrication to verify compliance with these specifications.

.3 Observe quality control methods for mixing resins and testing of completed equipment.

.4 Generally observe quality of other, ongoing fabrication.

.5 Prepare an Initial QA Inspection Report.

.2 Provide services of an Independent FRP Testing Inspector to be present at the point of manufacture, upon completion of fabrication and prior to shipment, to perform or witness the following:

.1 Visual inspection of all FRP tanks supplied to the requirements of ASTM C-582 and ASTM D-2563.

.2 Barcol Hardness measurements per ASTM D2583.

.3 Acetone sensitivity test for all internal secondary bonds.

.4 Glass content by ignition loss on three cutouts per ASTM D2584.

.5 Hydrostatic leak test

.1 Perform on each tank.

.2 Fill to overflow nozzle and allow to stand for 24 hours with no visible leakage.

.3 Repairs deemed acceptable by the Independent FRP Testing Inspector must be approved by the Contract Administrator.

.4 Identify and retain all cutouts. The Contract Administrator may select certain cutouts for testing for physical properties of the laminate.

.5 Factory test reports: certify the results, by signature, of the following:

.1 Inspections

.2 Results of hydrostatic testing

.3 Test reports of physical properties of standard laminates

3. EXECUTION

3.1 Manufacturer's Representative

.1 Provide the services of a technically qualified Manufacturer's Representative for installation, testing and commissioning as defined in Division 1.

3.2 Installation

.1 Ensure the equipment is installed in accordance with Section 11050, as required to provide satisfactory service.

.2 Have the Manufacturer’s Representative instruct installer in the methods and precautions to be followed in the installation of the equipment. Certify the installers understanding by completing Form 101 included in Section 01650.

.3 Accurately place anchor bolts using templates furnished by the fabricator and as specified in Section 05500, Metal Fabrications and Castings.

.4 Coordinate installation of FRP tanks in designated containment areas with other Divisions.

.5 Have the Manufacturer’s Representative supervise and cooperate with the installer as necessary.

.6 Have the Manufacturer’s Representative verify successful installation, as documented by Form 102, included in Section 01650.

3.3 Testing

.1 Conduct testing in accordance with Section 01650 to prove equipment operation, performance, and function.

.2 Performance Testing

.1 Functional test: conduct hydrostatic leak test on all tanks supplied. Fill tank with clean water and allow water to stand for 24 hours to verify no leakage.

.2 Acoustic emission test

.1 Provide services of an acoustic emission test agency to conduct test on each tank following installation and immediately prior to commissioning.

.2 Test completed tank in accordance with ASTM E1067.

.3 Test results and report for acoustic emission test.

.4 In the event that the test fails acceptance criteria as per ASTM E1067, the equipment will be rejected as not conforming to the performance guarantees. In this event modify or replace the equipment and re-test such that the tank(s) will meet the performance test requirements, at no additional cost.

.3 Cooperate with the installer to fulfill the requirements for successful testing of the equipment as documented by Form 103, included in Section 01650.

3.4 Training

.1 Training for fiberglass reinforced plastic tanks will not be required.

3.5 Commissioning

.1 Have the Manufacturer's Representative attend during commissioning of the process system, which includes the equipment specified in this Section and to ensure the equipment functions as intended in the process system.

END OF SECTION

GENERAL MECHANICAL PROVISIONS

1. GENERAL

1.1 Intent

.1 Provide complete, fully tested and operational mechanical systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.

.2 Contract Documents and Drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.

.3 Follow Manufacturers' recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

.4 Install equipment generally in locations and routes shown. Run piping and ductwork close to building structure, parallel to building lines to maximize head room and with minimum interference with other services and free space. Remove and replace improperly installed equipment to satisfaction of the Contract Administrator at no extra cost.

.5 Install equipment to provide access and ease of maintenance.

.6 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the City. Uncrate equipment, move in place and install complete; start-up and test.

.7 Install control valves, control dampers, thermal wells, and other devices on piping and ducts, furnished by Contractor.

.8 The Contractor shall, at his own expense, repair and replace any Work which fails or becomes defective during the term of the guarantee/warranty, providing such work is not due to improper usage. The period of guarantee specified shall not in any way supplant any other guarantees of a longer period but shall be binding on work not otherwise covered.

.9 If the equipment is used during construction, the guarantee or guarantee period shall not be shortened or altered.

1.2 Coordination of Work

.1 Cooperate and coordinate with other trades on the project.

.2 Make reference to electrical, mechanical, structural and architectural drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Jointly work out all conflicts on-site before fabricating or installing any materials or equipment.

.3 Where dimensional details are required, work with the applicable architectural and structural drawings.

.4 Full size and detailed drawings shall take precedence over scale measurements from drawings. Drawings shall take precedence over Specifications.

.5 Any areas indicated as space for future materials or equipment shall be left clear.

1.3 Permits

.1 Refer to Division 1.

1.4 Tender Price Breakdown

.1 Submit a Tender price breakdown within 30 days of Tender closing and before first progress claim, in a format agreed to with the Contract Administrator.

.2 As a minimum, include the following in the tender price breakdown:

.1 Site Services: materials, labour

.2 Mechanical: equipment, materials, labour

.3 Plumbing: equipment, materials, labour

.4 Sheet Metal: equipment, materials, labour

.5 Fire protection: equipment, materials, labour

.6 Controls: equipment, materials, labour

1.5 References

.1 Conform to all referenced codes and standards to their latest edition.

1.6 Metric Conversion

.1 All units in this division are expressed in SI units.

.2 Submit all Shop Drawings and maintenance manuals in SI units.

.3 On all submittals (Shop Drawings etc.) use the same SI units as stated in the Specification.

.4 Equivalent Nominal Diameters of Pipes - Metric and Imperial:

.1 Where pipes are specified with metric dimensions and Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment and piping.

.2 When CSA approved SI Metric pipes are provided, the Contractor shall provide at no extra cost adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

mm (inch, NPS)	mm (inch, NPS)	mm (inch, NPS)
3 (1/8)	65 (2-1/2)	375 (15)
6 (1/4)	75 (3)	450 (18)
10 (3/8)	100 (4)	500 (20)
15 (1/2)	125 (5)	600 (24)
20 (3/4)	150 (6)	750 (30)
25 (1)	200 (8)	
30 (1-1/4)	250 (10)	
40 (1-1/2)	300 (12)	
50 (2)		

.5 Metric Duct Sizes:

.1 The metric duct sizes are expressed as 25 mm = 1 inch.

1.7 Drawings and Specifications

.1 Drawings and Specifications are complementary each to the other, and what is called for by one shall be binding as if called for by both.

.2 Should any discrepancy appear between Drawings and Specifications which leaves the Contractor in doubt as to the true intent and meaning of the plans and specifications, obtain a ruling from the Contract Administrator, before submitting a Tender. If this is not done, it will be assumed that the most expensive alternate had been included.

.3 Examine all Contract Documents, including all Drawings and Specifications, and work of other trades to ensure that work is satisfactorily carried out without changes to building.

1.8 Shop Drawings

.1 Refer to Division 1.

1.9 Salvage

.1 Remove from Site all equipment, ducting or piping which is no longer required because of work under this Contract.

.2 Turnover to and deliver to the City's storage area all items which have been determined to have salvage value and has been removed due to the work.

1.10 Cutting, Patching and Coring

.1 Provide holes and sleeves, cutting and fitting required for mechanical work.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Obtain written approval from the Structural Contract Administrator before cutting or burning structural members.

.4 Provide openings and holes required in precast members for mechanical work. Cast holes 100 mm or larger in diameter. Field-cut smaller than 100 mm.

.5 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective section.

1.11 Excavation and Backfill

.1 Refer to requirements of Division 2.

.2 Provide all excavating to facilitate installation of the mechanical work, including shoring, pumping, 150 mm compacted sand bedding under and first 300 mm of compacted sand over piping and ducting.

1.12 Installation of Equipment

.1 Pipe all equipment drains to building drains.

.2 Unions and flanges shall be provided in piping or ductwork to permit easy removal of equipment.

.3 Maintain permanent access to equipment for maintenance.

1.13 Fire-Stopping

.1 Fire-stop all pipe, duct, conduit and wire penetrations through floors and walls, designated as fire and/or smoke separations. The contractor is required to coordinate with the architectural drawings to contractual rated wall types and installation details.

.2 Fire-stopping materials to meet ULC CAN 2S115. Acceptable Materials: by "Tremco" or "National Firestopping".

.3 Preparation of surfaces and installation of fire-stopping materials shall be carried out as per Manufacturer's instructions.

1.14 Connections to Existing Services

.1 Maintain liaison with the City and provide a schedule to interrupt, re-route or connect to water, sewer, heating, or gas systems, with minimum interruption of services.

.2 Major services shall not be interrupted before all preparatory work is completed and all required materials are on site. Provide a minimum of 48 hours notice for all service shutdown.

.3 Interruptions and shutdowns of existing services shall be by the building/plant maintenance staff.

1.15 Equipment and Materials

.1 Materials and equipment installed shall be new, full weight and of quality specified.

.2 Each major component of equipment shall bear Manufacturer's name, address, catalogue and serial number in a conspicuous place.

.3 Where two or more Products of the same type are required, Products shall be of the same Manufacturer.

.4 Make known in writing to the Contract Administrator ten (10) days prior to the Tender closing date any materials specified that are required to complete the work which are not currently available or will not be available for use as called for herein. Failing to do so, it will be assumed that the most expensive alternate has been included in the Tender price.

1.16 Equipment Protection and Clean-Up

.1 Protect equipment and materials in storage on-site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 Protect equipment with polyethylene covers and crates.

.3 Operate, drain and flush out unsealed bearings and refill with new change of oil, before final acceptance.

.4 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.

.5 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.

.6 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.17 Electrical Motors

.1 Supply mechanical equipment complete with electrical motors.

.2 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: NEMA, EEMAC, CSA, CEC Part 1, IEEE and ANSI. All motors to be CSA labelled. All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch. All motors intended for use with a variable speed drive (variance frequency drive) shall be inverter only rated.

.3 Unless specified otherwise, provide motors designed for full voltage starting, EEMAC Design B. Motors driving high torque or high inertia loads may be EEMAC Design C or D.

.4 Provide motors rated for continuous duty with 1.15 service factor unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection.

.5 Motors less than ½ hp shall be 120 V, 60 Hz, 1 phase. Motors ½ hp and larger shall be 3 phase at the indicated voltage.

.6 All motors shall be 1800 rpm except where indicated.

.7 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.

.8 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.

.9 Refer to electrical specifications, Division 16, for voltage, frequency, and phase data. This shall take precedence over any reference in Division 15.

.10 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.

.11 Minimum certified motor efficiency shall be as outlined in Manitoba Hydro's latest high efficiency motor incentives program, or the following table, whichever indicates the higher minimum efficiency.

	MINIMUM EFFICIENCY (%)*			
HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1	75.5	82.5	80.0	74.0
1.5	82.5	84.0	85.5	77.0
2	84.0	84.0	86.5	82.5
3	85.5	87.5	87.5	84.0
5	87.5	87.5	87.5	85.5
7.5	88.5	89.5	89.5	85.5
10	89.5	89.5	89.5	88.5
15	90.2	91.0	90.2	88.5
20	90.2	91.0	90.2	89.5
25	90.5	91.7	91.3	89.6
30	90.8	91.9	91.4	90.7
40	91.4	92.5	92.3	90.6
50	91.9	92.7	92.3	91.3
60	92.4	93.2	92.9	91.6
75	92.5	93.5	93.1	92.8
100	93.0	93.7	93.5	92.7
125	93.6	93.9	93.6	93.4
150	93.8	94.3	94.2	93.4
200	94.3	94.5	94.6	93.9
250	95.0	95.0	95.0	95.0
300	95.0	95.0	95.0	95.0
400	95.0	95.0	95.0	95.0
500	95.0	95.0	95.0	95.0

* as defined in CSA C390 or IEEE 112B Nominal Standards

1.18 Access Doors

.1 Provide access doors for maintenance or adjustment purposes for all mechanical system components including:

.1 Valves

.2 Volume and splitter dampers

.3 Fire dampers

.4 Cleanouts and traps

.5 Controls, coils and terminal units

.6 Expansion joints

.7 Filters

.8 Strainers

.2 Steel frame access panel with stainless steel piano-type hinge, channel reinforced steel door panel, three "Symmons" fasteners per door. Door panel recessed to receive ceiling or wall material to give finished appearance showing only hinge and fasteners. Provide acoustic gasket between door panel perimeter and steel frame. Rated access doors shall be UL-listed.

.3 Mark removable ceiling tiles used for access with colour coded dots.

.4 Sizes to be 200 mm x 200 mm for cleanout, 300 mm x 300 mm for hand 600 mm x 600 mm for body access minimum.

.5 Provide ULC-listed fire rated access doors installed in rated wall and ceilings.

1.19 Miscellaneous Metals

.1 Provide all necessary miscellaneous to hang or support materials, equipment and provide access for work under this Contract.

.2 All miscellaneous metals shall be prime painted.

.3 Miscellaneous metals shall include but not limited to:

.1 Hangers for equipment, piping and ductwork.

.2 Support for equipment.

1.20 Escutcheon and Plates

.1 Provide escutcheon and plates on piping and ductwork passing through finished walls, floors and ceilings.

.2 Escutcheons shall be split type, stainless or chrome plated steel.

1.21 Painting and Identification

.1 Coordinate colour coding of piping and equipment with work of Division 9.

.2 Colour code mechanical equipment, piping and exposed ductwork. Refer to colour schedule at end of this Section.

.3 Legend and direction of flow arrows shall consist of adhesive backed labels, yellow colour, with minimum 20 mm high black lettering equal to Brady System B-500, vinyl cloth labels for non-insulated surfaces; and Brady B 946 for insulated surfaces.

.4 For colour coding for Medical Gas, refer to CSA Standard for Non-Flammable Medical Gas Piping Systems Z305.1.

.5 Identify piping with labels, colour bands, and flow arrows. Provide identification at 15 m maximum intervals, before and after pipes pass through walls, at all sides of tees, behind access doors and in equipment rooms as required.

.6 Apply colour bands at both ends of the label with primary colour bands used to secure both ends of individual labels. Refer to colour schedule at end of this Section.

.7 Provide 20 mm diameter brass, with metal photo black numbers, or white lamacoid with black engraved numbers, secured to valve stem with key chain.

.8 Provide neat, typewritten directories, giving valve number, services and location. Frame one (1) copy under glass for wall mounting as directed, second copy to be forwarded to the City. Include copies in O & M Manuals.

.9 Tag automatic controls, instruments and relays and match/key to control Shop Drawing identification numbers. Tag all equipment and control panels.

.10 Identify electric starting switches, thermostats controlling motors, remote push button stations, and controls equipment supplied under this Division with lamacoid plates having 6 mm minimum letter size. Identification to state equipment controlled.

.11 Identify the usage of duct access panels with self adhesive Brady stick-on coloured labels. Apply labels conforming to the following schedule.

	Color	Letters
Cleaning and service access	yellow	CA
Controls, including heat sensors	black	C
Dampers (backdraft, balance & control)	blue	D
Fire dampers	red	FD
Smoke dampers and detectors	red	SD

Note: provide black lettering for yellow or white background, white for all other colours.

.12 Identify the location of the following items of equipment which are concealed above a ceiling with Avery "Data Dots". Place identification dots on the access panel. The colours shall conform to the following schedule:

Concealed equipment and cleaning access	yellow
Control equipment, including control dampers and valves, and heat sensors	black
Fire, smoke, and sprinkler equipment including dampers	red
Pipe mounted equipment with the exception of fire, smoke, sprinkler and control equipment	green
Balancing Dampers	blue

When T-bar ceilings are installed, adhere "Data Dots" on T-bar framing adjacent to panel to be removed.

1.22 Colour Coding Schedule

.1 Colour numbers are called for in Canadian Government Specification No. 5-GP-1a. Colours assigned from CGSB 1-GP-12c for colour code identification.

MECHANICAL PRIMARY COLOURS FOR PIPE LINES/EQUIPMENT

1.	Yellow	-	505-102
2.	Light Blue	-	502-106
3.	Green	-	503-107
4.	Orange	-	508-102
5.	Brown	-	504-103
6.	Red	-	509-102
7.	White	-	513-101
8.	Aluminum	-	515-101
9.	Purple	-	501-101
10.	Grey	-	501-107

.2 Identification symbols and colour for piping, refer to Division 11 for colour references:

	Pipe Colour*	Stripe Colour	Symbol*
Compressed Air	Forest Green	None	Comp. Air
Domestic Cold Water	Sky Blue	None	Dom. Cold Wat.
Domestic Hot Water	Sky Blue	None	Dom. Hot Wat.
Domestic Tempered Water	Sky Blue	None	Dom. Temp. Wat.
Glycol Return	Light Fuschia	None	Glycol Return
Glycol Supply	Medium Fuschia	None	Glycol Supply
Heating Hot Water Return	Aqua Green	None	HWR
Heating Hot Water Supply	Green	None	HWS
Natural Gas	Safety Yellow	None	Nat.Gas
Oil, Lubricating	Brown	None	Lub. Oil
Water Non-Potable	Blue	None	Flushing Water

*to match existing

.3 Mechanical Control Systems

.1 Conduit pull boxes, terminal boxes and junction boxes - GREY Covers - GREY with black 'C'.

.2 Main and secondary control panels, factory finish acceptable - Contractor to install company label to identify.

.4 Ductwork

All ductwork in mechanical rooms to be identified as follows, complete with directional arrows:

Supply Air	S.A.
Combustion Air	Comb.Air
Exhaust Air	Exh.Air.

1.23 Temporary Heat

.1 Do not use the permanent system for temporary heating purposes without written permission from the Contract Administrator.

.2 Thoroughly clean and overhaul permanent equipment used during the construction period, replace worn or damaged parts before final inspection.

.3 Use of permanent systems for temporary heat shall not modify terms of warranty.

.4 Operate heating systems under conditions which ensure no temporary or permanent damage. Operate with proper safety devices and controls installed and fully operational. Operate systems only with treated water as specified.

.5 Air systems shall not be used for temporary heating.

.6 When permanent systems are used for temporary heat, provide alarm indicating system failure.

.7 Where pumps are used for temporary heating, replace mechanical seals, regardless of condition, with new mechanical seals.

1.24 Temporary or Trial Usage

.1 Temporary or trial usage by the City or Contract Administrator of mechanical equipment supplied under Contract shall not represent acceptance.

.2 Repair or replace permanent equipment used temporarily.

.3 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

.4 Avoid thermal shock to heating system by coordination with the City during planning, construction and operation of temporary heating system.

.5 Return condensate to the heating plant. Meter equipment is not required.

1.25 Substantial and Total Performance

.1 Prior to requesting an inspection for Substantial Performance, provide a complete list of items which are deficient.

.2 A certificate of Substantial Performance will not be granted unless the following items are completed:

.1 Heating air conditioning, plumbing and fire protection systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation. Commissioning checklists must be submitted prior to the request by the Contractor to have a substantial completion inspection.

.2 The necessary tests on equipment and systems including those required by authorities have been completed with certificates of approval.

.3 Air and water systems have been balanced with draft report submitted to Contract Administrator.

.4 Valve tagging and equipment identification is complete.

.5 Warranty forms have been mailed to the Manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one year.

.6 Systems have been chemically cleaned. Flush and initiate water treatment. Provide report from Manufacturer's representative to confirm status of treatment.

.7 Draft Operating & Maintenance Manuals have been submitted.

.8 Operating and Maintenance demonstrations have been provided to the City.

.9 Written inspection report by Manufacturer’s representative has been submitted for noise and vibration control devices and flexible connections.

.10 Record Drawings have been submitted.

.11 Fan plenums have been cleaned, and temporary filters have been replaced with permanent filters.

.12 All previously identified deficiencies have been corrected.

.3 The following shall be an outline checklist of the minimum requirements to be met by the contractor prior to the Contract Administrators’ Substantial Performance by the Contractor.

.1 Inspection:

.1 Complete Commissioning Checklists

.2 Final Plumbing Inspection Certificate from local plumbing inspector

.3 Final Gas Inspection Certificate from local gas inspector

.4 Final Sprinkler Materials and Test Certificate

.5 Final Backflow Prevention test reports for all backflow devices

.6 Controls Commissioning, Checklist and 15 day trend logs for all major equipment (AHU's)

.7 Fire alarm test certificate (via DIV.16)

.8 Fire stopping and Fire Damper test letter

.9 Vibration isolation supplier's inspection report

.10 Chemical Treatment supplies final inspection and test certificate

.11 Potable watermains flushing and chlorination test certificate

.12 Sound level tests reports (as required)

.13 Major equipment – suppliers start-up test sheets and letters certifying start up. (packaged equipment)

.14 Final As-Built Drawings ready for review

.15 Operating & maintenance manuals, ready for review

.4 Prior to Total Performance Inspection provide declaration in writing that deficiencies noted at time of Substantial Performance Inspection have been corrected and the following items completed prior to the Total Performance Inspection:

.1 Submit find air and water balance reports.

.2 Submit final operating and maintenance manuals.

.3 Complete final calibration.

.5 The Contract Administrator shall provide one visitation for the purpose of Total Performance Inspection. Subsequent visitations if required shall be at the expense of the Contractor.

.6 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until Substantial Performance is declared.

1.26 Acceptable Manufacturers

.1 The following listed Manufacturers are acceptable for their ability to meet the general design intent, quality and performance characteristics of the specified Product. The list does not endorse the acceptability of all Products available from the listed Manufacturers/suppliers.

.2 It remains the responsibility of the Contractor to ensure the Products supplied are equal to the specified Products in every respect, operate as intended, and meet the performance Specifications and physical dimensions of the specified Product.

.3 The Contractor shall be fully responsible for any additional work or materials, to accommodate the use of equipment from the acceptable Manufacturers and suppliers list.

.4 Submit within fourteen (14) days of contract award a copy of the list underlining the name of the Manufacturer whose price was carried in the Tender. If no Manufacturers names are submitted, it will be assumed that the price carried in the Tender was that of the specified Manufacturer or where the specified Product is generic, the first acceptable Manufacturer listed for each item and equipment.

.5 List of acceptable Manufacturers:

• Access Doors	Maxam, Acudor, Milcor, Can.Aqua, Mifab
• Air Flow Measuring Air Monitor, Air Stations	Cambridge, Sentinel, Ebtron
• Air Handling Units - Indoor or Outdoor Pre-manufactured	Trane, Haakon, McQuay, Scott Springfield
• Air Separators, Relief Valves	Armstrong, Bell & Gossett, Taco, Wheatley
• Air Terminals - Grilles Registers, Diffusers	E.H. Price, Titus, Anemostat,Nailor
• Air Vents	Hoffman, Maid-O-Mist, Taco
• Backdraft Dampers	Airolite, Vent-Aire, Penn, T.A. Morrison
• Backflow Preventers	Febco, Watts, Hersey, Singer, Ames
• Balancing Dampers	Maxam, Ruskin
• Balancing Agents	AMS, AHS, DFC, Airdronics
• Bypass Filter (HW)	Sumco, GESL, Pace Chemicals
• Chimney and Breeching	Metalbestos P/S, Van Packer P/S, Metal Fab PIL, Selkirk
• CO and Combustible Gas Detector	MSA, ACME, Armstrong, Critical Environment Technology, Cromag
• Coils - Heating and Cooling	Trane, Aerofin, Engineered Air, Colmac
• Controls Contractors	Honeywell, Siemens, Siebe (Barber Coleman), Energrated (Delta), Johnson Controls

• Dampers - Control, Backdraft	Ruskin, Tamco
• Dampers - Smoke-Fire Combination	Ruskin, Controlled Air, Prefco
• Domestic Water Heaters - Electric	Jetglas, Aerco, AO Smith, Ruud-Rheem, State
• Domestic Water Heaters - Gas	Jetglas, Aerco, Rudd, AO Smith, uud-Rheem, State
• Drains - Floor, Roof, Cleanouts Trap Primers, Water Hammer Arrestors	Zurn, Ancon, PPP, J.R. Smith
• Expansion Compensators	Flexonics, Tube Turn, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
• Expansion Joints	Flexonics, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
• Eye Wash Fountains, Emergency Showers	Western, Haws
• Fan Coil Units	Trane, Engineered Air, Williams
• Fans - Axial (Belted-Adjustable Pitch)	Woods, Joy
• Fans - Axial (Belted-Fixed Pitch, Direct Drive-Adjustable Pitch)	Northern, Chicago, Woods, Joy, CB&F
• Fans - Axial (Variable Pitch in Motion)	Woods, Joy
• Fans - Centrifugal	Buffalo, Twin City, Trane, Chicago, Barry Blower, Northern
• Fans - In-Line Centrifugal	Greenheck, Jenn Air, Ammerman, ILG, Cook, Penn, Twin-City, Carnes
• Fans - In-Line Centrifugal (Tubular)	Chicago, Greenheck, Twin-City, Barry/CML, Northern Blower
• Fans - Propeller	Greenheck, Cook, Penn, Jenn Air, ACME, Powerline, Joy
• Fans - Roof and Wall Mounted	Greenheck, Ammerman, Powerline, ACME, Loren Cook, Penn, Jenn Fan, ILG, Carnes, Twin City
• Filters	Cambridge, AAF, Pacific, FARR
• Fire Dampers	Controlled Air, Ruskin, Canadian Advanced Air, Maxam, Nailor
• Fire Hose Cabinets, Valves and Extinguishers	NFE, Grigor, Wilson & Cousins, Flag
• Flexible Connectors - Ducting	Thermaflex, G.I. Industries Type IHP
• Flexible Connectors - Piping	Flexonics, Tube Turn, Atlantic, Hyspan, Hydroflex, Metraflex, United Flexible, Mason

• Flexible Duct	Thermaflex, Wiremold, GI Industries Type H.P.
• Furnaces - Forced Air	Lennox, Carrier
• Gauges - Air	Dwyer, Magnehelic
• Gauges - OWG Pressure	Trerice, Marsh, Ashcroft, Weiss
• Grooved Mechanical Pipe Joints	Victaulic, Mech Line (only where permitted)
• Heat Exchangers - Plate	Alpha Laval, Tranter, Armstrong, APV
• Heat Exchangers - Shell and Tube	Armstrong, Taco, Leitch, Bell & Gossett
• Hose Bibbs	Jenkins,Dahl, Crane, Toyo, Kitz, Mifab
• Insulation - Piping and Duct	Fibreglass Canada, Manson, Knauf Fibreglass, Plasti-Fab, Manville
• Louvres	Airolite, Penn, Airstream, West Vent, Nailor, Ruskin
• Makeup Air Units - Packaged Indirect or Direct Fired	I.C.E., Reznor
• Pipe Restraints	Trelleborg
• Piping Hangers and Saddles	Grinnell, Myatt
• Plug Cocks	DeZurik, Newman-Milliken
• Plumbing Brass	Crane, American Standard, Cambridge Brass, Waltec, Kohler, Symmons
• Plumbing Fixtures	Crane, American Standard, Kohler
• Pumps - In-Line Circulators	Armstrong, B & G, Taco, Grundfos
• Pumps - Manual	Crane
• Pumps - Submersible Bilge or Sewage	Monarch, Barnes, Hydromatic or Sewage, Myers, Zoeller
• Pumps - Sump	Monarch, Barnes, Hydromatic, Myers, Zoeller
• Pumps - Vertical In-Line and Base Mounted	Armstrong, B & G, Taco, Leitch, Grundfos
• Silencers - Fan and Duct	Vibro Acoustics, Vibron, Korfund, I.A.C, Koopers
• Sinks - Mop	Fiat, Crane, American Standard
• Sinks - Stainless Steel	KIL, American Standard, Elkay
• Strainers	Armstrong, Sarco, Mueller, Toyo, Anderson, Metraflex, Yarway
• Tank - Diaphragm Type Expansion	Amtrol, Hamlet and Garneau Inc.

• Tanks - Domestic Hot Water Storage	Clemmer, PVI, Everdur, Westeel-Rosco, Ruud/Rheem, State
• Tanks - Expansion	Bell & Gossett, AS Leitch, Sanford, Westeel-Rosco Steelweld, Clemmer, Wheatley
• Thermometers	Trerice, Marsh, Ashcroft, Winters
• Unit Heaters - Gas Fired	Lennox, Modine, Reznor
• Unit Heaters - HW	Engineered Air, Trane, Rosemex, McQuay, Dunham Bush
• Valves - Butterfly	Jenkins, Keystone, DeZurik, Centreline, Monotight, Dresser, Lunkenheimer, Crane, Bray, Toyo, Grinnell
• Valves - Circuit Balancing	Armstrong, B & G, Wheatley, Tour & Anderson
• Valves - Drain, Radiator	Jenkins, Dahl, Crane, Toyo, Kitz
• Valves - Eccentric Plug	DeZurik, Homestead
• Valves - Gate, Globe, Swing, Check, Ball	Jenkins, Toyo, Crane, Kitz, Milwaukee
• Valves - Plumbing Flush	Crane, Sloan, Teck
• Valves - Pressure Balanced Mixing	Symmons
• Valves - Pressure Reducing	Armstrong, Bell & Gossett, Taco
• Valves - Relief	Armstrong, Bell & Gossett, Taco, Wheatley
• Valves - Silent Check	Val-matic, APCO, StreamFlo
• Valves - Suction Diffusers Combination Check and Balance	Armstrong, B&G, Taco
• Valves - Thermostatic Mixing	Symmons, Powers, Lawler
• Valves - Water Pressure Reducing	Watts, Clayton, Singer, Zurn, Wilkins, BCA, Cash Acme, Braukman
• Vent Caps	Jenn-Air, Penn Ventilator
• Vent Sets	Greenheck, Trane, Sheldons, Buffalo, New York, Brundage, Loren Cook, Lau
• Vibration Isolation	Mason, Vibro Acoustic

1.27 Non-specific Date/Time Compliance

.1 All equipment, hardware, software and firmware (for the purposes of this clause, the "Product") delivered or deliverables resulting from any services provided are fully Date Compliant and the Product will not adversely or materially effect the daily business operations as a result of a date related computer problem (for the purposes of this clause #, the "warranty"). Date Compliant means that the Product accurately and correctly processes

and stores date/time data (including, but not limited to, calculating, comparing, displaying, recording and sequencing operations) including year, century and leap year calculations.

.2 Provide documentary proof of Date Compliance prior to substantial completion listing all equipment and certifying their compliance.

.3 Notwithstanding any other remedy available under this agreement or at law for breach of the warranty, any Product that is not Date Compliant shall, within 24 hours of receipt of notice of the breach, be repaired or replaced at the Contractors sole cost and expense, including parts, labour, transportation and insurance, so as to correct any failure to meet the warranty.

1.28 Equipment Supplied by Others (owner)

1.29 Scope

.1 Provide rough-in for and make all connections to equipment supplied by others including kitchen, laundry and sterilising equipment.

1.30 Related Work in Other Sections

.1 Refer to other Specification Sections to complete list of equipment supplied by others.

1.31 Installation

.1 Make all mechanical connections to equipment supplied by others under this Contract. This shall include all water, drain, gas, exhaust, traps, ductwork and similar connections required. Provide isolation valves, unions, flanges and traps as required for a complete installation.

.2 Change to rough-in of services or final equipment connections due to a change in the make of equipment from that specified shall be made at no extra cost to the City, provided that proper Shop Drawings are available for rough-in. Prior to commencing installation of rough-in for the equipment, coordinate with the final reviewed equipment Shop Drawings and with the Manufacturer.

.3 Exposed piping shall be painted as per Architect's instructions.

.4 Arrange piping connections to allow for equipment removal.

2. PRODUCTS

.1 Not used

3. EXECUTION

.1 Not used

END OF SECTION

DOCUMENTATION

1. GENERAL

1.1 Scope

.1 Operating and Maintenance Manuals

.2 Record Drawings

1.2 Quality Assurance

.1 Work specified in this section shall be performed by the Contractor.

2. PRODUCTS

2.1 Operating and Maintenance Manuals

.1 Refer to Division 1.

.2 Index binders according to the following system:

Tab-1.0 Mechanical Systems:

Title page with clear plastic protection cover.

Tab-1.1 List of Mechanical Drawings:

Tab-1.2 System Descriptions:

Provide complete description of the operating sequence for all systems. Include detailed system description, with individual components described, explanation of how components interface with others and to the complete system, location of thermostats, controllers or operating variances, and controller operating setpoints.

Tab-1.3 Operating Division:

Provide complete and detailed operation of major components and systems. Provide information on location of components, how to energise switches and controls, how components interface with other components, operation of controls including operational sequence, operational changes for summer of winter operation, how to accomplish the changeover, complete trouble shooting sequence, emergency operating sequences in event of major component failure, and safeguards to indicate if equipment goes off-line.

Tab-1.4 Maintenance and Lubrication Division:

Provide general maintenance and lubrication schedule for major components to include daily, weekly, monthly, semi-annual and yearly checks and tasks. Explain how to

execute maintenance tasks required for typical equipment such as bearings, drives, motors, and filters. Compile this information for equipment and separate from shop drawings.

Tab-1.5 List of Equipment Suppliers and Contractors:

Provide list of equipment suppliers and contractors, including address and telephone number. Outline procedures for purchasing parts and equipment.

Tab-Certification (2.0, 2.1, ...):

Include copy of test data on degreasing and flushing of heating system, analysis of system water taken at time system was put into operation, hydrostatic or air tests performed on piping systems, equipment alignment certificates, copy of balancing data for air and water systems, copy of valve tag identification and pipe colour code, inspection approval certificates for plumbing system, heating and ventilation systems and operational tests on oil-fired equipment.

Tab-Shop Drawings and Maintenance Bulletins (3.0, 3.1, ...):

Provide materials received in compliance with clause "Shop Drawings".

.3 The divider tabs shall be laminated Mylar plastic and coloured according to Section. The colouring is as follows: Mechanical Systems - 1.0 - 1.5 Orange; Certification - 2.0 - 2.4 Green; Shop Drawings & Maintenance - 3.0 - 3.17 Yellow. Plastic tabs with typewritten card insertions will not be accepted.

2.2 Record Drawings

.1 Refer to Division 1.

3. EXECUTION

3.1 General

.1 Submit documents to the Contract Administrator for approval prior to transmitting to the City.

3.2 Record Drawings

Refer to Division 1.

END OF SECTION

COMMISSIONING

1. GENERAL

1.1 General

.1 This Section describes the commissioning of the mechanical system and outlines the duties and responsibilities of the team.

.2 The commissioning of the mechanical system shall be in accordance with the Code of Practice for Commissioning Mechanical Systems in Buildings and as described in this section.

.3 The commissioning process shall be applied to all products, equipment and systems provided under this Division.

.4 Work specified in this Section shall be performed by the Contractor and paid by the Contractor.

1.2 Scope

.1 Demonstration of equipment and systems operations.

.2 Instruction seminars for City's personnel.

1.3 Quality Assurance

.1 Work specified shall be performed by the Contractor.

2. THE COMMISSIONING PROCESS

2.1 The Commissioning Team

.1 Refer to Section 01670.

2.2 Commissioning Plan

.1 Refer to Section 01670.

2.3 Commissioning Phases

.1 **Phase 1** - Before starting any of the separate systems, provide written verification stating that the specific system is ready for start-up and the following conditions have been met:

.1 Copies of all test and certificates have been submitted to the Contract Administrator.

.2 All safety controls installed and fully operational (dry run test).

.3 Flushing, chemical cleaning (as required), charging, fluid operating (as required), are complete.

.4 Equipment lubrication and pre-start checks are complete.

.5 Air system cleaning complete.

.6 Filter systems installed and sealed in place (except for air system charcoal filters).

.7 Adjusting vibration isolation completed.

.8 Alignment of drives (direct and belt) completed.

.9 Control functional checks, including all alarms performed.

.10 Start-up verification checks by manufacturers representatives completed.

.11 All deficiencies to be recorded, reviewed by the commissioning team and, subsequently corrected before proceeding to the next phase, Phase 2.

.2 **Phase 2** - System Commissioning shall include but not necessarily be limited to:

.1 Activation of all systems.

.2 Testing and adjustment of all systems.

.3 As in the case of the System Readiness Phase, all deficiencies are to be recorded, reviewed by the commissioning team and, subsequently, corrected. The process at the point of the deficiency shall be repeated before proceeding forward.

.4 Phase 2 is concluded when the installation is in full working order and acceptable for use. The Work will include the following:

.1 Position all balance dampers in ductwork.

.2 Position all balance valves in piping systems (where appropriate).

.3 Make provisions for testing air pressures and flow rates.

.4 Set up air diffusers, registers and grilles.

.5 Set up all automatic temperature control devices.

.6 Set up constant volume and variable volume fans.

.7 Plug all air pressure and flow measuring holes.

.8 Adjust vibration isolators as necessary.

.9 Verification by the air balance contractor that all fire dampers have been checked.

.10 Air and water balance complete.

.5 Fine Tuning:

.1 Setting up automatic controls for accurate response and precise sequencing.

.2 Correction of problems revealed by Balancing Agency and change of fan speed and pitch as necessary.

.6 Testing:

.1 The commissioning coordinator shall perform a detailed check of the following:

.1 All items and functions to be later demonstrated to the City's representatives.

.2 Systems operation in the fire mode (pressurisation and smoke removal) in the presence of the authorities having jurisdiction. Obtain a written statement/ certificate of approval from the authorised manual jurisdiction.

.3 **Phase 3 -** Verification of Commissioning.

.1 Verification of commissioning by the Contract Administrator shall not commence until the commissioning process, Phase 2, has been totally completed. Submit test procedure completion test certificates at the time of requesting the commencement of the verification procedure. The verification process will include the demonstration of the following:

.1 Location of and opening and closing of all access panels.

.2 Operation of all automatic control dampers and automatic temperature/volume adjustment controls.

.3 Proper response of all heating, cooling and ventilation equipment to thermostats and volume adjustment controls.

.4 Operability of randomly selected fire dampers.

.5 Operation of all equipment and systems, under each mode of operation, including:

.1 Electronic control features

.2 Exhaust/make-up air systems

.3 Exhaust fans

.4 Pumps

.5 Unit heaters

.6 Fans

.7 Coils

.8 Tanks-expansion

.9 Heat recovery system

.2 At the completion of Phase 3, the Contractor shall submit the following to the Contract Administrator:

.1 A letter certifying that all Work specified under this Contract is complete, clean and operational in accordance with the Specification and Drawings.

.2 A copy of Phase 2 Verification Certificates provided by the specialist trades for submission to the Contract Administrator.

.3 Record Drawings as specified.

.4 A letter from the testing and balancing agency certifying that all necessary data for inclusion in operating and maintenance manuals has been received.

.5 A statement confirming completion of EMCS acceptance test, Section 15900.

.3 Upon receipt of all documents and a satisfactory outcome of the verification procedure, the Contract Administrator will provide a Certificate of Verification for Phase 3.

.4 Substantial Performance may, thereupon, be declared.

.4 **Phase 4** - Demonstration and Acceptance shall not commence until the commissioning process Phase 3 has been successfully completed - verification certificate issued and Substantial Performance declared. The demonstration process is a statement of satisfaction from the Contract Administrator and the City upon completion. Total Performance will not be accomplished without this achievement.

3. EXECUTION

3.1 Plumbing

.1 Domestic hot and cold water systems - system pressure tests, flush and clean lines, system pressures at fixtures, water delivery at each fixture; identification of piping systems.

.2 Domestic hot water heater - capacity flow tests, combustion controls verification.

.3 Storm drainage - system pressure tests, pipe identification.

.4 Sanitary drainage - system pressure tests, pipe identification.

.5 Fixtures - cleaning, test hot and cold water and drain, installation.

3.2 Fire Extinguishers

.1 Confirm fire extinguisher location and charge. Verify that all tags are filled out and signed.

3.3 HVAC Systems

.1 Pumps - alignment, rotation, motor current draw, piping connections, flow and pressure test.

.2 Piping System - pressure tests, insulation, identification, water balance, hangers, expansion.

.3 Duct System - pressure tests, insulation, identification, air balance identification.

.4 Exhaust Fans - installation, rotation, motor current draw, accessories dampers, etc., air balance, identification.

.5 Gas Fired Ventilation Units - installation, gas connection, control checkout by Manufacturer's representative, duct connections, system capacity, air balance, identification certificate from inspection authority.

.6 Makeup Air Units - installation vibration isolation, duct connections, motor rotation, air balance, filters, capacity identification, controls.

.7 Control Valves - Installation, controls, capacity modulation, connection to EMCS, identification.

.8 Control Dampers - installation, operation, identification, capacity modulation, connection to EMCS.

.9 Controls - See Section 15900 - commissioning of controls by the Contractor under the supervision of the commissioning coordinator.

.10 Gas Fired Unit Heaters - installation, gas connection, motor rotation, identification certificate from inspection authority.

.11 Radiation Heating - installation, expansion, compensation, cleaning, controls.

3.4 General

.1 Contractor shall arrange for presentation and demonstration of mechanical equipment and systems by appropriate specialists and shall ensure that required Manufacturer's representatives are in attendance.

3.5 Demonstrations

.1 Demonstrate specific starting and general maintenance requirements for each major piece of equipment. Ensure all labelling and identification is completed.

.2 Demonstrate the following systems, in the form of instruction seminars and contractor-guided tour of the facility.

.1 Air Systems

.2 Fire Protection Systems

.3 Plumbing Systems

.4 Control Systems

.5 Heat Recovery Systems

.3 Demonstrate the following pieces of equipment:

.1 Fans/Makeup Air Units

.2 Domestic Water Heaters

.3 Pumps

.4 Prepare a schedule identifying the proposed sequence of demonstration. Sequence of demonstration shall correspond to full system starting. Submit for review by Contract Administrator one month prior to demonstration.

.5 Answer all questions raised by the City at demonstrations; if unable to satisfactorily answer questions immediately, provide written response within three (3) days.

END OF SECTION

TESTING

1. GENERAL

1.1 Scope

.1 Test domestic water piping

.2 Test sanitary sewer piping

.3 Test storm sewer piping

.4 Test natural gas piping

.5 Test heating water piping

.6 Test dry hydrant system piping

.7 Test refrigerant piping

.8 Test compressed air piping

.9 Test low velocity ducts

.10 Test medium and high velocity ducts

.11 Test glycol piping

.12 Performance testing of equipment

.13 Manufacturer's start-up of equipment

1.2 Quality Assurance

.1 Test equipment and material where required by Specification or authority having jurisdiction to demonstrate its proper and safe operation.

.2 Test procedures in accordance with the current applicable portions of ASME, ASHRAE, and other recognised test codes as far as field conditions permit.

.3 Perform tests on site to the satisfaction of the Contract Administrator.

.4 Piping, fixtures or equipment shall not be concealed or covered until inspected and approved by the Contract Administrator. Provide ample written notice (two working days) to the Contract Administrator before tests.

.5 Coordinate with Contract Administrator at start of project, those tests that will require witnessing by the Contract Administrator.

.6 Use factory trained representatives and submit Manufacturer's check sheets for starting the following specialty equipment.

.1 Air handling units

.2 Pumps

.3 Variable speed drive units

.4 Air flow measuring stations

.5 Control components

.6 Chemical cleaning and treatment

.7 Domestic water heaters

.7 Prior to starting, testing, balancing, 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.

.8 Contract Administrator shall be allowed to witness any testing, adjusting, starting, balancing and cleaning procedures.

.9 Assume all costs associated with starting and testing, including the supply of testing or cleaning medium.

.10 Prior to starting equipment or systems, secure and review Manufacturer's installation, operation and starting instructions. Read in conjunction with procedures defined herein.

.11 Use Manufacturer's or supplier's starting personnel where required to ensure integrity of Manufacturer's warranty.

.12 Compare installations to published Manufacturer's data and record discrepancies. Items proving detrimental to equipment performance shall be corrected prior to equipment starting.

.13 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. (Gas inspectors, pressure vessels inspections etc.)

.14 All starting, testing procedures shall be in accordance with applicable portions of the latest, current ASME, ASHRAE, AABC, CSA, NFPA, SMACNA, ASTM and ASPE codes and standards.

.15 Personnel involved in starting, testing, balancing 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 reading and tests.

.16 Assume all liabilities associated with starting, testing and balancing procedures.

1.3 Submittals

.1 Obtain certificates of approval, acceptance, and comply with current rules and regulations from authorities having jurisdiction and include in Operating and Maintenance Manuals.

.2 Perform tests as specified and upon completion of mechanical installation. Provide certification of tests with detailed data as required. Itemise each test as to time performed and personnel responsible. Include in Operating and Maintenance Manuals.

1.4 Liability

.1 Take charge of plant during tests, assume responsibility for damages in event of injury to personnel, building or equipment and bear costs for liability, repairs, and restoration in this connection.

2. PRODUCTS

.1 Not used

3. EXECUTION

3.1 Pressure Tests

.1 Provide equipment, materials and labour for tests and pay expenses. Use test instruments from approved laboratory or manufacturer and furnish certificate showing degree of accuracy. Install permanent gauges and thermometers used for tests just prior to tests to avoid possible changes in calibration.

.2 Carry out tests for eight-hour period and maintain pressure with no appreciable pressure drop. Where leakage occurs, repair and re-test and pay necessary costs for re-witnessing.

.3 Drainage Systems: Test by filling with water to produce water pressure to 30 kPa minimum and 62 kPa maximum.

.4 Water Piping: Test to 1-1/2 times maximum working pressure or 1033 kPa, whichever is greater, water pressure measured at system low point.

.5 Natural Gas: Test as required by current edition of CAN/CGA 149.1, and authority having jurisdiction.

.6 Ducts: Test ducts as per current edition of SMACNA Manual.

.7 Check systems during application of test pressure including visual check for leakage of water test medium, soap bubble test for air.

.8 During heating and cooling piping system tests, check linear expansion at elbows, U bends, expansion joints and offsets for proper clearance.

.9 When using water as test medium for system not using water, evacuate and dehydrate the piping and certify the lines are dry. Use agency specialising in this type of Work.

.10 Should tests indicate defective Work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by re-making joints in screwed fittings, cutting out and re-welding welded joints, re-making joints in copper lines. Do not caulk.

3.2 Testing of Soldered Copper Joints

.1 Submit two (2) sample soldered copper pipe joints prepared by each tradesmen to be used on the project, to the Contract Administrator within two months of contract award. These samples may be subjected to radiographic testing to verify quality of workmanship.

.2 Remove ten (10) samples of soldered copper pipe joints on heating system during construction as selected by the Contract Administrator and remake joints removed. Arrange and pay for radiographic testing of removed joints to verify quality of workmanship.

.3 Rejection of a sample will require re-test of adjacent joints at the Contractor's expense.

.4 Failure of more than 75 percent of the above removed samples will necessitate removal and replacement of all joints completed up to the time of test, at Contractor's expense.

3.3 General

.1 Conduct performance tests to demonstrate equipment and systems meet specified requirements after mechanical installations are completed and pressure tested. Conduct tests as soon as conditions permit. Make changes, repairs, and adjustments required prior to operating tests.

.2 Where required by the Authority having jurisdiction, gas fired appliances rated in excess of 117 kW shall be subjected to an operational test established by the Authority and shall pass this test before being approved for operation.

.3 Meet with Division 16 Manufacturers, suppliers, and other specialists as required to ensure all phases of work are properly coordinated prior to the commencement of each particular testing procedure. Establish all necessary manpower requirements.

.4 Operate and test motors and speed switches for correct wiring and sequences and direction of rotation. Check and record overload heaters in motor starters.

.5 Confirm voltages and operating amperages at full load.

.6 Failure to follow instruction pertaining to correct starting procedures may result in re-evaluation of equipment by an Independent Testing Agency selected by the City at Contractor's expense. Should results reveal equipment has not been properly started,

equipment may be rejected, removed from site, and replaced. Replacement equipment shall also be subject to full starting procedures, using same procedures specified on the originally installed equipment.

3.4 Procedures

.1 Procedures shall be identified in the following five distinct phases:

.1 Pre-Starting: Visual inspection.

.2 Starting: Actual starting procedure.

.3 Post-Starting: Operational testing adjusting or balancing, and equipment run-in phase.

.4 Pre-Interim Acceptance of the Work: Final cleaning, re-testing, balancing and adjusting, and necessary maintenance.

.5 Post-Interim Acceptance of the Work: Repeat tests and fine-tuning resulting from corrective action of deficiency clean-up.

.2 Check specified and Shop Drawing data against installed data.

.3 Check the installation is as defined by contract documents and as per Manufacturer's recommendations including Manufacturer's installation check sheets.

END OF SECTION

VIBRATION ISOLATION

1. GENERAL

1.1 Scope

.1 Supply all labour, materials and equipment required and necessary to isolate and restrain the equipment as indicated on the Drawings and specified herein and guarantee the function of the materials and equipment supplied.

.2 Install 300 mm long flex connection on all duct work connected to isolated equipment.

1.2 Qualifications

.1 All vibration isolators and bases shall be supplied by an acceptable supplier with the exception of isolators which are factory installed and are standard equipment with the machinery.

.2 Provide shop and placement drawings for all vibration isolation elements for review, before materials are ordered. The Drawings shall bear the stamp and signature of the responsible supplier's technical representative.

.3 The Work shall be carried out in accordance with the Specification and, where applicable, in accordance with the Manufacturer's instructions and only by workmen experienced in this type of Work.

1.3 Samples

.1 Samples of materials required to complete the Work of this Section shall be submitted to the Contract Administrator for inspection and review, prior to submission of the Shop Drawings.

1.4 Inspection

.1 A qualified representative of the isolator Manufacturer shall inspect the isolated equipment after installation and submit a concise report stating any deficiencies in the installation.

2. PRODUCTS

2.1 Isolators

.1 Spring isolators located out of doors or in humid areas shall have Rustoleum painted housing and neoprene coated springs, unless otherwise indicated on Drawings.

.2 Isolation mounts for equipment with operating weights substantially different from the installed weights, such as chillers or boilers, shall have adjustable limit stops.

2.2 Open Spring Isolators

.1 Springs shall be "ISO-Stiff" having equal stiffness in the horizontal and vertical planes with a working deflection between 0.3 and 0.6 of solid deflection.

.2 Spring mounts shall be complete with levelling devices, minimum 6 mm thick neoprene sound pads and zinc chromate plated hardware.

.3 Sound pads shall be sized for a minimum deflection of 1.2 mm and shall meet the requirements for neoprene isolators.

2.3 Closed Spring Isolators

.1 Compression springs shall be used both for hangers and floor mount isolators.

.2 Springs shall be stable under operating conditions.

.3 Housings shall incorporate a minimum 6 mm thick sound pad sized for a minimum static deflection of 1.2 mm meeting the requirements for neoprene isolators.

.4 Floor mount units shall incorporate neoprene side stabilisers with a minimum 6 mm clearance.

2.4 Neoprene Isolators

.1 All neoprene isolators shall be tested to latest ASTM specifications.

.2 Where a ribbed pad is used, the height of the ribs shall not exceed 0.7 times the width of the rib. A steel layer shall be used to distribute the load in a multi-layered unit.

.3 Neoprene pads or elements shall be selected at the Manufacturer's optimum recommended loading and shall not be loaded beyond the limit specified in the neoprene Manufacturer's literature.

2.5 Inertia Bases

.1 Concrete inertia bases shall be a minimum of 1.5 times the weight of the isolation equipment and shall be constructed using a channel iron perimeter and adequate reinforcing. The concrete shall be rated at 20 MPa. Design shall be by the isolation suppliers.

.2 Concrete inertia bases shall meet the requirements of the isolation supplier's Shop Drawings.

.3 Structural steel bases shall be sufficiently rigid to prevent misalignment or undue stress on the machine, and to transmit design loads to the isolators.

2.6 Spring Hangers

.1 Hangers capable of a 10 degree misalignment shall be provided unless otherwise specified.

3. EXECUTION

3.1 Application

.1 Provide vibration isolator for mechanical motor driven equipment throughout, unless specifically noted otherwise.

.2 Set steel bases for 25 mm clearance between housekeeping pad and base. Set concrete inertia bases for 50 mm clearance. Adjust equipment level.

.3 Deflections 12 mm and over shall use steel spring isolators.

.4 Deflections 5 mm and under shall use neoprene isolators.

.5 Horizontal limit springs shall be provided on fans in excess of 1.5 kPa static pressure except vertical discharge fans and on hanger supported, horizontally mounted axial fans where thrust due to static pressure exceeds 300 N.

.6 All equipment mounted on vibration isolators shall have a minimum clearance of 50 mm to other structures, piping equipment, etc. All isolators shall be adjusted to make equipment level.

.7 Prior to making piping connections to equipment with operating weights substantially different from installed weights, the equipment shall be blocked up with temporary shims to the final heights. When full load is applied, the isolators shall be adjusted to take up the load just enough to allow shim removal.

.8 Adjustable, horizontal stabilisers on close spring isolators shall be adjusted so that the side stabilisers are clear under normal operating conditions.

.9 All piping connections to isolated equipment shall be supported resiliently for the following distances or to the nearest flexible pipe connector.

Pipe Size	Distance, *m*
15 - 40 mm	3.0
50 - 65 mm	4.5
75 - 100 mm	7.0
125 - 200 mm	9.0
225 - 275 mm	13.5
300 - 350 mm	15.0

The three closest hangers to the vibration source shall be selected for the lesser of a 25 mm static deflection or the static deflection of the isolated equipment. The remaining isolators shall be selected for the lesser of the 25 mm static deflection or 1/2 the static deflection of the isolated equipment.

.10 Spring hangers shall be installed without binding.

.11 Adjust isolators as required and ensure springs are not compressed.

.12 Provide neoprene side snubbers or retaining springs where side torque or thrust is developed.

.13 Where movement limiting restraints are provided, they shall be set in a position with minimum 6 mm air gap. Restraints, isolator equipment and attachment points shall be designed to withstand the impact of the isolated equipment subjected to an acceleration not exceeding 3 g without permanent distortion or damage.

.14 Wiring connections to isolated equipment shall be flexible.

3.2 Performance

.1 Install isolators of type and deflection as indicated on the following table, whichever provides the greater deflection.

.2 The required static deflection of isolators for equipment exceeding 0.35 kW is indicated below. Spring isolators shall be "open spring". Closed spring isolators shall only be used where specified.

Machine Speed r/min	Basement		Upper Floor	
	Under *15 kW*	Over *15 kW*	Normal	Critical
Under 400	Special*	Special*	Special*	Special*
400 - 600	25 mm	50 mm	90 mm	Special*
600 - 800	12 mm	25 mm	50 mm	90 mm
800 - 1100	5 mm.	12 mm	25 mm	50 mm
1100 - 1500	3 mm	4 mm	5 mm	12 mm

* "Special" indicates as directed by the acoustical consultant.

END OF SECTION

METERS AND GAUGES

1. GENERAL

1.1 Scope

.1 Provide meters, gauges, and taps where shown on Drawings or specified herein.

.2 Submit Shop Drawings of proposed Products to the Contract Administrator for review.

.3 Submit data sheets on thermometers and pressure gauges indicating service, and temperature or pressure ranges to the Contract Administrator for review.

2. PRODUCTS

2.1 Thermometers

.1 Dial thermometers: 75 mm diameter dial in drawn steel case, bimetallic helix actuated, brass separable socket of flange and bushing, glass cover, adjustable pointer.

.2 Mercury thermometer: red reading mercury filled, 2 degree graduations, aluminum case, 230 mm scale, straight shank, separable socket, adjustable angle.

2.2 Thermometer Well

.1 Stainless steel suitable for stem type thermometer with gasket and cap except in potable water and open systems, in which case brass type shall be used.

2.3 Pressure Gauges

.1 100 mm diameter, drawn steel case, phosphor bronze bourdon tube, brass movement, extruded brass socket, 1 percent midscale accuracy, front calibration adjustment, black figures on white background. Provide gauge cock and syphon for steam service, pulsating damper and pet cock for water service.

2.4 Pressure Gauge Taps

.1 Brass needle valve.

2.5 Static Pressure Gauges

.1 Dial gauge: 100 mm dial, diaphragm actuated, suitable for positive, negative or differential pressure measurement. Accuracy within +2 percent of full scale, complete with static pressure tips and mounting accessories.

.2 Inclined vertical manometer: moulded plastic manometer, accuracy within +3 percent of full scale, suitable for positive, negative or differential pressure measurement, complete with static pressure tips and mounting accuracy.

3. EXECUTION

3.1 Installation

.1 Provide one pressure gauge per pump installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

.2 Select gauges so that normal operating point is approximately mid-point of instrument range.

.3 On pipes 65 mm and smaller, place well in tee used in lieu of an elbow to accommodate well.

3.2 Meters and Gauges Installation Schedule

.1 Pressure Gauges:

.1 Pumps

.2 Expansion tanks

.3 Pressure tanks

.4 Leaving side of automatic make-up valves

.5 Where shown on Drawings

.2 Pressure Gauge Taps:

.1 Both sides of two-way control valves

.2 All lines to three-way control valves

.3 Major coils, inlet and outlet

.4 Heat exchangers, inlet and outlet, tube and shell side

.5 Where shown on Drawings

.3 Thermometers:

.1 Supply and return headers of central equipment

.2 Heat exchangers, inlet and outlet tube and shell side

.3 Heating water zone supply and return mains

.4 Heating and cooling coils, inlet and outlet

.5 Where shown on Drawings

.4 Thermometer Wells Only:

.1 All lines to three-way control valves

.2 Where shown on Drawings

.5 Static Pressure Gauges:

.1 Across built-up filter banks

.2 Across unitary filter sections

.3 Across supply and return fans

.4 Where shown on Drawings

.6 Static Pressure Taps:

.1 Across all major dampers

.2 Across heating and cooling coils

.3 Across heat recovery sections

.4 Where shown on Drawings

END OF SECTION

SUPPORTS, ANCHORS AND SEALS

1. GENERAL

1.1 Scope

.1 Pipe hangers and supports

.2 Duct hangers and supports

.3 Flashing for mechanical equipment

.4 Sleeving for mechanical equipment

.5 Pipe anchors

1.2 Reference Standards

.1 Pipe supports shall meet the requirements of current edition of ANSI B31.1, Power piping.

.2 Duct hangers shall follow the recommendations of the current edition of the SMACNA Duct Manuals.

1.3 Submittals

.1 Submit Shop Drawings of each factory manufactured component.

1.4 General Requirements

.1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade, provide for expansion and contraction and to accommodate insulation; provide insulation protection saddles.

.2 Install supports of strength and rigidity to suit loading without unduly stressing building. Locate adjacent to equipment to prevent undue stresses in piping and equipment.

.3 Select hangers and supports for the service and in accordance with the Manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.

.4 Fasten hangers and supports to building steel or inserts in concrete construction.

.5 Provide and set sleeves required for equipment, including openings required for placing equipment. Provide sleeves for all pipe and duct penetrations through walls, ceilings, floors and footings. Pipe sleeves are not required where pipes pass through cored concrete walls or floors.

.6 Dielectrically isolate dissimilar metals.

.7 Obtain approval from the Contract Administrator prior to drilling for inserts and supports for piping systems.

.8 Obtain approval from the Contract Administrator prior to using percussion type fastenings.

.9 Use of piping or equipment for hanger supports is not permitted.

.10 Use of perforated band iron, wire or chain as hangers is not permitted.

.11 Do not weld piping, ductwork or equipment supports to building metal decking or building structural steel supports unless prior written approval has been obtained from the Contract Administrator.

.12 Where deemed necessary by the Contract Administrator the contractor shall, at his own cost, employ a structural consultant to design equipment supports and/or pipe anchors.

2. PRODUCTS

2.1 Inserts

.1 Inserts shall be malleable iron case or galvanised steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.

.2 Size inserts to suit threaded hanger rods.

2.2 Pipe Hangers and Supports

.1 Hangers, Pipe Sizes 15 mm to 40 mm: adjustable wrought steel ring.

.2 Hangers, Pipe Sizes 50 mm to 100 mm and Cold Pipe Sizes 150 mm Over: adjustable wrought steel clevis.

.3 Hangers, Hot Pipe Sizes 150 mm and Over: adjustable steel yoke and cast iron roll.

.4 Multiple or Trapeze Hangers: steel channels with welded spacers and hanger rods, cast iron roll and stand for hot pipe sizes 150 mm and over.

.5 Wall Support, Pipe Sizes to 80 mm: cast iron hook.

.6 Wall Support, Pipe Sizes 100 mm and Over: welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll for hot pipe sizes 150 mm and over.

.7 Vertical Support: steel riser clamp.

.8 Floor Support, Pipe Sizes to 100 mm and All Cold Pipe Sizes: cast iron adjustable pipe saddle, locknut nipple, floor flange and concrete pier to steel support.

.9 Floor Support, Hot Pipe Sizes 125 mm and over: adjustable cast iron roll and stand, steel screws and concrete pier or steel support.

.10 Install hangers so they cannot become disengaged by movements of supported pipe.

.11 Provide copper plated hangers and supports for copper piping or provide sheet lead packing between hanger or support and piping. Provide galvanised hangers and supports for galvanised piping.

.12 Support all piping below grade and under floor slabs in 3.2 mm continuous cadmium plated channel. Support channel with cadmium plated clevis hangers and rods. Install supports on centres as specified in 3.2. Extend cadmium plated hanger rods 450 mm above slab rebar and bend back over rebar so as to provide a minimum of 450 mm of support in slab. Do not stress rod when bending.

2.3 Hanger Rods

.1 Provide steel hanger rods, threaded both ends, threaded one end, or continuous threaded.

2.4 Duct Hangers and Supports

.1 Conform to current edition of SMACNA handbooks.

2.5 Flashing

.1 Steel Flashing: 0.85 mm minimum thickness galvanised sheet steel.

.2 Lead Flashing: 25 kg/m² sheet lead for waterproofing, 5 kg/m² sheet lead for soundproofing.

.3 Safes: 25 kg/m² sheet lead or 0.5 mm neoprene.

.4 Caps: steel, 0.7 mm thickness minimum, 1.6 mm thickness at fire resistance structures.

2.6 Sleeves

.1 Pipes through Floors: form with 1.2 mm galvanised steel.

.2 Pipes through Beams, Walls, Fire Proofing, Footings, Potentially Wet Floor: form with schedule 40 steel pipe.

.3 Ducts: form sleeves with galvanised steel.

.4 Size large enough to allow for expansion with continuous insulation.

2.7 Pipe Seals

.1 Provide “Link-seal” pipe sealing system where passing through room foundation walls.

2.8 Finishes on Hanger Rods, Hangers and Supports

.1 All steel hanger rods, hangers and supports shall be galvanised or factory primed with alkyd red oxide primer to CGSB 1-GP-40m.

3. EXECUTION

3.1 Inserts

.1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

.2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying piping over 100 mm or ducts over 1500 mm wide.

.3 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

.4 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

3.2 Pipe Hangers and Supports

.1 Support horizontal steel and copper piping as follows:

Nominal Pipe Size	Distance Between Supports		Hanger Rod Diameter
	Steel	Copper	
15 mm	1.8 m	1.5 m	10 mm
20 mm to 40 mm	2.1 m	1.8 m	10 mm
50 mm & 65 mm	3.0 m	2.4 m	10 mm
80 mm & 100 mm	3.6 m	3.0 m	16 mm
150 mm to 300 mm	4.2 m	4.0 m	22 mm
350 mm to 450 mm	6.0 m	--	25 mm

.2 Install hangers to provide minimum 12 mm clear space between finished covering and adjacent work.

.3 Place a hanger within 300 mm of each horizontal elbow.

.4 Use hangers which are vertically adjustable 40 mm minimum after piping is erected.

.5 Support horizontal soil pipe near each hub with 1.5 m maximum spacing between hangers.

.6 Support vertical piping at every other floor. Support vertical soil pipe at each floor at hub.

.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.8 Where practical, support riser piping independently of connected horizontal piping.

.9 Use oversized hangers to accommodate pipe insulation thickness. For pipes up to 50 mm use high density rigid pipe insulation at hanger location, with an insulation protection shield. For pipes 65 mm and over, use insulation protection saddle.

3.3 Low Velocity Duct Hangers and Supports

.1 Hanger Minimum Sizes:

.1 Up to 750 mm wide: 25 x 1.6 mm at 3 m spacing.

.2 790 to 1200 mm wide: 40 x 1.6 mm at 3 m spacing.

.3 Over 1200 mm wide: 40 x 1.6 mm at 2.4 m spacing.

.2 Horizontal Duct on Wall Supports Minimum Sizes:

.1 Up to 450 mm wide: 40 x 1.6 mm or 25 x 25 x 3 mm at 2.4 m spacing.

.2 480 to 1000 m wide: 40 x 40 x 3 mm at 1.2 m spacing.

.3 Vertical Duct on Wall Supports Minimum Sizes at 3.65 m spacing:

.1 Up to 610 mm wide: 40 x 1.6 mm.

.2 640 to 900 mm wide: 25 x 25 x 3 mm.

.3 940 to 1200 mm wide: 30 x 30 x 3 mm.

.4 Over 1200 mm wide: 50 x 50 x 3 mm.

.4 Vertical Duct Floor Supports Minimum Sizes, riveted or screwed to ducts:

.1 Up to 1520 mm wide: 40 x 40 x 3 mm.

.2 Over 1520 mm wide: 50 x 50 x 3 mm.

3.4 Medium and High Velocity Duct Hangers and Supports

.1 Hanger Minimum Sizes:

.1 Up to 900 mm wide: 2 at 25 x 1.6 mm at 3 m spacing.

.2 940 to 1520 mm wide: 2 at 25 x 1.6 mm at 2.4 m spacing and 50 x 50 x 6 mm trapeze.

.3 1550 to 3050 mm wide: 2 at 38 x 2.6 mm at 2.4 m spacing and 50 x 50 x 7 mm trapeze.

.4 2070 to 6700 mm wide: 3 at 10 mm diameter at 1.2 m spacing and 65 x 65 x 5 mm trapeze.

.2 Round Duct Hangers Minimum Sizes at 3 m spacings:

.1 Up to 460 mm diameter: 25 x 1.6 mm.

.2 480 to 900 mm diameter: 25 x 2.6 mm.

.3 940 to 1270 mm diameter: 40 x 2.6 mm.

.4 1300 to 2130 mm diameter: 2 at 40 x 2.6 mm from girth reinforcing angle.

.3 Vertical Duct Floor Supports Minimum Sizes:

.1 Up to 1220 mm wide: 40 x 40 x 3 mm.

.2 Over 1220 mm wide: 50 x 50 x 3 mm.

.3 Rivet to duct and tie angles together with rod, angles or band iron.

.4 Angle reinforcing may be used for support omitting trapeze.

3.5 Equipment Bases and Supports

.1 Provide for floor mounted equipment, reinforced concrete housekeeping bases poured directly on structural floor slab 100 mm thick minimum, extended 100 mm minimum beyond machinery bedplates. Provide templates, anchor bolts and accessories required for mounting and anchoring equipment.

.2 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

.3 Rigidly anchor ducts and pipes immediately after vibration connections to equipment.

3.6 Flashing

.1 Flash and counterflash where mechanical equipment passes through weather or waterproofed walls, floors, and roofs.

.2 Flash vent and soil pipes projecting 75 mm minimum above roof membrane with lead worked 25 mm minimum into hub, 200 mm minimum clear on sides with minimum 600 x 600 mm sheet size. For pipes through outside walls turn flange back into wall and caulk.

.3 Flash floor drains over finished areas with lead 250 mm clear on sides with minimum 920 x 920 mm sheet size. Fasten flashing to drain clamp device.

.4 Provide curbs for mechanical roof installations minimum 200 mm high. Flash and counterflash with steel; solder and make waterproof.

.5 Counterflashings are attached to mechanical equipment and lap the base flashings on the roof curbs.

.6 All joints in counterflashings shall be flattened and soldered double seam. Storm collars shall be adjustable to draw tight to pipe with bolts. Caulk around the top edge. Storm collars shall be used above all roof jacks.

.7 Vertical flange section of roof jacks shall be screwed to face of curb.

.8 Provide continuous lead or neoprene safes below air supply casings, built-up mop sinks, shower stalls, shower room floors located above finished rooms. Solder at joints, flash into floor drains and turn up 150 mm into walls or to top of curbs and caulk into joints.

.9 Provide lead flashing around ducts and pipes passing from equipment rooms, installed according to Manufacturer's data for sound control.

3.7 Sleeves

.1 Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeve.

.2 Extend sleeves through potentially wet floors 25 mm above finished floor level. Caulk sleeves full depth and provide floor plate.

.3 Piping and duct work passing through floor, ceiling or wall, close off space between duct and sleeve and non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.

.4 Piping passing through mechanical room floor, roof or wall, close off space between pipe and sleeve with synthetic rubber compound mechanical type seals.

.5 Sleeves provided through walls or floors where liquids could potentially pass from one side to the other, provide sleeves with a 25 mm "flange" welded to the external face of the sleeve at the mid point of the thickness of the structure to provide a water stop.

.6 Install chrome plated escutcheons where piping passes through finished surfaces.

END OF SECTION

PRE-OPERATIONAL CLEANING AND CHEMICAL TREATMENT

1. GENERAL

1.1 Scope

.1 Provide for cleaning and degreasing of hot water heating, glycol and air washer systems.

.2 Provide all necessary equipment and chemicals to treat hot water heating, glycol and air washer systems.

.3 Provide for flushing and disinfection of domestic water systems.

1.2 Acceptable Agency

.1 Chemical treatment agency shall provide equipment, chemicals and site supervision so as to fully comply with all requirements and their intent contained within this specification section.

1.3 Quality Assurance

.1 Perform the cleaning and degreasing operation on site in conjunction with the mechanical contractor and submit written reports on all situations found, actions taken and final results. Reports shall be signed by the Contractor, commissioning coordinator, and chemical treatment agency. Inform the Contract Administrator and commissioning agency fifteen (15) working days prior to commencing of Work.

.2 Provide chemical treatment as specified herein and provide written reports. Reports shall be signed by the chemical treatment agency, Contractor and commissioning agency.

.3 Chemical treatment agency shall provide directive and assistance to the Contractor in the degreasing, cleaning and chemical treatment of all piping systems. Use of the permanent mechanical systems for pumping or heating of cleaning and dilution solutions is not permitted. Permanent systems shall be isolated and portable pumps and boilers utilised for the duration of the cleaning process. Permanent equipment shall be flushed, degreased and chemically treated independent of the piping systems.

1.4 Submittals

.1 Submit Shop Drawings with complete description of proposed chemicals, quantities, calculations, procedures, test kits and equipment to be supplied. Along with Product Shop Drawings, provide copies of data sheets, procedure instructions and analysis reports to be used on this project. Shop Drawings shall be submitted within ten (10) working days of the award of Contract.

.2 Include with the Shop Drawings Material Safety Data Sheets (MSDS) for all chemicals to be used.

.3 Provide written reports containing procedure of system cleaning and degreasing, giving times, dates, conditions of water and problems and actions encountered.

.4 Submit written reports to the Contractor and Contract Administrator containing results of tests taken every seven (7) days after completion of chemical treatment. Reports shall be done every seven (7) days for a minimum time period of 35 days.

.5 Provide monthly site visits (12 minimum) within the warranty year to check the treatment, take samples, analyse and recommend proper addition of treatment. Provide written reports to the City after each visit with a copy to the Contract Administrator.

2. PRODUCTS

2.1 Materials

.1 Provide sufficient chemicals to treat and test the systems from the time of activation and acceptance of the building for the first year of operation by the City.

.2 Materials which may contact finished areas shall be colourless and non-staining. Chemicals used must comply with environmental and health standards applicable to the usage on this project.

.3 System cleaner: alkaline compound which in solution removes grease and petroleum products.

.4 Close system treatment: sequestering agent to reduce deposits and adjust pH, and a corrosion inhibitor.

2.2 Equipment

.1 Solution pumps: provide positive displacement diaphragm type metering pumps for adding chemicals. Pumps shall have an adjustable flow rate and be suitable for chemicals to be pumped. Pumps shall be self flushing. Provide pumps with plastic solution tanks complete with agitator, pump mounting, cover, provision for fill line and pump strainer. Size the pumps and tanks to permit operation for three days at 50 percent pump capacity without refill of tanks. Provide agitator motor with terminals and junction box for electric wiring.

.2 Provide chemical pot feeder with a minimum of 10 L capacity, semi-sphere top and bottom, one pot feeder per system, located as shown on system schematics and floor plans. If location is in question obtain clarification from the Contract Administrator prior to installation.

2.3 Test Kits

.1 Provide test kits as required to determine proper system treatment consisting of, but not limited to the following:

.1 Heating water test kit to determine proper treatment.

.2 Glycol systems treatment test kits to determine proper concentration and glycol inhibitor, this shall include a hydrometer type tester.

.3 Air washer (domestic cold water) treatment test kits to determine proper treatment and blowdown.

.2 Provide test kits for hardness and chlorides in addition to those listed above.

.3 Provide an electronic pH meter complete with three different calibration standard solutions.

.4 All test kits shall be provided with adequate chemicals and reagents for one year of testing.

3. EXECUTION

3.1 System Cleaning

.1 Ensure reasonable care is exercised to prevent debris, dirt and other foreign material from entering the pipe during construction. This is to include proper protection of piping on-site prior to installation, temporary caps on partial systems, and complete evacuation of moisture within systems being hydrostatically pressure tested.

.2 Chemical treatment agency shall, in conjunction with the Contractor, review connections for complete draining and venting of the systems. The Contractor shall provide adequate drain connections to completely drain the systems within one hour. Utilise water meter to record capacity within each system, and record for maintenance manuals.

.3 Protect and/or remove control devices from systems during cleaning. All terminal control valves shall be in open position during cleaning. Particular attention is to be made to control valves which have a normally closed position.

.4 Make systems completely operational, totally filled, thoroughly vented, and completely started.

.5 Add system cleaner and degreasant to flow systems at concentration of 1 kg per 1000 L of water contained in systems for hot systems, 1 kg per 500 L of water for cold systems, and fill the boilers only with cleaner for steam systems.

.6 For hot water heating systems apply heat while circulating, raise temperature to 71°C slowly and maintain at 71°C for a minimum of 12 hours. Remove heat and circulate systems to 38°C or less. Drain system, entirely at one time, including all low points and coils. Intermittent start/stop of drainage is not approved. The Contractor to provide additional temporary pipe, pumps as necessary and drainage location for complete drainage. Refill the entire system with clean water, circulate for 6 hours at design temperature, provide complete venting and deaeration, repeat the draining procedure. Refill complete system with clean water and retest.

.7 For hot water heating systems, circulate at ambient temperature for a minimum of 48 hours.

.8 For glycol systems utilise the same procedure for hot water heating systems specified above.

.9 For open systems clean, degrease and flush in the same methods utilised for closed systems of same temperature. Drain completely and refill.

.10 Inspect, clean of sludge and flush all low points with clean water after cleaning and degreasing process is completed. Include disassembly of components as required. All cleaning and flushing of low points, coils, boilers, etc. shall be done prior to final fill and chemical treatment.

.11 All domestic hot, cold and domestic recirculation water systems will be required to be flushed and disinfected. Add chlorine to water in system to 50 mg/L and let stand for 24 hours. Check chlorine content after 24 hours and insure the content is not less than 20 mg/L. If less than 20 mg/L repeat process. Flush system until the chlorine content of water being drained is equal to the chlorine content of the make-up water. Utilise plumbing fixtures (i.e. lav., sinks, flushometers, etc.) for drainage.

3.2 Heating Water and Glycol Systems

.1 Provide one pot feeder for each individual system. Install complete with isolating and drain valves and necessary piping. Install as indicated on schematics.

.2 Treat closed systems with closed systems treatment introduced through pot feeder when required or indicated by test.

.3 Provide one side stream 5 micron filter per main circulation pump system, c/w isolation valves, unions, and bypass with N.C. valve.

.4 Provide "Dowfrost" brand propylene glycol to 50 percent for heat recovery system to act as an antifreeze solution.

END OF SECTION

PIPE AND PIPE FITTINGS

1. GENERAL

1.1 Quality Assurance

.1 Welding materials, fabrication standards and labour qualifications must conform to ANSI/ASME B31.1, ANSI B16.25, ASME Section IX, and the Provincial Board of Labour Regulations latest current editions.

.2 Use welders fully qualified and licensed by Provincial Authorities.

.3 Gas Piping: National Standard of Canada CAN1-B149.1, installation Code for Natural Gas Burning Appliances and Equipment.

.4 Domestic Water, Drainage and Vent Piping: current Provincial and Municipal Codes.

.5 All below grade steel piping shall be yellow jacketed with taped and sealed joints.

.6 Non specified pipe joining and pipe fitting methods such as T-drill and press fit are not permitted in any piping system covered under Division 15.

2. PRODUCTS

2.1 Pipe

	Service	Material
.1	Sanitary drainage, and vent, inside building, above ground	`DWV' copper, ASTM B306 Cast iron, CSA B70
.2	Sanitary drainage, and vent, inside building, below ground	Cast iron, CSA B70 PVC-DWV, CAN3B182
.3	Sanitary drainage and vent, outside building	Cast iron, CSA B70 PVC, SDR-35 for sizes to 300 mm**,** ASTM-D3034, complete with tracer wire. Concrete pipe for sizes over 300 mm
.4	Storm drainage, inside building, above ground	Cast iron, CSA B70 DWV Copper, ASTM B306
.5	Storm drainage, inside building, below ground	Cast iron, CSA B70 PVC-DWV, CAN3B182.1
.6	Storm drainage, outside building	Cast iron, CSA B70

		PVC, SDR-35 for sizes to 300 mm, ASTM-D3034, complete with tracer wire.
		Concrete pipe for sizes over 300 mm
.7	Domestic water, above ground (inside building)	Type `L' hard copper for cold water and Type 'K' hard copper for hot water and recirc. water for sizes up to 100 mm, ASTM B88M
		Ductile Iron centrifugally cast for cold water main sizes 100 mm and larger, ANSI/AWWA C151/A21.51. No steel piping allowed for domestic hot water.
.8	Domestic Water (buried inside building)	Type `K' soft copper, ASTM B88M
.9	Domestic water service	Type `K' soft copper, ASTM B88M below ground
		PVC, Class 150, conforming to CSA B137.3 and AWWA C900, complete with tracer wire
.10	Hot water and glycol heating to 120°C	Steel, Sch.40, ASTM A53, Grade B heating to 120°C
.11	Natural gas, propane Grade B	Steel, Sch.40, ASTM A53
.12	Equipment drains and overflows	Sch.40, galvanised steel, ASTM A120
		Type `L' hard copper ASTM B88M
.13	Compressed air	Type `L' hard copper, ASTM B88M
		Steel Sch.40, galvanised, ASTM A120 (for pipes over 65 mm diameter)

2.2 Fittings and Joints

	Service	Material	Joint
.1	Sanitary drainage and vent inside building, above ground	Cast iron	Gasket clamp
		Wrought or Cast copper	50-50 Solder

.2	Sanitary drainage and vent, inside building, below ground	Cast iron (hubless fitting)	Gasket & clamp
		PVC-DWV	Solvent weld
.3	Sanitary drainage and vent, outside building	Cast iron	Hub & spigot
		PVC- Gravity Sewer	Hub & spigot with gasket
		Concrete	Hub & spigot
.4	Storm drainage, inside building, above ground	Cast iron	Gasket & clamp
		Wrought or cast copper	50-50 solder
.5	Storm drainage, inside building, below ground	Cast iron	Gasket & clamp
		PVC-DWV	Solvent weld
.6	Storm drainage, outside building	Cast iron	Hub & spigot
		PVC-Gravity sewer	Hub & spigot with gasket
		Concrete	Hub & spigot
.7	Domestic water, above ground	Wrought copper, bronze	Lead free solder, brazed for pipes over 50 mm
		Cast bronze	Screwed
		Ductile Iron pipe	Grooved mechanical
.8	Domestic water, buried	PVC	Hub & spigot, with "O" ring
		Copper pipe	No joints permitted underground
.9	Hot water and glycol heating 120°C	Banded malleable iron, 1033 kPa, up to 50 mm	Screwed,
		Steel, same schedule as pipe, for sizes 50 mm and	Welded

		larger	
		Wrought copper,	95-5 solder, brazed bronze, for pipes over 50 mm
		Cast brass	Screwed
		Cast bronze	Flare tube
.10	Natural gas	Banded malleable iron, 1033 kPa, for sizes 40 mm and under	Screwed
		Steel, same schedule as pipe, for sizes 50 mm and larger: and for high pressure(over 860 kPa)- all sizes; and for piping installed outdoors - all sizes	Welded
.11	Equipment drains and overflows	Galvanised banded malleable iron	Screwed
		Wrought copper, bronze	50-50 solder
		Cast brass	Screwed
.12	Compressed air	Wrought copper or cast brass	95-5 solder

.13 Use factory fabricated butt welded fittings for welded steel pipes.

.14 Use long radius elbows for steel and cast iron water piping, including grooved mechanical fittings.

2.3 Unions, Flanges and Couplings

.1 Size 50 mm and under: 1033 kPa malleable iron, bronze to iron ground joint unions for threaded ferrous piping, air tested for gas service, all bronze for copper piping.

.2 Sizes 65 mm and over: 1033 kPa forged steel welding neck flanges for ferrous piping, 1033 kPa bronze slip-on flanges for copper piping. Gaskets shall be 1.5 mm thick performed synthetic rubber bonded asbestos. Gaskets for gas service shall be synthetic rubber.

.3 Flange bolting: For systems up to 120°C, use carbon steel stud bolts, semi-flushed and heavy hex nuts, ASTM A307-GrB. For systems up to 215°C, use alloy steel bolts ASTM A193-GrB7, and semi-finished heavy hex nuts ASTM A194-Gr2H.

.4 Where permitted by the Contract Administrator, use grooved mechanical couplings to engage and lock grooved or shouldered pipe ends and to allow for some angular deflection,

contraction and expansion. Couplings consist of malleable iron housing-clamps, C-shaped composition sealing gasket EPDM Grade `E' and steel bolts. Use galvanised couplings for galvanised pipe. Victaulic brand or Grinnel Gruv-Lok only

3. EXECUTION

3.1 Preparation

.1 Ream pipes and tubes. Clean off scale and dirt, inside and outside, before assembly. Remove welding slag or other foreign material from piping.

.2 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.

3.2 Connection

.1 Screw joint steel piping up to and including 40 mm. Weld piping 65 mm and larger, including branch connections. Screw or weld 50 mm piping for liquid systems, weld 50 mm piping for air and gas systems.

.2 Make screwed joints with full cut standard taper pipe threads with approved non-toxic joint compound applied to male threads only.

.3 Make joints for plain end pipe with gasket and clamp type mechanical fastener.

.4 Clamp cast iron water pipe at fittings with 20 mm rods and properly anchor and support.

.5 Use grooved mechanical couplings and mechanical fasteners, only where permitted by the Contract Administrator.

.6 Use galvanised couplings with galvanised pipe.

.7 Make connections to equipment, specialty components, and branch mains with unions or flanges.

.8 Provide dielectric type connections wherever joining dissimilar metals in open systems. Brass adapters and valves are acceptable.

.9 Use insulating plastic spacers for copper pipe installation in metal studs.

3.3 Route and Grades

.1 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.

.2 Slope water piping 0.2 percent and provide hose bibb drains at low points.

.3 Equip low points with 20 mm drain valves and hose nipples.

.4 Provide air collection chambers with manual air vent at all high points of system. Collection chambers to be 25 mm diameter or line size whichever is greater and 150 mm high minimum. Square tees may only be used to assist with complete venting and draining.

.5 Make reductions in water pipes with top flat eccentric reducing fittings installed to provide drainage and venting.

.6 Grade horizontal drainage and vent piping 2 percent minimum, unless noted otherwise.

.7 Pipe the discharge from all relief valves, safety valves, vents, drains, equipment blowdowns, water columns and overflows to the nearest building drain. Pipe to glycol recovery tanks for a glycol based system.

3.4 Installation

.1 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.

.2 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.

.3 Install piping material specified as inside the building to 2500 mm outside of building.

.4 Yellow jacket buried steel lines, joints and fittings, prime coat and paint lines exposed to outdoors.

3.5 Welded Pipe Branch Connections

.1 Make branch connections according to the following schedule.

Legend:

T: Forges tee or reducing tee

S: Socolet

W: Weldolet

HEADER	BRANCH PIPE SIZE												
	15 mm	T											
	20 mm	T	T										
	25 mm	T	T	T									
	30 mm	T	T	T	T								
	40 mm	T	T	T	T	T							
	50 mm	S	S	S	T	T	T						
	65 mm	S	S	S	S	T	T	T					
	75 mm	S	S	S	S	S	T	T	T				
	100 mm	S	S	S	S	S	T	T	T	T			
	150 mm	S	S	S	S	S	W	T	T	T	T		
	200 mm	S	S	S	S	S	W	W	W	T	T	T	
	250 mm	S	S	S	S	S	W	W	W	W	T	T	T
	300 mm	S	S	S	S	S	W	W	W	W	W	T	T	T
		15	20	25	30	40	50	65	75	100	150	200	250	300

END OF SECTION

VALVES AND STRAINERS

1. GENERAL

1.1 Scope

.1 Ball valves

.2 Check valves

.3 Plug cocks

.4 Eccentric plug valves

.5 Butterfly valves

.6 Drain valves

.7 Strainers

1.2 Manufacturer

.1 Provide valves of the same type by the same manufacturer throughout.

.2 Provide valves with Manufacturer's name and pressure rating clearly marked on outside of body.

1.3 Shop Drawings

.1 Submit copies of valves "ordering schedule" for review before ordering valves.

.2 Submit detailed Shop Drawings clearly indicating make, model, size, pressure rating, materials of construction and intended service.

2. PRODUCTS

2.1 Domestic Water System

.1 Ball Valves up to 50 mm: brass body, chrome plated brass ball, threaded or solder ends, TFE seat and packing. 4134 kPa non-shock WOG rating. Threaded, Red-White Fig. 5044A. Solder joint, Red-White Fig. 5049A.

.2 Butterfly Valves: cast iron wafer full-lug body, 300 Series stainless steel shaft, bronze disc, replaceable EPDM seat, lever lock handle operator with multiple position lock plate for valve sizes to 100 mm, heavy duty gear handwheel operator with position indicator for valve sizes 150 mm and over. Minimum rating 1200 kPa, 121°C. Keystone F1000, F1020.

.3 Swing Check Valves up to 50 mm: bronze body, screw-in cap, replaceable disc, 860 kPa steam rating. Threaded, Red-White Fig. 236. Solder ends, Red-White Fig. 237.

.4 Swing Check Valves 65 mm and over: cast iron body, regrind-renew swing check, bolted cover, flanged ends, bronze disc and seat ring, rating 860 kPa steam. Red-White Fig. 435.

.5 Silent Check Valves for Pump Discharge:

.6 Up to 50 mm: bronze body, SS stem, 316 SS spring, Teflon disc and seat ring, 430 SS seat screw, threaded ends. 1380 kPa water. Val Matic VM-S1400.

.7 65 mm and over: wafer style, cast iron body, 316 SS seat, plug, spring and bushing. ANSI Class 125. Val Matic, Series 1400.

2.2 Hot Water Heating and Glycol Systems

.1 Ball Valves up to 50 mm: brass body, chrome plated brass ball, threaded or solder ends, TFE seat and packing. 4134 kPa non-shock WOG rating. Threaded, Red-White Fig. 5044A. Solder joint, Red-White Fig. 5049A.

.2 Butterfly Valves: cast iron wafer full-lug body, 300 Series stainless steel shaft, bronze disc, replaceable EPDM seat, lever lock handle operator with multiple position lock plate for valve sizes to 100 mm, heavy duty gear handwheel operator with position indicator for valve sizes 150 mm and over. Minimum rating 1200 kPa, 121°C. Keystone F1000, F1020.

.3 Swing Check Valves up to 50 mm: bronze body, screw-in cap, replaceable disc, 860 kPa steam rating. Threaded, Red-White Fig. 236. Solder ends, Red-White Fig. 237.

Swing Check Valves 65 mm and over: cast iron body, regrind-renew swing check, bolted cover, flanged ends, bronze disc and seat ring, rating 860 kPa steam. Red-White Fig. 435.

.4 Silent Check Valves for Pump Discharge:

.1 Up to 50 mm: bronze body, SS stem, 316 SS spring, Teflon disc and seat ring, 430 SS seat screw, threaded ends. 1380 kPa water. Val Matic VM-S1400.

.2 65 mm and over: wafer style, cast iron body, 316 SS seat, plug, spring and bushing. ANSI Class 125. Val Matic, Series 1400.

.5 Eccentric plug valves: cast iron body with resilient faced cast iron plug, bolted bonnet, stainless steel bearings, nickel seat. Multiple packing ring, stem seal and resilient plug facing materials suitable for hot water/glycol service to *121°C.* Valve ends threaded up to 50 mm, flanged 65 mm and over. Lever operator with adjustable open position memory stop up to 100 mm valves, heavy duty gear reducer handwheel operator with adjustable open position memory stop for valves 150 mm and over. Rating: 1210 kPa water at 121°C. DeZurik Series 100.

.6 Drain valves up to 50 mm: brass two-piece body ball valve, blowout proof stem, Teflon seats, forged brass chrome palted ball, hose end connection with cap and chain by male IP, 4200 kPa water, oil, gas rating, Red-White Fig. 5046.

.7 Circuit balancing valves: suitable for throttling. All metal parts non-ferrous, die cast non-porous copper alloy. Flow measuring accuracy ±2 percent. Positive shut-off, drain connection with cap. Memory balancing feature. Fittings for connection of portable differential pressure meter. Bell & Gossett circuit setter.

.8 For glycol systems, provide glycol-compatible equipment.

2.3 Natural Gas Systems

.1 Plug cocks: Class 125 non-lubricated parallel-plug valve, cast iron body and plug, short pattern, regular port, full bore, threaded or flanged ends, CGA approved.

.2 Ball valves up to 50 mm: Class 125 non-lubricated ball valves suitable for outdoor use, brass body, CGA approved Section 3.16 threaded ends, Kitz Fig. #68 (AKTAF).

.3 Ball valves 65 mm and larger: flanged, carbon steel body, stainless steel trim, lever operated, Teflon seats and seals. Kitz Fig. 150SCTB-N.

2.4 Valve Operators

.1 Provide suitable hand wheels for radiation and drain valves and inside hose bibbs.

.2 Provide one plug cock wrench for every ten plug cocks sized 50 mm and smaller, minimum of one. Provide each plug cock sized 65 mm and larger with a wrench, with set screw.

.3 Provide valves larger than 100 mm located more than 2.1 m from floor in equipment rooms with chain operated sheaves. Extend chains to 1.5 m above floor and hook to clips to arrange to clear walking aisles.

2.5 Strainers

.1 Size 50 mm and under: screwed brass or iron body, Y pattern with 0.75 mm stainless steel perforated screen.

.2 Size 65 mm to 100 mm: flanged iron body, Y pattern with 1 mm stainless steel perforated screen.

.3 Size 125 mm and larger: flanged iron body, Y pattern with 3 mm stainless steel perforated screen.

.4 Screen free area shall be minimum three times area of inlet pipe.

2.6 Triple Duty Valve

.1 For base mounted or vertical inline pump discharge application, performs the functions of a nonslam check valve, throttling valve, shut-off valve and calibrated balancing valve. Equip with brass readout valves (with integral check valves) to read differential pressure across valve.

.2 Cast iron, bronze seat, replaceable bronze disc with EPDM insert.

.3 Up to 50 mm: NPT connections, 1200 kPa working pressure, brass stem, chatter preventing SS spring.

.4 Over 50 mm: flanged connections, 860 kPa rated, stainless steel stem and chatter preventing spring.

2.7 Suction Diffuser

.1 For base mounted or floor mounted vertical inline pumps where scheduled.

.2 Cast iron construction; NPT connections up to 50 mm: flanged connections.

.3 Over 65 mm: cast iron straightening fitting, stainless steel combination diffuser - strainer - orifice cylinder with 4.8 mm perforations, and permanent magnet. Provide complete with a 16 mesh bronze strainer.

3. EXECUTION

3.1 Installation and Application

.1 Install valves with stem upright or horizontal, not inverted.

.2 Provide threaded lug type butterfly valves for equipment isolation service. Provide wafer or threaded lug type valves for zone shut-off service.

.3 Where permitted by codes, butterfly valves may be used in fire protection systems.

.4 Use eccentric plug valves in water systems for throttling and balancing service.

.5 Provide drain valves at main shut-off valves, low points of piping and apparatus and terminal units.

.6 Size drain lines and drain valves equal to size of apparatus drain connection.

.7 For pipe sizes 20 mm and over, minimum drain size to be 20 mm

.8 Provide hose thread connection with cap and chain for 20 mm drain valves located in ceiling and public areas.

.9 Provide male NPT nipples with threaded pipe cap for drain sizes over 20 mm where not piped directly to floor drains.

.10 Provide valved drain and hose connections off the bottom of all strainers.

END OF SECTION

GLYCOL SPECIALTIES

1. GENERAL

1.1 Scope

.1 Pressure reducing stations

.2 Glycol mixing-charging tank, fill pump

.3 Propylene glycol solution

.4 Manual and automatic air vents

.5 Air separators

.6 Relief valves and fittings

.7 By-pass filter

1.2 Quality Assurance

.1 Thoroughly check system and make necessary corrections if system continually loses solution.

.2 Perform tests determining strength of glycol solution before system is turned over to the City. Provide test prior to end of guarantee and replenish as required. Provide written test results for review.

1.3 Submittals

.1 Provide Shop Drawings for all equipment in this Section.

2. PRODUCTS

2.1 Manual Air Vents

.1 Provide manual air vents with 25 mm or line diameter pipe which ever is greater to form air collection chamber. Collection chamber to be 150 mm high.

2.2 Air Separators

.1 Provide centrifugal type with 861 kPa WSP steel tank, galvanised steel 5 mm perforated strainer, perforated stainless steel air collector tube and drain connection.

2.3 Relief Valves

.1 Provide ASME rated direct spring loaded type, lever operated non-adjustable factory set discharge pressure as indicated.

2.4 Glycol Solution

.1 Provide propylene glycol-water solution suitable for a temperature range of -40°C to 104°C. Solution to be suitable for heating or cooling complete with appropriate corrosion inhibitors. Solutions must be factory premixed.

2.5 Bypass Filter

.1 Unit to consist of cartridge filter, flow indicator, flow control valves and filter cartridges. Cartridge filter; stainless steel shell of single centre bolt construction with cast nick-plated brass head, drain plug and air vent. Flow indicator - cast bronze body with two sight glasses of high temper, thermo shock-resistant glass and nylon rotor on stainless steel pin.

Flow control valves: cast bronze globe valves, 25 mm Female NPT Thread.

Filter cartridges: ten (10) each of 10 micron retention, and 20 micron retention.

Manufacturer: Guthrie Hydroniclean System.

2.6 Glycol Mixing, Charging Tank and Manual Fill Pump

.1 Refer to Section 15130 for tank specifications.

.2 Aluminum die-cast nitrite rubber diaphragm pump, 800 mm suction pipe, 20 mm diameter x 2400 mm neoprene hose with female hose thread connections. Monarch L-30 A.

2.7 Expansion Tank

.1 Provide glycol expansion tanks as described in Section 15130.

3. EXECUTION

3.1 Air Vents

.1 Provide manual type at system high points and convection type heating units.

.2 Where large air quantities can accumulate, provide enlarged air collection standpipe.

3.2 Air Separator

.1 Provide on suction side of system circulation pump and connect to expansion tank.

3.3 Relief Valve

.1 Provide relief valves on pressure tanks, low pressure side of reducing valves, heating convertors, expansion tanks and where indicated.

.2 Drain relief valve to glycol collection tanks. Do not waste glycol to floor drains.

.3 System relief valve capacity shall equal make-up pressure reducing valve capacity. Equipment relief valve capacity shall exceed input rating of connected equipment.

.4 Where one line vents several relief valves, cross sectional areas shall exceed sum of individual vent areas.

3.4 Bypass Filter

.1 Install between pump's suction and discharge. Provide isolation valves and sight glass as indicated.

3.5 Glycol Mixing-Charging Tank and Fill Pump

.1 Provide one tank and one pump for each glycol system.

3.6 Expansion Tanks

.1 Provide air lines, checks, charging valves and pressure gauges for expansion tanks and glycol fill tanks. Charging valves to be piped to 1200 mm above finished floor.

3.7 Installation

.1 Do necessary piping to complete installation as shown on the drawings specified.

.2 Thoroughly clean and flush system before antifreeze solution is added.

.3 Manually feed glycol to system through make-up line with pressure regulator.

.4 Provide one extra 20 L drum of glycol, at turn over of the building to the City.

.5 Provide antifreeze solution lost from the systems from any cause other than neglect by the City during the first year of operation.

END OF SECTION

EXPANSION COMPENSATION

1. GENERAL

1.1 Scope

.1 Flexible pipe connections

.2 Expansion joints and compensators in pipe systems

.3 Pipe loops, offsets, and swing joints

1.2 Reference Standard

.1 Conform to current Standards of EJMA and Manufacturer's recommendations.

1.3 Shop Drawings

.1 Provide Shop Drawings for all equipment in this Section.

.2 Flexible pipe connector shop drawing data shall include maximum allowable temperature and pressure rating, overall face-to-face length, live length, hose wall thickness, hose convolutions per 300 mm and per assembly, fundamental frequency of assembly, braid structure and total number of wires in braid.

.3 Expansion joint Shop Drawings shall include maximum allowable temperature and pressure rating, and maximum expansion compensation.

1.4 Inspection

.1 Provide inspection services by flexible pipe Manufacturer's representative for final installation and certify installation is in accordance with Manufacturer's recommendations and connectors are performing satisfactorily.

2. PRODUCTS

2.1 Flexible Pipe Connectors

.1 Flexible rubber spools: neoprene twin sphere connector of molded multiple plys of nylon tire cord fabric and neoprene, rated for 1035 kPa at 120°C. Union end connections for sizes 50 mm and under; floating galvanised ductile iron flanges for sizes over 50 mm.

.2 Spherical rubber spools: neoprene single sphere elbow connector, construction and service rating same as 2.1.1 above.

.3 Braided spools for copper piping: stainless steel inner core and braid braized to copper tube ends, suitable for 1035 kPa at 120°C.

.4 Braided spools for steel piping: stainless steel inner core and braid welded to steel pipe nipples, threaded for pipe up to 50 mm diameter, flanged for 65 mm diameter pipe and over. Suitable for service at 1035 kPa at 120°C.

2.2 Expansion Joints

.1 Copper piping: laminated stainless steel bellows brazed to copper tube ends, internal guide, stainless steel external shroud. Suitable for 1035 kPa at 260°C.

.2 Steel piping up to 100 mm: laminated stainless steel bellows welded to steel pipe nipples. Anti-torque device and threaded ends for sizes to 50 mm, flanged ends for sizes 65 mm and over. Internal guide and carbon steel shroud suitable for 1035 kPa at 260°C.

.3 Steel piping 100 mm and over: guided externally pressurised laminated stainless steel bellows, flanged ends, internal guide tube and ring, external shroud and guide ring. Suitable for 1035 kPa at 260°C.

2.3 Pipe Guides

.1 Four finger "spider" inside a guiding sleeve formed of two halves suitable for clamping onto pipe.

.2 Guided sleeve formed of two parts, suitable to be bolted to supporting structure.

.3 Guide length to be minimum 300 mm.

3. EXECUTION

3.1 Application

.1 Provide flexible pipe connectors on pipes connected to equipment supported by vibration isolation and where indicated on the drawing.

.2 Provide structural work and equipment required to control expansion and contraction of piping, loops, pipe offsets, and swing joints and provide expansion joints where indicated or required. Where deemed necessary by the Contract Administrator, the Contractor shall, at his own cost, employ a Professional Engineer to design pipe anchors to control piping expansion and contraction.

.3 Provide pipe guides as required to ensure correct pipe alignment for expansion joints.

3.2 Installation

.1 Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end.

.2 Rigidly anchor pipe to building structure at points shown, and where necessary provide pipe guides so that movement takes place along axis of pipe only.

.3 Install flexible connectors and expansion joints in accordance with Manufacturer's instructions.

.4 Do not compress or expand connector during installation.

END OF SECTION

TANKS

1. GENERAL

1.1 Scope

.1 Expansion tanks

.2 Domestic hot water storage tanks

.3 Glycol fill tanks

.4 Accessories and connection to piping system

.5 Saddles and structural supports

.6 Provide Shop Drawings for all scheduled tanks

1.2 Standards

.1 Construct pressure tanks to current ASME Code for Unfired Pressure Vessels.

.2 Comply with current Provincial Government Regulations.

1.3 Submittals

.1 Submit as part of Shop Drawings for domestic hot water storage tanks, specifications and installation instructions for tank lining method.

1.4 Inspections

.1 Obtain inspection certificates for pressure vessels from Provincial Authorities.

2. PRODUCTS

2.1 Expansion Tanks, Diaphragm Type

.1 Welded steel, rated for working pressure, supplied with steel support structure.

.2 Precharged air chamber, heavy duty butyl diaphragm bonded with polypropylene liner to steel sheel separating air chamber from water.

.3 Provide with air side charge connection, and water side inlet connection precharged as scheduled.

2.2 Domestic Hot Water Storage Tanks

.1 Tank shall be steel, rated for working pressure. Screwed connections shall be stainless steel.

.2 Line with internal corrosive resistant concrete lining of approximately 20 mm thickness. Line flanged connections. Clean and prime coat before lining.

.3 Tank shall be complete with access manhole and steel support saddles.

.4 Construct tank with necessary tappings for installation of accessories. Include tank drain, bottom water inlet and top outlet, thermometer (range 5°C to 93°C) and pressure relief valve suitable for maximum working pressure.

.5 Provide domestic hot water storage tank complete with two (2) inspection tappings, one near the top and the other near the bottom. Supply tank with factory attached magnesium anodes to provide cathodic protection against corrosion.

.6 Atmospheric Vessel Type

.1 Welded steel, atmospheric vessel

.2 Provide with lid with hinged half. Provide 50mm diameter hole for fill pump in the fixed portion of the lid.

.3 Red zinc rich primer coating, inside and out

.4 Tank capacity: 180 L

2.3 Glycol Feed Tank (GFT-1)

.1 Glycol feed tank shall include 25 L storage-mixing tank with level gauge; pump suction hose with inlet strainer; pressure pump with fuse protection; integral low fluid cut-out switch; integral check valve; power supply adapter; manual diverter valve for purging air and agitating contents of storage tank; pressure switch with two sets of SPST contacts, each adjustable from 55 kPA (8 psig) to 175 kPa (18 psig) cut-out pressure; 6 mm FPT connection. Power supply 115 V, 1 phase, 60 Hz to 24 VDC 50 W.

.2 Pressure pump shall be capable of running dry without damage.

.3 Unit shall be completely pre-assembled and certified by a recognized testing agency to CSA standard C22.2 No.68.

.4 Pump and tank capacity: See Schedule.

.5 Standard of acceptance: ‘Axiom Industries Ltd.’ model MF200.

3. EXECUTION

3.1 Installation

.1 Support tanks inside building from building structure as indicated on drawings. Provide 100 mm high housekeeping bases on floor mounted tanks.

.2 Provide 12 mm compressed air line with flexible coiled hose at each expansion tank and charging tank complete with fitting compatible with quick connect on the tank. Extend line and hose down to 1200 mm above floor level.

.3 To protect the domestic hot water storage tank from corrosion following installation method shall be used:

.1 Isolate heater tube bundle from the tank by the use of an isolation rubber ring around the tube, preventing physical contact of the tube sheet with the retaining studs, and an electrical isolation gasket on each side of the tube sheet.

.2 Electrically isolate the piping from the tank by using isolation gasket on flanged connections; and isolation bushing on threaded connections. Use isolation unions, and dielectric nipples.

.3 Tube bundles requiring support structures inside the tank should be isolated by using dielectric pads between bundle and support structure.

.4 Any attachments of electrical wiring, temperature sensors, etc., must be isolated from tank fittings with dielectric bushings.

.5 Provide dielectric pads between the tank and the saddle.

.6 Provide dielectric pads between welded-on legs and floor; and isolation washers and sleeves for the bolts.

3.2 Performance

.1 Provide tanks of dimensions and capacities as indicated on the tank schedule in Section 15999.

END OF SECTION

PIPING INSULATION

1. GENERAL

1.1 Scope

.1 Piping insulation

.2 Adhesives, tie wires, tapes

.3 Recovering

1.2 Quality Assurance

.1 Insulation shall be installed by skilled workmen regularly engaged in this type of Work.

.2 Materials shall meet or exceed fire and smoke hazard ratings as stated in this Section and defined in applicable building codes.

1.3 Submittals

.1 Submit Shop Drawings which indicate complete material data, "K" value temperature rating, density, finish, recovery jacket of materials proposed for this project and indicate thickness of material for individual services.

.2 Submit samples of proposed insulating and recovering materials.

1.4 Job Conditions

.1 Deliver material to job site in original non-broken factory packaging, labelled with Manufacturer's density and thickness.

.2 Perform Work at ambient and equipment temperatures as recommended by the adhesive Manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

1.5 Alternatives

.1 Alternative insulations are subject to review and acceptance by the Contract Administrator. Alternatives shall provide the same or better thermal resistance at normal conditions as material specified.

2. PRODUCTS

2.1 General

.1 Insulation Materials, Recovery Jackets, Vapour Barrier Facings, Tapes and Adhesives: Composite fire and smoke hazard ratings shall not exceed 25 for flame spread and 50 for smoke developed.

.2 All insulation materials shall meet current Building Code Standards, and packages or containers of such materials shall be appropriately labelled.

.3 Insulate fittings and valve bodies with preformed removable insulated fittings.

2.2 Materials

.1 Cold piping: formed fine fibrous glass or formed mineral fibre pipe insulation, with factory applied vapour barrier jacket, factory moulded to conform with piping, "K" value at 24°C maximum 0.035 W/m°C. Service temperature -14°C to 100°C.

.2 Hot piping: formed fine fibrous glass or mineral fibre pipe insulation, with factory applied general purpose jacket, factory moulded to conform to piping, "K" value maximum 0.035 W/m°C at 24°C. Service temperature up to 150°C.

.3 Refrigerant piping: foamed plastic of closed cell structure or closed cell elastomer, "K" value maximum 0.04 W/m°C at 24°C. Maximum water vapour transmission rating of 0.1 perms.

.4 Roof Drains, Vents and Radiant Panels: flexible fibrous glass or mineral fibre insulation, "K" value maximum 0.035 W/m°C at 24°C with factory applied reinforced aluminum foil vapour barrier. Service temperature -14°C to 50°C.

.5 Recovery Jackets:

.1 ULC labelled thermo-canvas flamespread less than 25 smoke developed less than 50.

.2 0.4 mm aluminum sheet for piping where specified.

3. EXECUTION

3.1 Preparation

.1 Do not install covering before piping and equipment has been tested and approved.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.2 Installation

.1 Ensure insulation is continuous through inside walls. Pack around pipes with fire proof self-supporting insulation material, properly sealed.

.2 Insulate piping, fittings and valves. Do not insulate unions, flanges, Victaulic couplings, strainers, flexible connections and expansion joints. Terminate insulation neatly with plastic material trowelled on a bevel.

.3 Finish insulation neatly on hangers, supports and other protrusions.

.4 Locate insulation or cover seams in least visible locations. Locate seams on piping in ceiling spaces on the underside of the pipe.

.5 Provide recovering jackets on exposed insulation throughout, including equipment rooms. Insulation located in crawl spaces, pipe shafts and suspended ceiling spaces is not considered exposed. Make smooth uneven insulated surfaces before recovering.

.6 Cover insulation exposed to outdoors with aluminum jacket secured with aluminum bands on 200 mm centres or screws on 150 mm centres. Lap joints 75 mm minimum and seal with compatible waterproof lap cement.

.7 Cold piping: seal lap joints with 100 percent coverage of vapour barrier adhesive. Seal butt joints with 50 mm wide strips of vapour barrier sealed with vapour barrier adhesive. For fittings and valves, apply hydraulic insulating cement; or apply factory fabricated insulation half shells, seal all laps and joints.

.8 Flare out staples may be used to secure jacket laps on hot systems. Staples are to be applied on 100 mm centres.

.9 Hot piping: for fittings and valves, apply hydraulic insulating cement; or apply factory fabricated insulation half shells.

.10 Vents: adhere flexible insulation with adhesive applied to all laps. Provide annealed tie wire at 400 mm centres for securing insulation. Butt insulation and seal joints and breaks with 50 mm of foil adhered over joint.

3.3 Insulation Installation Thickness Schedule

Piping or Equipment	Pipe Sizes mm	Insulation Thickness mm	Recovery Jacket
Domestic Cold Water Piping	15 to 20 25 and over	15 25	Canvas
Domestic Hot Water Supply and Recirculation Piping	15 to 50 Over 50	25 40	Canvas
Glycol Heat Recovery Piping	All sizes	25	Canvas

PIPING INSULATION

Piping or Equipment	Pipe Sizes mm	Insulation Thickness mm	Recovery Jacket
Vents (Interior) within 3 m of building penetration, as measured along pipe	All sizes	25	Canvas
Exterior Process Vents	All sizes	25	Aluminum
Air Separators		25	Canvas
Condensate Drains from Heat Reclaim	All sizes	25	Canvas

Note: Pipe insulation for piping installed in 38 mm x 92 mm wall cavity can be reduced 15 mm, for pipe sizes 40 mm to 65 mm. Install insulation to thickness specified piping outside the wall cavity.

END OF SECTION

DUCT INSULATION

1. GENERAL

1.1 Scope

.1 Duct thermal insulation

.2 Breeching insulation

.3 Adhesives, tie wires, tapes

.4 Recovery

.5 All outdoor mounted ductwork

1.2 Quality Assurance

.1 Insulation shall be installed by skilled workmen regularly engaged in this type of Work.

.2 Materials shall meet fire and smoke hazard ratings as stated in this Section and defined in applicable current building codes.

1.3 Submittals

.1 Submit Shop Drawings which indicate complete material data, "K" value temperature rating, density, finish, recovery jacket of materials proposed for this project and indicate thickness of material for individual services.

.2 Submit samples of proposed insulating materials and recovering.

1.4 Job Conditions

.1 Deliver material to job site in original non-broken factory packaging, labelled with Manufacturer's density and thickness.

.2 Perform Work at ambient and equipment temperatures as recommended by the adhesive Manufacturer. Make good separation of joints or cracking of insulation due to thermal movement, poor workmanship or material defects.

1.5 Alternatives

.1 Alternative insulations are subject to approval. Alternatives shall provide the same or better thermal resistance at normal conditions as material specified.

2. PRODUCTS

2.1 General

.1 Insulation Material, Recovery Jackets, Vapour Barrier Facings, Tapes and Adhesives: composite fire and smoke hazard ratings shall not exceed 25 from flame spread and 50 for smoke developed.

.2 Insulating materials and accessories shall withstand service temperatures without smouldering, glowing, smoking or flaming.

.3 Recovery Jackets:

.1 ULC labelled thermo-canvas

.2 0.5 mm aluminum sheet for interior duct work where specified

.3 0.9 mm aluminum sheet for exterior duct work and where subject to damage

.4 All insulation materials shall meet current Building Code Standards, and packages or containers of such materials shall be appropriately labelled.

2.2 Materials

.1 Exposed Rectangular Ducts: rigid fibrous glass or mineral fibreboard insulation, "K" value maximum 0.035 W/m°C at 24°C. Factory applied reinforced aluminum foil vapour barrier for cold ducts. Hot duct service temperature 20°C to 65°C. Cold ducts service temperature -40°C to 65°C.

.2 Round Ducts and Concealed Rectangular Ducts: flexible fibrous glass or mineral fibre insulation, "K" value maximum 0.035 W/m°C at 24°C. Factory applied reinforced aluminum foil vapour barrier for cold ducts. Hot duct service temperature 20°C to 65°C. Cold duct service temperature -40° to 65°C .

.3 Breeching Insulation: semi-rigid mineral fibre insulation with glass mat "K" value 0.035 W/m°C maximum at 24°C. Service temperature 65°C to 450°C.

3. EXECUTION

3.1 Preparation

.1 Do not install covering before ductwork and equipment has been tested and approved.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions where possible.

3.2 Installation

.1 Ensure insulation is continuous through inside walls. Pack around ducts with fireproof self-supporting insulation materials, properly sealed.

.2 Finish insulation neatly at hangers, supports and other protrusions.

.3 Do not insulate ductwork with external thermal insulation where acoustic duct insulation is specified.

.4 Locate insulation or cover seams in least visible locations. Locate seams on ductwork in ceiling spaces on the underside of the duct.

.5 Provide recovering jackets on exposed insulation throughout, including equipment rooms. Insulation located in crawl spaces, shafts and suspended ceiling spaces is not considered exposed. Make smooth any uneven insulated surface before recovering.

.6 Cover insulation exposed to outdoors with aluminum jacket secured with aluminum bands on 200 mm centres or screws on 150 mm centres. Lap joints 75 mm minimum and seal with compatible waterproof lap cement.

.7 Exposed Rectangular Ducts: secure rigid insulation with galvanised anchors or welded pins on 400 mm centres. Secure in place with retaining pins. Seal all insulation joints and breaks with joint tape. Seal adhesive; cover joints with 100 mm strips of open mesh cloth imbedded between two coats of lap seal adhesive. Use vapour barrier tape for insulation joints or breaks on cold ducts.

.8 Round Ducts and Concealed Rectangular Ducts: adhere flexible insulation to ductwork with adhesive applied in 150 mm wide strips on 400 mm centres. Provide annealed tie wire tied at 400 mm centres for securing duct insulation. Butt insulation and seal joints and breaks with lap seal adhesive; cover joints with joint tape. Use vapour barrier tape for cold ducts.

.9 Where duct velocities exceed 15 m/s, cover internal duct insulation with 0.8 mm perforated galvanised steel with 24 percent free area.

.10 Breeching Insulation: face breeching with 9.5 mm rib lath turn out to provide 12 mm space between insulation and hot surface and 12.5 mm mesh expanded lath on the outside. Butt blankets firmly together and secure with 1.6 mm galvanised wire. Lace metal mesh together. Coat with 12 mm thick insulating cement. Finish with a final 12 mm coat of insulating cement. Trowel to a smooth hard finish. Recover with aluminum jacket.

.11 Fasten aluminum recovery jacket in place with aluminum banding on 200 mm centres or screws or rivets on 150 mm centres.

3.3 Insulation Installation Thickness Schedule

Ducts and Equipment	Insulation Thickness (mm)	Recovery Jacket
Combustion Air and Relief Duct	50	Canvas
Exhaust Ducts within 3000 mm of Exterior Walls or Openings	25	Canvas
Outside Air Intake Ducts	50	Canvas
Ducts Exposed to Outdoors	50	Aluminum
Ventilation Equipment Casings	25	Canvas
Ventilation Equipment	50	Canvas
Exhaust Duct Between Heat Recovery Coil and Exhaust Louvre	25	Canvas

END OF SECTION

PUMPS

1. GENERAL

1.1 Scope

.1 All pumps except where integral with a manufactured piece of equipment.

.2 Pumps controls where self contained.

1.2 Submittals

.1 Submit with Shop Drawings certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Show pump weights, motor and pump operating or efficiencies and electrical power characteristics.

1.3 Quality Assurance

.1 Pumps shall be aligned by qualified millwright and alignment certified.

.2 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

.3 Motors shall be high efficiency or inverter only as specified in Section 15010.

2. PRODUCTS

2.1 General

.1 Statically and dynamically balance rotating parts.

.2 Construction shall permit complete servicing without breaking piping or motor connections.

.3 Pumps shall operate at 1750 rpm unless specified otherwise.

.4 Pump connections shall be flanged.

2.2 Vertical In-Line Pump

.1 Type: centrifugal, single stage, close coupled in-line, back pullout design, suitable for vertical operation.

.2 Casing: cast iron, rated for greater of 1200 kPa or 1.5 times actual discharge working pressure. Suction and discharge gauge port, air vent, wear rings, seal flush connection, drain plug, flanged suction and discharge.

.3 Impeller: bronze, fully enclosed, keyed to shaft and secured with locknut.

.4 Shaft: stainless steel or carbon steel with bronze or stainless steel sleeve through seal chamber.

.5 Seals: high performance multiple spring outside type balanced mechanical seal, 1790 kPa maximum stuffing box pressure. Tungsten carbide rotating face against stationary carbon seat. Viton secondary seat.

.6 Provide external heat exchanger to cool seal flush water to below 90°C, when pumping fluids over 93°C.

.7 Seals: Mechanical, Carbon on Silicon Carbide.

.8 Motor: open drip proof unless noted otherwise in pump schedule.

.9 For pumps 3.7 kW and larger, provide split spacer couplings.

2.3 In-Line Circulator

.1 Casing: bronze rated for 860 kPa working pressure.

.2 Impeller: Noryl.

.3 Shaft: alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.

.4 Seal: carbon rotating against a stationary ceramic seat Crane Type 2.

.5 Motor: drip proof construction, resilient mounted oil lubricated journal bearings.

3. EXECUTION

3.1 Installation

.1 Provide drains for bases and stuffing boxes piped to and discharging into floor drains.

.2 Provide domestic water and drain for seal flush water heat exchangers. Pipe to nearest floor drain.

.3 Provide air cock and drain connection on horizontal pump casings.

.4 Decrease from line size, with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 100 mm and over.

.5 Check and align pumps prior to start-up.

3.2 Performance

.1 Refer to the Pump Schedule.

END OF SECTION

PLUMBING GENERAL

1. GENERAL

1.1 Scope

.1 Cleanouts

.2 Air chambers or water hammer arresters

.3 Floor drains

.4 Sumps

.5 Domestic water heaters

.6 Sanitary sewer service connections

.7 Water service connections

.8 Natural gas service connection

.9 Backflow preventers

.10 Vacuum breakers

.11 Backwater valves

1.2 General Requirements

.1 Provide materials, equipment and labour to install plumbing as required by Provincial and Local Codes and as specified herein.

.2 Provide water and drainage connections to equipment furnished in other Sections of this Specification and as supplied by the City.

.3 Provide and include charges for connections to Municipal and Utility Company Service.

1.3 Submittals

.1 Submit Shop Drawings for review by the Contract Administrator, in accordance with Division 1. Provide Shop Drawings for the following items:

.1 Floor drains

.2 Domestic water heaters

.3 Backflow preventers

.4 Vacuum breakers

2. PRODUCTS

2.1 Clean-Outs and Clean-Out Access Covers

.1 Provide caulked or threaded type extended to finished floor or wall surface. Provide bolted coverplate clean-outs on vertical rainwater leaders only. Ensure ample clearance at clean-out for rodding of drainage system.

.2 Floor cleanout access covers in unfinished areas shall be round with nickel bronze scoriated frames and plates. Provide round access covers in finished areas with depressed centre section to accommodate floor finish. Wall cleanouts to have chrome plated caps.

2.2 Water Hammer Arresters

.1 Fit water supply to each fixture or group of fixtures with an air chamber. Provide air chambers same size as supply line or 20 mm minimum, and minimum 450 mm long.

2.3 Floor Drains

.1 Floor drains shall have lacquered cast iron body with double drainage flange; weep holes combined two piece body reversible clamping device and adjustable nickel/bronze strainer.

.2 Floor drains in equipment rooms shall have polished bronze funnel type strainer and extension for floating floor where applicable.

.3 Floor drains for warehouses and vehicle areas shall have lacquered extra heavy duty type drain body with 300 x 300 hinged grate and sediment bucket. The entire drain assembly, body, sump, and grate shall be factory coated with 3 M Scotchkote 206 standard for fusion bonded epoxy coating. Ancon FD-460AF.

2.4 Area Drains

.1 Area drain shall have lacquered cast iron body with adjustable collar and galvanised ductile iron locking grate.

2.5 Equipment Drains

.1 Provide a sloped connection from packaged equipment drain pans to nearest sanitary sewer trapped connection. Slope at minimum of 0.5 percent grade. Drains size to be 20 mm complete with 100 mm deep trap at unit.

2.6 Domestic Water Heaters

.1 Construct electric domestic water heaters to CAN/CSA C22.2 No. 110. Heaters exceeding an input of 30 kW (100 MBH) or an inside diameter of 610 mm must also meet the requirements of Boiler and Pressure Vessel Safety Act.

.2 Construct gas fired domestic water heaters with inputs up to 117 kW (400 MBH) to CANI-4.1 or CANI-4.3, as applicable.

.3 Refer to equipment schedules for specific selection.

2.7 Backflow Preventer Assemblies

.1 Provide backflow preventer assembly complete with shut-off valves before and after check valves and test cocks. Assembly shall meet current AWWA requirements and CSA B64 standards.

.2 Provide complete reduced pressure principle type assembly, consisting of pressure differential relief valve, located between two positive seating replaceable check valves with stainless steel or bronze seats Watts No. 909. Provide strainer between gate valve and first check valve on units 50 mm and smaller.

2.8 Vacuum Breaker Assemblies

.1 Provide hose connection type vacuum breaker assembly, consisting of a check valve disc assembly to be vandal proof and drainable. Watts No. 8A. For freezing conditions, Watts No. NF8.

2.9 Backwater Valve Assemblies

.1 Provide complete assembly, epoxy coated, cast-iron body, bronze flapper check valve, bolted access cover with neoprene gasket heavy gauge steel epoxy coated access housing and neoprene gasketted heavy-duty nickel-bronze cover.

3. EXECUTION

3.1 Installation

.1 Bury outside water and drainage pipe minimum 2400 mm, unless noted otherwise.

.2 Lubricate clean-out plugs with mixture of graphite and linseed oil. Prior to building turnover remove clean-out plugs, re-lubricate and reinstall using only enough force to ensure permanent leakproof joint.

.3 Install backflow prevention devices on plumbing lines, to code requirements, where contamination of domestic water may occur. Generally necessary on boiler make-up lines, hose bibs and flush valves.

.4 Install gas piping in open or ventilated spaces. Pitch lines and provide drip legs for condensation collection points. Where gas piping is run in a concealed space, provide ventilation grilles as required.

.5 Where floor drains are located over occupied areas, provide waterproof installation.

.6 Drainage lines shall grade 2 mm per 100 mm unless otherwise indicated on drawings.

.7 Locate plumbing vents minimum 5000 mm from air intakes.

.8 Provide a heat trap loop in domestic hot water supply piping at domestic hot water storage tank.

3.2 Services

.1 Provide new sanitary sewer connections to site services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with sufficient slope for drainage and adequate cover to avoid freezing.

.2 Provide new water service. Provide necessary thrust blocks on underground water piping as required and detailed. Provide steel pipe sleeve in wall for service main and adequately support at wall with reinforced concrete bridge. Caulk enlarged sleeve and make watertight with pliable material. Securely anchor service main inside to concrete wall. Size for minimum of 50 mm of loose fill insulation.

.3 Provide new gas service complete with gas meter and regulators. Gas service distribution piping shall have initial minimum pressure of 35 kPa (5 psi). Provide regulators on each line servicing gravity type appliance, sized in accordance with equipment. These regulators are in addition to normal controls.

END OF SECTION

PLUMBING FIXTURES AND TRIM

1. GENERAL

1.1 Scope

.1 Plumbing fixtures and trim

.2 Thermostatic mixing valves

1.2 General Requirements

.1 Provide new fixtures, CSA approved, free from flaws and blemishes with finished surfaces clear, smooth and bright.

.2 Provide CSA approved plumbing fittings. Visible parts of fixture brass and accessories shall be heavily chrome plated.

.3 Fixtures shall be product of one manufacturer. Fittings of same type shall be of product of one manufacturer.

.4 Protect fixtures against use and damage during construction.

1.3 Job Conditions

.1 Confirm location and size of fixtures and openings before rough-in and installation.

1.4 Submittals

.1 Submit Shop Drawings for review.

2. PRODUCTS

2.1 Combination Emergency Shower & Eyewash (EW-1)

.1 Eyewash: barrier-free floor mounted freeze-resistant heated combination shower and eye/face wash with 250 mm (10 inch) ABS plastic shower head with integral 75.7 L/min (20 gpm) and twin ABS plastic eye/face wash heads with built-in 9.5 L/min (2.5 gpm) flow control with integral flip top dust cover, waste tailpiece, trap, 15 mm (0.5 inch) IPS bleed valve, 32 mm (1.25 inch) IPS supply, automatic thermal actuated bleed valve, combination emergency shower and eyewash sign, cast-iron 230 mm (9 inch) diameter floor mount flange, 'Test This Week' waterproof test card. Standard of Acceptance: Haws Model No. 8317CTFPT.

2.2 Cabinet Thermostatic Mixing Valve System (TMV-1)

.1 Mixing valve: self-contained water blending system, hot and cold mixing to deliver up to 133 L/min (35 gpm) of tempered water for EW-1. TMV-1 will including a thermostatic

water mixing valve, bypass valve, outlet temperature gauge, wall mounting bracket, fittings factory assembled and tested, unit set for 29ºC (85ºF), and a maximum temperature of 32ºC (90ºF). Unit must be able to be set to the correct temperature for the specific contaminant but must be locked in place to prevent changing of the temperature by accident with use of optional cabinet. Unit must be checked weekly for performance in conjunction with the requirements of ANSI Z-358.

.2 Schedule:

.1 Flow L/s (USgpm): 133 (35)

.2 Differential kPa (psi): 172 (25)

.3 System Model Number: Haws TWBS.SH

.4 Cabinet Model No: Haws TWBS.CAB

2.3 Hose Reel (HR-1)

.1 Hose Reel: water medium, reel with 20 mm (0.75 inch) hose, 15 m (49 ft) length, 1.2 MPa (170 psi) max. working pressure, pivoting wall bracket, ABS plastic covering. Standard of Acceptance: Nederman 884, Part No. 810484.

3. EXECUTION

3.1 Installation

.1 Install each fixture with its own trap, easily removable for servicing and cleaning. At completion thoroughly clean plumbing fixtures and equipment.

3.2 Fixtures Rough-In Schedule

.1 Rough-in fixture piping connections in accordance with the following table of minimum sizes.

	Hot Water	Cold Water	Waste	Vent
TMV-1	30 mm	30 mm	--	--
EW-1	30 mm	tempered supply	--	--
HR-1	--	20 mm	--	--

END OF SECTION

NATURAL GAS DISTRIBUTION SYSTEM

1. GENERAL

1.1 Scope

.1 Gas piping

.2 Valves and fittings

.3 Pressure regulators

.4 Testing

.5 Service connections

1.2 Related Work

.1 Fill Material: Division 2

.2 Excavation, Trenching and Backfilling: Division 2

.3 Site Restoration: Division 2

.4 Site Gas Service: 15406

1.3 Utility Service Connections

.1 Provide new natural gas service complete with regulators.

1.4 Submittals

.1 Submit shop drawings for all equipment and accessories specified in this section.

2. PRODUCTS

.1 Polyethylene coated steel piping manufactured to CSA Z245.1M. High density polyethylene coating shall be to following schedule:

Pipe Size (mm)	Thickness (microns)
Up to 25	686
30	762
40	787
50 and over	863

.2 Jointing Methods:

.1 Threaded fittings to ANSI Standard B16.3:

.1 For above ground use, Schedule 80 pipe.

.2 Threaded joints not allowed underground.

.2 Forged steel socket weld ANSI Standard B16.11.

.3 Wrought steel butt welding fitting CSA Z245.10.

2.2 Polyethylene Pipe (PE)

.1 Pipe: to CSA B137.4.

.2 Diameter as shown on drawings. Grade PE 2306 or 3406, Series 160.

.3 Jointing Methods: joint pipe according to manufacturer's recommendations. Threading and gluing not permitted on polyethylene pipe.

.1 Socket fittings: to ASTM D2683.

.2 Butt fusion.

.3 Compression fitted joints: to ASTM D746 with internal tubular stiffener.

.4 Use approved transition fittings when jointing polyethylene pipe to other pipe materials.

2.3 Valves

.1 Conform to CGA Standard 3.16.

.2 Steel plug type gas valve, complete with cast iron curb box, cover and key (where applicable).

.3 Bronze plug-type gas valve, 900 kPa (130 psi) working pressure, complete with cast iron curb box, cover and key.

2.4 Pressure Regulator

.1 Self operated gas pressure regulator. Cast iron body. Size for full gas load to reduce pressure down to 35 kPa (5 psi). Body rating 1030 kPa (150 psi). Manufacturer: Fisher.

2.5 Building Pressure Regulator

.1 Self operated gas pressure regulator; malleable iron body. Size for full gas load to reduce gas pressure from 35 kPa to 2.7 kPa (5 psi to 0.4 psi). Manufacturer: Fisher.

3. EXECUTION

3.1 Utilities

.1 Maintain, re-route or extend existing lines which remain.

.2 Cap, plug or seal abandoned lines that remain.

3.2 Excavation

.1 Excavate trenches in accordance with Division 2.

.2 In roads, streets, driveways and parking areas, excavate depth of trench to provide 1200 mm of cover over pipe.

.3 On private property, in open non-travelled areas, excavate depth of trench to provide 900 mm of cover over pipe.

3.3 Pipe Installation

.1 Lay pipe to specified alignment, to within tolerance of 200 mm. Survey all routes and show measurements on as-built drawings complete with benchmarked dimensions.

.2 Lay pipe on 50 mm cushion of compacted clay fill or on flat, undisturbed trench bottom. Backfill around sides and to top of pipe with clay fill thoroughly tamped in place.

.3 Lower steel pipe carefully into trench to prevent damage to coating.

.4 Lay polyethylene pipe on undisturbed trench bottom. Backfill around sides and to top of pipe with sand filled material and thoroughly tamp in place.

.5 Provide recesses on trench bottom for couplings, fittings and valves to ensure bearing will occur along barrel of pipe.

.6 Prevent dirt from entering exposed ends of pipe.

.7 In roads, streets, driveways, and parking areas, provide pipe sleeve of diameter 50 mm greater than gas pipe diameter.

.8 Lay service line pipe on proper grade to drain from building to gas main.

.9 Lay gas pipe on properly graded trench bottom to prevent sags and low points in piping.

.10 For steel pipe, wrap couplings and fittings with polyethylene tape and heat shrink over pipe.

.11 For polyethylene pipe, provide tracer wire to aid in pipe location.

.12 Whenever pipe is to be deflected vertically or horizontally, do not exceed amount of deflection recommended by manufacturer in order to maintain satisfactory piping.

.13 Ensure minimum clearance of 1000 mm between gas pipe and any underground structure that runs parallel to gas pipe.

.14 Ensure minimum clearance of 100 mm between gas pipe and any underground structure that crosses gas pipe.

3.4 Valves and Valve Box

.1 Locate valves as specified.

.2 Set valves on solid bearing. Set plumb and level.

.3 Centre and plumb valve box over valve. Set box cover flush with finished ground surface. Prevent shock or stress from being transmitted through valve box to valve.

.4 For steel valves and cast iron valve boxes, wrap valve and valve box with polyethylene tape and heat shrink; or paint valves and valve boxes with red anti-rust primer and one coat of epoxy paint.

3.5 Pressure and Leakage Tests

.1 Test medium: air, gas or inert gas such as carbon dioxide or nitrogen.

.2 Fill piping with test medium for 24 hours prior to actual test.

.3 For steel piping, subject pipe to pressure of 700 kPa (100 psi) for 24 hours or double the intended working pressure, whichever is greater.

.4 For polyethylene piping, subject pipe to pressure of 350 kPa (50 psi) or 1.5 maximum operating pressure whichever is greater for 24 hours.

.5 Supply pumps, connections, gauges and other necessary apparatus required for test.

.6 Test will consist of visual inspection of the line for leaks and of measuring the pressure after 24 hours. No pipe installation will be accepted if leaks are detected or if pressure at end of test is less than 95 percent of original test pressure.

.7 Replace all material found to be defective.

3.6 Purging

.1 If air or inert gas was used for testing, purge lines with natural gas before using.

3.7 Building Regulator Installation

.1 Install service regulator adjacent to building wall in specified location.

.2 Install service regulator and riser pipe in such manner as to prevent undue stress upon service pipe. For plastic service pipe, use steel pipe riser from below ground to regulator.

.3 Ensure regulator vent has rain and insect proof opening and terminates away from building openings.

END OF SECTION

FIRE EXTINGUISHERS

1. GENERAL

1.1 Scope

.1 Fire extinguishers

.2 Fire extinguisher cabinets and mounting hardware

1.2 General Requirements

.1 Provide portable hand extinguishers where indicated on drawings and specified herein.

1.3 Quality Assurance

.1 Fire protection equipment and installation shall be approved by local Fire Commissioner.

.2 Equipment and installation shall meet the requirements of NFPA No. 10 Portable Fire Extinguishers.

1.4 Submittals

.1 Submit Shop Drawings for review. Submit with Shop Drawings Material Safety Data Sheets (MSDS) for each chemical used in the Fire Extinguishers.

2. PRODUCTS

2.1 Portable Hand Fire Extinguishers

.1 Multi-Purpose Dry Chemical (Type 1): pressurised with hose and shut-off nozzle or integral shut-off nozzle and mounting brackets 4.5 kg capacity rating 4A:60BC; 9.0 kg capacity rating 10A:80BC.

2.2 Fire Extinguisher Cabinets and Brackets.

.1 Fire Extinguishers Bracket: surface type steel construction.

3. EXECUTION

3.1 Installation

.1 Install extinguishers so that the bottom of extinguisher is no more than 1200 mm above floor.

3.2 Schedules

Building	Location	Type	Size	Rating

FIRE EXTINGUISHERS

.1	Rail Car Building	North Exit	Dry Chem ABC	10 lbs	4A:60BC
.2	Rail Car Building	East Exit	Dry Chem ABC	10 lbs	4A:60BC
.3	Chemical Building	North Exit	Dry Chem ABC	10 lbs	4A:60BC
.4	Chemical Building	East Exit	Dry Chem ABC	10 lbs	4A:60BC
.5	Chemical Building	Mezzanine Level	Dry Chem ABC	10 lbs	4A:60BC

END OF SECTION

COILS

1. GENERAL

1.1 Scope

.1 Water coils

.2 Glycol coils

.3 Coil installation

.4 Coil piping and accessories

1.2 Quality Assurance

.1 Coils shall be the proaduct of Manufacturer regularly engaged in production of coils who issues complete catalogue data on such Products.

.2 Coil capacities, pressure drops, and selection procedures shall be certified in accordance with ARI Standards and bear ARI seal.

1.3 Submittals

.1 Shop Drawings shall include dimensions, materials of construction and performance data to match Specifications.

.2 Submit coil selection sheets or computer calculations with Shop Drawings.

2. PRODUCTS

2.1 General

.1 Provide extended surface type coils with tubes of copper or brass, and plate of helical type fins of copper or aluminum.

.2 Space fins 14 fpi maximum. Helical fins may be crimped.

.3 Mount coil section in galvanised steel casing designed for bolting to other sections of ductwork.

2.2 Water and Glycol Heating Coils

.1 Design for maximum operating limits of 1380 kPa (200 psig) and 104°C (220°F).

.2 Coil headers shall be cast iron, copper tube or steel pipe.

.3 Face length shall not exceed 3000 mm.

2.3 Cooling and Cold Side Heat Recovery Coils

.1 Design for maximum operating limits of 1380 kPa (200 psig) at 104°C (220°F).

.2 Face length shall not exceed 3000 mm per section.

.3 Provide moisture eliminator of 24 gauge galvanised steel where air velocity exceeds 2.5 m/s (500 fpm).

.4 Provide drip pan and drain connection for each field assembled coil section.

.5 Coil headers shall be cast iron, copper tube or steel pipe.

.6 Refrigerant coils shall be serpentine type with brass or copper header arranged to prevent trappings of oil and to distribute liquid refrigerant to circuits. Silver soldered or brazed joints. Maximum operating pressure: 1722 kPa (250 psig).

3. EXECUTION

3.1 Installation

.1 Support coil sections on steel channel or double angle frames and secure to casings. Arrange supports for cooling coils so they do not pierce or short circuit drip pans. Level serpentine coils and install drainable tube coils with pitch within casing. Arrange galvanised steel casings for bolting to other section, ductwork or unit casings. Provide airtight seal between coils and duct or unit cabinets.

.2 Make necessary connections to coils, including valves, air vents, unions and connections from drip pans. Provide isolating valve on supply line and eccentric plug valve on return line to each water coil.

.3 Locate water supply at bottom of supply header and return water connection at top to provide self-venting and reverse return arrangement. Provide manual air vents at high points complete with stop valves. Ensure water coils are drainable and provide drain connection at low points.

.4 Protect coils so fins and flanges are not damaged. Replace loose and damaged fins. Comb out bent fins unless required to be replaced.

.5 If turn over occurs during winter months, turn over systems to the owners with all chilled water cooling coils drained and valved off from the system.

3.2 Performance

.1 Refer to Equipment Schedules.

END OF SECTION

DIRECT FIRED MAKE-UP AIR UNITS

1. GENERAL

1.1 Scope

.1 Direct fired make-up air heater

.2 Summer and winter filter sections

.3 Service platform

.4 Controls

1.2 Quality Assurance

.1 Comply with local and Provincial Regulations and have CSA/CGA approval.

.2 Shall be a product of a manufacturer regularly engaged in the production of such units and who ensures complete catalogue data on such products.

.3 The unit shall be fully assembled, wired and flame tested prior to shipment. A detailed pre-shipment test report shall be submitted to the Consultant. If necessary, the unit may be broken down for shipment after the test.

.4 Fans shall conform to AMCA Bulletins regarding construction and testing.

.5 Operationally test after installation.

.6 Filter media shall be UL-listed, Class I or Class II as approved by local authorities.

.7 Motors shall be high efficiency as specified in Section 15010.

1.3 Submittals

.1 Submit with shop drawings certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Show pump weights, major efficiencies and electrical power characteristics.

2. PRODUCTS

2.1 General Construction

.1 Construct heater casing and components of 1.3 mm (18 gauge) steel panels, reinforced with structural angles and channels to ensure rigidity under normal handling. Provide access panels to burner and blower motor assemblies from both sides of unit.

.2 Locate observation port on burner section for observing main and pilot flames.

.3 Insulate complete unit with 25 mm neoprene faced fibrous glass insulation, including inlet components to burner profile plate.

.4 Protect all internal insulation with 22 gauge galvanised steel liner.

.5 Finish casing and components with heat resistant baked enamel.

.6 For elevated installations, provide service platforms complete with handrails and access ladder.

2.2 Filters

.1 Filters containing asbestos, and urea formaldehyde are not acceptable.

.2 Provide filter section complete with removable 50 mm thick pleated disposable filters in metal frames. Average efficiency 30 to 35 percent on ASHRAE Test Standard 52-76.

.3 Arrangement: flat or angle filter section to limit filter velocity, based on gross area, to less than 2 m/s (400 fpm). Provide access doors minimum 450mm wide x height of unit.

2.3 Burner

.1 Provide raw gas burner suitable for natural gas and capable of modulating turn down ratio of 25:1. Burner assembly and gas piping arrangement to include electric modulating main gas valve, motorised shutdown valve, main and pilot gas regulators, pilot electric gas valve, manual shut-off valve and pilot adjustment valve.

.2 Furnish gas burner with electrically ignited supervised pilot. Pilot automatically ignited by spark rod through high voltage ignition transformer.

.3 Provide motorised damper complete with end switch to prove position before burner will fire.

2.4 Fans

.1 Provide statically and dynamically balanced forward curve or backward inclined air foil centrifugal fan mounted on solid steel shaft with heavy duty self-aligning pre-lubricated ball bearings and V-belt drive with matching motor sheaves and belts.

.2 Fan motor assembly shall be mounted on a free floating angle-iron frame, and internally isolated from rest of the unit using base isolators and canvas connectors.

2.5 Controls

.1 Refer to Section 15900.

.2 Pre-wire unit complete so connection of power supply and field wiring from unit to remote control panel shall make unit operative.

.3 The control system shall include the following components required to provide automatic operation and low fire start.

.1 Non-fused disconnect switch

.2 Control circuit transformer

.3 Magnetic fan starter and overloads

.4 Control circuit fuses

.5 High and low temperature limit switches

.6 Supply fan high and low velocity air proving differential switches

.7 Flame safeguard relay

.8 Flame rod flame sensors

.9 Ignition transformer

.10 Electronic temperature control system

.4 Fan discharge thermostat shall control modulating gas valve to maintain supply air temperature. Provide discharge temperature adjustment at the unit.

.5 Provide safety controls to provide correct air flow before energising pilot and to sense pilot ignition before activating main gas valve.

.6 Provide manual reset low and high limit controls to maintain supply air temperature between set points. Shut modulating gas valve down if outside temperature reset is exceeded.

.7 Provide purge period time to delay burner ignition and automatically bypass low limit control.

.8 Provide indicating lights and lamicoid labels for supply fan, exhaust fan pilot operation, burner operation, clogged filter indication, and lockout indication

3. EXECUTION

3.1 Installation

.1 Mount on 100 mm high housekeeping pad for floor-mounted units.

3.2 Performance

.1 Refer to Equipment Schedules.

END OF SECTION

GAS FIRED UNIT HEATERS

1. GENERAL

1.1 Scope

.1 Gas fired unit heaters.

1.2 Quality Assurance

.1 Conform to requirements of CGA, CSA, Provincial and Municipal Codes and be CSA listed.

1.3 Warranty

.1 Supplementary to Warranty specified in General Condition GC13, provide ten (10) year parts warranty on heat exchangers.

1.4 Submittals

.1 Provide shop drawings of unit heater, including controls wiring diagrams.

2. PRODUCTS

2.1 Type

.1 Provide self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, exchanger, gas burner and controls.

2.2 Construction

.1 Cabinet: heavy gauge galvanised steel with baked enamel finish, easily removed and secured access doors, glass fiber insulation and reflective liner.

.2 Heat exchanger: aluminised, steel of welded construction.

.3 Supply fan: propeller fans to be direct drive rubber mounted, overload protected motor.

2.3 Burner

.1 Gas Burner: power-vented type, equipped with combination gas valve and pressure regulator incorporating manual shut-off, pilot valve, automatic 100% shut-off and thermocouple pilot safety device.

.2 Gas Burner Safety Controls: thermocouple sensor prevents opening of solenoid gas valve until pilot flame is proven and stops gas flow on ignition failure.

2.4 Burner Operating Controls

.1 Room thermostat to be supplied and installed by Section 15900.

.2 High limit control, with fixed stop at maximum permissible setting, de-energises burner on excessive bonnet temperature and energises burner when temperature drops to lower safer value.

.3 Control supply fan in accordance with bonnet temperatures and independent of burner controls. Include manual switch for continuous fan operation.

2.5 Draft Control

.1 Unit heater shall come complete with a factory-installed power venter to draw combustion air in from outside of the building

.2 Provide each unit heater with galvanised steel flue pipe having airtight joints.

3. EXECUTION

3.1 Installation

.1 Unit shall be suspended from roof structure as recommended by manufacturer.

3.2 Performance

.1 Refer to Equipment Schedules.

END OF SECTION

GAS FIRED INFRARED HEATERS

1. GENERAL

1.1 Scope

.1 It is the intent of this specification to identify design requirements and minimum standards for the quality, construction, delivery, installation and operation of the low intensity, vacuum vented, gas fired infrared heating equipment.

1.2 Quality Assurance

.1 Conform to requirements of CGA, CSA, Provincial and Municipal Codes and be CSA listed.

.2 The entire heating system shall be designed certified to CSA 2.34.

1.3 Warranty

.1 Supplementary to the Warranty specified in General Conditions GC13, provide ten (10) year parts warranty for radiant tubes against internally created corrosion.

1.4 Quality Assurance

.1 The low intensity, gas fired infrared heating system shall be a product of a manufacturer who has a minimum of ten (10) years experience in design and fabrication.

.2 Installation of the gas fired low intensity infrared heating equipment shall be supervised by an authorized representative of the heater manufacturer and shall be in accordance with reviewed installation drawings.

1.5 Submittals

.1 Provide shop drawings of infrared heater assemblies showing the layout of the components and the labelling of the components to be used by installation contractor, all components and controls wiring diagrams.

1.6 Delivery and Storage

.1 Storage of the components shall be in a dry location free from dust and water and available for inspection and handling. Handle equipment carefully to prevent damage. Remove damaged items and replace with new items.

2. PRODUCTS

2.1 General

.1 Standard of acceptance: Combustion Research Corporation model Omega II.

2.2 Natural Gas Burner

.1 Burners: capable of firing at 105,000 Btu/hr up to and including 200,000 Btu/hr at 5,000 Btu/hr increments with natural gas.

.2 Features:

.1 Differential air pressure switch to prove adequate combustion air is present before burner fires.

.2 100 mm combustion air inlet with a fixed combustion air-metering orifice.

.3 Solid state electronic controls with spark ignition and 100% lockout in event of flame failure.

.4 Minimum natural gas inlet pressure: 872 Pa (3.5 inches w.c.).

.5 Gas valve, ignition controls and differential pressure switch shall be enclosed within the burner compartment and separated from the combustion air supply.

.6 Inspection window for visual inspection of the spark and flame.

.7 Gas Inlet: 15 mm pipe thread (0.5 inch NPT). Gas inlet is not to be on the combustion tube side of the burner.

.8 Burner Casing: 1.6 mm (16 gauge) powder coated aluminized steel.

.9 Electrode and flame rod to be NiChrome.

.10 Heavy duty nozzle pre-mix combustion system – minimum 3 mm metal thickness.

.11 Burner shall have a 15 second pre-purge before ignition.

.12 Fitted with a 100 mm diameter combustion air inlet with a fixed combustion air-metering orifice.

.13 Power: 24 V, 1 phase, 60 hz – 40 VA.

.14 Stainless steel gas connector with manual shutoff valve.

2.3 Radaint Tube Assemblies

.1 Materials:

.1 Radiant tubing: spiral wound 0.8 mm (22 gauge) aluminized steel, 100 mm OD.

.2 Combustion tubing: 3000 mm in length, 1.6 mm (16 guage) aluminized steel, 100 mm OD, swaged at one end.

.3 Fittings: Minimum 1.3 mm (18 guage) aluminized steel, nominal 100 mm OD swaged at both ends to fit radiant tubing.

.4 Reflectors: 0.64 mm bright aluminium.

.2 Finish: all radiant tubing and combustion tubing shall be factory "heat treated" to have an emissivity greater than 0.9, inside and outside. Painted and non-treated radiant tubes are not allowed.

2.4 Hangers

.1 Tubing and reflector hangers to be 6 mm diameter zinc plated steel.

2.5 System Controls

.1 The assembly shall be provided with:

.1 Pre-wired controls, 115 V, 1 phase, 60 Hz – 16 amps.

.2 Solid state spark ignition and flame rectification (separate probe) with 100 percent flame lockout and 30 second pre-purge (24 V AC, 22 VA).

.2 Room thermostat to be supplied and installed by Section 15900.

3. EXECUTION

3.1 Installation

.1 The system shall be assembled in accordance with the manufacturer's installation manual and the reviewed shop drawings.

.2 Hangers:

.1 Combustion tube to be supported at a maximum spacing 1200 mm for straight or 'U' tube systems using tube and reflector hangers.

.2 Radiant tube to be supported using tube and reflector hangers on maximum centres of 3000 m for straight sections and 1200 mm for 'U' tube systems.

.3 Burner head is to be supported by an approved hanging method and not allowed to be supported by the combustion tube.

.3 All joints to be sealed and mechanically fastened with self drilling and tapping screws in accordance with the manufacturer's recommendations.

.4 All radiant tubing shall be continuously covered by the reflector with no gap between the reflectors. Reflectors are to be overlapping a minimum of 25 mm and secured together with

sheet metal screws allowing for one unsecured overlap for expansion on each straight segment exceeding 3000 mm in length.

.5 Burners venting into a common stack shall be controlled by one thermostat.

.6 Install thermostats as indicated.

3.2 System Performance

.1 System shall attain a net exhaust temperature of not less than 93°C (200°F) in a 15 minute run cycle and shall not exceed a maximum net temperature of 204°C (400°F).

.2 System steady state efficiency shall be a minimum of 77 percent.

.3 System shall be a non-condensing dry tube system after a minimum run time of eight (8) minutes.

.4 Refer to Equipment Schedules.

3.3 Cleaning

.1 Clean reflectors as may be required and touch up painted surfaces as may be needed.

3.4 Testing

.1 Upon completion of installation, including work by other trades, adjust and test the heating system in accordance with the manufacturer's owners manual. Adjust and re-test heating system until entire system is fully operable and acceptable.

END OF SECTION

FANS

1. GENERAL

1.1 Scope

.1 Centrifugal fans

.2 In-line duct fans

.3 Fan accessories

.4 Roof curbs

1.2 Quality Assurance

.1 Conform to AMCA Bulletins regarding construction and testing. Fans shall bear AMCA certified rating seal.

.2 Fans shall bear CSA label.

.3 Motors to be high efficiency as specified in Section 15010.

1.3 Submittals

.1 Submit with Shop Drawings acoustical data and fan curves showing fan performance with fan and system operating point plotted on curves, including equipment weights and centre of gravity diagrams for suspended fans.

1.4 Job Conditions

.1 Do not operate fans for any purpose, temporary or permanent until ductwork is clean, filters are in place, bearings are lubricated and fan has been run under close supervision of unit manufacturer.

1.5 Alternates

.1 Equivalent fan selections shall not increase motor kilowatts, increase rpm, increase noise level, increase tip speed by more than 10 percent, or increase inlet air velocity by more than 20 percent, from that of the specified fan.

2. PRODUCTS

2.1 General

.1 Statically and dynamically balance fans so no objectionable vibration or noise is transmitted to occupied areas of the building.

.2 Provide balanced variable sheaves for motors 11.2 kW (15 hp) and under and fixed sheave for 15 kW (20 hp) and over.

.3 Fans are to be capable of accommodating static pressure variations of ±10% with no objectionable operating characteristics.

.4 Fan suppliers to provide replacement sheaves for balancing purposes.

.5 Provide cross linkage and inlet vanes on double inlet fan.

.6 Size motors for parallel operating fans for non-overloading operation with only one fan operating.

.7 Provide belt guards with tachometer holes.

.8 External static pressure means external to the fan cabinet and all accessories such as backdraft dampers, mixing boxes, filters and coils, etc. These accessories if supplied as part of the unit are considered as internal losses for fan.

.9 Two speed motors shall have separate winding for each speed. Variable speed applications shall be inverter duty c/w variable speed drive matched to fan motor.

2.2 Centrifugal Fans

.1 Fabricate with multi-blade wheels in heavy gauge steel housing reinforced for service encountered.

.2 Provide V-belt drives with fan and motor mounted on reinforced, rigid steel base with adjustable motor mount.

.3 Provide heavy duty, self-aligning, anti-friction bearings. Extend lubrication fittings to outside of fan casing.

.4 Provide where indicated variable inlet vanes complete with linkage and pneumatic operators.

.5 Provide access door and drain connection to scroll.

.6 Unless noted otherwise, centrifugal fans over 425 mm diameter shall have die formed air foil blades welded to side and back plate.

.7 Provide fan cabinets lined with minimum 25 mm acoustic insulation, unless noted otherwise elsewhere in the specifications.

2.3 Belted Vent Sets

.1 Comply generally with requirements of centrifugal fans suitable for pressure to 1000 Pa (4 in wg).

.2 Provide with multi-blade rattle free backdraft damper with felt lined bladed edges.

.3 Provide belt guards with tachometer holes. Provide weatherproof housing.

.4 Provide all cabinets lined with 25 mm acoustic insulation.

3. EXECUTION

3.1 Installation

.1 Where inlet or outlet is exposed, provide safety screen.

.2 Provide belt guards on belt driven fans complete with tachometer access.

.3 Supply and install sheaves as necessary for final air balancing.

.4 Provide 100 mm high housekeeping base for floor mounted units.

3.2 Priming

.1 Prime coat fan wheels and housing at factory inside and outside. Prime coating on aluminum part is not required.

.2 Provide two additional coats of paint on fans handling air downstream of humidifiers.

3.3 Performance

.1 Fan performance based on 225 m above sea level conditions.

.2 Refer to Equipment Schedule.

END OF SECTION

DUCTWORK

1. GENERAL

1.1 Scope

.1 Ductwork and plenums

.2 Fasteners

.3 Sealants

.4 Duct cleaning

1.2 Definitions

.1 Low Pressure: Static pressure in duct less than 500 Pa (2 inches wg) and velocities less than 10 m/s (2000 fpm).

.2 Medium Pressure: Static pressure in duct less than 1500 Pa (6 inches wg) and velocities greater than 10 m/s (2000 fpm).

.3 High Pressure: Static pressure over 1500 Pa (6 inches wg) and less than 2500 Pa (10 inches wg) and velocities greater than 10 m/s (2000 fpm).

.4 Duct sizes shown on plans are inside clear dimensions. For acoustically lined or internally insulated ducts, maintain sizes inside ducts.

1.3 Quality Assurance

.1 Ductwork shall meet the requirements of NFPA No. 90A - Air Conditioning and Ventilating Systems.

.2 Fabricate in accordance with SMACNA duct manuals and ASHRAE handbooks.

.3 Flexible air duct shall conform to NFPA 90A and UL181 standard for factory made air duct materials and air duct connectors.

1.4 Submittals

.1 Submit Shop Drawings and Samples of duct fittings for review, including particulars such as gauge sizes, welds and configurations prior to start of Work.

1.5 Alternatives

.1 Obtain written permission from the Contract Administrator prior to making variations in duct configuration or sizes. Size alternatives using ASHRAE table for circular equivalents of rectangular ducts.

2. PRODUCTS

2.1 Materials

.1 Ducts: galvanised steel lock forming quality, having galvanised coating of 380 g/m^2 (1.25 oz/ft^2) for both sides.

.2 Fasteners: use rivets and bolts throughout; sheet metal screws accepted on low pressure ducts.

.3 Sealant: water resistant, fire resistive, compatible with mating materials.

.4 Use stainless steel ducts for handling moisture laden air, gauges as per SMACNA for pressure rating.

3. EXECUTION

3.1 Installation

.1 Fabricate ductwork from field measurements and not from Drawings and Shop Drawings exclusively. Failure to do so will not constitute an extra to the Contract.

.2 Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 450 mm crossbrace for rigidity. Open corners are not acceptable.

.3 Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.

.4 Construct tees, bends and elbows with radius of not less than 1.5 times width of cut on centre line. Where not possible and where rectangular elbows are specified, provide double wall air foil type turning vanes.

.5 Increase duct sizes gradually, not exceeding 15 degree divergence wherever possible. Maximum divergence upstream of equipment to be 30 degree and 45 degree convergence downstream.

.6 Rigidly construct metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breathe, rattle, vibrate or sag. Caulk duct joints and connections with sealant as ducts are being assembled. Seal seams on fresh air and exhaust ducts watertight with mastic or low velocity duct sealant.

.7 Weld all stainless steel ductwork and ensure a smooth finish on all interiors.

.8 Provide drains in fresh air sections with deep seal traps.

.9 Set plenum doors 150 mm above floor. Arrange door swings so that fan static holds door in closed position.

3.2 Plenum Gauges

.1 Fabricate fan plenums and plenums downstream of fan in accordance with SMACNA manual.

.2 Fabricate plenums between fan and upstream apparatus of 1.6 mm (16 ga) thick material.

.3 Fabricate plenums between filters and upstream apparatus of 1.3 mm (18 ga) thick material.

3.3 Duct Sealing

.1 All supply, return and exhaust duct joints, longitudinal as well as transverse, should be sealed using:

.1 Low Pressure Ductwork:

.1 Slip joints: apply heavy brush-on high pressure duct sealant. Apply second application after the first application has completely dried out. Where metal clearance exceeds 1.5 mm use heavy mastic type sealant.

.2 Flanged joints: soft elastomer butyl or extruded form of sealant between flanges followed by an application of heavy brush-on high pressure duct sealant.

.3 Other joints: heavy mastic type sealant.

.2 Medium and High Pressure Ductwork

.1 Combination of woven fabrics and sealing compound followed by an application of high pressure duct sealant.

.2 Duct tapes as sealing method are not permitted.

.3 Surfaces to receive sealant should be free from oil, dust, dirt, moisture, rust and other substances that inhibit or prevent bonding.

.4 Prior to sealing all ductwork, demonstrate sealing of a section of each type of duct and obtain approval from the Contract Administrator.

.5 Do not insulate any section of the ductwork until it has been inspected and approved of duct sealant application.

3.4 Installation

.1 Locate ducts with sufficient space around equipment to allow normal operation and maintenance activities.

.2 Co-ordinate the location of duct access doors. Refer to Section 15860 - Duct Accessories and 15896 - Ductwork Cleaning.

.3 Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

.4 Interrupt duct linings at fire, balancing backdraft and smoke dampers so as not to interfere with operation of devices. Provide sheet metal edge protection over linings on both sides of damper device.

.5 Shield ductwork from dust and construction material during construction. Clean any ductwork found to be dirty at no extra cost to the Contract.

.6 Protect carbon steel ductwork exposed to weather by painting or coating with suitable weather resistant material.

.7 Install ducts associated with fans subject to forced vibration with flexible connections immediately adjacent to equipment. Refer to Section 15860 - Duct Accessories.

.8 Prove that ductwork is substantially air tight before covering or concealing.

.9 Clean duct systems and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with filters or bypass during cleaning.

.10 Clean systems with power vacuum machines. Refer to Section 15840 - Ductwork Cleaning.

END OF SECTION

DUCT ACCESSORIES

1. GENERAL

1.1 Scope

.1 Access doors

.2 Fire dampers

.3 Fire stop flaps

.4 Balancing dampers

.5 Flexible connections

.6 Backdraft dampers

1.2 Quality Assurance

.1 Fire dampers shall be ULC listed and constructed in accordance with ULC Standard S 112 "Fire Dampers".

.2 Fusible links on fire dampers shall be constructed to ULC Standard S 505.

.3 Demonstrate re-setting of fire dampers to authorities having jurisdiction and Owner's representative.

.4 Access doors shall be ULC labelled.

.5 Accessories shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems. Fabricate in accordance with ASHRAE Handbooks and SMACNA Duct Manuals.

.6 Prove all dampers to inspector at job completion.

1.3 Submittals

.1 Submit Shop Drawings of factory fabricated assemblies.

2. PRODUCTS

2.1 Duct Access Doors

.1 Fabricate rigid and close-fitting doors of galvanised steel with sealing gaskets and suitable quick fastening locking devices. Duct access panels with screws are not acceptable. Install minimum 25 mm thick insulation with suitable sheet metal cover frame for insulated ductwork.

.2 Fabricated with two butt hinges and two sash locks for sizes up to 450 mm, two hinges and two compression latches with outside and inside handles for sizes up to 600 mm x 1200 mm and an additional hinge for larger sizes.

2.2 Fire Dampers

.1 Fabricate of galvanised steel or prime coated black steel weighted to close and lock in closed position when released by fusible ink.

.2 Fire dampers shall be curtain type with damper blades retained out of air stream in a recess so free area of connecting ductwork is not reduced.

.3 Fusible links shall be set for 71°C (160°F).

2.3 Fire Stop Flaps.

.1 Fabricate of heat retardant fabric in galvanised or prime coated black steel frame, spring loaded action to close and lock in closed position when released by fusible link.

.2 Blanket shall be retained in a recess so free area of connecting ductwork is not reduced.

.3 Fusible links shall be set for 71°C (160°F).

2.4 Balancing Dampers

.1 Fabricate of galvanised steel, minimum 1.6 mm (16 gauge). Full blade-length shafts of hollow square construction with blades rigidly fastened along entire blade length.

.2 Lockable quadrant type operating mechanism with end bearings on accessible rectangular ducts up to 400 mm deep and on accessible round ducts.

.3 Wide pitch screw operating mechanism with crank operator and end bearings on accessible rectangular ducts 425 mm and over in depth and on all inaccessible rectangular and round ducts.

.4 On rectangular ducts up to 275 mm deep construct of single blade (butterfly) type.

.5 On rectangular ducts 300 mm to 400 mm deep construct of two opposed blades mechanically interlocked with pivots at quarter points.

.6 On rectangular ducts over 425 mm deep construct of multiple opposed blades mechanically interlocked with blades no greater than 200 mm deep and pivots equally spaced.

.7 On round ducts construct of single blade (butterfly) type. On 500 Pa (2 inch wg) class and on all dampers over 300 mm diameter fabricate with full blade-length shaft.

.8 Construct damper blades for medium and high pressure systems to block air passage 70 percent maximum. Provide complete with locking type handles.

.9 Provide over-ride limiting stops on all operating mechanisms.

.10 Identify the air flow direction and blade rotation and open and close positions on operating mechanism.

.11 On round ductwork install operating mechanism on a steel mounted base firmly secured to the ductwork.

.12 On externally insulated ductwork, install operating mechanisms on a steel bridge type mounting base to permit continuity of insulation under the mechanism.

2.5 Flexible Connections

.1 Fabricate of ULC approved neoprene coated flameproof glass fabric approximately 150 mm wide tightly crimped into metal edging strip and attached to ducting and equipment by screws or bolts at 150 mm intervals. Flexible connection airtight at 500 Pa (2 inch wg).

2.6 Backdraft Dampers

.1 Construct of minimum 1.3 mm (18 gauge) aluminum channel frame.

.2 Construct of minimum 0.6 mm (24 gauge) aluminum blades, complete with stiffeners along trailing edge. Fabricate single blade dampers for duct sizes to 240 mm, multiblade dampers for ducts greater than 240 mm.

.3 Provide full blade-length shafts complete with brass or nylon bearings.

.4 Provide neoprene anti-clatter blade strips on pivot side of blades.

.5 Construct blade connecting linkage of minimum 2.0 mm (12 gauge) aluminum rod with eyelet, pin bearings, and adjustable counter weight to assist blade opening action.

.6 Maximum blade length of 750 mm.

.7 Backdraft damper suitable for 10 m/s (2000 fpm) face velocity.

3. EXECUTION

3.1 Application

.1 Provide access door minimum 450 mm x 350 mm or 50 mm smaller than duct dimension for cleaning and inspection at positions indicated by drawings and as follows:

.1 Both sides of turning vanes in all ducts.

.2 At each fire damper location.

.3 At each side of all heating or cooling coils.

.4 At all locations of internally duct mounted devices including automatic dampers, damper motors and control sensors and devices.

.2 Provide fire dampers at locations shown, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Fire dampers shall be complete with required perimeter mounting angles sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

.3 At each point where ducts pass through duct shall be sealed with non-combustible material.

.4 Provide balancing dampers at points on supply and exhaust systems where branches are taken from larger ducts as required for proper air balancing.

.5 Install ducts associated with fans and equipment subject to forced vibration with flexible connections, immediately adjacent to equipment and/or where indicated on drawing.

.6 All fire dampers and fire stop flaps are to be left in the closed position for balancing contractor to fix open.

.7 Support ceiling fire stops from the structure above the fire stop and not from air outlets on associated ductwork.

END OF SECTION

DUCTWORK CLEANING

1. GENERAL

1.1 Scope

.1 When the duct systems are completed and before any fan systems are operated, all ductwork, plenums, coils and air handling equipment shall be cleaned by compressed air and mechanical equipment; or compressed air and high power suction equipment. No special cleaning is required for exhaust ductwork systems that convey air directly to the outside at all times without recirculation.

.2 A letter shall be submitted by the cleaning company certifying that all systems have been completely cleaned.

1.2 Quality Assurance

.1 Submit list of equipment, capacities, method and sequence of cleaning to the Contract Administrator for approval prior to beginning work.

2. PRODUCTS

2.1 Materials

.1 The sheet metal subtrade shall provide all necessary access doors to facilitate efficient ductwork cleaning as listed under installation.

.2 Provide approved filters to protect equipment during cleaning operation. Submit shop drawings indicating which type of filters are to be utilised to protect equipment during construction and cleaning operation.

.3 The contractor shall sample and analyse the contamination in the ductwork as requested by the Contract Administrator. The results may be verified by an independent laboratory, paid for by the Contractor, specialising in this type of work.

3. EXECUTION

3.1 Installation

.1 Ductwork access doors for ductwork cleaning shall be installed as follows:

.1 At 10 m intervals in all duct systems.

.2 At the base of all duct risers.

.3 Both sides of turning vanes in all ducts.

.4 At each fire damper location.

.5 At each side of all heating or cooling coils.

.6 At all locations of internally duct mounted equipment or devices including balancing dampers, automatic dampers, damper motors and controls.

.2 Access doors shall be as specified in Section 15835. Access panels with screws are not acceptable.

.3 Access door size shall be a minimum 450 mm x 350 mm or 50 mm smaller than duct dimension.

.4 For duct cleaning system utilising compressed air and mechanical brush, suitably sized access points with positive locking cover shall be installed at 3 m interval in the duct work and on both sides of dampers, coils, turning vanes, etc.

.5 Access system shall be reusable to allow for future inspection or cleaning.

.6 All ductwork outlets shall be sealed with suitable cover after ductwork has been cleaned. All plenums to be sealed after plenums have been cleaned.

.7 Prior to any work being started on the system, filter media shall be installed behind every supply grille or diffuser. This will act as a safety net for contamination which may be disturbed during cleaning. After a settling down period of two (2) to five (5) days, the filter media will be removed.

.8 Each aspect of the system shall be cleaned regardless of the size, type or configuration. Dirt clinging to the sides or top of ducting must be removed and left as clean as the bottom. Spiral ducting should be as clean as flat.

3.2 Inspection

.1 Any ductwork found to be dirty shall be redone through its entire length at no extra cost to the City.

END OF SECTION

AIR OUTLETS

1. GENERAL

1.1 Scope

.1 Diffusers

.2 Grilles and registers

.3 Outside louvres

.4 Diffuser boots

.5 Goosenecks

1.2 Quality Assurance

.1 Air flow tests and sound level measurement shall be made in accordance with applicable ADC equipment test codes, ASHRAE Standards and AMCA Standards.

.2 Unit rating shall be approved by ADC and AMCA.

.3 Manufacturer shall certify catalogued performance and ensure correct application of air outlet types.

.4 Outside louvres shall bear AMCA seal for free area and water penetration.

1.3 Project Conditions

.1 Review requirements of outlets as to size, finish and type of mounting prior to submitting Shop Drawings and schedules of outlets.

.2 Positions indicated are approximate only. Check locations of outlets and make necessary adjustments in position to conform with Architectural features, symmetry and lighting arrangement.

1.4 Submittals

.1 Submit Shop Drawings with complete catalogue information, materials of construction, dimensions and accessories for all air outlets, louvres and components in this specification section, and as scheduled.

.2 Submit colour selection charts of finishes for approval prior to fabrication.

2. PRODUCTS

2.1 General

.1 Base air outlet application on space noise level of NC 30 maximum.

.2 Provide supply outlets with sponge rubber seal around the edge.

.3 Provide baffles to direct air away from walls, columns or other obstructions within the radius of diffuser operation.

.4 Provide plaster frame for diffusers located in plaster surfaces.

.5 Provide anti-smudge frames or plaques on diffusers located in rough textured surfaces such as acoustical plaster.

.6 Refer to Air Outlet Schedule for specifications of air outlets.

2.2 Outside Louvres

.1 Louvres 100 mm deep with blades on 45 degree slope with centre baffle and return bend heavy channel frame, birdscreen with 15 mm square mesh.

.2 Fabricate of 1.6 mm (16 gauge) galvanised steel blades and frame. Provide welded assembly.

.3 Finish in factory baked enamel. Colour shall be selected by the Architect.

2.3 Goosenecks

.1 Fabricate goosenecks of minimum 1.3 mm (18 gauge) galvanised steel.

.2 Mount on minimum 300 mm high curb base where size exceeds 225 mm x 225 mm.

3. EXECUTION

3.1 Priming

.1 Paint ductwork visible behind air outlets matte black.

3.2 Sizing

.1 Size outside air louvres as indicated on drawings.

.2 Size air outlets as indicated on drawings.

3.3 Air Outlets Schedule

.1 Refer to Equipment Schedules.

END OF SECTION

BREECHING AND CHIMNEYS

1. GENERAL

1.1 Scope

.1 Site fabricated breeching.

.2 Manufactured vents and chimneys for atmospheric gas fired equipment.

.3 Manufactured chimneys for forced draft natural gas fired equipment.

1.2 Quality Assurance

.1 Vents and Chimneys: Labelled by Underwriters' Laboratory of Canada.

.2 The successful bidder for the self-supporting stack shall provide to the Contractor, all relevant moments and loads that result from wind and vortex shedding so that the contractor can design and install the suitable concrete base and building tie backs as required.

1.3 Definitions

.1 Vent: enclosed passageway for conveying flue gases from the appliances to outdoors.

.2 Breeching: portion of vent from the appliance to the chimney.

.3 Chimney: primary vertical portion of vent.

.4 Draft: flow of air or combustion products or both, through an appliance and its venting system.

.5 Mechanical Draft: draft produced by a mechanical device such as a fan, blower, or aspirator which may supplement natural draft.

.6 Forced Draft: a mechanical draft produced by a device upstream of the combustion zone of an appliance.

.7 Induced Draft: a mechanical draft produced by a device downstream from the combustion zone of an appliance.

.8 Natural Draft: a draft other than mechanical draft.

1.4 Submittals

.1 Comply with requirements of Section 15010, supply shop drawings for all fabricated and pre-manufactured breeching and fuel elements.

2. PRODUCTS

2.1 Vents

.1 Type A: to CAN 4-S604.

.1 Application: gas and liquid fuel fired appliances.

.2 Service temperature: maximum flue gas temperature of 540°C (1000°F).

.2 Type A-2 Vent: to CAN 4-S629.

.1 Application: gas, liquid and solid fuel fired appliances.

.2 Service temperature: maximum flue gas temperature of 650°C (1200°F).

.3 Type B Vent: to CAN 4-S605.

.1 Application: gas fired appliances certified with draft hoods or diverters.

.2 Service temperature: maximum flue gas temperature of 243°C (470°F).

.4 Type BW Vent: to CAN 4-S605.

.1 Application: gas fired recessed heaters.

.2 Service temperature: maximum flue gas temperature of 243°C (470°F).

.5 Type L Vent: to ULC S609.

.1 Application: fuel burning appliances certified to use with Type L vents.

.2 Service temperature: maximum flue gas temperature of 298°C (570°F).

.6 For condensing boiler applications:

.1 SAF-T-CI Ventilator stainless steel construction, sealed, suitable and rated for condensing flue gas applications.

2.2 Breeching

.1 Breeching Type 1: for natural draft, gas burning appliances with draft hoods, use one of the following:

.1 Galvanised steel with thicknesses as follows:

Vent Diameter	Minimum Thickness
125 mm and smaller	0.4 mm (30 ga)
125 mm to 200 mm	0.5 mm (26 ga)
200 mm and larger	0.6 mm (24 ga)

.2 Breeching constructed of same vent components as chimney.

.2 Breeching Type 2: for forced, induced, or natural draft with dilution, gas or liquid fuel fired appliances, use one of the following:

.1 Mild steel, all welded construction with thicknesses as follows:

Vent Diameter	Minimum Thickness
300 mm and smaller	1.3 mm (18 ga)
325 mm and 600 mm	1.6 mm (16 ga)
625 mm to 900 mm	2.0 mm (14 ga)
925 mm and larger	3.0 mm (11 ga)

.2 Breeching constructed of same vent components as chimney.

.3 Breeching Type 3: for solid fuel fired appliances, use one of the following:

.1 Mild steel, minimum thickness of 3 mm (11 gauge), all welded construction, lined with 50 mm thick castable refractory.

.2 Breeching constructed of same vent components as chimney.

2.3 Accessories

.1 Cleanouts: bolted, gasketted type, full size of breeching area.

.2 Barometric damper: double acting sized to 70 percent of full size of breeching area.

.3 Breeching damper: motor operated damper 3.5 mm (10 gauge) thick steel, ball bearings on full length shaft, 80 percent maximum closure.

.4 Appurtenances: raincap, thimbles, support brackets and guys, flashing and counter flashings, fly ash screen, and other materials required to complete the assembly.

3. EXECUTION

3.1 Vent Installation

.1 Install vents, complete with accessories and appurtenances, in accordance with latest editions of CAN 4-B149.2, Provincial Building Code, manufacturer's instructions and as follows:

.1 Type A: to CAN 4-S604

.2 Type A-2: to CAN 4-S629

.3 Type B: to CAN 4-S605

.4 Type BW: to CAN 4-S605

.5 Type L: to ULC S609

.2 Do not penetrate flue gas chamber of vent with screws or mechanical fasteners.

.3 Install breeching with positive slope upward from appliance, minimum 2 percent.

.4 Suspend breeching using trapeze hangers at 1500 mm centres.

.5 Install cleanout at base of chimney.

.6 Support chimney at bottom, roof and intermediate levels.

.7 Install thimbles where penetrating roof, floor, ceiling and where breeching enters masonry chimney.

.8 Install raincap on chimney outlet.

.9 Install counterflashing where chimneys pass through roof.

.10 Provide for expansion and contraction of chimney and breeching.

END OF SECTION

HVAC CONTROLS GENERAL PROVISIONS

1. GENERAL

1.1 Scope

.1 Complete and fully operational system of automatic controls for building heating, ventilation, and air conditioning systems, including all materials and labour.

1.2 Work by Other Trades

.1 Division 16 shall provide 120 V power for control panels, 120 V control voltage and all low voltage wiring/conduit.

.2 Division 15 shall install thermal wells, control valves and devices on piping, furnished by controls contractor.

.3 Unless noted otherwise in Contract Documents, control dampers integral with the air handling units are supplied by air handling unit supplier. Damper operators are supplied by Division 17 and installed by the air handling unit manufacturer at the factory. All other control dampers are supplied by Division 17.

1.3 Quality Assurance

.1 Install all components in accordance with the latest regulations of the Canadian Electrical Code, applicable Municipal and Provincial Codes and Regulations, and latest CSA Electrical Bulletins.

.2 The equipment manufacturer shall have trained service representatives resident in the Province where project is located.

1.4 Submittals

.1 Meet with Contract Administrator prior to submitting Shop Drawings. Submit Shop Drawings in accordance with Section 15010.

.2 Provide Shop Drawings including complete operating data, system drawings, wiring diagrams and written detailed operational description of sequences and engineering data on each control system component. Include sizing and arrangements as requested.

.3 Submit approved Shop Drawings for inclusion in operations and maintenance manuals.

1.5 Orientation

.1 Contractor to provide three weeks written notice to the Contract Administrator and the City prior to commencing formal training sessions.

.2 Formal training sessions for the City shall commence only after "as-built" drawings have been completed, reviewed and approved by the Contract Administrator and shall be in addition to 15010 requirements.

1.6 Warranty

.1 Include Warranty provisions identified in Part D of these Specifications.

.2 The warranty provisions shall commence for one year from the date of final acceptance and shall include at no cost all material and labour required to correct control system equipment failures that occur during the one year period.

.3 The Contractor shall supply and install at no cost all system software and hardware updates and upgrades occurring prior to the expiration of the Warranty period.

1.7 Acceptance Testing

.1 A final operational acceptance test of seven consecutive days shall be conducted on the complete and total installed and operational control system to demonstrate that it is functioning properly in accordance with the Specifications.

.2 The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control programs and algorithms, diagnostics and all other software.

.3 In the event of the failure of function, during the test, of any of the hardware components or software application or routines, the test will recommence and run until seven failure-free test days have occurred.

.4 After successful completion of the acceptance test, the Contract Administrator will issue written acceptance of the control system.

.5 Prior to acceptance of the Work, submit hard copy and electronic copy on diskette of final data base listings.

1.8 As-Built Drawings

.1 Before the certification of substantial performance will be issued the contractor must provide the Contract Administrator with as-built drawings in accordance with Section 01300.

.2 Maintain as-built data on the data gathering and automatic control equipment schedule and panel schedules.

2. PRODUCTS

2.1 Approved Suppliers

.1 Honeywell

.2 Johnson Controls

.3 Siemens

.4 Barcol

2.2 Control Panels, General

.1 Provide control panel of unitized cabinet type construction. Mount relays, switches and control point adjustment in cabinet and pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face

.2 Fabricate panels from 2.5 mm rolled sheet metal sheet with baked enamel finish, flush fitting, gasketted doors hung on piano type hinges and three point latches and locking handles. CSA approved for line voltage applications.

.3 Mount panels on vibration free wall or free standing angle iron supports. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.

.4 Provide pans and rails for mounting terminal blocks, relays, wiring and other necessary devices.

.5 Provide an individual switch for disconnection and a fuse for isolation of all panel mounted instruments requiring a 120 V supply.

.6 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.

.7 Identify all wiring by means of stamped markings on heat shrinkable tubing. Install all wiring neatly and laced or bunched into cable form using plastic wire clips, where practical, contained in plastic wiring channels with covers. Maximum 25 conductors to each wire bundle.

.8 Provide terminal blocks, tabular 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 percent spare unit terminals, with a minimum of two spare terminals. Provide all necessary terminal block accessories such as manufacturer jumpers and marking tape.

.9 Install "Hand-Off-Auto" selector switches such that safety controls and electrical over current protection are not overridden when selector switch is in the "Hand" position.

2.3 Wire

.1 Conform to Division 16 requirements.

.2 Control wiring for digital functions shall be 18 AWG minimum with 300 Volt insulation.

.3 Control wiring for analog functions shall be 18 AWG minimum with 300 V insulation, twisted and shielded, 2 or 3 wire to match analog function hardware.

.4 Sensor wiring shall be 18 AWG minimum twisted and shielded, 2 or 3 wire to match analog function hardware or 16 AWG as required by code.

.5 Transformer current wiring shall be 16 AWG minimum.

2.4 Conduits and Cables

.1 All wiring shall be in conduit or trays. Conform to Division 16 requirements for conduit and tray specifications.

.2 Seal conduit where such conduit leaves heated areas and enters unheated area.

.3 Run low level signal lines in separate conduit from high level signal and power transmission lines.

.4 Identify each cable and wire at every termination point.

.5 Where applicable, mount field interface equipment (i.e., relays, transducers, etc.) in local device cabinets adjacent to field interface panels.

.6 Separate conduits shall be provide for pneumatic tubing and electrical wiring runs.

.7 Colour-code all conductors and conduits by permanently applied color bands. Colour code shall follow base building schedule.

2.5 Related Accessories

.1 Provide and install all necessary transformers, transducers, interposing relays, interface devices, contactors and starters to perform control functions required.

.2 It is the responsibility of the Contractor to identify, at the time of tender submission, all additional items not specified that are required to meet the operational intent specified.

.3 Items required but not identified at the time of tender acceptance shall be the Contractor's responsibility.

2.6 Electric Thermostats

.1 Electric room thermostats shall be low profile type with heavy duty metal covers with setpoint adjustment.

.2 Remote temperature sensors may be either RTD or thermistor type providing the following minimum performance requirements are met:

.1 Accuracy: ±0.6°C
.2 Operating Range: 2°C to 46°C
.3 Setpoint Adjustment Range: 2°C to 30°C
.4 Calibration Adjustments: None required

2.7 CO Monitors

.1 Acceptable Products: Cromag

2.8 Pressure Sensor

.1 Acceptable Products: Honeywell, Seimens, Johnson Controls

2.9 Dampers

.1 Automatic dampers shall be extruded aluminum multiple blade mounted in extruded aluminum flanged frame. Dampers on exterior wall applications shall be internally insulated with blade gaskets suitable for cold weather service and mounted in a thermally broken insulated frame. Individual blades shall not exceed 150 mm in width or 1200 mm in length. Provide interlocking edges and compressible seals. Provide dual bearing system with additional thrust bearings for vertical blades. Damper configuration to be as shown on drawings. Use flanged to duct type dampers for all sizes under 0.4 m^2.

.2 Damper leakage shall be certified under the AMCA certified rating program and shall carry AMCA seal:

.1 Standard Leakage: 25 L/s per m^2 at 250 Pa pressure difference for a 1220 x 1220 mm damper.

2.10 Damper Operators

.1 Electronic Damper Operators

.1 Spring return, 24 VAC operating voltage, 0-10 VDC input signal, 0-10 Vdc position output signal, 70 seconds max. running time for 90 degree opening and 30 seconds maximum closing time.

.2 Provide sufficient damper motors to achieve unrestricted movement, with a minimum of one damper operator per damper section.

2.11 Railcar Shelter Control Panel

.1 Remote control panel shall contain, but not be limited to, the following:

.1 A six-hour switch to be the occupied mode switch and to be labeled with lamacoid as “OCCUPIED TIMER”.

.2 A one-hour switch to be for increased ventilation and to be labeled with lamicoid as “EXTRA VENTILATION”.

3. EXECUTION

3.1 Installation

.1 Verify location of thermostats and other exposed control sensors with drawings before installation. Locate thermostats 1500 mm above floor.

.2 Install damper motors on outside of ducts. Do not locate in air stream.

.3 Wire "hand/off/auto" selector switches such that automatic operating controls and not safety controls and electrical over current protection shall be overridden when switch is in the "hand" position.

.4 Install all safety limits at the operators level.

.5 Install outdoor temperature sensors on north walls or if no north walls are available, on east wall.

3.2 Sequence of Operation – Railcar Shelter

.1 The radiant heaters in the Railcar Shelter shall be each controlled by a thermostat as indicated to maintain a temperature of 5°C. The thermostats shall have an adjustable setpoint.

.2 The makeup air unit and exhaust fan ventilation system to be reverse-interlocked (interlock unit to start when exhaust fan is running; interlock burner to operate when flow switch located in exhaust duct proves flow) and to be controlled as follows:

.1 In Occupied Mode, the makeup air unit and exhaust fan to run continuously at their minimum indicated airflow rates. In Unoccupied Mode, makeup air unit and exhaust fan to be off unless on a call for cooling. The ventilation system to operate in Occupied Mode when the eight-hour occupied timer switch is activated. The ventilation system to operate at its maximum indicated airflow when the two-hour timer switch is activated.

.2 In heating mode, the makeup air unit burner section to cycle and modulate as required to maintain a supply air temperature of 5°C.

.3 In cooling mode, the makeup air unit and exhaust fan are energized and modulate to maintain the space at setpoint (27°C).

.3 Interlock with CO monitoring system to operate ventilation system on high volume when pre-determined CO concentration detected.

3.3 Sequence of Operation – Chemical Storage Building

.1 The unit heaters in the Chemical Storage Building shall be each controlled by a thermostat as indicated to maintain a temperature of 10°C. The thermostats shall have an adjustable setpoint.

.2 The makeup air unit and exhaust fan to be reverse-interlocked (interlock unit to start when exhaust fan is running; interlock burner to operate when flow switch located in exhaust duct proves flow) and to be controlled as follows:

.1 In Occupied Mode, the makeup air unit to run continuously at its maximum indicated airflow rate. In Unoccupied Mode, the makeup air unit to run continuously at its minimum indicated airflow rate. The makeup air unit is to operate in Occupied Mode when the main lighting for the Chemical Storage Building is on and in Unoccupied Mode when the main lighting for the Chemical Storage Building is off. The exhaust fan to modulate to maintain a negative pressure of 2.5 Pa (0.01 inches WC) in the Chemical Storage Building.

.2 In heating mode, the burner section to cycle and modulate as required to maintain a supply air temperature of 10°C.

.3 In cooling mode, the makeup air unit and exhaust fan are energized and modulate to maintain the space at setpoint (27°C).

.3 Interlock with CO monitoring system to operate ventilation system on high volume when pre-determined CO concentration detected.

.4 The glycol heat recovery system to be activated via its recirculation pump when the outdoor air temperature is 5°C or less. When the outdoor air temperature is below 0°C, the heat recovery loop will cycle every hour into an adjustable five (5) minute defrost mode. The glycol recirculating pump will stop during the defrost mode.

END OF SECTION

HVAC CONTROL SYSTEMS INPUT/OUTPUT DEVICES

1. GENERAL

.1 This section is a module which specifies the Field Instrumentation, Sensing Devices and Actuators.

.2 For general requirements relating to all sections see Section 15900.

2. PRODUCTS

2.1 General

.1 Provide field instrumentation and sensing devices analog or digital as applicable which measure temperature, humidity, pressure, flow, current, voltage, equipment states, etc., and which input signals to the SCU terminal strip that conform to the input requirements.

.2 Provide output devices and actuators which convert the digital or analog output signal from the SCU to activate relays or open and close valves, dampers, etc.

.3 The end to end accuracy called for in Subsection 2.2 includes the combined effect of sensitivity, hysterisis, linearity and repeatability between the measured variable and the input to the analog-to-digital converter in the SCU or between the SCU input to the digital-to-analog converter and the controlled variable for the full sensing range.

.4 The letter under the "Type" column in Subsection 2.2 is the same used in the points list.

.5 Acceptable manufacturers of sensors are listed next to the sensor type where applicable:

2.2 Analog Input Sensors

.1 Temperature

Application	Type	Operating Range	End to End Accuracy	Remarks
Duct Mounted	Tp	0°C to 60°C (32°F to 140°F)	±0.3°C (±0.5°F)	
Pipe Well Mounted	Tw	0°C to 50°C (32°F to 122°F) 0°C to 100°C (32°F to 212°F) 50°C to 150°C (122°F to 302°F)	±0.2°C (±0.4°F) ±0.5°C (±0.9°F) ±0.5°C (±0.9°F)	c/w thermal wells

Application	Type	Operating Range	End to End Accuracy	Remarks
Averaging	Ta	-30°C to 60°C (-22°F to 140°F)	±0.5°C (±0.9°F)	Length to suit duct size
Space Temp.	Tr	2°C to 46°C (36°F to 115°F)	±0.6°C (±1.08°F)	c/w tamper-proof cover
Outside Air	To	-50°C to 50°C (-58°F to 122°F)	±0.5°C (±0.9°F)	c/w solar-shield
Surface Temp.	Ts	0°C to 50°C (32°F to 122°F)	±0.3°C (±0.5°F)	

.2 Relative Humidity

Acceptable Manufacturers: Hy-Cal, General Eastern

Application	Type	Operating Range	End to End Accuracy	Remarks
Duct Mounted	Hp	5-90% RH	±3% 0°C to 60°C (32°F to 140°F)	
Space	Hr	5-90% RH	±5%	c/w tamper-proof cover
Outside Air	Ho	5-100% RH	±5%	c/w solar-shield

.3 Pressure

Acceptable Manufacturers for Sp and Vp Sensors: Modus, Setra

Application	Type	Operating Range	End to End Accuracy	Remarks
Static-Water	Ps	0 to 104 kPa (0 to 15 psi) 0 to 208 kPa (0 to 30 psi) 0 to 689 kPa (0 to 100 psi) 0 to 2,000 kPa (0 to 290 psi)	±3% ±3% ±3% ±3%	

Application	Type	Operating Range	End to End Accuracy	Remarks
Static-Air	Sp	0 to 500 Pa (0 to 2 in wg) 0 to 1,250 Pa (0 to 5 in wg) 0 to 2,500 Pa (0 to 10 in.wg)	±2% ±2% ±2%	
Instrument	Ia	0 to 120 kPa (0 to 17 psi)	±2%	
Velocity Pressure monitoring station (air)	Vp	0-62.5 Pa (0-0.25 in wg) [0-125 Pa] [(0-0.5 in wg)] [0-250 Pa] [(0-1.0 in wg)]	±1.0%	- multi-point static & total pressure sending element manifold - self-averaging manifold - air equaliser & straightener - max, pressure loss 36 Pa (0.15 in.w.g.) @ 10 m/s (2000 fpm) - lowest sensitivity 1% of range
Velocity Pressure monitoring station (water, steam)	Pv	As required	±2.0% full scale	- annubar or orifice plate

.4 Electrical

Application	Type	Operating Range	End to End Accuracy	Remarks
Watt Meters	Kw	110/208V 347V 600V	±0.25% full scale	3 current transformers 2 potential transformers as applicable for 'Y' or 'D' configuration
Current Transformers	Ct	As required	±0.25% full scale	

2.3 Analog Output Devices

Application	Type	Operating Range	End to End Accuracy	Remarks
To Damper Motors	Dm	0-10 VDC 4-20 mA 20-104 kPa (3-15 psi)	±2% full scale	
To Valve Actuators	Vm	0-10 VDC 4-20 MA 20-104 kPa (3-15 psi)	±1% full scale	

2.4 Digital Input Devices

Application	Type	Operating Range	End to End Accuracy	Remarks
Pressure Switches	Pd	As required	±1.5%	- adjustable set- point and differential - automatic reset
Temperature	Td	As required	±1°C (1.8°F)	- adjustable set- point and differential - automatic reset - normal reset for freeze protection
Current Sensing Relays	Ri	As required	N/A	- adjustable trip c/w LED Status Indication
Motor Status Relays	St	As required	N/A	- auxiliary contacts
Level	Ls	N/A	N/A	- pressure range suitable to application - adjustable set- point and differential
Motion	Md			- passive infrared sentrol Series 6147

2.5 Digital Output Devices

Application	Type	Operating Range	End to End Accuracy	Remarks
Relays	Ry	N/A	N/A	- double voltage DPDT plug-in type with terminal base contacts rated at 5 Amp 120 VAC

3. SIGNAL TRANSMISSION

.1 Provide a digital transmission network to communicate between all SCUs as required.

.2 Digital transmission at 56,600 baud minimum.

END OF SECTION

GENERAL MECHANICAL PROVISIONS

1. GENERAL

1.1 RELATED DOCUMENTS

.1 All Division 15 Specification Sections, Drawings, and General Provisions of the Contract apply to Work of this Section, as do other documents referred to in this Section.

1.2 SCOPE OF WORK

.1 The Contractor will contract with and independent testing, adjusting, and balancing (TAB) agency to test, adjust, and balance the heating, ventilation, and air conditioning (HVAC) systems.

.2 The work included in this section consists of furnishing labour, instruments, and tools required in testing, adjusting and balancing the HVAC systems, as described in these specifications or shown on accompanying drawings. Services shall include checking equipment performance, taking the specified measurements, and recording and reporting the results.

.3 The items requiring testing, adjusting, and balancing include the following:

.1 Air Systems:

.1 Supply Fan MUAs

.2 Exhaust Fans

.3 Zone branch and main ducts

.4 Diffusers, Registers and Grilles

.2 Hydronic Systems:

.1 Pumps

.2 System Mains and Branches

.3 Coils

1.3 DEFINITIONS, REFERENCES, STANDARDS

.1 AABC: the Associated Air Balance Council is a non-profit association of independent, certified agencies specializing in testing, adjusting, and balancing HVAC systems. The AABC National Standards, provides standards and operational criteria for HVAC systems.

.2 All Work shall be in accordance with the latest edition of the Associated Air Balance Council National Standards. If these contract documents set forth more stringent requirements than the AABC National Standards, these contract documents shall prevail.

1.4 QUALIFICATIONS

.1 Agency Qualifications: the TAB Agency shall be a current member of the AABC.

1.5 SUBMITTALS

.1 Qualifications: the TAB agency shall submit a company resume listing personnel and project experience in air and hydronic system balancing and a copy of the agency's test and balance engineer certificate.

.2 Procedures and Agenda: the TAB agency shall submit the TAB procedures and agenda proposed to be used.

.3 Sample Forms: the TAB agency shall submit sample forms, which shall include the minimum data required by the AABC National Standards.

1.6 TESTING ADJUSTING AND BALANCING PREPARATION AND COORDINATION

.1 Shop Drawings, submittal data, up-to-date revisions, change orders, and other data required for planning, preparation, and execution of the TAB work shall be provided to the TAB agency no later than 30 days prior to the start of TAB work.

.2 System installation and equipment start-up shall be complete prior to the TAB agency's being notified to begin.

.3 The building control system shall be complete and operational. The Contractor shall install all necessary computers and computer programs, and make these operational. Assistance shall be provided as required for reprogramming, coordination, and problem resolution.

.4 All test points, balancing devices, identification tags, etc., shall be accessible and clear of insulation and other obstructions that would impede TAB procedures.

.5 Qualified installation or start-up personnel shall be readily available for the operation and adjustment of the systems. Assistance shall be provided as required for coordination and problem resolution.

1.7 REPORTS

.1 Final TAB Report: the TAB agency shall submit the final TAB report for review by the Contract Administrator. All outlets, devices, HVAC equipment, etc., shall be identified, along with a numbering system corresponding to report unit identification. The TAB agency shall submit an AABC "National Project Performance Guaranty" assuring that the project systems were tested, adjusted and balanced in accordance with the project specifications and AABC National Standards.

.2 Submit six (6) copies of the Final TAB Report.

1.8 DEFICIENCIES

.1 Any deficiencies in the installation or performance of a system or component observed by the TAB agency shall be brought to the attention of the appropriate responsible person.

.2 The work necessary to correct items on the deficiency listing shall be performed and verified by the Contractor before the TAB agency returns to retest. Unresolved deficiencies shall be noted in the final report.

2. INSTRUMENTATION

.1 All instruments used for measurements shall be accurate and calibrated. Calibration and maintenance of all instruments shall be in accordance with the requirements of AABC National Standards.

3. EXECUTION

3.1 GENERAL

.1 The specified systems shall be reviewed and inspected for conformance to design documents. Testing, adjusting and balancing on each identified system shall be performed. The accuracy of measurements shall be in accordance with AABC National Standards.

.2 Adjustment tolerances shall be plus or minus ten percent unless otherwise stated.

.3 Equipment settings, including manual damper quadrant positions, manual valve indicators, fan speed control levers, and similar controls and devices shall be marked to show final settings.

.4 All information necessary to complete a proper TAB project and report shall be per AABC standards unless otherwise noted. The descriptions for work required, as listed in this section, are a guide to the minimum information needed.

3.2 AIR SYSTEMS

.1 The TAB agency shall verify that all ductwork, dampers, grilles, registers, and diffusers have been installed per design and set in the full open position. The TAB agency shall perform the following:

.1 TAB procedures in accordance with the AABC National Standards:

.1 For supply fans:

.1 Fan speeds: test and adjust fan rpm to achieve maximum or design air flow rate.

.2 Current and voltage: test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.

.3 Pitot-tube traverse: perform a pitot-tube traverse of main supply and return ducts, as applicable to obtain total air flow rate.

.4 Outside air: test and adjust the outside air on applicable equipment using a pitot-tube traverse.

.5 If a traverse is not practical use the mixed-air temperature method if the inside and outside temperature difference is at least 11°C (20°F) or use the difference between pitot-tube traverses of the supply and return air ducts.

.6 Static pressure: test and record system static profile of each supply fan.

.2 For exhaust fans:

.1 Fan speeds: test and adjust fan rpm to achieve maximum or design air flow rate.

.2 Current and voltage: test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.

.3 Pitot-tube traverse: perform a pitot-tube traverse of main exhaust ducts to obtain total air flow rate.

.4 Static pressure: test and record system static profile of each exhaust fan.

.3 For zone, branch and main ducts:

.1 Adjust ducts to within design air flow rate requirements. As applicable, at least one zone balancing damper shall be completely open. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.

.4 For diffusers, registers and grilles:

.1 Tolerances: test, adjust, and balance each diffuser, grille, and register to within ten percent of design requirements. Minimize drafts.

.2 Identification: identify the type, location, and size of each grille, diffuser, and register. This information shall be recorded on air outlet data sheets.

.5 For coils:

.1 Air temperature: once air flows are set to acceptable limits, take wet bulb and dry bulb air temperatures on the entering and leaving side of each cooling coil. Dry-bulb temperature shall be taken on the entering and leaving side of each heating coil.

3.3 HYDRONIC SYSTEMS

.1 The TAB agency shall, as applicable, confirm that all hydronic equipment, piping, and coils have been filled and purged; that strainers have been cleaned; and that all balancing valves (except bypass valves) are set full open. The TAB agency shall perform the following testing and balancing functions in accordance with the AABC National Standards:

.1 For pumps:

.1 Test and adjust domestic hot water and glycol pumps to achieve maximum or design flow rate. Check pumps for proper operation. Pumps shall be free of vibration and cavitation. Record appropriate gauge readings for final TDH and Block-Off/Dead head calculations.

.2 Current and voltage: test and record motor voltage and amperage, and compare data with the nameplate limits to ensure pump motor is not in or above the service factor.

.3 For system mains and branches:

.1 Adjust flow in pipes to achieve maximum or design flow rate.

.4 For coils:

.1 Tolerances: test, adjust, and balance all heat recovery coils within ten percent of design requirements.

.2 Verification: verify the type, location, final pressure drop and flow rate of each coil. This information shall be recorded on coil data sheets.

3.4 OPTIONAL TAB SERVICES

.1 Preconstruction Plan Check and Review:

.1 The TAB agency shall review the project documents and contractor submittals for their effect on the TAB process and overall performance of the HVAC system. It shall submit recommendations for enhancements or changes to the system within 30 days of document review.

.2 Job Site Inspections:

.1 During construction, the TAB agency shall inspect the installation of pipe systems, sheet metal work, temperature controls, and other component parts of the HVAC systems. Inspections shall be conducted a minimum of two times. (Typically, these are

performed when 60 percent of the total system is installed and again when 90 percent of the total system is installed, prior to insulation of the duct and piping). The TAB agency shall submit a written report of each inspection.

.3 Verification of HVAC Controls:

.1 The TAB agency shall be assisted by the building control systems contractor in verifying the operation and calibration of all HVAC and temperature control systems. The following tests shall be conducted:

.1 Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, fire and freeze stats, and other safety devices.

.2 Verify that all controlling instruments are calibrated and set for design operating conditions.

.4 Temperature Testing:

.1 To verify system control and operation, a series of three temperature tests shall be taken at approximately two hour intervals in each separately controlled zone. The resulting temperatures shall not vary more than 1°C (2°F) from the thermostat or control setpoint during the tests. Outside temperature and humidity shall also be recorded during the testing periods.

.5 TAB Report Verification:

.1 At the time of final review, the TAB agency may be required to recheck, in the presence of the Contract Administrator, specific or random selections of data recorded in the certified report. Points and areas for recheck shall be selected by the Contract Administrator. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for recheck, specific plus random, will not exceed ten percent of the total number tabulated in the report.

.6 Building/Zone Pressurization:

.1 The TAB agency shall test and adjust building/zone pressurization by setting the design flows to meet the required flow direction and pressure differential. For positive pressure areas, it shall set the supply air to design flow, and gradually reduce the exhaust air rate to obtain the required flow or pressure difference. For negative pressure areas, it shall set the supply air to design flow, and gradually increase the exhaust air rate to obtain the required flow or pressure difference.

END OF SECTION

LIST OF SCHEDULES

1. LIST OF SCHEDULES

.1 Air Handling Unit Schedule

.2 Exhaust Air Fan Schedule

.3 Packaged Gas Fired Furnaces/Gas Fired Unit Heaters Schedule

.4 Heat Reclaim Coil Schedule

.5 Gas Fired Radiant Heater Schedule

.6 Tank Schedule

.7 Pump Schedule

.8 Grilles, Registers and Diffusers Schedule

.9 Louver Schedule

.10 Domestic Hot Water Tank Schedule

.11 Variable Frequency Drive Schedule

LIST OF SCHEDULES

1.1 Air Handling Unit Schedule

Tag	W-795-MAU	W-790-MAU
Location	Chemical Building	Rail Car Shelter
Area Served	Chemical Building	Rail Car Shelter
Type	Direct fired	Direct Fired
Manufacturer	ICE	ICE
Model	BMA 112	BMA115
Supply Fan		
Tag		
Volume, L/s (cfm)	1215 (2577)	1975 (4181)
ESP, Pa (in wg)	185 (0.75)	185 (0.75)
Fan Type	Belt	Belt
Fan Size, mm (in)	300-300 (12-12)	375-375 (15-15)
Motor Power, kW (hp)	2.25 (3)	3.75 (5)
Power Supply, V/Ph/Hz	600/3/60	600/3/60
Return Fan		
Tag		
Volume, L/s (cfm)		
ESP, Pa (in wg)		
Fan Type		
Speed rpm		
Motor Power, kW (hp)		
Power Supply		
Minimum Outdoor Air, L/s (cfm)	608 (1289)	0
Heating Section		
Type	Natural Gas	Natural Gas
Gas Input, kW (MBH)	64.4 (220)	84.9 (290)
Heating Output, kW (MBH)	64.4 (220)	84.9 (290)
Temperature rise ºC (°F)	42 (76)	36 (64)
Pre-heat Coil	See PHC-1	
Tag		
Size, H x L, mm (in)		
Face Area, m² (ft²)		
Rows / fpi		
Face Velocity m/s (fpm)		
Air side P.D, Pa (in wg)		
Htg. Capacity, kW (MBH)		
EAT DB/WB, ºC (°F)		
LAT DB/WB, ºC (°F)		
Condensing Unit		
No. of Cond. Fans		
Cond. Fan Power, kW (hp)		
No. of Compressors		
Power Supply		
Minimum Circuit Ampacity	6.5A	9.0A
Arrangement	Horizontal Unit	Vertical Unit
Supply Outlet	Bottom	Top
Return Inlet		
Outdoor Air Inlet	End	Right
Relief Air Outlet		
Physical Data		
Overall Length, mm (in)	4800 (184)	762 (30)
Overall Width, mm (in)	1372 (54)	1473 (58)
Overall Height, mm (in)	838 (33)	3580 (141)
Overall Weight, kg (lb)	680 (1500)	816 (1800)

1.2 Exhaust Air Fan Schedule

Tag	W-796-EF	W-791-EF
Function	Exhaust Fan	Exhaust Fan
Location	Chemical Building	Rail Shelter
Volume, L/s (cfm)	1215 (2577)	1975 (4181)
E.S.P., Pa (in wg)	448 (1.80)	187 (0.75)
Fan Speed, rpm	1582	811
Motor Power, kW (hp)	1.1 (1.5)	1.1 (1.5)
Power Supply, V/Ph/Hz	208/3/60	208/3/60
Drive	Belt	Belt
Type	Centrifugal Inline	Centrifugal Inline
Arrangement	Inline	Inline
Manufacturer	Cook	Cook
Model	165SQN-B	225SQN-B
Control	VFD	2 Speed (1/2-spd)
Accessories & Remarks	5,6,8	5,6,8

Accessories: (Select Appropriate)

1. Gasketted bolted access door
2. Housing drain with plug
3. Totally enclosed belt guard
4. Shaft and bearing guard
5. Extended grease fittings
6. Spring vibration isolators
7. Weatherproof motor
8. Drive cover
9. Shaft seal

LIST OF SCHEDULES

1.3 Packaged Gas Fired Furnaces and Gas Fired Unit Heaters Schedule

Tag	W-797-UH	W-798-UH
Location	Chemical Storage Building	Chemical Storage Building
Service	Chemical Storage Building	Chemical Storage Building
Air Flow, L/s (cfm)	297 (629)	297 (629)
Fan T.S.P., Pa (in wg)		
Fan Motor Power, hp	0.03	0.03
Fan Motor Power Supply (V/Ph/Hz)	115/1/60	115/1/60
Gas Input, kW (MBH)	13.2 (45.0)	13.2 (45.0)
Heating Output, kW (MBH)	11.0 (37.4)	11.0 (37.40)
Air Temp. Rise, ^{o}C (^{o}F)	34 (60)	34 (60)
Manufacturer	Reznor	Reznor
Model No.	UDAS 45	UDAS 45

Notes:

1. All selections based on maximum 14 inch WC gas inlet pressure to appliance.

2. All units shall be complete with packaged wall mounted thermostat, c/w Auto/On fan switch.

3. All units shall include Option CC2, vertical vent and combustion air kit.

1.4 Heat Reclaim Coil Schedule

Tag	HRC-1	PHC-1
Location	Downstream of W-796-EF	Inside of W-795-MAU
MAU served	W-795-MAU	W-795-MAU
Dimension (H x W), mm (in)	610 x 762 (24 x 30)	610 x 762 (24 x 30)
Air Data		
Flow, L/s (cfm)	1215 (2577)	1225 (2597)
EAT, db/wb, °C (°F)	23.9/13.5 (75.0/56.3)	-34.4 (-30.0)
LAT, db/wb, °C (°F)	4.6/4.2 (40.2/39.5)	-14.0 (6.8)
PD, Pa (in wg)	249 (1.0)	112 (0.45)
Capacity, kW (MBH)	30.2 (103)	30.2 (103)
Fluid Data		
Flow, L/s (gpm)	1.3 (20)	1.3 (20)
EWT, °C (°F)	-1.1 (30)	5.7 (42.3)
LWT, °C (°F)	5.7 (42.3)	-8.1 (17.4)
PD, kPa (in wg)	3.4 (13.7)	2.4 (9.6)
Fluid Type	50% E.G.	50% E.G.
Remarks		

1.5 Gas Fired Radiant Heater Schedule

Tag	W-792-RH	W-793-RH
Location	Rail Car Building	Rail Car Building
Service	Rail Car Building	Rail Car Building
Power Supply (V/Ph/Hz)	120/1/60	120/1/60
Gas Input, kW (MBH)	23.4 (80)	23.4 (80)
Reflected Tube Length, mm (ft)	12192 (40)	12192 (40)
Configuration	Straight - 45° Tilt	Straight - 45° Tilt
Manufacturer	Superior Radiant Products	Superior Radiant Products
Model No.	UA-80	UA-80

Notes:

1. All selections based on maximum 5 inches WC gas inlet pressure to appliance.

2. All units shall be complete with packaged wall mounted thermostat.

1.6 Tank Schedule

Tag	W-702-T-1	W-702-T-2	W-702-T-3	W-702-T-4
Service	DHW Storage	DHW Storage	DHW Storage	DHW Storage
Location	Rail Shelter	Rail Shelter	Chemical Building	Chemical Building
Type	Insulated	Insulated	Insulated	Insulated
Capacity, litres (USgal)	435 (115)	435 (115)	435 (115)	435 (115)
Diameter, mm (in)	718 (28.25)	718 (28.25)	718 (28.25)	718 (28.25)
Height, mm (in)	1505 (59.25)	1505 (59.25)	1505 (59.25)	1505 (59.25)
Manufacturer	Rheem	Rheem	Rheem	Rheem
Model	ST 120	ST 120	ST 120	ST 120
Accessories & Remarks				

Tag	GFT-1
Service	Glycol Fill
Location	Chemical Storage Building
Type	Storage Tank
Capacity, litres (USgal)	25 (6.6)
Width/Depth, mm (in)	300 (11.75)
Height, mm (in)	400 (16)
Manufacturer	Axiom
Model	MF200
Accessories & Remarks	SMW003 Tank Mounting Shelf

1.7 Pump Schedule

Tag	P-1	P-2	P-3
Function	DHW circulating pump	DHW circulating pump	DHW circulating pump
Location	Rail Car Shelter	Chemical Building	Chemical Building
Type	Inline circulating	Inline circulating	Inline circulating
Impeller	Noryl	Noryl	Glass Filled PPS
Casing	Bronze	Bronze	
Medium Pumped	Water	Water	50% Ethylene Glycol
Design Pressure, kPa (psi)	860 (125)	860 (125)	860 (125)
Maximum Operating Temp., ºC (ºF)	60 (140)	60 (140)	107 (225)
Pump Speed rpm			3250
Design Flow Rate, L/s (USgpm)	0.3 (5)	0.3 (5)	1.26 (20)
Discharge Head, kPa (ft wg)	14.9 (6)	14.9 (6)	105 (35.1)
Suction/Discharge Sizes, mm (in)	19 (0.75 FNPT)	19 (0.75 FNPT)	38 (1.5)
Motor Power, kW (hp)	0.02 (0.025)	0.02 (0.025)	0.3 (0.4)
Power Supply (V/ph/Hz)	120/1/60	120/1/60	120/1/60
Manufacturer	Taco	Taco	Bell & Gossett
Model	006-BT4-1	006-BT4-1	PL-55

1.8 Grilles, Registers and Diffusers Schedule

Tag	Manufacturer Model No.	Border/ Frame	Core	Module Size (mm)	Neck Size (mm)	Finish	Fastening	Remarks
SA-1	E.H. Price 620DAL	32mm Frame		N/A	Ref Dwgs	2	Counter-sunk screw	Front blades parallel to long dimension
EA-1	E.H. Price 630 DAL	750		N/A	Ref Dwgs	2	Counter-sunk screw	Front blades parallel to long dimension

Finishes: (Select Appropriate)

1. off-white baked enamel
2. Aluminum baked enamel
3. Aluminum prime coat
4. Brushed finish and clear acrylic coat
5. White baked enamel
6. White powder coat

LIST OF SCHEDULES

1.9 Louver Schedule

Tag	Manufacturer Model No.	Frame	Core	Size, mm (in) Width x Height	Capacity, L/s (cfm)	Free Area Vel., m/s (fpm)	ΔP, Pa (in)	Fast-ening	Finishes	Options
LV-A	Airolite 638C1004x	Drain-able	Drain-able	1400 x 1600 (56 x 64)	1975 (4185)	2.3 (450)	7.5 (0.03)	Mtg Angle	3,4	1,3
LV-B	Airolite 638C1004x	Drain-able	Drain-able	1400 x 1600 (56 x 64)	1975 (4185)	2.3 (450)	7.5 (0.03)	Mtg Angle	3,4	1,3
LV-C	Airolite 638C1004x	Drain-able	Drain-able	1200 x 1200 (48 x48)	1215 (2572)	2.3 (450)	7.5 (0.03)	Mtg Angle	3,4	1,3
LV-D	Airolite 638C1004x	Drain-able	Drain-able	1050 x 1050 (42 x 42)	1215 (2572)	3.0 (600)	7.5 (0.03)	Mtg Angle	3,4	1,3

Finishes:
(Select Appropriate)
1. Baked enamel
2. Duranar
3. Duranar XL
4. Match adjacent panelling

Options:
(Select Appropriate)
1. Formed metal sill
2. Aluminum insect screen
3. Aluminum bird screen
4. Removable access door

1.10 Domestic Hot Water Tank Schedule

Tag	W-702-HWT-1	W-702-HWT-2
Service	Rail Car Building	Chemical Storage Building
Location	Rail Car Building	Chemical Storage Building
Manufacturer	Rheem	Rheem
Model	EGS 85-9	EGS 85-9
Dimensions		
Capacity, litres (USgal)	372 (85)	372 (85)
Height, mm (in)	1465 (57.69)	1465 (57.69)
Diameter, mm (in)	718 (28.25)	718 (28.25)
Heat Input, kW (MBH)	9 (30.7)	9 (30.7)
Recovery Rate, L/hr (USgph)	227 (60)	227 (60)
Electrical (V/ph/Hz)	600/3/60	600/3/60
Remarks		

LIST OF SCHEDULES

1.11 Variable Frequency Drive Schedule

Tag	W-796-VFD
Service	W-796-EF
Driven Motor, kW (hp)	1.1 (1.5)
Power Supply (V/ph/Hz)	600/3/60
Manufacturer	See Section 16815
Model No.	11

END OF SECTION

ELECTRICAL GENERAL REQUIREMENTS

1. GENERAL

1.1 Work Included

.1 Complete and operational electrical system as required by the Drawings and as herein specified.

1.2 Related Work

.1 General Requirements: Division 1

.2 Site Work: Division 2

.3 Concrete: Division 3

.4 Process: Division 11

.5 Mechanical: Division 15

1.3 Drawings and Specifications

.1 The General Conditions, Supplementary Conditions, and Division 1 are a part of this Specification and shall apply to this Division.

.2 The intent of the Drawings and Specifications is to include all labour, Products, and services necessary for complete Work, tested and ready for operation.

.3 Symbols used to represent various electrical devices often occupy more space on the Drawing than the actual device does when installed. In such instances, do not scale locations of devices from electrical symbols. Install these devices with primary regard for usage of wall space, convenience of operation, and grouping of devices.

.4 These Specifications and the Drawings and Specifications of all other divisions shall be considered as an integral part of the accompanying Drawings. Any item or subject omitted from either the Specifications or the Drawings but which is mentioned or reasonably specified in and by the others, shall be considered as properly and sufficiently specified and shall be provided.

.5 Provide all minor items and Work not shown or specified but which are reasonably necessary to complete the Work.

.6 If discrepancies or omissions in the Drawings or Specifications are found, or if the intent or meaning is not clear, advise the Contract Administrator for clarification before submitting Bid.

.7 Responsibility to determine which Division provides various Products and Work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of Specifications.

1.4 Quality Assurances

.1 Codes, Rules, Permits, and Fees

.1 Comply with all laws, ordinances, rules, regulations, codes, and orders of all authorities having jurisdiction relating to this Work.

.2 Quality of Work specified and shown on the Drawings shall not be reduced by the foregoing requirements.

.3 Immediately after award of Contract and prior to installation, verify location, arrangement and point of attachment for service and service entrance equipment with supply authority and inspection departments. Failure to do so will render this Division responsible for any corrections necessary without additional compensation.

.4 Give all required notices, submit Drawings, obtain all permits, licences and certificates and pay all fees required for this Work.

.5 Furnish a Certificate of Final Inspection and approvals from inspection authority to the Contract Administrator.

.2 Standard of Workmanship:

.1 Execute all Work in a competent manner and to present an acceptable appearance when completed.

.2 Employ a competent supervisor and a sufficient number of licensed tradesmen to complete the Work in the required time.

.3 Arrange and install Products to fit properly into designated building spaces.

.4 Unless otherwise specified or shown, install Products in accordance with recommendations and ratings of Manufacturers.

1.5 Submittals

.1 Within 30 days of award of Contract, the Contractor shall submit a completed equipment procurement schedule, which lists the Manufacturer and model of equipment, indicating the projected ordering, Shop Drawing submittal date and delivery dates of all Products to meet the required construction schedule.

.2 Submit samples as required where specified in Division 16.

.3 Prior to delivery of any Products to job Site and sufficiently in advance of requirements to allow ample time for checking, submit Shop Drawings for review as specified in Division 1. Submit Shop Drawings for all equipment as required in each Section of this Specification.

.4 Prior to submitting the Shop Drawings to the Contract Administrator, the Contractor shall review the Shop Drawings to determine that the equipment complies with the requirements of the Specifications and Drawings.

.5 The term "Shop Drawing" means drawings, diagrams, illustrations, schedules, performance characteristics, brochures and other data, which are to be provided by the Contractor to illustrate details of a portion of the Work.

Indicate materials, methods of construction and attachment of support wiring, diagrams, connections, recommended installation details, explanatory notes and other information necessary for completion of Work. Where equipment is connected to other equipment, indicate that such items have been coordinated, regardless of the section under which the adjacent items will be supplied and installed. Indicate cross-references to Design Drawings and Specifications.

Adjustments made on Shop Drawings by the Contract Administrator are not intended to change the contract price. If adjustments affect the value of the Work state such in writing to the Contract Administrator prior to proceeding with the Work.

.6 Manufacture of Products shall conform to revised Shop Drawings.

.7 Keep one (1) complete set of Shop Drawings at job Site during construction.

1.6 Record Drawings

.1 The Contractor shall keep one (1) complete set of white prints at the Site office, including all addenda, change orders, Site instructions, clarifications, and revisions for the purpose of Record Drawings. As the Work on-site proceeds, the Contractor shall clearly record in Red Pencil all as-built conditions, which deviate from the original Contract Documents. Record Drawings to include circuiting of all devices, conduit and feeder runs (complete with conductor size and number) and locations of all electrical equipment.

.2 Prior to substantial performance, the Contractor shall obtain CAD files of all electrical Drawings, using AutoCAD Release 2000i, and use the services of a competent CAD operator to transfer all as-built information, including: Addenda, Change Orders, Clarifications, Revisions, Site Instructions and Shop Drawings. Upon completion, the Contractor shall certify, in writing, that the As-built Record Drawings are complete and that they accurately indicate all electrical services, including exposed as well as concealed items.

.3 On completion of the Work, two (2) weeks prior to final inspection, submit Record Drawings to Contract Administrator for review.

.4 Within one (1) month after return of Record Drawings by the Contract Administrator, obtain and pay for a complete set of original reproducible sepias. Transfer all changes from Record Drawings to electronic Drawings (AutoCAD) and certify accuracy. Deliver electronic Drawings to the Contract Administrator.

1.7 Operation and Maintenance Manuals

.1 All maintenance manual data shall be submitted in an electronic format in accordance with the requirements of Division 1.

.2 Within thirty (30) days prior to substantial performance, the Contractor shall submit a draft copy of the proposed contents of each maintenance manual to the Contract Administrator for review. Once the draft copy is approved, the Contractor will supply four (4) copies in electronic format in accordance with the requirements of Division 1 Final copies of manuals to be received by Contract Administrator not less than seven (7) days prior to substantial performance.

.3 Each section of the manual shall contain the following information:

.1 Systems Descriptions. A brief synopsis of each system typed and inserted at the beginning of each section. Include sketches and diagrams where appropriate.

.2 Descriptive and technical data

.3 Maintenance and operating instructions for all electrical equipment and controls. (These operating instructions need not be Manufacturer's data but may be typewritten instructions in simple language to guide the City in the proper operation and maintenance of his installation.)

.4 Lubricating and servicing intervals recommended.

.5 A copy of all wiring diagrams complete with wire coding.

.6 List of spare parts of all electrical equipment complete with names and addresses of sales, service representatives and suppliers.

.7 Copy of test data

.8 A motor list showing each motor number, name, horsepower, full load amps, overload settings, nameplate, current rating, heater size and type, and current being drawn, on the form specified in Section 16970.

.9 Include type and accuracy of instruments used to obtain test data.

.10 Copy of final inspection certificate

.11 Copy of the purchase order, showing equipment make and model numbers issued to the Manufacturer complete with all addenda. All cost details may be hidden.

.12 Copy of all warranty certificates

.13 Set of final reviewed Shop Drawings

.14 Names, addresses, phone numbers, and facsimile numbers of Contractor, Contract Administrators, Sub-contractors and suppliers used on the Work together with a Specification reference of the portion of the Work they undertook.

1.8 Product Handling

.1 Use all means necessary to protect the Products of this Division before, during and after installation and to protect Products and installed Work of all other trades.

.2 Immediately make good any damage by repair or replacement at no additional cost to the City and to the approval of the Contract Administrator.

.3 Remove advertising labels from all electrical equipment. Do not remove identification of certification labels.

.4 Remove dirt, rubbish, grease, etc., resulting from this Work from all surfaces, including the inside of all cabinets, equipment enclosures, panelboard tubs, etc.

1.9 Alternate and Separate Prices

.1 In accordance with the Instructions to Bidders, state on the Bid Form in the space provided, the amount to be added or deleted from the base bid tender amount for the use and installation of equipment as an alternate to those specified.

1.10 Guarantee

.1 Furnish a written guarantee to the City prior to final contract payment, which will be in effect for one (1) year from the date of final acceptance of the complete Work. Replace or repair at no cost to the City any defective material or workmanship except where, in the opinion of the Contract Administrator, such defects are due to the misuse or neglect by the City.

.2 This general guarantee shall not act as a waiver of any specified or special equipment guarantees, which cover a greater length of time.

1.11 Progress Claims

.1 Within thirty (30) days after award of Contract, a breakdown of material and equipment items including labour and expense components shall be compiled on the consultant format. Subsequent request for payment shall be documented accordingly.

2. PRODUCTS

2.1 Selected Products and Equivalents

.1 Products and materials provided shall be new and free from all defects. Defective Products or materials will be rejected, regardless of previous inspections. The Contractor shall be responsible to remove and replace defective Products at their expense, and shall be

responsible for any resulting delays and associated expenses, which result from defective Products being rejected. Related materials shall be of the same Manufacturer throughout the project.

.2 Products and materials referred to in the Specifications by trade names, Manufacturer's name and catalogue reference are those, which shall be used as the basis for the Bid.

.3 The design has been based on the use of the specified Product.

2.2 Quality of Products

.1 All Products provided shall be CSA Approved, Canadian Underwriters' Laboratory (UL) approved where applicable, and new, unless otherwise specified.

.2 If Products specified are not CSA approved, obtain special approval from the local regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

.3 Products provided, if not specified, shall be new, of a quality best suited to the purpose required and their use subject to approval by the Contract Administrator.

2.3 Uniformity of Manufacture

.1 Unless otherwise specifically called for in the Specifications, uniformity of manufacture shall be maintained for similar Products throughout the Work.

2.4 Product Finishes

.1 Finish all cabinets, panelboards, switchboards, equipment cabinets, cable trays, etc., in American National Standards Institute (ANSI) 61 grey enamel unless otherwise specified.

.2 Apply primer on all items, which are to be finished on the job.

.3 Touch up all damaged painted finishes with matching lacquer, or, if required by the Contract Administrator, completely repaint damaged surface.

2.5 Use of Products during Construction

.1 Any equipment used for temporary or construction purposes shall be approved by the Construction Manager and in accordance with the General Conditions, "Use of Premises." Clean and restore to "as new" condition all equipment prior to the time of substantial completion.

.2 The warranty period shall not begin until the date of Substantial Performance of the Work.

2.6 Non-Specific Date/Time Compliance

.1 All equipment, hardware, software and firmware (for the purposes of this clause, the "Product") delivered or deliverables resulting from any services provided are fully Date

Compliant and the Product will not adversely or materially effect the daily business operations as a result of a date related computer problem (for the purposes of this clause number the "Warranty"). Date Compliant means that the Product accurately and correctly processes and stores date/time data (including, but not limited to, calculating, comparing, displaying, recording and sequencing operations) including year, century and leap year calculations.

.2 Provide documentary proof of Date Compliance prior to substantial completion listing all equipment and certifying their compliance.

.3 Notwithstanding any other remedy available under this agreement or at law for breach of the Warranty, any Product that is not Date Compliant shall, within 24 hours of receipt of notice of the breach, be repaired or replaced at the Contractor's sole cost and expense, including parts, labour, transportation and insurance, so as to correct any failure to meet the Warranty.

3. EXECUTION

3.1 Site Examination

.1 Examine the Site of Work and become familiar with all features and characteristics affecting this Work before submitting Bid.

.2 No additional compensation will be given for extra Work due to existing conditions, which such examination should have disclosed.

.3 Report to the Contract Administrator any unsatisfactory conditions, which may adversely affect the proper completion of this Work.

3.2 Location of Outlets and Luminaires

.1 Electrical Drawings are, unless otherwise indicated, drawn to scale and approximate distances and dimensions may be obtained by scaling. Figured dimensions shall govern over scaled dimensions. Where exact dimensions and details are required, refer to Architectural and Structural Drawings.

.2 Outlet and equipment locations shown on the Drawings are approximate. Locations may be revised up to 3 m to suit construction and equipment arrangements without additional cost to the City, provided that the Contractor is notified prior to the installation of the outlets, or equipment.

.3 Maintain luminaire locations wherever possible. Notify the Contract Administrator of conflicts with other services.

.4 Unless otherwise specified or shown, install Products in accordance with recommendations and ratings of Manufacturers.

3.3 Separation of Services

.1 Maintain separation between electrical wiring system and building piping, ductwork, etc., so that wiring system is isolated (except at approved connections to such systems) to prevent galvanic corrosion.

.2 In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is not permitted.

.3 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings shall not be used for the support of wiring.

3.4 Equipment Identification

.1 3 mm thick plastic lamicoid name plates, black face, white core, mechanically attached with self tapping screws, to be attached to the front face of the following equipment:

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

.1 Distribution Centres (indicate designation, bus capacity, voltage)

.2 MCCs (designation, voltage)

.3 Starters, contactors, disconnects (designation, voltage, load controlled)

.4 Panelboard (designation, voltage, bus capacity)

.5 Automatic transfer switch (designation, voltage, rating)

.6 Terminal cabinets and pull boxes (system, voltage)

.7 Transformers (designation, capacity, primary and secondary voltage)

.2 Color code exposed conduits (including conduits above T-bar ceilings), junction and pull boxes, and metallic sheathed cables with paint or plastic tape (25 mm wide band) at 15 m intervals. Color coding to be as follows:

SYSTEM	MAJOR BAND	MAJOR BAND
High Voltage	Yellow	Purple
347/600 V Normal	Dk. Blue	
120/208 V Normal	Lt. Blue	
UPS System	Lt. Blue	White
Fire Alarm System	Red	
Communication Circuits	Black	Yellow

.3 Provide neatly typed circuit directories in panelboards to indicate the area or equipment controlled by each branch circuit.

.4 All conductors shall be identifiable by coloured insulation and permanent markers at every terminal and accessible points throughout its entire run.

Conductors:

Equipment Grounding – Green
Neutral Conductor – White

347/600 Volt System	277/480 Volt System
Phase A – Orange	Phase A – Orange/Black
Phase B – Brown	Phase B – Blue/Black
Phase C – Yellow	Phase C – Black/White

120/208 Volt System
Phase A – Red
Phase B – Black
Phase C – Blue

3.5 Wiring to Equipment Supplied by Others

.1 Others will move equipment supplied by the City or under other Divisions to the installation Site. However, this Division shall do the electrical connection to the equipment.

3.6 Testing

.1 Refer to Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

3.7 Instructions to City's Personnel

.1 Refer to Section 16990 - Electrical Equipment and Systems Demonstration and Instruction.

3.8 Access Panels

.1 Where electrical equipment, junction boxes, remote ballasts or the like are concealed, access panels shall be supplied. Panels shall be of adequate size for servicing of the electrical Work and complete with necessary frames and hinged doors held closed with captive fasteners. Coordinate type and size of panels with the Contract Administrator.

.2 In removable ceiling areas, provide markers on ceiling tile to locate equipment requiring access. Markers shall be of a type approved by the Contract Administrator.

3.9 Mounting Heights

.1 Unless a conflict exists, use the following as mounting heights from finished floors to centre of device.

Thermostats	1,400 mm
Panelboards, starters, and disconnects (to top of cover)	2,000 mm
End of line resistors	1,800 mm
Receptacles	1,400 mm
Light Switches	1,400 mm
Fire Alarm Manual Stations	1,400 mm
Fire Alarm Bells	2,100 mm
Telephone outlet	1,400 mm

3.10 Sealing of Wall and Floor Openings

.1 All conduit and cable entries through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade shall be sealed to prevent passage of moisture, dust, gasses, flame, or to maintain pressurization.

.2 Openings shall be sealed when all wiring entries shown on the Drawings have been completed.

.3 Sealing material shall be fire resistant and shall not contain any compounds, which will chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations to be sealed.

3.11 Housekeeping Pads

.1 All floor mounted electrical equipment installed by this Division shall be mounted on concrete housekeeping pads that, unless otherwise noted, shall be the responsibility of the Contractor.

.2 The Contractor shall determine the extent of the housekeeping pads required and supply all information and details as to size and locations to the Contract Administrator within thirty (30) days after the award of Contract.

3.12 Sleeves

.1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.

.2 For wall, partitions, and ceilings the ends shall be flush with the finish on both sides but for floors they shall extend 100 mm above finished floor level.

.3 The space between the sleeve and the conduit shall be filled with Dow Corning silicone room temperature vulcanizing (RTV) foam for fire stop and caulked around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound. Ensure that the seal is compatible with the floor and ceiling finishes.

.4 Locate and position sleeves exactly prior to construction of walls, floors.

.5 Failure to comply with the above requirements shall be remedied at this Division's expense.

3.13 Temporary Lighting and Power

.1 Provide grounded extension cords and temporary lights as required for electrical Work.

.2 Coordinate with General Contractor for obtaining temporary power service.

.3 If City’s operations will be affected by any power outage required for this Work, give adequate notice to the City and do not interrupt power until approval has been obtained.

.4 Give adequate notice to Contractor of any power outage required for this Work. Schedule outages to provide least interference with other Work.

3.14 Insulation Resistance Testing

.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

.3 Check resistance to ground before energizing.

.4 Carry out tests in presence of the Contract Administrator.

.5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.6 Submit test results for the Contract Administrator’s review.

3.15 Load Balance

.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes (maximum deviation of 15 percent).

.2 Measure phase voltages at loads and adjust transformer taps to within 2 percent of rated voltage of equipment.

.3 Submit, at completion of Work, report listing phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

END OF SECTION

SCOPE OF ELECTRICAL WORK

1. GENERAL

.1 Supply and Install all material, equipment, wiring and labour necessary for the installation of the systems detailed on the Drawings in accordance with the latest edition of the Canadian Electrical Code.

2. WORK INCLUDED

2.1 Related Work

.1 The Administrative Sections under Division 0 (Bidding and Contract Requirements) and 1 (General Requirements) shall be considered to be part of these Specifications.

2.2 General Requirements

.1 General Clean up

.2 All inspection and obtaining all permits, licenses required by various Inspection Agencies and local regulations related to Electrical Trade.

.3 Scaffolding

.4 Shop Drawings

.5 Project Record Documents (As-built Drawings) where specified

.6 Operating and Maintenance (O&M) Data, where specified

2.3 Specific Requirements Included But Not Limited to Scope of Work

.1 Provide a new 600 V 150A-3P breaker to be installed in existing Sludge Dewatering MCC-2WB, cell No. 4, lower MCC cell space. Breaker shall be complete with MCC wrapper suitable for a size 1 space. Provide a new MCC door over breaker compartment. Existing equipment is a Westinghouse 5 Star MCC. Breaker shall be of the same manufacture as the existing breakers with the same fault current rating.

.2 Provide a new 3/C No. 1/0 from new MCC breaker, through floor to room below the Sludge Dewatering Electrical Room, through the exterior wall of the Dewatering building and into the new Chemical Building. Connect to new 600 V panel, main lugs, in Chemical Building.

.3 Provide a new 600 V 3 phase 225 amp panel (P100), a new 30 kVA transformer (600 V-120/208 V 3 phase 4-wire) and a new 120/208 V 3 phase 4-wire panel in new Chemical Building. Provide and sub electrical service to the new Railcar Shelter from Panel P-100.

.4 Provide a new 600V panel in the Railcar Shelter (P-200). This panel is fed from a 600 V breaker in panel P-100. Provide a 30 kVA transformer (600 V-120/208 V 3 phase 4-wire), and a 120/208 V 3 phase 4-wire panel in Railcar Shelter

.5 Provide all wiring, cable, and conduit for all mechanical equipment for the Chemical Building and the Railcar Shelter.

.6 Provide all lighting, lighting controls, and general power as specified herein and indicated on the drawings.

.7 Provide welding outlets (one in Chemical Building and one in the Railcar Shelter) to accommodate portable welders as shown on the drawings and herein specified. New outlets shall match existing plant welding outlets.

.8 Provide disconnects switches at equipment where required.

.9 Extending existing grounding system in the Sludge Dewatering Building to the new Chemical Building and the new Railcar Shelter. All grounding shall comply with the Canadian Electrical Code and local amendments to this code.

.10 Install existing light standard as indicated on the drawings. Connect relocated lighting standard to existing, undisturbed, light standards to complete circuit.

2.4 Demolition

.1 Remove existing light standard and turn over to City .

2.5 Additional Requirements

.1 Provision of all necessary testing, detailed wiring continuity checks, wiring completion checks, installation integrity checks, functional equipment operation checks and written system verification reports to provide a complete system that is ready for commissioning and startup (refer also to Section 16980).

.2 Provision of commissioning and startup of all systems included in the Scope of Work.

2.6 Materials

.1 Bus systems including all forms of buses integral with the electrical power system, together with their associated insulation, supports, bus ducts, and protective devices.

.2 Conductors, including all types of wires, conductors, cables, which form an integral part of the electrical power system.

.3 Cables and bus support systems, which are intended to enclose or support all forms of electrical conductors used for any purpose covered by this scope. This includes cable trays, raceways and all forms of rigid, flexible, metallic and non-metallic conduit, and including conduit for communication systems or others, which may be installed at a later date, or buried conduit for wiring work by others, only when such buried conduit is indicated in the Contract Documents.

.4 Control panels associated with any electrical equipment covered under this Section of Work.

.5 Circuit breakers of all types and for all applications associated with electrical equipment, which receives its power supply from the main, auxiliary or emergency (including battery) system.

.6 Grounding systems, as required by the Canadian Electrical Code, or as otherwise specified in the bid documents.

.7 Control and instrumentation systems – electrical or electronic including high frequency, ultra high frequency and microwave control and instrumentation systems, with auxiliary equipment and components, unless specified otherwise.

.8 Transformers of various types, dry, encapsulated, etc., and for all applications, except control transformers supplied with Mechanical Equipment included in Division 15.

.9 Electronic data processing and transmission systems, including auxiliary equipment, interface, and components.

3. WORK EXCLUDED

3.1 Work Excluded

.1 Special starters, including multi-speed switches, which are associated with packaged units not detailed in the Electrical Specifications

.2 Perforations through roofing materials for electrical servicing or attachments (Division 7)

.3 Painting (on-site), except touch-up of electrical equipment (Division 9)

.4 Ducted fans (Division 15)

.5 Ducted heaters (Division 15)

.6 Pneumatic tube systems (Division 15)

.7 Control transformers supplied with Mechanical Equipment (Division 15)

.8 All control wiring between equipment supplied by Division 15 HVAC system will be performed by Division 17.

4. UNITS OF MEASUREMENT

4.1 General

.1 The Contract Documents have been prepared using the modified International System (SI) units of metric measurement. Whenever appropriate, available metric Products shall be used unless otherwise specified herein.

.2 Only metres (m) and millimetres (mm) are used. Generally, metres are used for measurements of 10 m or more, and millimetres for measurements less than 10 m.

.3 All measurements on Drawings are in millimetres unless otherwise indicated.

4.2 Conversions

.1 The following three (3) conversion methods were used in Product and location dimensions:

.1 Hard conversion: industry available Products which are manufactured in metric measurements

.2 Soft conversion: products, which are still manufactured in Imperial units and are converted in Specifications using arithmetic conversion factors

.3 Rationalized conversion: dimensions which are soft converted and rounded off for ease of measurements

.2 In cases where measurements may be open for interpretation, dual dimensions have been incorporated until hard conversions can be used exclusively.

5. DEFINITIONS

5.1 General

.1 All terminologies, abbreviations and acronyms used in this document are as listed in the various Standards, Codes, Rules, and Bulletins used herein.

6. FORMAT

6.1 Practice

.1 This Scope of Work has been written to conform to the Manitoba Construction Association Bid Depository Rules and Procedures and Scope of Work.

6.2 Sections

.1 The Sections are written in a three-part format: General, Products, and Execution.

6.3 Reference

.1 Imperative tense has been used throughout this Document for Work intended for the successful Contractor. There shall be no Work exclusions unless they have been clearly identified as such herein.

.2 The word "provide" shall mean "supply and install" unless otherwise indicated.

7. CODES

7.1 General

.1 All Codes, Standards, Rules, Regulations, Bulletins, By-laws, etc., shall be those that are currently enforced in the locality of job Site, unless otherwise specified herein.

END OF SECTION

INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS

1. GENERAL

1.1 Related Work

.1 Excavation and Backfilling: Division 2

2. PRODUCTS

2.1 Cable Protection

.1 Provide 600 x 600 x 50 concrete patio blocks above directed buried duct banks. Patio blocks are to be colored RED for identification.

2.2 Markers

.1 Concrete type cable markers: 600 x 600 x 100 mm with words: “cable”, “joint”, or “conduit” impressed in top surface, with arrows to indicate change in direction of cable and duct runs.

3. EXECUTION

3.1 Direct Burial of Cables

.1 After sand bed specified in Division 2 is in place, lay cables maintaining 75 mm clearance from each side of trench to nearest cable. Do not pull cable into trench.

.2 Provide offsets for thermal action and minor earth movements. Offset cables 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.

.3 Make termination and splice only as indicated leaving 0.6 m of surplus cable in each direction.

.1 Make splices and terminations in accordance with Manufacturer’s instructions using approved splicing kits.

.4 Underground cable splices not acceptable.

.5 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable; for metallic armoured cables, 12 times diameter of cables or in accordance with Manufacturer’s instructions.

.6 Maintain 75 mm minimum separation between cables of different circuits. Maintain 300 mm horizontal separation between low and high voltage cables. When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position. At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables. Maintain 300 mm minimum lateral and vertical separation for fire alarm and control, cables when crossing

other cables, with fire alarm and control cables in upper position. Install treated planks on lower cables 0.6 m in each direction at crossings.

.7 After sand protective cover specified in Division 2 is in place, install continuous row of concrete patio as indicated to cover length of run.

3.2 Cable Installation in Ducts

.1 Install cables as indicated in ducts.

.2 Do not pull spliced cables inside ducts.

.3 Install multiple cables in duct simultaneously.

.4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.

.5 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.

.6 Before pulling cable into ducts and until cables properly terminated, seal ends of lead covered cable with wiping solder; seal ends of non-leaded cables with moisture seal tape.

.7 After installation of cables, seal duct ends with duct sealing compound.

3.3 Markers

.1 Mark cable every 150 m along cable or duct runs and changes in direction.

.2 Where markers are removed to permit installation of additional cables, reinstall existing markers.

.3 Install concrete patio type markers.

.4 Lay concrete markers flat and centered over cable with top flush with finish grade.

3.4 Field Quality Control

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Perform tests using qualified personnel. Provide necessary instruments and equipment.

.3 Check phase rotation and identify each phase conductor of each feeder.

.4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.

.5 Pre-acceptance test

.1 After installing cable but before splicing and terminating, perform insulation resistance test with 5000 V megger on each phase conductor.

.2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.6 Acceptance Tests

.1 Ensure that terminations and accessory equipment are disconnected.

.2 Ground shields, ground wires, metallic armour, and conductors not under test.

.3 High Potential (Hipot) Testing

.1 Conduct Hipot testing at 200 percent of original factory test voltage in accordance with Manufacturer's or IPCEA recommendations.

.4 Leakage Current Testing

.1 Raise voltage in steps from zero to maximum values as specified by IPCEA Manufacturer for type of cable being tested.

.2 Hold maximum voltage for specified time period by IPCEA or Manufacturer.

.3 Record leakage current at each step.

.5 Provide Contract Administrator with list of test results showing location at which each test was made, circuit tested and result of each test.

.6 Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

1. GENERAL

1.1 Work Included

.1 Provide a complete system of conduit and fittings for installation of wiring.

2. PRODUCTS

2.1 Rigid Steel Conduit

.1 Galvanized with threaded joints and connections.

.2 Connections in dry locations: steel or malleable iron locknuts inside and outside enclosures. Insulated bushings Thomas & Betts Series 222 or approved alternate.

.3 Connectors subjected to moisture interior and exterior: liquid and dust tight with insulated throat, Thomas & Betts "Bullet Hub" 370 Series or approved alternate.

.4 Fittings: cast metal "Condulet" as manufactured by Crouse-Hinds Canada Ltd. including gasketted covers in damp locations.

.5 Expansion joints: cast metal Crouse-Hinds type XJ or approved alternate.

2.2 Flexible Conduit

.1 Connectors: slip-proof, insulated throat or non-metallic bushings, steel, Thomas & Betts Ltd. "Tite-Bite", Series 300

2.3 Liquid-Tight Flexible Conduit

.1 Conduit: Flexible metal conduit with liquid-tight PVC jacket. Industrial Wire & Cable "Liquiseal".

.2 Connectors: Captive sealing jacket and ground cone insulated throat, steel (Thomas & Betts Ltd. "Super-Tight", Series 6000).

3. EXECUTION

3.1 Rigid Steel Conduit

.1 Use as raceways for following applications:

.1 In all areas exposed to weather

.2 In all areas where Teck cable is not used

.3 For all fire alarm circuits and related wiring

.4 For all lighting and receptacle power distribution

.5 For all computer communication wiring

3.2 Flexible Conduit

.1 Use as raceways for following applications:

.1 Connections to motors in dry locations

.2 Flexible connections to luminaries

.2 Provide a separate insulated ground wire in all flexible conduits.

3.3 Liquid-Tight Flexible Conduit

.1 Use as raceways for following applications:

.1 At all motors, pipe mounted control devices, and other devices subject to movement or water.

.2 At all motors provide a short length before connecting to the motor terminal box. Minimum length shall be 450 mm plus four (4) times the conduit diameter.

.3 Provide a separate ground wire within flexible conduit, bonded to motor frames and system ground.

3.4 Workmanship

.1 Install all conduit and wiring concealed, unless otherwise shown on the Drawings. Do not recess conduit in columns, except as noted, without permission.

.2 Where conduit is run exposed, run parallel to building lines. Where conduits are grouped two or more, space evenly, make bends concentric and mount on Unistrut racks.

.3 Lay out conduit to avoid interference with other Work. Maintain a minimum clearance of 150 mm from steam or hot water piping, vents, etc.

.4 Organize conduit in slabs to minimize crossovers.

.5 Where conduits or ducts enter or exit concrete structures below grade provide 16 mm x 1500 mm steel reinforcing dowels to prevent shearing. Extend dowel 1000 mm beyond concrete and band conduit to dowel. The first 3 m length of conduit extending from the structure to be Polykin wrapped rigid steel.

.6 Where steel conduit is required to be bent, do not heat, and do not bend conduit in such a way as to reduce pipe cross Section area at any point. Radii of bends shall be as per Canadian Electrical Code.

.7 For all runs of conduits, do not include more than equivalent of four (4) quarter bends. Provide conduit fittings, pullboxes and junction boxes where necessary. Pulling elbows shall not be used except by special permission.

.8 Where possible, install conduits so that they are not trapped, cap turned up conduits to prevent the entrance of dirt of moisture during construction. Swab out conduit and thoroughly clean internally before wires and cables are pulled.

.9 Take extreme care in reaming ends of all conduits to ensure a smooth interior finish that will not damage the insulation of the wires.

.10 Use insulated non-metallic bushings on all conduit terminations.

.11 Ensure electrical continuity in all conduit systems.

.12 All conduits shown exposed in finished areas is to be free of unnecessary labels and trade marks.

.13 Install a 90 lb. test line in all conduits left empty by this Contractor including those which others will pull cables, wires, etc.

.14 Conduits and ducts crossing building expansion joints shall have conduit expansion fittings to suit the type of conduit used, and shall be Crouse-Hinds, Sceptre, or approved fitting.

.15 Seal conduits with duct seal where conduits are run between heated and unheated areas. Where conduits, cables, or cable trays pierce fire separations, seal openings with Dow Corning 3-6548 sealant or approved equal.

.16 Where conduits pass through walls, they shall be grouped and installed through openings. After all conduits shown on the Drawings are installed, wall openings shall be closed with material compatible with the wall construction. Review size and quantity of conduit sleeves with the Contract Administrator.

.17 Where Drawings show conduit designations, these conduits shall be identified at each point of termination with Thomas & Betts "Ty-Rap" No. TY532M labels.

.18 Where conduit finish is damaged, repair or replace.

.19 Use "Condulet" fittings for power and telephone type conduit terminations in lieu of boxes where support is not provided.

.20 All branch circuit wiring, home runs, communication and data to be minimum 20 mm diameter unless otherwise stated.

.21 Provide necessary flashing and pitch pockets, making watertight joints where conduits pass through roof or watertight membranes.

.22 Where panel board branch circuit conduits are amalgamated, size shall not exceed 25 mm diameter.

END OF SECTION

WIREWAYS AND AUXILIARY GUTTERS

1. GENERAL

1.1 Description

.1 Supply and install wireways and auxiliary gutters and fittings as a means for flexible wiring system.

.2 All wireways and gutters to be two-piece with removable cover to provide access to wiring.

.3 Wireways, auxiliary gutters, and fittings are based on CSA CSS.2, No. 26.

1.2 Submittals

.1 Submit Shop Drawings in accordance with Section 16010 - Electrical General Requirements.

2. PRODUCTS

2.1 Wireways

.1 Sheet steel with bolted cover to give uninterrupted access.

.2 Finish: based gray enamel

.3 Elbows, tees, couplings and hanger fittings manufactured as accessories to wireway supplied.

3. EXECUTION

3.1 Installation

.1 Install wireways and auxiliary gutters.

.2 Keep number of elbows, offsets, and connections to minimum.

.3 Install supports, elbows, tees, connectors, and fittings.

.4 Install barriers to separate different voltages or to separate different systems.

.5 Install gutter to full length of equipment.

END OF SECTION

WIRES AND CABLES 0 - 1000 V

1. GENERAL

1.1 Work Included

.1 Provide a complete system of wiring, making all connections necessary for the installation shown on Drawings.

1.2 References, Codes and Standards

.1 CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.

.2 Install and rate power cables in accordance with the CEC requirements.

1.3 Product Data

.1 Submit Product data in accordance with Section 16010 – Electrical General Requirements.

2. PRODUCTS

2.1 Building Wires

.1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.

.2 Copper conductors: size as indicated, with 600 V insulation of chemically cross-linked thermosetting polyethylene (XLPE) material rated RW90.

2.2 Teck Cable

.1 Conductors:

.1 Grounding conductor: copper

.2 Circuit conductors: copper, size as indicated

.2 Insulation:

.1 Type: ethylene propylene rubber

.2 Chemically XLPE rated type RW90, 1000 V

.3 Inner jacket: polyvinyl chloride material

.4 Armour: interlocking aluminum

.5 Overall covering: thermoplastic polyvinyl chloride material

.6 Fastenings:

.1 One-hole malleable iron straps to secure surface cables 50 mm and smaller. Two-hole steel straps for cables larger than 50 mm.

.2 Channel type supports for two or more cables at 1500 mm centers

.3 6 mm diameter threaded rods to support suspended channels

.7 Connectors:

.1 Watertight, approved for TECK cable

2.3 Control Cables

.1 Single conductor wire to be 98 percent conductivity copper type TEW or TBS insulation rated at 600 V, solid or stranded conductor as required, size as noted on Drawings and specified herein, 90^0C insulation and manufactured to CSA Specification C22.2, No. 38.

.2 Cable for power and control shall be based on Teck 90 armoured cable, with stranded copper conductors, 90^0C insulation, rated at 600 V ac, manufactured to CSA Specification C22.2, No. 131, integral copper ground wire, PVC inner jacket, aluminum interlocking armour, and PVC outer jacket having heat, flame, and moisture retardant properties. Flame retardancy of outer jacket to be rated in accordance with CSA Standard C22.2, No. 0.3.

.3 Analog instrumentation cable shall use single or multiple pair, seven (7) strand copper conductor, individually twisted and shielded, individual tinned copper drain wire, complete electrical isolation between shields, overall multi-conductor cable shield with drain wire, XLPE inner jacket, interlocking aluminum armour, and FT4 flame retardant rated outer PVC jacket. Cable to be manufactured to CSA Specifications C22.2, No. 239 and CSA, No. 38 and shall be provided with a black, white, colour code and number code for each pair. Cable and conductor insulation to be rated for 105^0C (dry) and 600 V. Conductor size shall be minimum No. 16 AWG or as noted on the Drawings. Standard of acceptance shall be Shawflex 69 series instrumentation and control cable.

3. EXECUTION

3.1 General

.1 Minimum conductor size No. 12 AWG except for luminaire drops which can be No. 14 AWG if fed from 15A circuits.

3.2 Installation of Building Wires

.1 Install wiring as follows:

.1 In conduit systems in accordance with Section 16111

.2 In cabletroughs in accordance with Section 16114

.3 In wire ways and auxiliary gutters in accordance with Section 16116

3.3 Installation of Teck Cable 0 - 1000 V

.1 Install cables.

.2 Group cables wherever possible on channels.

.3 Lay cable in cabletroughs in accordance with Section 16114.

.4 Terminate cables in accordance with Section 16151 – Wire and Box Connectors – 0 – 1000 V.

3.4 Installation of Control Cables

.1 Install control cables in conduit or cable troughs.

.2 Ground control cable shield at one end only. Shields to be continuous over entire run.

3.5 Workmanship

.1 Before pulling wire, ensure conduit is dry and clean. If moisture is present, thoroughly dry out conduits; vacuum if necessary. To facilitate pulling, recognized specially manufactured wire pulling lubricants may be used. Do not use grease. Employ suitable techniques to prevent damage to wire when ambient temperature is below the minimum permitted for each insulation type. Do not pull wires into incomplete conduit runs.

.2 Installation to be free of opens and grounds. Before energization, measure insulation resistance and comply with the Canadian Electrical Code. Submit data sheet with values measured.

.3 Do not install any conductor smaller than No. 12 AWG, except where specifically indicated otherwise, i.e., for fire alarm system station circuits, P.A. wiring, etc.

.4 Provide sizes of conductors as shown on Drawings. Voltage drop from lighting panels to farthest outlet must not exceed 2 percent at full load in any case. Advise Contract Administrator if problem is foreseen.

.5 Exercise care in stripping insulation from wire. Do not nick conductors.

3.6 Identification, Coding and Balancing

.1 For branch circuit wiring, follow identification system shown on the Drawings and as specified in Section 16010 – Electrical General Requirements.

.2 Connect single-phase equipment to minimize imbalance on feeders. Adjust branch circuiting shown as required for optimum balancing. Record all changes on "record" Drawings.

.3 Colour code all feeders at all terminations, at all points where taps are made, and at all panelboards, switchboards, motor control centres, etc. Use two wraps of 3M No. 471 plastic film tape 48 mm wide.

.4 Conductors sized No. 10 and smaller are required to be factory coloured, not taped on Site.

.5 For direct current wiring use red for positive and black for negative.

3.7 Testing

.1 All power and control wiring shall be tested for insulation resistance value with a 1000 V megger. Resistance values shall be as recommended by the cable Manufacturer.

.2 All wire test results shall be properly tabulated, signed, dated, and submitted to the Contract Administrator.

END OF SECTION

SPLITTERS, JUNCTION BOXES PULL BOXES, AND CABINETS

1. GENERAL

1.1 Work Included

.1 Provide a complete system of splitters boxes and cabinets for the installation of wiring and equipment.

1.2 Shop Drawings and Product Data

.1 Submit Shop Drawings and Product data for cabinets in accordance with Section 16010 Electrical General Requirements and Section 01300 Submittals.

2. PRODUCTS

2.1 Junction Boxes and Pull Boxes, Weatherproof

.1 Materials:

.1 Cast steel, Crouse Hinds, WBJ Series

2.2 Junction Boxes and Pull Boxes, Indoor Dry Locations

.1 Materials:

.1 Code gauge sheet steel, welded construction, phosphatized and factory paint finish

.2 Components:

.1 For flush mounting, covers to overlap box by 25 mm minimum all around with flush head cover retaining screws.

.2 Use rolled edges for surface boxes.

.3 Junction boxes mounted in exterior walls shall be complete with box vapour barriers.

2.3 Cabinets

.1 Materials:

.1 Cabinets: code gauge sheet steel, welded construction, phosphatized and factory paint finish, suitable for field painting

.2 Locks: to match panel boards

.2 Components:

.1 With hinged door and return flange overlapping sides, with handle, lock and catch for surface mounting, size as indicated or to suit.

.2 Install a back mounting plate for DIN rail mounted terminal blocks. Plate to be painted white enamel.

.3 Install metal divider in cabinets with more than one voltage.

.4 Surface or flush with trim and hinged door, latch and lock and two keys, size as indicated or to suit. Keyed to match panelboard keys 19 mm.

2.4 Splitters

.1 Materials:

.1 Code gauge sheet steel, welded construction, phosphatized, and factory paint finish.

.2 Components:

.1 Formed hinged cover suitable for locking in the closed position.

.2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.

.3 At least three spare terminals on each set of lugs in splitters less than 400 A.

3. EXECUTION

3.1 Installation

.1 Junction Boxes and Pull Boxes:

.1 Supply all pull boxes and junction boxes shown on the Drawings or required for the installation.

.2 Boxes installed in party walls to be offset by a minimum of one stud space.

.3 Install in inconspicuous but accessible locations, above removable ceilings or in electrical rooms, utility rooms, or storage areas.

.4 Identify with system name and circuit designation as applicable.

.5 Size in accordance with the Canadian Electrical Code, as a minimum.

.2 Cabinets:

.1 Mount cabinets with top not greater than 1980 mm above finished floor, coordinated with masonry, panelboards, fire hose cabinets, and similar items.

.2 Install terminal block where indicated.

.3 Splitters

.1 Install splitters and mount plumb, true and square to the building lines.

.2 Extend splitters full length of equipment arrangement except where indicated otherwise.

.4 Identification

.1 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.

END OF SECTION

OUTLET BOXES, CONDUIT BOXES, AND FITTINGS

1. GENERAL

1.1 Work Included

.1 Provide a complete system of boxes for the installation of wiring and equipment.

1.2 References

.1 CSA C22.1-CEC, Part 1

2. PRODUCTS

2.1 Outlet and Conduit Boxes General

.1 Size boxes in accordance with CSA C22.1.

.2 102 mm square or larger outlet boxes as required for special devices

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices

.5 Combination boxes with barriers where outlets for more than one system are grouped

2.2 Outlet Boxes for Metal Conduit

.1 Materials:

.1 Surface mounting exposed: cast ferrous for threaded conduit, with attached lugs, corrosion resistant two (2) coats finish

.2 Components:

.1 Ceiling outlets, surface mounting:

.1 Cast outlet boxes suitable for rigid conduit.

.2 Crouse Hinds VXF/VFT series

.2 Wall outlets, surface, exposed mounting or used for outdoor outlets: one or more gang, Crouse-Hinds FS series or FD series, condulet

.3 Covers: unless wiring devices and plates are mounted, provide blank, round canopy covers to match boxes.

2.3 Concrete Boxes

.1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.4 Conduit Boxes

.1 Cast FS or FD feraloy boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle.

2.5 Fittings - General

.1 Bushing and connectors with nylon insulated throats

.2 Knock out fillers to prevent entry of debris

.3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits

.4 Double locknuts and insulated bushings on sheet metal boxes

3. EXECUTION

3.1 Installation

.1 Support boxes independently of connecting conduits.

.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of Work.

.3 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

.4 Install all outlets flush and surface mounted as required for the installation.

.5 Surface mount above suspended ceilings, or in unfinished areas.

.6 Adjust position of outlets in finished masonry walls to suit course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes.

.7 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.

.8 Use plaster rings to correct depth. Use 30 mm on concrete block.

.9 Do not use sectional boxes.

.10 Provide boxes sized as required by the CEC.

.11 Install vapour barrier material to surround and seal all outlet boxes located on exterior walls of building. Maintain wall insulation.

.12 Outlets installed in partition walls to be offset by a minimum of one stud space.

.13 Primary bushings in termination box for cable connection

.14 Secondary bushings in termination box for bus duct connection

.15 Control junction box

.16 Stainless steel nameplate and connection diagram

END OF SECTION

WIRING DEVICES

1. GENERAL

1.1 Work Included

.1 Provide and connect all wiring devices for the complete installation.

2. PRODUCTS

2.1 Manufacturer

.1 Wiring devices to be of one manufacture throughout project.

.2 Manufacturers shall be Arrow-Hart, Crouse-Hinds, Hubbell, or Pass & Seymour.

2.2 Devices

.1 The catalogue numbers shown below are for the particular Manufacturer's series and all necessary suffixes shall be added for the requirements as stated. All devices shall be Specification grade minimum and wherever possible shall be of the same manufacture.

.2 Devices to be brown with stainless steel coverplates in all but mechanical areas unless noted otherwise. Use galvanized steel coverplates in mechanical areas and for surface mounted devices.

2.3 Switches

.1 120-277 volt, 20 amp, single and double pole, 3- and 4-way: as Hubbell No. 1221, 1222, 1223, and 1224

.2 For wet locations use the following switches: 20 A, 120 V single pole brown, side wired press-switch, as Hubbell No. 1281

.3 Manually-operated general purpose AC switches shall have the following features:

.1 Terminal holes approved by AWG No. 10 wire

.2 Silver alloy contacts

.3 Urea or melamine molding for parts subject to carbon tracking

.4 Suitable for back and/or side wiring

2.4 Receptacles

.1 Duplex 15 A, 120 V, 3 wire, brown, U-ground, as Hubbell No. 5252, with the following features:

.1 Brown urea molded housing

.2 Suitable for No. 10 AWG for back and side wiring

.3 Eight (8) back wired entrances, four (4) side wiring screws.

.4 Break-off links for use as split receptacles.

.5 Triple wipe contacts and riveted grounding contacts

.2 Duplex 15 A, 120 V, 3 wire, brown, U-ground ground fault receptacle, as Hubbell No. GF-5261

.3 Single 15 A, 120 V, 3 wire housekeeping receptacle with stainless steel plate engraved with Housekeeping, as Hubbell No. 5262

.4 Receptacles located on the exterior of the building to be weatherproof construction.

.5 Welding outlets to be 60A 600 V; Crouse-Hinds CAT. No. DBR56742. Contractor to confirm on-site receptacle to match existing welding outlet.

.6 Provide coverplates for all wiring devices.

.7 Use sheet steel utility box cover for wiring devices installed in surface mounted utility boxes.

.8 Use stainless steel 1 mm thick coverplates on all wiring devices mounted in flush-mounted outlet boxes unless otherwise specified.

.9 Weatherproof double lift spring-loaded cast aluminum coverplates, complete with gaskets for single receptacles or switches.

.10 Weatherproof spring-loaded cast aluminum coverplates complete with gaskets for single receptacles or switches.

.11 Use gasketted DS cast covers on FS and FD type boxes.

3. EXECUTION

3.1 Installation

.1 Install single throw switches with handle in the "UP" position when switch closed.

.2 Install switches vertically in gang type outlet box when more than one switch is required in one location.

.3 Mount switches on the latch side of the doorway as close as possible to doorframe unless otherwise indicated on Drawings.

.4 Install receptacles vertically in gang type outlet box when more than one receptacle is required in any one location.

.5 Protect cover plate finish with paper or plastic film until all painting and other Work is finished, and then remove paper.

.6 Install suitable common coverplates where wiring devices are grouped. Do not distort plates by tightening screws excessively.

.7 Do not use coverplates meant for flush outlet boxes on surface mounted boxes.

.8 Wherever possible, mount equipment in a straight line at a uniform mounting height, coordinated with other equipment and materials.

.9 Mounting dimensions are to the centre of the devices. Final instructions on mounting heights shall be given by the Contract Administrator's representative at the Site. The above shall be used as a guide, but shall be subject to final verification prior to installation.

END OF SECTION

WIRE AND BOX CONNECTORS 0-1000 V

1. GENERAL

1.1 Work Included

.1 Provide a complete system of wiring, making all connections necessary for the installation shown on Drawings.

1.2 Special Codes

.1 Install and rate power cables in accordance with the CEC requirements or in accordance with Insulated Power Cable Engineers Association (IPCEA) requirements where permissible.

1.3 References

.1 CSA C22.2 No. 65 Wire Connectors

.2 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 A Maximum Rating)

2. PRODUCTS

2.1 Materials

.1 Pressure type wire connectors: with current carrying parts same material as conductors sized to fit the conductors as required

.2 Fixture type splicing connectors: with current carrying parts same material as conductors sized to fit the conductors 10 AWG or less

.3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:

.1 Connector body and stud clamp for stranded copper conductors

.2 Clamp for stranded copper conductors

.3 Stud clamp bolts

.4 Bolts for copper bar

2.2 Wire Connectors

.1 Use 3M “Scotchlock” self-insulated connectors for hand twist wire joints for lighting, small power, and control wiring.

.2 Use Thomas & Betts (T & B) non-insulated ring type compression lugs for terminating No. 10 AWG and smaller motor connections. Tape with rubber and scotchtape. Lugs to accept ten 32 x 3/8” machine bolts.

.3 Terminate conductors No. 8 AWG and larger with T & B Colour-Keyed compression connectors Series 54000 or on lugs provided with equipment.

.4 T & B "KOPR-SHIELD" compound Series CP8 on all terminations for compression connectors.

3. EXECUTION

3.1 Installation

.1 Remove insulation carefully from ends of conductors and:

.1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.

.2 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.

.3 Install fixture type connectors and tighten. Replace insulating cap.

.4 Install bushing stud connectors in accordance with EEMAC 1Y-2.

3.2 Wire Connectors

.1 Select hand twist connectors for wire size and install tightly on conductors.

.2 Brush "KOPR-SHIELD" compound on terminations for compression connectors as recommended by the Manufacturer.

.3 Install compression connectors using methods and tools recommended by Manufacturer.

.4 Do not install stranded conductors under screw terminals unless compression lugs are installed.

END OF SECTION

FASTENINGS AND SUPPORTS

1. GENERAL

1.1 Work Included

.1 Supply and install all hangers, supports, and inserts for the installation shown on the drawings and specified herein, as necessary to fasten electrical equipment securely to the building structure.

2. PRODUCT

2.1 Framing and Support System

.1 Materials:

.1 Intermediate duty supporting structures shall employ P1000 Unistrut or equal together with the manufacturer's connecting components and fasteners for a complete system.

.2 Heavy duty supporting structures to be fabricated and welded from steel structural members and prime painted before installation.

.2 Finishes:

.1 Outdoors, wet locations: hot dipped galvanized

.2 Indoors, dry locations: galvanized when available, prime painted if not available

.3 Nuts, bolts, machine screws: cadmium plated

.3 Unistrut:

.1 Section P1000 or as required for load and span, with mounting screws, or approved. P1000 or equal is a minimum standard for supporting conduits 50 mm and larger.

2.2 Concrete and Masonry Anchors

.1 Materials: hardened steel inserts, zinc plated for corrosion resistance. All anchor bolts must be galvanized.

.2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four (4).

.3 Manufacturer: Hilti (Canada) Limited or approved equal

2.3 Non-Metallic Anchors

.1 Material: plastic anchors for sheet metal screws

.2 Manufacturer: Fischer

2.4 Conduit Supports

.1 General: malleable iron one-hole conduit straps where exposed to weather. Stamped steel two-hole straps indoors.

.2 Structural Steel: Crouse-Hinds "Wedgetite" supports or equivalent manufactured by Appleton

.3 Masonry, concrete, stone, etc.: anchors

.4 Title: toggle bolts

.5 Metal studs, ceiling hangers, etc.: "Caddy-Clips"

.6 Unistrut: unistrut conduit clamps

2.5 Cable Supports and Clamps

.1 General: as per conduit supports, except that for single conductor cables, suitable non-ferrous, or approved stainless steel or aluminum clamps shall be used.

3. EXECUTION

3.1 General

.1 Do not cut or drill beams, joists, or structural steel unless written permission of the Contract Administrator is obtained.

.2 Distance between conduit or cable supports not to exceed code requirements.

.3 Supports to be suitable for the real loads imposed by equipment.

.4 Supports to be securely fastened, free from vibration, and excessive deflection or rotation. Maximum deflections are 4 mm over a 1 m span and 8 mm over a 2 m span.

.5 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with Manufacturer's installation recommendations.

.6 Provide conduit rack with 25 percent spare capacity for multiple runs.

.7 Provide channel support with fittings for vertical runs of conduit and cables.

3.2 Installation

.1 Secure equipment to solid masonry, tile, and plaster surfaces with lead anchors or nylon shields.

.2 Secure equipment to poured concrete with expandable inserts.

.3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.

.4 Support equipment, conduit, or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.5 Fasten exposed conduit or cables to building construction or support system using straps.

.1 One-hole malleable iron or steel straps to secure surface conduits and cables 50 mm and smaller.

.2 Two-hole steel straps for conduits and cables larger than 50 mm

.3 Beam clamps to secure conduit to exposed steel.

.6 Suspended support systems.

.1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.

.2 Support two or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.

.7 Use plastic anchors for light loads only. Use metal anchors for all other loads.

.8 Shot driven pins may only be used with written approval of the Contract Administrator.

.9 Use round or pan head screws for fastening straps, boxes, etc.

.10 Do not support heavy loads from the bottom chord of open web steel joists.

.11 Support outlet boxes, junction boxes, panel tubs, etc., independent of conduits running to them. Support conduits within 600 mm of outlet boxes. Support surface mounted panel tubs with a minimum of four 6 mm fasteners.

.12 For surface mounting of two or more conduits use channels at 1500 mm of spacing.

.13 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.14 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.15 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.16 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Contract Administrator.

END OF SECTION

DISCONNECT SWITCHES FUSED AND NON-FUSED UP TO 600 V – PRIMARY

1. GENERAL

1.1 Description

.1 Provide disconnect switches for 347/600 volt and 120/208 volt distribution as indicated on the Drawings, as manufactured by Eaton Cutler-Hammer or Schneider.

2. PRODUCTS

2.1 Disconnect Switches

.1 Ratings: 600 V for 347/600 V, 240 V for 120/208 V distribution. Unless otherwise shown, 3-pole for 3-phase, 3-wire distribution, 3-pole and solid neutral for 3-phase 4-wire distribution. Ampere ratings as shown on the drawings or to suit load requirements. For motors, use disconnect switches with HP ratings at least equal to motor HP.

.2 Enclosures: CSA code gauge galvanized steel, hinged doors, external operating handles. Disconnect switches in dry locations shall be EEMAC-1 and EEMAC-3 where exposed to weather. Provide ON-OFF switch position indication on switch enclosure cover.

.3 Finish: one (1) primer coat and one finish coat on all metal surfaces, colours as per Section 16010 – Electrical General Requirements.

.4 Switch mechanisms: quick make and quick break action with self-wiping contacts, solderless pressure lug connectors. For switches 100 amperes and over, provide non-tracking arc shrouds. All switch poles to operate together from a common operating bar. Provide for padlocking disconnect switches in OFF position. Doors to be interlocked and complete with defeat mechanism, to prevent opening when handle in ON position.

.5 Neutral Bars: where distribution system has grounded neutral conductor, provide neutral bar where required with ampere rating equal to switch rating, in enclosure. Provide ground bar for terminating ground conductors.

.6 Fuse Holders: provide fuse holders (relocatable and suitable without adapters) on load side of switches, ampere rating equal to switch ratings, suitable for fuses specified.

2.2 Fuses

.1 All fuses to be 100,000 ampere (minimum) interrupting capacity of the current limited type. In addition, fuses feeding motors to be of the time delay type. Provide one (1) full set of spare fuses, three (3) for each different ampere rating used, stored in suitable enclosure.

3. EXECUTION

3.1 Disconnect Switches

.1 Mounting: provide supports independent of conduits. Wall mount where possible, otherwise provide Unistrut frame support. Where switches are grouped mount in uniform arrangement.

.2 Wiring: connect line and load cable to all switches

.3 Fuse Rating: install so that rating is visible

.4 Identification: provide lamacoid plate in accordance with Section 16010 – Electrical General Requirements, on each switch showing voltage, source of supply and load being fed, for example:

.1 Door Controller

.2 120/208 Volts

.3 Fed from PPA

.5 Nameplate to be Size 3.

END OF SECTION

GROUNDING - SECONDARY

1. GENERAL

1.1 Description

.1 Supply and install a complete secondary grounding system to include new equipment provided in this Contract. Securely and adequately ground all components of the electrical system in accordance with the requirements of all related sections in the latest Canadian Electrical Code, Local Building Code, and the local Electrical Inspection Branch.

.2 The system is to consist of cables, supports, and all necessary materials and inter-connections to provide a complete system. Measured resistance to ground of the network shall not exceed 5 ohms.

.3 All ground conductors shall be run in conduit.

1.2 References

.1 ANSI/IEEE 837, Qualifying Permanent Connections Used in Substation Grounding

2. PRODUCTS

2.1 Equipment

.1 Cables 2/0 and smaller to be connected to ground bars via Burndy Quiklug Type QA-2B connectors. Connections for cables larger than 3/0 shall be brazed.

.2 All ground wires to be stranded copper TWH complete with a green jacket unless otherwise shown.

.3 Uninsulated ground wires shall be bare stranded copper, soft annealed. Size as indicated.

.4 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:

.1 Grounding and bonding bushings

.2 Protective type clamps

.3 Bolted type conductor connectors

.4 Bonding jumpers, straps

.5 Pressure wire connectors

3. EXECUTION

3.1 General

.1 Install complete permanent, continuous grounding system, including conductors, accessories. Where EMT is used, run ground wire in conduit. All connectors shall be installed in accordance with Manufacturers' requirements. All frames and metallic enclosures of all electrical equipment and electrically operated equipment shall be grounded through the conduit system or via a ground wire.

.2 All transformers, switchgear, motor control centres, panel boards, and splitters fed from the main distribution centre shall be grounded by grounding conductors sized in accordance with the Canadian Electrical Code. The ground wire shall be terminated at each end with an appropriate grounding lug, which shall be connected to the equipment ground bus. Ground wire to be green TWH. Use mechanical connectors for grounding connections to equipment provided with lugs.

.3 All sub panels such as lighting panels, local distribution panels, etc., shall be grounded with a green ground wire run back to the panel from which it is fed. The ground conductor shall be sized according to the Canadian Electrical Code.

.4 All main distribution centres, motor control centres, switchgear, and all panels requiring equipment grounds shall contain a ground bus of adequate size, and tapped for lugs for the ground wire required.

.5 All bolted connections must be accessible.

.6 All motors shall be grounded by means of an adequately sized green ground wire contained within the feeder conduit.

.7 Include a separate green ground wire in all power conduits including branch circuit wiring sized to Canadian Electrical Code.

.8 Expansion joints and telescoping sections of raceways shall be bonded using jumper cables as per Canadian Electrical Code.

.9 Use Burndy compression connectors or approved equal for all grounding splices and terminations unless otherwise shown on the Drawings. For bolted ground connections use Burndy "Durium" or approved equal hardware.

.10 Connect all transformer neutrals to the main building ground wire, using compression terminations.

.11 Install rigid conduit sleeves where ground wires pass through concrete slabs.

.12 Conduit installed buried in earth or installed in or under grade floor slabs shall have separate ground wire installed, whether the conduits are metal or not.

.13 Ground all utility services to the electrical system ground.

.14 Protect exposed grounding conductors from mechanical injury.

.15 Install bonding wire for flexible conduit, connected at one end to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

.16 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

.17 Soldered joints shall not be permitted.

.18 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

.19 Install electrical room ground bus to wall as indicated, utilizing insulated off sets.

3.2 System and Circuit Grounding

.1 Install system and circuit grounding connections to neutral of secondary 600 V systems.

3.3 Equipment Grounding

.1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, and duct systems, frames of motors, motor control centres, starters, and control panels distribution panels.

3.4 Field Quality Control

.1 Perform tests in accordance with Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Perform ground continuity and resistance tests using method appropriate to Site conditions and to approval of Contract Administrator and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

.4 Disconnect ground fault indicator during tests.

END OF SECTION

DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY

1. GENERAL

.1 Provide enclosed dry type transformers 600 V primary to 120/208 V.

.2 Product Data – Three Phase, Four Wire Secondary

.1 Submit Product data in accordance with Section 16010 – Electrical General Requirements.

.3 Transformers to conform to CSA C57.12 and L2 standards, and are to be approved to CSA Code Part 2, Standard C22.2, No. 47 and CSA C9.

2. PRODUCTS

2.1 Transformers

.1 General: dry type, air-cooled, self-ventilated. Enclosures to be EEMAC 1 type, code gauge steel, complete with ventilation openings, access panels, mounting brackets, and solderless primary and secondary cable connectors. Enclosures to have zinc chromate prime coat and enamel finish coat per Section 16010. Transformers to be single or three phase as noted on the Drawings.

.2 Design

.1 Type: ANN

.2 3 phase, kVA as indicated on the Drawings, 600 V input, 120/208 V output, 60 Hz.

.3 Voltage primary taps: 2.5 percent full capacity above and below normal

.4 Insulation: Class H

.5 Basic Impulse Level (BIL): 10 kV BIL

.6 Hipot: 4 kV

.7 Average Sound Level: to meet the local municipal and building codes and meet at minimum the following criteria:

.1 45 dB maximum up to 45 kVA

.2 50 dB maximum up to 150 kVA

.3 55 dB maximum up to 300 kVA

.4 60 dB maximum above 500 kVA

.8 Impedance at 170°C: 6.0 percent maximum up to 112.5 kVA, 5.5 percent maximum above 112.5 kVA

.9 Enclosure: EEMAC 1, removable metal front panel

.10 Mounting: up to 45 kVA suitable for wall or floor mounting and above 45 kVA suitable for floor mounting unless otherwise shown

.11 Finish: in accordance with Section 16010 – Electrical General Requirements

.12 Three Phase Windings: arrange with three primary windings connected in delta and three secondary windings connected in wye

.13 Maximum Winding Temperature: 150°C rise with temperature continuous full load

.14 Maximum Lead Connection: 55°C rise with temperature continuous full load

.15 Copper winding

2.2 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.

.2 Label: Size 7

2.3 Acceptable Manufacturers:

.1 Eaton Culter-Hammer

.2 Schneider

.3 Hammond Manufacturing

.4 Delta Transformers

.5 BEMAG Transformers

3. EXECUTION

3.1 Installation

.1 Mount dry type transformers up to 45 kVA as indicated.

.2 Mount dry type transformers above 45 kVA on floor.

.3 Ensure adequate clearance around transformer for ventilation

.4 Install transformers in level upright position.

.5 Remove shipping supports only after transformer is installed and just before putting into service.

.6 Loosen isolation pad bolts until no compression is visible.

.7 Make primary and secondary connections in accordance with wiring diagram.

.8 Mount transformers as indicated on Drawings and connect primary, secondary, neutral and ground conductors. Provide brackets and bolts for wall-mounted transformers. Ensure all transformers have good ventilation.

.9 Do not use permanent distribution system dry type transformers for temporary power distribution without permission from the Contract Administrator.

.10 Mount transformers to reduce direct and transmitted noise. Mount core and coils of transformers on vibration and sound absorbing pads.

.11 Record secondary voltage when transformers are carrying approximately 75 percent of full load. Adjust tap connections to give a continuous secondary voltage of 120 V phase to neutral. Set tap connections for above 120 V rather than below.

.12 Connections to transformers shall be in flexible conduit and shall enter the enclosure below the coils.

.13 Before energization, keep transformers or storage room enclosures above 10°C ambient.

END OF SECTION

PANELBOARDS – BREAKER TYPE

1. GENERAL

1.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 16010 – Electrical General Requirements.

.2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity, and enclosure dimension.

2. PRODUCTS

2.1 Panelboards

.1 Panelboards: product of one (1) Manufacturer

.1 Install circuit breakers in panelboards before shipment.

.2 In addition to CSA requirements Manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.2 Panel boards: bus and breakers rated for 250 V to be 14 KA, 600 V to be 18 KA (symmetrical) interrupting capacity or as indicated.

.3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.4 Panel boards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.5 Two (2) keys for each panel board and key panel boards alike.

.6 Copper bus with neutral of same ampere rating as mains.

.7 Mains: suitable for bolt-on breakers

.8 Trim with concealed front bolts and hinges.

.9 Trim and door finish: baked grey enamel

.10 TVSS surge protection – bus connected

2.2 Breakers

.1 Breakers: refer to Section 16477 – Moulded Case Circuit Breakers

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

2.3 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.

.2 Nameplate for each panelboard Size 4 engraved as indicated.

.3 Nameplate for each circuit in distribution panelboards Size 2 engraved as indicated.

.4 Complete circuit directory with typewritten legend showing location and load of each circuit.

2.4 Acceptable Products

.1 Eaton Cutler-Hammer

.2 Schneider Electric

3. EXECUTION

3.1 Installation

.1 Locate panel boards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Mount panel boards to height specified in Section 16010 – Electrical General Requirements or as indicated.

.3 Connect loads to circuits.

.4 Connect neutral conductors to common neutral bus with respective neutral identified.

END OF SECTION

MOULDED CASE CIRCUIT BREAKERS

1. GENERAL

1.1 Product Data

.1 Submit Product data in accordance with Section 16010 – Electrical General Requirements.

.2 Include time-current characteristic curves for breakers with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

2. PRODUCTS

2.1 Breakers General

.1 Bolt-On Moulded Case Circuit Breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient

.2 Common-Trip Breakers: with single handle for multi-pole applications

.3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from three (3) to eight (8) times current rating.

.4 Circuit breakers with interchangeable trips as indicated.

2.2 Thermal Magnetic Breakers

.1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 Magnetic Breakers

.1 Moulded case circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.

2.4 Moulded Case Switch

.1 Moulded case switch shall be complete with a high instantaneous magnetic fixed trip, factory set to trip at high fault currents.

2.5 Optional Features

.1 Include where indicated on Drawings:

.1 Shunt trip

.2 Auxiliary switch

.3 Motor-operated mechanism c/w time delay unit

.4 Under-voltage release

.5 On-off locking device

.6 Handle mechanism

.7 Keyed interlocks

.8 Non-auto

2.6 Enclosure for Individually Mounted Breakers or Moulded Case Switch

.1 Enclosure shall be CSA code gauge galvanized steel, hinged door, front mounted external operating handle, lockable in "OFF" position, Electrical and Electronic Manufacturer's Association of Canada EEMAC-1 unless shown otherwise. Use EEMAC-12, for industrial application, enclosure for wet environment or as shown "WP" on Drawings. Increase enclosure size above standard for large cables.

.2 Where distribution system has grounded neutral conductor, provide neutral bar, with ampere rating equal to breaker/switch rating in enclosure.

3. EXECUTION

3.1 Installation

.1 Install circuit breakers as indicated on Drawings and specified herein.

.2 Install circuit breakers in panelboards to satisfy branch circuit requirements under the Scope of Work of this Contract.

.3 Provide 15 percent spare quantity of circuit breakers in each panel board.

.4 Identification: provide lamacoid plate on each breaker showing voltage, source of supply and load being fed - 120/208 V, 3 phase, 4W fed from LDP No.1 to Splitter Trough No. 1.

END OF SECTION

POWER SURGE PROTECTORS

1. GENERAL

1.1 Related Work

.1 General Electrical Requirements: Section 16010

.2 Panelboards – Breaker Type: Section 16471

1.2 System Description

.1 A transient voltage surge suppressor for the protection of downstream electronic equipment connected to the building power supply. The specified unit shall be compatible with non-linear loads and shall provide effective high-energy transient voltage suppression, surge (TVSS) current diversion and high-frequency electrical noise filtering while connected in parallel with a facility's distribution system. The filtering unit shall utilize non-linear voltage dependent metal oxide varistors or selenium cells. The suppression system's components shall not utilize gas tubes, spark gaps, or silicon avalanche diodes. The device shall be referred to as a TVSS filter for the purpose of this document and Drawings.

2. PRODUCT

2.1 Operation and Environment

.1 Voltage: the TVSS devices shall be suitable for the voltage and systems configuration as indicated on the single line diagram(s)

.2 Maximum Continuous Operating Voltage (MCOV): the maximum continuous operating voltage of the suppressor unit shall be greater than 125 percent for 120/208 V systems and 347/600 V systems.

.3 Protection Modes: transient voltage surge suppression paths shall be provided for all possible common and normal modes (between each line and ground, neutral and ground, line to line and each line and neutral). The primary suppression path shall not be to ground.

2.2 Suppression Component

Peak surge Current per Phase	120,000 Amps	(Branch Panel Applications)
Let Through Voltage (L-N)	208 V Units 600 V Units	500 V 1200 V
TVSS clamping components response time	< 1 nanosecond	

2.3 Filtering

.1 TVSS shall contain a high frequency extended range-tracking filter.

.2 Noise attenuation ≥45 dB at 100 kHz

2.4 Panelboard Component (Integrated TVSS Panel)

.1 Main Bus: the device shall have a copper, tin-plated main bus.

.2 Circuit Breakers: are to be of the over center toggle mechanism type which use bolt-on connectors to line side panelboard connectors.

.3 Panelboard Enclosure: the panel board shall be provided in an EEMAC-1 enclosure. The TVSS/filter status indicators shall be visible without the need to open the panel board door. A lockable door shall be provided to limit access to authorized personnel only. Trim assembly shall be tamper proof. The trim (doors) shall be finished in grey ASA61 paint.

2.5 General Features

.1 The integrated TVSS panel shall be factory installed and connected to the bus bar.

.2 Connectors: terminals shall be provided for all the necessary input and output power and ground connections on the TVSS.

.3 Enclosure: the specified system shall be provided in a heavy duty NEMA 12 dust tight enclosure with no ventilation openings for maintenance and branch panel applications. Indication of surge current module status shall be visible without opening the door.

.4 Internal Connections: all surge current diversion connections shall be by way of low impedance wiring. Surge current diversion components shall be wired for reliable low impedance connections. no plug-in component modules, quick disconnect terminals or printed circuit boards shall be used in surge suppression paths.

.5 Unit Status Indicators: red status indicators shall be provided on the hinged front cover to indicate unit phase status. The absence of the red light shall reliably indicate that one or more surge current diversion phases have failed and that service is needed to restore full operation.

.6 Fuses: the unit shall utilize internal fuses rated with a minimum interrupting capability of 200,000 A or greater.

.7 Identification: the unit shall include Manufacturer’s nameplate, UL rating, and a CSA approval on the exterior enclosure.

.8 Warranty: the Manufacturer shall provide a five (5) year warranty on the TVSS filter, a one (1) year warranty on the panelboard and circuit breakers, and a one (1)-year warranty on individual equipment plug-in units. These warranties shall commence from date of shipment.

.9 Testing: testing at each unit shall include assurance checks, “Hi-Pot” test at two (2) times rated voltage plus 1000 volts per UL requirements, and operation and calibration tests.

2.6 Approved Manufacturers

.1 IT Innovative Technology Inc.

.1 Main panel application: PTE 300

.2 Branch panel application: PTE 300

.2 Cutler Hammer

.1 Main panel applications: Model Visor Series

.2 Branch panel application: Model Visor Series

.3 Tyco International Corporation.

.1 Main and branch panel applications: Model PTY-HE

3. EXECUTION

3.1 Installation

.1 Install with Manufacturer's recommended conductors tapped from the electrical service switchboard conductor system. Conductors are to be as short and as straight as possible. Input conductors to the TVSS shall be twisted together to reduce impedance during high frequency filtering.

.2 An appropriately sized manual safety disconnect shall be installed before and in line with the TVSS from the electrical service for the purpose of electrically isolating the device from the system should service be required without interrupting the main service. Coordinate required disconnect ampacity with TVSS Manufacturer.

.3 The TVSS should be following the Manufacturer's recommended practices as outlined in the Manufacturer's installation and Maintenance Manual and in compliance with all applicable electrical codes.

.4 Individual equipment protection devices shall be installed at the same voltage rating as the intended protected equipment and as close as possible to the intended protected equipment.

END OF SECTION

CONTACTORS

1. GENERAL

1.1 Description

.1 Supply and Install contactors as indicated on Drawings and specified herein to ensure a complete operational system.

.2 This Specification covers contactors for voltages up to 600 V. Refer to Drawings for voltage, amperage, number of poles, and auxiliary contacts.

1.2 Product Data

.1 Submit Product data in accordance with Section 16010 – Electrical General Requirements.

2. PRODUCTS

2.1 Contactors

.1 Contactors: to EEMAC No.1CS

.2 Electrically held controlled by pilot devices as indicated and rated for type of load controlled. This rating shall be on the basis of incandescent or non-inductive loading for continuous operation. Half size contactors not accepted. All contactors shall have 120V-operating coils.

.3 Breaker combination contactor as indicated

.4 Complete with two (2) normally open and two (2) normally closed auxiliary contacts unless indicated otherwise.

.5 Mount in CSA Enclosure 1 unless otherwise indicated.

.6 Include the following options in cover:

.1 Red indicating lamp

.2 Hand-Off-Auto selector switch

.3 On-Off selector switch

.7 Control transformer: to Section 16825 - Control Devices**,** in contactor enclosure

2.2 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.

.2 Provide a Size 4 nameplate-indicating name of load controlled.

3. EXECUTION

3.1 Installation

.1 Install contactors and connect auxiliary control devices where indicated on Drawings and specified herein.

.2 Contactors shall be mounted separately in suitable CEMA-1 enclosures.

END OF SECTION

GENERAL PROVISIONS FOR INTERIOR LIGHTING

1. GENERAL

1.1 Work Included

.1 Supply and Install lighting fixtures complete with lamps, ballasts, and all necessary fittings.

1.2 Code Requirements

.1 Installation of lighting equipment to conform to Section 30, Canadian Electrical Code, Part 1, and as amended or supplemented by provincial, municipal, or other regulatory agencies having jurisdiction.

1.3 Shop Drawings

.1 Submit a complete list of the types of lighting fixtures, lamps, ballasts and accessories with catalogue illustrations, data sheets, etc., for review. Bind in a suitable booklet and keep one copy of this booklet at the job Site at all times.

.2 Submit complete photometric data, based on actual fixtures proposed for project. Substantiate brightness and efficiency requirements. Photometric data must be produced by a recognized independent laboratory.

1.4 Manufacturer's Operational Test

.1 Test fixtures for acceptance of lamp made to maximum tolerance as required in ANS standards.

.2 Test fixtures with rated lamps for starting and operation.

.3 Check wiring for agreement with design circuit.

.4 Test for short circuits and improper grounds.

.5 Test operation of fixture and lamp with ballast.

1.5 Samples

.1 Provide samples of all fixtures, lamps, ballasts, and accessories when requested.

.2 If directed, set up these fixtures on or near Site, to show coordination of fit with ceiling and other equipment, i.e., mechanical air diffuser assemblies, wiring channels, brackets, davits, and standards. Retain fixture design, if approved, at the Site as a control standard. If submitted fixtures are disapproved, resubmit after revision for further field tests until approval is given.

.3 Install one (1) or more sample fixtures in a mock-up of specified ceiling. Pay all costs associated with Work of this trade in connection with construction of mock-up, installation and connection of fixtures, lamps, ballasts and accessories.

1.6 Lamps Used for Temporary Lighting

.1 Fluorescent or mercury lamps may be used for temporary light and lamps used for this purpose will be accepted when the project or portions of the Work are turned over to the City. Spot relamp faulty or burned out lamps prior to this acceptance, without additional cost to the City.

.2 Metal halide, sodium, incandescent and quartz lamps are not to be used for temporary lighting, unless all lamps so used are replaced with new lamps immediately prior to completion at no additional cost to the City.

2. PRODUCTS

.1 All lighting units and associated equipment shall be Manitoba Hydro Power Smart approved where applicable.

.2 Provide, wherever possible, commercially available stock lighting fixtures meeting specified requirements and as shown on the Drawings.

.3 Different fixtures may be supplied by different Manufacturers. Similar fixtures shall be supplied by the same Manufacturer.

.4 Provide only lighting fixtures, which are structurally well designed and constructed, and which use new parts and materials of highest commercial grade available. Unless otherwise specifically noted, fixtures shall be of the quality stated in the Manufacturer's catalogues and data sheets.

.5 Refer to Luminaire Schedule on Drawings for details of fixtures and accessories.

.6 Use self-aligning ball joint hangers for rod suspended fixtures.

.7 Use cadmium plated chains for suspended fixtures in unfinished areas.

3. EXECUTION

3.1 Installation

.1 Install fixtures in accordance with the Manufacturer's requirements, code requirements, and as shown on the Drawings.

.2 Confirm compatibility and interface of other materials with luminaire and ceiling systems. Examine the room finish schedule and reflected ceiling Drawings. Report discrepancies and defer ordering until clarified.

.3 Supply plaster frames, trim rings and backboxes to other trades, as the Work requires.

.4 Ground lighting equipment to metal raceway, armour of armoured cable, grounding conductor in non-metallic-sheathed cable, or to a separate grounding conductor.

.5 Coordinate with other trades to avoid conflicts between luminaires, supports and fittings and mechanical and structural equipment.

.6 Provide guards where fixtures are subject to mechanical damage as required by code or shown on the Drawings.

3.2 Workmanship

.1 Completely clean all glassware, lamps, and hangers. Polish metal parts before completion.

.2 Provide suitable extension couplings for row-mounted fixtures.

.3 Protect fixtures, hangers, supports, fastenings, and accessory fittings at the Site prior to and during installation. Unless fixtures are erected immediately, after delivery to Site, deliver in original cartons or enclosed in air-tight plastic wrapping. Store in a dry and secure space on Site. Protect hangers, supports, fastenings and accessory fittings against corrosion. Take care during installation to ensure that insulation and corrosion protection is not damaged.

.4 Fixtures, which show evidence of corrosion, rough handling, scratching of finishes, etc., are to be replaced with new fixtures at no additional cost.

.5 Install recessed fixtures to permit removal from below, for access to outlet or prewired fixture box.

.6 Hang and mount fixtures to prevent distorting fixture frame, housing, sides or lens frame, and permit correct alignment of several fixtures in a row.

.7 Support fixtures as shown on Drawings, level, plumb and true with structure and other equipment in horizontal or vertical position as intended. Install wall or side bracket mounted fixture housings rigidly and adjust to a neat flush fit with mounting surface.

.8 Adjust length of hangers of suspended fixtures to hang fixture bodies level and in same horizontal plane, unless shown otherwise on Drawings.

.9 Install ceiling canopies to cover suspension attachments and fit tightly to ceiling without restricting alignment of hanger.

.10 For recessed fluorescent fixtures mounted in suspended ceiling with exposed tee bar grid system, support by the ceiling tee bar grid structure. Provide any additional support necessary for oversize fixtures, or to meet code requirements.

.11 Metal inserts, expansion bolts or toggle bolts, which do not carry wiring, shall be accurately located in relation to outlet boxes, for perfect alignment and spacing of suspension stems or other hangers.

.12 For remote mounted ballasts, supply mounting board and space ballasts in accordance with Manufacturer's directions. Size wiring from ballasts to remote fixtures to meet Manufacturer's requirements.

.13 Remove any noisy ballasts from the fixtures and replace at no additional cost to the City prior to completion.

END OF SECTION

EXIT LIGHTS

1. GENERAL

1.1 Product Data

.1 Submit duct data in accordance with Section 16010 – Electrical General Requirements.

1.2 References

.1 CSA C860

2. PRODUCTS

2.1 Standard Units

.1 Housing: moulded high impact thermo plastic

.2 Face and back plates: moulded high impact thermo plastic

.3 Lamps: LED-2W 120 V

.4 Letters: 150 mm high x 19 mm, with 13 mm thick stroke, red on white glass, reading EXIT

.5 Face plate to remain captive for relamping.

.6 Universal mounting

3. EXECUTION

3.1 Installation

.1 Install exit lights.

.2 Connect fixtures to exit light circuits.

.3 Connect emergency lamp sockets to emergency circuits.

.4 Ensure that exit light circuit breaker is locked in on position.

END OF SECTION

UNIT EQUIPMENT FOR EMERGENCY LIGHTING

1. GENERAL

1.1 Work Included

.1 Supply emergency lighting units complete with all accessories.

1.2 Special Codes

.1 Canadian Electrical Code, Part 1, Section 46 “Emergency Systems, Unit Equipment and Exit Signs”

.2 CSA Standard C22.2 No. 141 “Unit Equipment for Emergency Lighting”

.3 Manitoba Building Code

1.3 Product Data

.1 Submit Product data in accordance with Section 16010 – Electrical General Requirements.

.2 Data to indicate system components, mounting method, source of power, and special attachments.

1.4 Warranty

.1 For batteries, the 12 months warranty period prescribed in subsection GC 13 of General Conditions is extended to 120 months, with a no-charge replacement during the first five (5) years and a pro-rate charge on the second five (5) years.

2. PRODUCTS

2.1 General

.1 Supply and Install battery power emergency lighting where shown on the Drawings. Lights are to switch “ON” automatically in the event of failure of normal power, and “OFF” on restoration of power. The batteries shall be automatically recharged from a 120 VAC supply.

2.2 Equipment

.1 Supply voltage: 120 VAC

.2 Output voltage: 12 VDC

.3 Operating time: 30 minutes

.4 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10 percent input variations.

.5 Solid state transfer circuit

.6 Low voltage disconnect: solid state, modular, operates at 80 percent battery output voltage

.7 Signal lights: solid state, for 'AC Power ON' and 'High Charge'

.8 Lamp heads: integral on unit and remote, 345° horizontal and 180° vertical adjustment. Lamp type: tungsten, 12 W, minimum.

.9 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.

.10 Finish: Whist Metal

.11 Auxiliary equipment:

.1 Ammeter

.2 Voltmeter

.3 Test switch

.4 Time delay relay

.5 Battery disconnect device

.6 AC input and DC output terminal blocks inside cabinet

.7 Shelf

.8 Cord and single twist-lock plug connection for ac

.9 RFI suppressors

2.3 Line Connection

.1 Each battery unit shall be equipped with AC line cord and plug.

2.4 Units

.1 Units to contain solid-state battery charger, transfer switch, and batteries. Provide all relays, hardware and circuitry for operation specified. Units to have push-to-test switch, "ON" and "CHARGING" lights with extended lamp life.

2.5 Batteries

.1 Unless specifically indicated provide batteries of sufficient watt-hour capacity to power the loads connected to each individual unit for 30 minutes, 12 V, long life, maintenance free, sealed lead acid batteries, contained within the units.

2.6 Wire Guard

.1 Where indicated provide substantial wire guards with chrome finish, for battery units and/or lamps.

2.7 Wiring of Remote Heads

.1 Conduit: type Rigid Galvanized Steel, to Section 16111 – Conduits, Conduit Fastenings, and Conduit Fittings.

.2 Conductors: No. 12 R90 (min.) type to Section 16122 – Wires and Cables 0-1000 V, sized in accordance with Manufacturer's recommendations.

3. EXECUTION

3.1 Installation

.1 Mount battery units with the bottom of the enclosure not less than 2200 mm above the floor, where practicable.

.2 Install duplex receptacle adjacent to unit and connect to 1 phase, 120 V unswitched area lighting circuit.

.3 Where applicable wire from unit to exit lights.

.4 Wiring from units to remote heads and/or exit lights shall be sized to prevent voltage drop of more than 5 percent.

.5 All emergency heads shall be properly aimed.

END OF SECTION

FIRE ALARM SYSTEMS

1. GENERAL

1.1 Related Work

.1 Conduits, Conduit Fastenings and Conduit Fittings: Section 16111

.2 Wires and Cables 0-1000 V: Section 16122

.3 Instrumentation and Control: Division 17

1.2 References

.1 CAN/ULC-S524, Installation of Fire Alarm Systems

.2 ULC-S525, Audible Signal Appliances for Fire Alarm Systems

.3 CAN/ULC-S526, Visual Signal Appliances, Fire Alarm

.4 CAN/ULC-S527, Control Units, Fire Alarm

.5 CAN/ULC-S528, Manual Pull Stations

.6 CAN/ULC-S529, Smoke Detectors, Fire Alarm

.7 CAN/ULC-S530, Heat Actuated Fire Detectors, Fire Alarm

.8 CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems

.9 CAN/ULC-S537, Verification of Fire Alarm Systems

.10 NBC, National Building Code of Canada

.11 CSA C22.1 Section 32, Fire Alarm Systems and Fire Pumps

.12 Local Building Code

1.3 Description of System

.1 System includes:

.1 Control panel to carry out fire alarm and protection functions including receiving alarm signals, initiating general alarm, supervising system continuously, actuating zone annunciators, and initiating trouble signals.

.2 Trouble signal devices

.3 Power supply facilities

.4 Manual alarm stations

.5 Automatic alarm initiating devices

.6 Audible signal devices

.7 End-of-line devices

.8 Annunciators

.9 Visual alarm signal devices

.10 Ancillary devices

1.4 Shop Drawings

.1 Submit shop Drawings in accordance with Section 16010 - Electrical General Requirements.

.2 Include:

.1 Layout of equipment

.2 Zoning

.3 Complete wiring diagram, including schematics of modules

1.5 Operation and Maintenance Data

.1 Provide operation and maintenance data for Fire Alarm System for incorporation into manual specified in Section 16010 - Electrical General Requirements.

.2 Include:

.1 Operation and maintenance instructions for complete fire alarm system to permit effective operation and maintenance.

.2 Technical data - illustrated parts lists with parts catalogue numbers.

.3 Copy of approved Shop Drawings.

.4 List of recommended spare parts for system.

1.6 Maintenance Materials

.1 Provide maintenance materials in accordance with Section 01300 – Submittals.

1.7 Maintenance

.1 Provide one (1) year's free maintenance with two (2) inspections by Manufacturer during warranty period. Inspection tests to conform to CAN/ULC-S536. Submit inspection report to the City and Contract Administrator.

1.8 Training

.1 Arrange and pay for two (2) on-site lectures and demonstrations by fire alarm equipment Manufacturer to train operational personnel in use and maintenance of fire alarm system. Seminars will use actual demonstration.

.2 A representative from the Manufacturers shall attend the seminar.

2. PRODUCTS

2.1 Materials

.1 Equipment and devices: ULC listed and labeled and supplied by single Manufacturer.

.2 Power supply: to CAN/ULC-S524.

.3 Audible signal devices: to ULC-S525.

.4 Visual signal devices: to CAN/ULC-S526.

.5 Control unit: to CAN/ULC-S527.

.6 Manual pull stations: to CAN/ULC-S528.

.7 Thermal detectors: to CAN/ULC-S530.

.8 Smoke detectors: to CAN/ULC-S529.

2.2 System Operation

.1 Single stage operation. Operation of any alarm initiating device to:

.1 Cause audible signal devices to sound throughout building.

.2 Transmit signal to fire department via monitoring station.

.3 Cause zone of alarm device to be indicated on control panel.

.4 Cause air conditioning and ventilating fans to shut down or to function so as to provide required control of smoke movement.

.5 Cause fire doors and smoke control doors if normally held open, to close automatically.

2.3 Control Panel

.1 Class B

.2 Single stage operation

.3 Zoned

.4 Non-coded

.5 Enclosure: CSA Enclosure 1, c/w lockable concealed hinged door, full viewing window, flush lock and two (2) keys. Enclosure to be suitable for surface wall mounting.

.6 Supervised, modular design with plug-in modules:

.1 Alarm receiver with trouble and alarm indications, for Class B initiating circuit.

.2 Spare zones: compatible with smoke detectors and open circuit devices.

.3 Space for future modules.

.4 Latching type supervisory receiver circuits. Discrete indication for both off-normal and trouble.

.7 Components:

.1 Coded alarm receiver panel with trouble and alarm indications for class B initiating circuit.

.2 Single stage alarm pulse rate panels:

.1 Single stroke control type for output to signal control panel continuously.

.3 Audible signal control panel with two (2) control circuits complete with terminals for wiring and two (2) plug-in modules for dc signals up to 2.0 A load with trouble indication with Class B connections.

.4 Common control and power units:

.1 Control panel containing following indications and controls:

.1 "Power on" LED (green) to monitor primary source of power to system.

.2 "Power trouble" indication.

.3 "Ground trouble" indication.

.4 "Remote annunciator trouble" indication.

.5 "System trouble" indication.

.6 "System trouble" buzzer and silence switch c/w trouble resound feature.

.7 System reset switch.

.8 "LED test" switch if applicable.

.9 "Alarm silence" switch to silence signals manually. If new alarm occurs after signals have been silenced, signals to resound.

.10 "Signals silenced" indication.

.2 Master power supply panel to provide 24 V DC to system from 120 V AC, 60 Hz input.

.5 Auxiliary relays: plug-in type, dust cover, supervised against unauthorized removal by common trouble circuit.

.1 Contact terminal size: capable of accepting 22-12 AWG wire.

.6 Fire Alarm shall be able to communicate with the DCS System via Ethernet connection port.

2.4 Power Supply

.1 120 V AC, 60 Hz input, 24 V dc output from rectifier to operate alarm and signal circuits. Power supply from 120/208 V local power panel. Include surge protection on incoming power wiring.

.2 Standby nickel cadmium battery unit with automatic battery charger to provide supervisory and trouble signal current for 24 hours, plus general alarm load for minimum of five (5) minutes, complete with voltmeter and charging meter. Unit to be sized to carry the complete fire alarm system.

2.5 Manual Alarm Stations

.1 Manual alarm stations: pull lever, wall mounted surface type, non-coded single pole normally open contact for single stage bilingual signage.

2.6 Automatic Alarm Initiating Devices

.1 Heat detectors, fixed temperature, non-restorable, rated 88°C.

.2 Smoke detector: ionization type air duct type with sampling tubes with protective housing.

.1 Twistlock plug-in type with fixed base.

.2 Wire-in base assembly with integral red alarm LED, and terminals for remote alarm LED.

2.7 Audible Signal Devices

.1 Bells: surface mounted, single stroke, polarized, 24 V DC, 250 mm.

.2 Bells: vibrating type, gongs of special alloy steel, 24 V DC, 250 mm.

2.8 End-of-Line Devices

.1 End-of-line devices to control supervisory current in alarm circuits, sized to ensure correct supervisory current for each circuit. Open, short or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel and remotely as indicated.

2.9 Ancillary Devices

.1 Remote relay unit to initiate fan shutdown.

3. EXECUTION

3.1 Installation

.1 Install systems in accordance with CAN/ULC-S524 and TB OSH Chapter 3-4.

.2 Install main control panel and connect to AC power supply.

.3 Locate and Install manual alarm stations and connect to alarm circuit wiring.

.4 Locate and install detectors and connect to alarm circuit wiring. Do not mount detectors within 1 m of air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.

.5 Connect alarm circuits to main control panel.

.6 Locate and Install audible signal devices and connect to signaling circuits.

.7 Connect signaling circuits to main control panel.

.8 Install end-of-line devices at end of alarm and signaling circuits, in a separate box not more than 1,730 mm above finished floor.

.9 Locate and Install remote relay units to control fan shut down.

.10 Mount battery pack and charger in the control cabinet.

.11 Connect remote fire alarm output to Control Panel UV CP1 for alarm transmission to the Administration Building Server Room. Exact location shall be determined on Site.

3.2 Wiring

.1 Ensure conductors are routed in such a manner to provide required fire rating.

.2 Signal circuits to be wired with a minimum 2-# 14 R90 per zone. In no case shall the voltage drop to any signal exceed 10 percent.

.3 Alarm initiating devices to be wired with multi conductor # 18 R90 cables as required in accordance with the Canadian Electrical Code. Circuit resistance shall not exceed 50 ohms.

.4 All wiring will be terminated into the terminal strips in the fire alarm cabinet with all wiring fully labeled. All cabling to be neat with cables bundled and wrapped inside the cabinets. No splicing will be allowed within the cabinets. A complete schedule of all wiring terminations will be mounted inside each control unit. A complete schematic with all devices, cable labeling information, destinations, etc. will be included with the Shop Drawings.

3.3 Field Quality Control

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and System and CAN/ULC-S537.

.2 Fire alarm system:

.1 Test each device and alarm circuit to ensure manual stations, thermal and smoke detectors transmit alarm to control panel and actuate general alarm ancillary devices.

.2 Simulate grounds and breaks on alarm and signaling circuits to ensure proper operation of system.

.3 Class B circuits.

.1 Test each conductor on all circuits for capability of providing alarm signal on line side of single open-circuit fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

.2 Test each conductor on all circuits for capability of providing alarm signal during ground-fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

3.4 Verification and Certification

.1 The Manufacturer shall make an inspection of the fire alarm equipment, including those components necessary to the direct operation of the system such as detectors and controls,

whether or not manufactured by the Manufacturer added under this Contract. The inspector shall comprise an examination of such equipment for the following.

.1 That the type of equipment installed is that designated by the Specification.

.2 That the wiring connections to all equipment components show that the installer undertook to have observed ULC and CSA requirements.

.3 That equipment of the Manufacturer's manufacture has been installed in accordance with the Manufacturer's recommendations and that all signaling devices of whatever manufacture have been operated or tested to verify their operation.

.4 That the supervisory wiring of those items of equipment connected to a supervised circuit is operating and that the governmental regulations, if any, concerning such supervisory wiring have been met to the satisfaction of inspecting officials.

.5 To assist the Contractor in preparing his bid the Manufacturer shall indicate the number of hours necessary to complete this inspection prior to closing of Bids, and the number of hours necessary to provide a seminar on the system for the City.

.2 The system shall be tested and verified according to requirements of CAN/ULC-S537 Standard for Verification of Fire Alarm System Installations. The complete verification procedure will be under the control and supervision of the Contract Administrator. The services of the Contractor and representatives of the fire alarm Manufacturer are required for the verification. The following is a rough breakdown of the responsibilities of each part participating in the verification. The following is a rough breakdown of the responsibilities of each party participating in the verification. This list does not necessarily note all the required Work. The Contractor and fire alarm Manufacturer shall provide equipment and manpower as necessary to complete the verification to the Contract Administrator's requirements and approval.

.3 Contractor:

.1 Remove/reinstall devices

.2 Activate alarms

.3 Activate trouble alarms

.4 Provide one pair of radios

.5 All Work to be 100 percent complete

.6 Provide necessary manpower

.7 Correct deficiencies

.8 Coordinate and schedule verification (all two weeks notice)

.4 Manufacturer:

.1 Ensure correct operation of all alarms, signals, auxiliary functions, trouble indication.

.2 Record all data and issue report and certificate of verification.

.3 Correct any deficiencies.

.4 Check, calibrate, adjust and confirm correct operation of control panels, annunciator.

.5 Generally assure that all aspects of system function properly.

.6 Provide all test equipment, including sound pressure level meter, volt meter, aerosol test smoke.

.5 Contract Administrator:

.1 Direct and supervise verification.

.2 Check and ensure that system is applied and installed to all applicable codes.

.3 Review test documentation, give to the City and fire authorities.

.6 All costs involved in this inspection, including Manufacturers, electrical Contractors included in total price.

.7 Inspection Certification: on completion of the inspection and when all of the above conditions have been complied with, the Manufacturer shall issue to the Contract Administrator:

.1 A copy of the inspecting technician's report showing location of each device and certifying the test results of each device.

.2 A certificate of verification confirming that the inspection has been completed and showing the conditions upon which such inspection and certification have been rendered.

.3 Seal the certificate with the seal of a Professional Engineer registered in the Province of Manitoba.

.4 Proof of liability insurance for the inspection.

.8 Include for complete verification and test of all devices, etc. at six (6) months after completion of initial verification.

END OF SECTION

SECURITY DOOR SUPERVISION

1. GENERAL

1.1 Related Work

.1 General Electrical Requirements: Section 16010

.2 Conduits, Conduit Fastening and Conduit Fittings: Section 16111

.3 Wire and Cables – 0-1000V: Section 16122

.4 Outlet Boxes, Conduit Boxes and Fittings: Section 16132

.5 Instrumentation and Control: Division 17

1.2 Requirements

.1 Installation subject to approval, inspection and test prior to final acceptance.

.2 All equipment to be CSA or ULC approved.

.3 Installation shall conform to the requirements of the Canadian Electrical Code.

1.3 Scope of Work

.1 Provide Motion detector and door contacts at locations indicated on the Drawings and specified herein.

.2 Provide complete conduit system for motion detection door access controllers and door contacts as indicated on Drawings.

.3 Supply and install a complete security CCTV system as indicated on the Drawings and specified herein. System shall be complete with cameras, lenses, housing, mounting hardware, cable and miscellaneous equipment to form a complete operating system. System to be connected to existing switcher and monitoring system located in the Main Administration Building Server Room. Exact termination location to be determined on-site.

1.4 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 16010 – Electrical General Requirements.

2. PRODUCTS

2.1 Motion Detectors

.1 Motion detectors for use in rooms indicated to detect unauthorized movement with in the range of the detector.

2.2 Door Switches

.1 Door switches: suitable for surface mounting on inside of door as indicated.

2.3 Security CCTV System

.1 Cameras to be Pelco CCC2400S-4 colour CCD camera complete with 8 mm wide-angle lens and indoor housing, Pelco EH100-8 wall mounted enclosure.

.2 Camera to be Pelco CCC2400S-4 colour CCD cameras complete with 8 mm wide-angle lens and out door heated housing, Pelco EH3508 wall mounted enclosure.

.3 Camera housing to be suitable for damp location within the building and weatherproof with internal heater for exterior camera.

3. EXECUTION

3.1 Installation

.1 Install a complete wire and conduit system for security equipment as indicated. Minimum conduit size to be 20 mm.

.2 Minimum wire size No. 18 AWG for all hardware. Data link cables to be in accordance with manufactures recommendations. Terminate system wiring in Control Panel UV CP1. Refer to Division 17 for detail of copper to fibre conversion and extension

.3 Conductors termination in panels shall be made on terminal strips with separate point for each conductor. All such stripes to be number identified.

.4 All wiring shall be labeled at each end, termination point or junction.

.5 Install all security equipment indicated.

.6 Test complete system to ensure compliance with the Specification and manufactures recommendations.

.7 Provide power from local 120 V circuits to each camera. All security cameras shall be powered from the same phase.

.8 Security Equipment and CCTV camera units to be connected to new Control Panel UV CP1 for conversion from copper wire to fibre optic. The fibre optics will be installed from UV CP1 control panel to existing main related monitoring equipment located in the Administration Building Server Room. Final connections at this point shall be determined on-site.

END OF SECTION

MOTOR STARTERS TO 600 V

1. GENERAL

1.1 References

.1 NEMA Contactors and Motor-starters

1.2 Related Work

.1 Variable Frequency Drive: Section 16815

.2 Connections to Mechanical Equipment: Section 16950

1.3 Starter Requirements

.1 In general, there are categories of starting equipment for three phase motors.

.1 Integral Mounted Starters: some items of mechanical equipment such as boilers, have the starter mounted as part of the equipment. For this equipment, supply disconnects and wire to the terminals of the equipment.

.2 Separately Mounted Starters: for motors without integral mounted starters, supply separately mounted starters as indicated on the Drawings and wire the equipment.

.2 Provide manual starters for all single-phase motors unless otherwise indicated on the motor schedule.

.3 Provide interlocking between starters where required.

.4 All starter accessories such as pilot lights, Hand-Off-Auto, Start-Stop, etc., whether integrally or remote mounted shall be heavy-duty oil tight, unless otherwise specified.

1.4 Shop Drawings and Product Data

.1 Submit shop drawings in accordance with Section 16010 – Electrical General Requirements and Division 1.

.2 Indicate:

.1 Mounting method and dimensions

.2 Starter size and type

.3 Layout of identified internal and front panel components

.4 Enclosure types

.5 Wiring diagram for each type of starter

.6 Interconnection diagrams

1.5 Operation and Maintenance Data

.1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 16010 – Electrical General requirements.

.2 Include operation and maintenance data for each type and style of starter.

1.6 Maintenance Materials

.1 Provide maintenance materials in accordance with Division 1 Maintenance Materials, Special Tools and Spare Parts.

.2 Provide listed spare parts for each different size and type of starter:

.1 Three (3) contacts, stationary

.2 Three (3) contacts, movable

.3 One (1) contact, auxiliary

.4 One (1) control transformer

.5 One (1) operating coil

.6 Two (2) fuses

.7 10 percent indicating lamp bulbs used

2. PRODUCTS

2.1 Materials

.1 Starters to NEMA Standards

2.2 Enclosure

.1 All individually mounted motor starters shall be enclosed in a general purpose sheet steel enclosure unless in wet areas where they shall be watertight EEMAC 4.

2.3 Manual Motor Starters

.1 Manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:

.1 Switching mechanism, quick make, and break

.2 Overload heaters, manual reset, trip indicating handle

.3 Rated volts and poles to suit application

.2 Accessories:

.1 Toggle switch or push-button: heavy duty oil-tight labelled as indicated

.2 Indicating lights: heavy duty oil tight type and colour as indicated

.3 Locking tab to permit padlocking in "ON" or "OFF" position

2.4 Full Voltage Non Reversing (FVNR) Magnetic Starters

.1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

.1 Contactor solenoid operated rapid action type.

.2 Motor overload protective device in each phase, manually reset from outside enclosure.

.3 Wiring and schematic diagram inside starter enclosure in visible location

.4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.

.2 Combination type starters to include motor circuit interrupter with operating lever on outside of enclosure to control motor circuit interrupter, and provision for:

.1 Locking in "OFF" position with up to three (3) padlocks

.2 Independent locking of enclosure door

.3 Provision for preventing switching to "ON" position while enclosure door open

.3 Accessories:

.1 Pushbuttons or Selector switches: heavy-duty oil tight labelled as indicated

.2 Indicating lights:heavy duty oil tight type and red pilot light to indicate energized motor circuit and where called for, green pilot light to indicate de-energized motor circuit. Pilot lights to be push-to-test transformer type.

.3 In addition to standard, 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

2.5 Multi-Speed Starters

.1 2 speed starters of size, type, rating and enclosure type as indicated. Starter suitable for variable torque type motor and with components as follows:

.1 One-3 pole contactor for each winding for separate winding motors.

.2 Three overload relays with 3 heater elements and manual reset for each speed.

.2 Accessories:

.1 Selector switches: heavy duty, oil-tight labeled as indicated.

.2 Indicating lights: heavy duty, oil-tight, type and color as indicated.

.3 Auxiliary control devices as indicated.

.4 Low speed compelling relay automatic sequence.

2.6 Control Transformer

.1 A control transformer of sufficient VA capacity, dry type, with primary voltage as indicated and 120 V secondary, complete with primary and secondary fuses (HRC Form J), installed in with starter as indicated.

.2 Size control transformer for control circuit load plus 20 percent spare capacity.

2.7 Finishes

.1 Apply finishes to enclosure in accordance with Section 16010 – Electrical General Requirements.

2.8 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.

.2 Manual starter designation label, white plate, black letters, Size 1, engraved as indicated

.3 Magnetic starter designation label, white plate, black letters, engraved as indicated

3. EXECUTION

3.1 Installation

.1 Install starters, connect power, and control as indicated.

.2 Ensure correct fuses and overload devices elements installed.

3.2 Starter Verification

.1 Field check motor starters supplied prior to commissioning equipment. As a minimum, verify the following:

.1 Check of control circuits.

.2 Verify that overload relay installed is correctly sized for motor used.

.3 Record overload relay size and motor nameplate amperage.

.4 Visual inspection of fuses and contactors.

.5 Ensure all connections are tight.

.2 Measure and record motor amps, under load conditions and compare with full load amps and motor service factor. Report any excessive readings and unbalance. Measure voltage as close to motor terminals as possible while motor is running

.3 Set all motor circuit protectors to the minimum level, which will consistently allow the motor to start under normal starting conditions.

3.3 Overload Relays

.1 For starters provided, select overload relays in accordance with relay and motor manufacturers' recommendations, considering motor service factors, ambient temperature, and temperature differences between motor and starter locations. Monitor motor operation during startup to ensure motor operation is satisfactory and relays provide proper protection. For side inlet fans and other long acceleration time loads, provide special overload relays to suite the start-up condition. Provide manufacturers' curves and data sheets where necessary to provide supporting data for motor protection.

3.4 Field Quality Control

.1 Perform tests in accordance with Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems and manufacturer's instructions.

.2 Operate switches and contactors to verify correct functioning.

.3 Perform starting and stopping sequences of contactors and relays.

.4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

VARIABLE FREQUENCY DRIVES

1. GENERAL

1.1 Related Work

.1 Mechanical: Division 15

.2 Process: Division 11

1.2 Scope

.1 Contractor shall supply, install, wire and connect VFD controllers and indicated on the drawings.

1.3 Standards Motor

.1 All VFDs supplied under this Contract shall meet or exceed these Specifications.

.2 Provide a complete inventory (as specified) of spare cooling fans, and fuses, for each VFD supplied.

.3 The adjustable frequency controller shall be designed to operate standard squirrel cage induction motor with a 1.15 S.F. or definite purpose motors meeting NEMA MG1 Part 31.

.4 Harmonic loading will not exceed a motor service factor of 1.0.

.5 Products shall comply with IEEE Standard 519.

.6 VFD units shall be UL listed and CSA certified.

.7 VFD unit shall comply with applicable requirements of the latest standards of CSA, ANSI, IEEE and the Canadian Electrical Code.

1.4 Tests

.1 Factory testing

.1 VFD units are to be factory tested prior to shipment. Provide confirmation from factory of actual tests completed and results.

.2 Provide certified copies of production test results required by CSA and EEMAC, prior to acceptance of the equipment.

.2 Field testing

.1 The VFD supplier shall provide on site startup, fine-tuning, commissioning, operator training and instruction.

.2 The VFD supplier shall provide site functionality test reports indicating loading/current levels during testing as well as control point proving results.

.3 The VFD supplier shall ensure shaft to ground voltages do not exceed 1.5 volts at any speed or load requirement.

.4 Allow for all costs and labour for as many trips as necessary to complete requirements.

.5 It is the intent of this specification to provide a VFD installation that does not adversely affect the electrical system. Included in the Contract Documents is information on the electrical system including:

.1 Single line drawing.

.2 Additional information on electrical system layout and load profile.

.1 The VFD supplier can use this information to evaluate the predicted effect of the VFD installation on the electrical system and advise the Contract Administrator of these effects. For the purposes of analysis, the point of common coupling will be taken as the secondaries of the main service breaker located in the MCC in the Sludge Dewatering Building.

.6 The Contractor, in conjunction with the Contract Administrator, will conduct a harmonic analysis upon completion of fine-tuning and commissioning phase of the installation. The harmonic analysis will be conducted at 50%, 75%, and 100% speed under normal load conditions and perform a Fourier (FFT) transform analysis spectrum for each waveform covering the fundamental to the 31st harmonic. Should the waveform analysis indicate that either the input or output voltage and current levels of the VFD(s) exceed NEMA Standards for electric motors and IEEE 519, the VFD supplier shall provide, at their cost, all the necessary line filtering equipment to correct the harmonic distortion back to the levels prior to the installation of the VFD(s).

.3 Provide certified copies of all production test results required by CSA and NEMA.

1.5 Warranty

.1 In addition to the Warranty specified in GC13 of the General Conditions, the VFD supplier shall provide a warranty coverage for a period of two (2) years upon the Contractor being granted Final Acceptance and the warranty period has commenced.

.2 VFD supplier will review specifications of motors for application compatibility. The Contractor shall obtain and submit written approval from both the motor and VFD suppliers confirming that both pieces of equipment are compatible when used together to maintain the required warranty.

.3 The Contractor shall indicate the level of local support detailing response time if a piece of equipment should happen to fail or malfunction. Details are to include estimated replacement part delivery times, as well as nearest parts depot location and a contact name and phone number. This must be included with all bid submissions.

.4 The VFD supplier shall guarantee that parts for drive units will be available for a minimum of ten (10) years from time of delivery.

2. PRODUCTS

2.1 Variable Frequency Drives

.1 Variable Frequency Drives as supplied by one of the following acceptable manufacturers:

.1 Asea Brown Boveri Ltd. (ABB).

.2 Variable speed controller shall be electronic adjustable frequency and voltage output unit.

.3 The VFD shall employ a minimum 12-pulse pulse width modulated (PWM) inverter system utilizing Insulated Gate Bipolar Transistors (IGBT) power switching devices and come complete with line reactors or DC link filters.

.4 The drive shall be rated for continuous duty while operating a NEMA design induction motor of the sizes and operating voltages as shown in the following schedules and indicated on the drawings. Drive output shall be sized for a 1.0 motor service factor. The VFD shall have a current rating at least 10 percent in excess of the motor full load amp rating. Overload service factors of 110 percent for thirty minutes and 135 percent for one minute must be provided to ensure adequate safety margins. VFD selection shall be based on load current at constant torque ratings. Do not size VFDs based on variable torque maximums.

.5 Input voltage shall be as indicated on motor schedules and drawings (line voltage variation ±10 percent) Based on 120/208 volt systems. Line frequency variation ±5 percent. Output voltage shall vary with motor speed to nominal motor voltage. Speed stability shall be ±1 percent. Drive shall match torque characteristic of load.

.6 Input frequency setting signal will be selective between 4-20 mA or 0-10v DC. Output speed monitoring signal shall be selective between 4-20 mA or 0-10 v DC.

.7 Enclosure:

.1 Drive shall be installed in individual CSA 4 enclosure, drip proof or Nema 4X as indicated on drawings. Filters to be provided for any forced air-cooled enclosures as required by the supplier. VFD(s) shall be suitable for mounting adjacent to pump unit and shall be able to operate under these conditions with no special cleaning requirements. VFD cabinets shall be mounted in such a way that there is adequate room for ventilation and no build up of heat. The minimum clearance in front of VFDs is 1m.

.8 Protective devices to be incorporated are:

.1 Fast acting electronic circuit board protective devices for protection of electronic components.

.2 Line reactor, DC link or filter in the drive input to protect electronic components from transient voltage conditions.

.3 Integral electronic motor overload protection adjustable up to 150 percent of motor rating for sixty (60) seconds.

.4 Overcurrent instantaneous trip 250 percent

.5 Programmable short-circuit protection.

.6 Programmable ground fault protection.

.7 Overvoltage and overcurrent DC bus monitoring and protection.

.8 Undervoltage protection.

.9 Loss of phase and phase unbalance protection.

.10 Inverter over-temperature protection.

.11 Capable of running without motor for startup.

.12 Output filter package (as required) to limit motor voltage to 208 volts maximum at motor terminals. A reflective wave trap mounted at the motor may be used to accomplish this.

.13 Longlead (motor feeder) filter package, as required for these installations. Supplier is responsible to determine where this will be required, and must indicate as to the requirement or non-requirement of longlead filter package components in their bid submission, and the Contractor is responsible for carrying all such costs in their bid price.

.14 Maximum acceptable noise level is 80 dBA at 1 m.

.9 Operation features:

.1 Integral flush mounted display in VFD cover with keypad (mounted on VFD enclosure) for programming, monitoring and operating of drive, accessible through password or other acceptable security measure only.

.2 Fault shutdown and indication.

.3 Automatic restart following power outage.

.4 Ability to disconnect motor load for setup or trouble.

.5 Manual speed control (potentiometer or keypad as required).

.6 Adjustable maximum and minimum speed.

.7 Acceleration and deceleration time adjustment.

.8 Controller "stop" interlock from a NC dry contact.

.9 Drive fault contact.

.10 Stop-start pushbuttons on keypad.

.11 Transient voltage protection.

.12 Provide three (3) dry "C" type contacts programmable for any combination of the following:

.1 Running (output frequency being generated)

.2 Fault lockout

.3 Lock off stopped pushbutton

.4 At speed

.5 Under speed

.6 Forward-Reverse

.7 Low reference

.8 Manual/Auto Mode.

.9 Local/Remote Mode.

.10 On/off indicating lights.

.13 Soft start sequence.

.14 Regenerative braking.

.15 Minimum of three (3) skip frequencies.

.16 Provide Hand/Off/Auto selector switch. Keypad HOA is not an acceptable replacement.

.17 Password protection of parameter programming or some method to prevent unauthorized changes.

.18 Output speed monitoring signal to be selective between 4-20 mA. or 0-10 V.

.10 Environmental capabilities: the drive shall operate without mechanical or electrical damage under any combination of conditions as follows:

.1 Ambient temperature -0° to 40°C.

.2 Humidity 0 to 90 percent (non-condensing).

.3 Vibration up to 0.5 g.

.4 Altitude 0 to 1250 m.

.11 Diagnostic and indicating features:

.1 Power On indication

.2 Percentage speed indicator

.3 Overload indication

.4 Short circuit indication

.5 Ground fault indication

.6 Overvoltage indication

.7 Undervoltage indication

.8 High temperature (controller)

.9 AC voltmeter (output)

.10 AC ammeter (output)

.11 Inverter ready

.12 Inverter fault

.13 External fault

.12 Cooling System:

.1 VFD supplier to provide adequate proven cooling devices for VFD equipment.

.2 VFD supplier to ensure any enclosure utilized will not allow a build up of heat. This can be accomplished by use of fans or sufficiently sized and guarded filtered openings.

.13 Normal Distribution

.1 Normal power distribution is subject to voltage surges and sags as a normal condition of operation. Design and supply with each VFD the required inverter protection such that the VFD will not be stressed or damaged, in the following conditions:

.1 Line transients of up to 3,000 V with energy levels of 50 joules.

.2 Line surges of up to 115 percent of rated voltage for up to 10 cycles, based on 120/208 V systems.

.3 Line voltage sags down to 85 percent of rated voltage of up to one (1) second duration.

.2 Control wiring shall be TEW 105°C rise.

.3 Terminal blocks in separate control enclosures for remote interface shall be Weidmueller SAK6N or approved equivalent.

.4 Provide wire markers at both ends of all control wires, Electrovert Type Z or approved equivalent.

3. EXECUTION

3.1 Operations Manual Information

.1 The Contractor will provide the VFD manufacturer and as built of each motor application. Motor application data will include at a minimum, the following:

.1 Motor manufacturer

.2 Class

.3 Motor model number

.4 Motor serial number

.5 Motor frame

.6 Motor power in kW

.7 Motor full load amps

.8 Motor conductor size

.9 Ground conductor

.10 Length of conductors from VFD to Motor

.11 Motor MCP or fuse and overload

.2 Installation

.1 Identify mounting requirements and include all materials and labour, including concrete pads for all floor-mounted equipment.

.2 Install VFD(s) in locations as indicated on drawings, and connect up all necessary wiring. All VFD(s) are to be mounted as close to the motor as possible. Follow manufacturer's recommendations for maximum distance between the VFD and the motor. The minimum clearance in front of VFDs is 1000 mm. Where required, install longlead motor package.

.3 Division 17 shall extend analog input signal cable, analog speed indicating output cable, shutdown contact and drive fault contact from the drive to the DCS System if required. Analog cable shall be No. 16 shielded twisted pair cable. Control wiring shall be run in conduit separate from VFD supply and motor feeder conduits.

.4 Contractor shall connect all interlocks including (but not limited to) vibration switch, freeze stats, and fire alarms to the VFD. These interlocks will be active in both the Hand (local) and Auto (remote) configurations.

.5 Contractor shall ensure that all control and stop commands shut down the drive as per manufacture's recommended procedure (example, ramp to stop, ramp and hold, or coast to stop). Contactors on the line or load side of the drive are not an approved method of control.

.6 Disconnect switch, VFD and motor isolation switch are to be labelled with proper shutdown procedures as follows:

"Caution"

"Ensure VFD is stopped before operating this switch"

"Record all faults before resetting"

.7 Motor supply cables and conductors shall be run in conduits separate from supply feeders to line side of VFD. No conductors (supply or motor feeders) are to be taped or otherwise bundled within the conduits.

.3 Field Quality Control

.1 Contractor shall be responsible for complete commissioning of each variable speed drive to satisfaction of the Prime Contractor and the City. Contractor shall allow for factory representative to completely calibrate all drive circuits after installation on site.

.2 Contractor shall be responsible to bring Factory representative back to reset, repair, and recommission the VFD during the two (2) year warranty period if problems arise with the normal operation of the VFD. This includes prevention of any motor shaft voltages exceeding 1.5 V when referenced to ground.

.4 Variable Frequency Drive Check-list

.1 The Contractor will furnish a VFD checklist that is to be completed and submitted with the VFD shop drawings. An example of the VFD checklist is attached to this specification section.

.5 Software

.1 Provide VFD programming and troubleshooting software to City.

.2 Provide VFD Parameter list "as programmed during commissioning" for each VFD.

.6 VFD Shop Drawings.

.1 The shop drawings for each type/size of VFD must be specific to that unit. Generic shop drawing shall not be acceptable. The shop drawings are to include dimensions and physical details of the cabinets, a wiring diagram and a ladder diagram showing both internal connections and terminals for field wiring. Separate diagrams are required for each VFD/motor functions. Generic diagrams shall not be acceptable.

.2 Provide lamicoid labels on each VFD disconnect isolation switch as follows:

"Caution"

"Ensure VFD is stopped before operating this switch"

"Record all faults before resetting"

.3 All drawings, manuals, parameter settings, and test reports are to be included with the "Electrical Maintenance Manual". This manual shall be issued in both Hard Copy, and Electronic format.

END OF SECTION

16815. INSTALLED VFD TEST

VFD EQUIPMENT NO. _____ DATE OF TEST _____

DRIVEN MOTOR EQUIPMENT NO. _____

DRIVEN LOAD CHARACTERISTIC: CONSTANT TORQUE _____

VARIABLE TORQUE _____

SETPOINTS:
MINIMUM FREQUENCY _____ Hz

MAXIMUM FREQUENCY _____ Hz

ACCELERATION TIME _____Sec

DECELERATION TIME _____ Sec

SPEED RANGE: MANUAL ____ RPM, _ RPM
CDACS _____RPM, _ RPM

VFD CURRENT AT FULL LOAD: PH.A. _____ Amp, PH.B _____ Amp, PH.C _____ Amp.

MOTOR CURRENT: PH.A. _____ Amp, PH.B _____ Amp, PH.C _____ Amp.

MOTOR NAMEPLATE DATA:

MFR.: _____ MFR. TYPE _____ FRAME _____ hp _____
VOLTS: _____ PHASE _____ RPM _____ SERVICE FACTOR _____

AMPS _ FREQ. Hz AMBIENT TEMP. RATING _____ °C

TIME RATING _____ DESIGN LETTER _____

kVA CODE LETTER _ INSULATION CLASS _____

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ **DATE**

CONTROL DEVICES

1. GENERAL

1.1 Work Included

.1 Control equipment such as (a) pushbutton stations, indicating lights, control and relay panels, are provided under this specification to form complete control system in conjunction with (b) starters, and (c) items provided under Division 15 for example, pressure flow, float, solenoid valves, panels, pneumatic electric switches, transducers, duct and space thermostats except heating systems. Some or all of preceding items are interconnected under Part 3 of this Specification. Specify control components and assemblies, relative work and interface between Divisions 15 and 16. Ensure Work required, to be performed, is indicated on layout drawings, diagrams, and motor starter and control list.

1.2 Shop Drawings

.1 Submit shop drawings in accordance with Section 16010 – Electrical General Requirements.

.2 Include schematic, wiring, interconnection diagrams.

2. PRODUCTS

2.1 AC Control Relays

.1 Convertible contact type: contacts field convertible from normally open (NO) to normally closed (NC), electrically held, solid state timer. Coil rating: as required. Contact rating: as required.

.2 Sealed contact type: electrically held with required poles and front mounted contact block to provide additional poles. Coil rating: as require. Contact rating: as required.

.3 Fixed contact plug-in type: general purpose with required poles. Coil rating: as required. Contact rating: as required.

2.2 Relay Accessories

.1 Standard contact cartridges: NO - convertible to NC in field

2.3 Solid State Timing Relays

.1 Construction: AC operated electronic timing relay with solid-state timing circuit to operate output contact. Timing circuit and output contact completely encapsulated to protect against vibration, humidity and atmospheric contaminants.

.2 Operation: on-delay or off-delay.

.3 Potentiometer: self-contained to provide time interval adjustment

.4 Supply voltage: 120 V, AC, 60 Hz

.5 Temperature range: minus 20°C to 60°C

.6 Output contact rating: maximum voltage 300 V AC or DC. Current: EEMAC B300

.7 Timing ranges: minimum 0.1 s, maximum 60 s

2.4 Instantaneous Trip Current Relays

.1 Enclosure: Canadian Standards Association (CSA) Type 1

.2 Contacts: NO, NC automatic reset with adjustable tripping point

.3 Control: 3 wire, with provision for shorting contacts during accelerating period of motor

.4 Contact rating: EEMAC B600

2.5 Operator Control Stations

.1 Enclosure: CSA Type 1 or 4 as required, surface mounting

2.6 Pushbuttons

.1 Illuminated, Heavy duty Oil tight. Operator flush type, as indicated. Green, with 1-NO and 1-NC contacts rated at as required, labels as indicated. Stop pushbuttons coloured red, provision for padlocking in depressed position labelled "emergency stop".

2.7 Selector Switches

.1 Maintained, two or three position labeled as indicated heavy-duty oil tight, operators wing lever, contact arrangement as indicated, rated as required.

2.8 Indicating Lights

.1 Heavy-duty Oil tight, transformer light emitting diode (LED) type, push-to-test, lens colour: as indicated, supply voltage: as required, lamp voltage: as required, labels as indicated.

2.9 Control and Relay Panels

.1 CSA Type 2 sheet steel enclosure with hinged padlockable access door, accommodating relays timers, labels, as indicated, factory installed and wired to identified terminals.

2.10 Control Circuit Transformers

.1 Single phase, dry type

.2 Primary: 208 V 60 Hz AC

.3 Secondary: 120 V AC

.4 Rating: 100 VA minimum

.5 Secondary fuse as required

.6 Close voltage regulations as required by magnet coils and solenoid valves

3. EXECUTION

3.1 Installation

.1 Install pushbutton stations, control and relay panels, control devices.

3.2 Field Quality Control

.1 Perform tests in accordance with Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at a time and check out operation of section.

.3 Upon completion of sectional test, undertake group testing.

.4 Check out complete system for operational sequencing.

.5 Submit to Contract Administrator one copy of test results.

END OF SECTION

CONNECTIONS TO MECHANICAL EQUIPMENT

1. GENERAL

1.1 Related Work

.1 Mechanical: Division 15

1.2 Requirements

.1 Provide a complete system of wiring to motors and controls as specified herein and as shown on the drawings.

.2 Unless specifically noted otherwise, wire and leave in operation all electrically operated equipment supplied under all contracts related to this project. Examine the drawings and shop drawings of all Divisions for the extent of electrically operated equipment supplied under other contracts.

.3 All control-wiring diagrams shown on the drawings illustrate typical control circuits applicable to the equipment. Control circuits may vary with different manufacturers of equipment. Verify all control circuits with the suppliers of the equipment and make any corrections that may be required.

.4 Unless specifically noted otherwise, supply all pushbuttons, relays, starters, etc., necessary for the operation of equipment. Check all starters, relay coils and thermal elements to ensure that they provide the necessary protection for motors.

.5 Do not operate motors and controls until approval is obtained from the trade providing equipment.

.6 Examine drawings and shop drawings of other Divisions to obtain exact location of motors and equipment shown on drawings. Where necessary, obtain conduit locations from other trades' drawings and shop drawings.

.7 Assist in placing in operation all mechanical equipment having electrical connections.

.8 Provide all power wiring for all motors and control wiring as indicated on the drawings.

.9 In general, wiring for freezestats, firestats, E.P. switches, P.E. switches, dampers, temperature controllers, flow switches, solenoid valves, etc., for heating ventilating and air conditioning (HVAC) equipment will be part of Division 17. Where 120 V power is required for mechanical equipment, i.e., roll type filters, refrigerated aftercoolers, control cabinets, etc. wiring to the equipment terminals is the Work of this Division.

.10 Refer to Motor Equipment Schedule.

2. PRODUCTS

2.1 3 Phase Motor Disconnect Switches

.1 Industrial Type "A", having quick make, quick break visible blade mechanism, cover interlocks and padlocking switch in the closed or open position. Use CSA 2 enclosures for indoor and CSA 3 for outdoor installation. Switches to be H.P. rated, Westinghouse heavy-duty type.

2.2 120 Volt, 1 Phase Disconnect Switches

.1 Manual starter without overload relay

2.3 208 Volt, 1 Phase Motor Disconnect Switches

.1 Manual starter without overload relay

3. EXECUTION

3.1 Installation

.1 Provide disconnect switches adjacent to all motors.

.2 Provide all wiring between all force flow and unit heaters and their thermostats. Install wiring between all flow switches and valve monitors and the fire alarm panel.

.3 Do control wiring as indicated on the drawings and the motor control schedules.

END OF SECTION

STARTING OF ELECTRICAL EQUIPMENT AND SYSTEM

1. GENERAL

1.1 Related Work

.1 Testing, Adjusting, and Balancing of Electrical Equipment and Systems: Section 16980

.2 Electrical Equipment and Systems Demonstration and Instruction: Section 16990

1.2 Coordination

.1 Coordinate starting of electrical equipment and systems with testing, adjusting, and balancing, and demonstration and instruction of:

.1 Electrical equipment and systems specified in Division 16.

.2 Mechanical equipment and systems specified in Division 15.

.3 Other equipment and systems specified in other Divisions.

.2 Where any equipment or system requires testing, adjusting or balancing prior to starting, ensure that such work has been completed prior to starting of electrical equipment and systems.

2. PRODUCTS

.1 Not used

3. EXECUTION

3.1 Energizing Electrical System

.1 Prior to energizing the new electrical system:

.1 Verify supply authority voltage and phase rotation.

.2 Close and open all devices to ensure proper mechanical operation.

3.2 Starting Motors

.1 Prior to starting motors:

.1 Confirm motor nameplate data with motor starter heater overloads.

3.3 Energizing Equipment

.1 Prior to energizing equipment provided under other Sections and equipment provided by the City, confirm equipment nameplate with characteristics of power supply.

END OF SECTION

TESTING, ADJUSTING AND BALANCING OF ELECTRICAL EQUIPMENT AND SYSTEMS

1. GENERAL

1.1 Intent

.1 Except where otherwise specified, arrange and pay for testing, adjusting, balancing and related requirements specified herein.

.2 If test results do not conform to applicable requirements, repair, replace, adjust or balance equipment and systems. Repeat testing as necessary until acceptable results are achieved.

.3 Provide all labour, materials, instruments and equipment necessary to perform the tests specified.

.4 All tests shall be witnessed by persons designated by the City, who shall also sign the test documentation.

.5 Submit procedures proposed in writing for approval two (2) weeks prior to test.

1.2 Related Work

.1 Electrical General Requirements: Section 16010

.2 Starting of Electrical Systems and Equipment: Section 16960

1.3 Manufacturer's Production Test Records

.1 If requested, submit copies of production test records for production tests required by EEMAC and CSA standards for manufactured electrical equipment.

1.4 Site Testing Reports

.1 Log and tabulate test results on appropriate test report forms.

.2 Submit forms to Contract Administrator for approval prior to use.

.3 Submit completed test report forms as specified, immediately after tests are performed.

1.5 Reference Documents

.1 Perform tests in accordance with:

.1 The Contract Documents

.2 Requirements of authorities having jurisdiction

.3 Manufacturer's published instructions

.4 Applicable CSA, IEEE, IPCEA, EEMAC and ASTM standards

.2 If requirements of any of the foregoing conflict, notify Contract Administrator before proceeding with test and obtain clarification.

1.6 Manufacturer's Site Services

.1 Arrange and pay for the site services of appropriately qualified manufacturer's representatives where site testing, adjusting, or balancing of electrical equipment or systems' performed by Manufacturer's representatives is:

.1 Specified, or

.2 Otherwise required to ensure that electrical equipment and systems are operational in full compliance with the Contract Documents.

1.7 Sequencing and Scheduling

.1 Except where otherwise specified, perform all testing, adjusting, balancing and related requirements specified herein prior to Interim Acceptance of the Work.

.2 Perform voltage testing and adjusting after user occupancy or utilization of facility.

2. PRODUCTS

2.1 Test Equipment

.1 Provide all equipment and tools necessary to perform testing, adjusting, and balancing specified herein and as otherwise required.

3. EXECUTION

3.1 Testing of Wiring and Wiring Devices

.1 All power and control wiring shall be tested for insulation resistance value with a 1000 V megger. Resistance values shall be as recommended by cable manufacturer. Test results shall be properly tabulated, signed, dated, and submitted with maintenance manuals.

.2 Test service grounding conductors for ground resistance.

.3 Test all wiring devices for correct operation.

.4 Test all receptacles for proper polarity and circuitry.

3.2 Ground Resistance Testing

.1 Measure ground resistance with earth test meter to verify compliance with CSA C22.2 No. 0.4 and CEC.

3.3 Load Balance Testing

.1 Perform load tests when as many loads as possible, prior to Interim Acceptance of the Work, are operable.

.2 Turn on all possible loads.

.3 Test load balance on all feeders at distribution centres, motor control centre and panelboards.

.4 If load balance exceeds 15 percent, reconnect circuits to balance loads.

3.4 Voltage Testing and Adjusting

.1 Test voltage at all panel boards.

.2 Adjust transformer tap settings to compensate for under-voltage or over-voltage conditions, if directed to do so by Contract Administrator.

3.5 Testing of Transformer

.1 Each transformer shall be completely factory tested and the results certified, proving the performance of the units to provide capacities as listed in these specifications.

.2 Factory tests for each transformer to include:

.1 Resistance measurements of all windings

.2 Ratio test at rated connection and on all taps

.3 Polarity and phase relation tests

.4 Audible sound level tests

.5 No load loss at rated voltage and losses at 25 percent, 50 percent, 75 percent and 100 percent load

.6 Exciting current at rated voltage

.7 Impedance

.8 Applied potential test

.9 Induced potential test

.10 95 kV B.I.L. test

.11 Hi-pot test

.12 Heat run, temperature rise tests on each transformer

.3 Submittals

.1 Submit for review, shop drawings of all items specified in this section in accordance with "Shop Drawings" in the General Conditions.

.2 At completion of Work the prior to final acceptance, provide maintenance manuals for all items specified in this section.

3.6 Coordination and Short Circuit Study

.1 Provide a coordination/protective system study and short circuit study of all equipment specified herein and submit for review. Refer to Section 16405.

3.7 Calibration and Verification

.1 Description

.1 Calibrate and verify the following equipment items supplied under this contract:

.1 Facility main breaker in Sludge Dewatering MCC

.2 600 V and 208V equipment

.2 The calibration and Verification shall be carried out in the field after installation and connection of equipment, but prior to energization, in the presence of the City and the Contract Administrator.

.3 Submittals

.1 Submit details of all test procedures and instruments, together with technicians' names, to the Contract Administrator, prior to proceeding.

.2 Submit written verification report after installation is completed to reflect as-built conditions.

.4 Qualification

.1 This firm shall also perform the final checkout and testing of the equipment specified in Item 3.7 of this Section.

.5 Products

.1 Not applicable.

.6 Calibration and Verification

.1 The calibration and verification shall be carried out in the following stages:

.1 600 and 208 V equipment.

.2 The Electrical Contractor shall advise well in advance when each stage is ready for the calibration and verification and he shall:

.1 Ensure that all equipment is installed, connected and cleaned inside and out.

.2 Provide 120 V convenience receptacles.

.3 Provide a qualified electrician to assist in the calibration and verification.

.4 Provide all other facilities, equipment and personnel as reasonably required to assist in the calibration and verification.

.3 For each circuit breaker, calibrate all protective relays and overcurrent device time and instantaneous trips in accordance with requirements of the protected equipment and overall coordination scheme. Field set each relay according to the recommend settings.

.4 Verify all transformer ratios, insulation values, fuse sizes, C.T. and P.T. ratios, etc. and certify that the installation is in accordance with the requirements of the manufacturer and the Coordination/Short Circuit Study. Submit a written report on this verification to the Contract Administrator.

.5 Carry out the tests required of calibration and verification firm as specified in the other related sections.

.6 Ensure all bus and cable connections are tightened to manufacturer's specifications.

.7 All relays are to be cleaned with dry, dust fee compressed air.

END OF SECTION

ELECTRICAL EQUIPMENT AND SYSTEMS DEMONSTRATION AND INSTRUCTION

1. GENERAL

1.1 Intent

.1 Provide demonstration and instruction sessions to familiarize the City's operation and maintenance personnel with electrical systems and their operation and maintenance.

.2 Submit system sign off sheets for each system listed prior to substantial completion.

.3 Complete a motor survey sheet for each motor and submit prior to substantial completion. Include a control-wiring diagram for each motor neatly drawn in ladder form. Indicate all terminal and wire numbers. Identify all associated control components. Provide typed copies of these lists and diagrams in the O&M manuals. Include motor overload selection charts for each type and application of overload relay.

.4 All sign off and survey sheets shall be typewritten.

1.2 Manufacturer's Site Services

.1 Arrange and pay for appropriately qualified manufacturers' representatives to provide or assist in providing electrical equipment and system demonstration and instruction as specified herein.

1.3 Contractor/City Coordination

.1 City will chair demonstration and instruction sessions.

.2 Establish agendas for demonstration and instruction sessions in conjunction with City. Coordinate scheduling of sessions with City.

2. PRODUCTS (NOT APPLICABLE)

3. EXECUTION

3.1 Systems Demonstration

.1 Demonstrate operation of the following systems:

.1 600/347 V Electrical System

.2 208/120 V System

.3 Mechanical Equipment Connections and Controls (including interface with the fire alarm system)

ELECTRICAL EQUIPMENT AND SYSTEMS
DEMONSTRATION AND INSTRUCTION

MOTOR SURVEY SHEET

Motor Name & Number

Manufacturer

H.P. Max. Ambient °C

R.P.M. Service Factor

Volts / / Insulation Class

AMPS / / EEMAC Design

PHASE Time Rating

Frame Type

Serial #

Model #

Starter Type

OPERATING CONDITIONS

Full Load Operating Amps A B C

Full Load Operating Voltage _____ A-B _____B-C _____ C-A
at Motor

Overload Relay Installed Adjustable Setting %

M.C.P. AMPS Adjustable Setting

Acceleration Time (If over 5 seconds)

Reduced Voltage Starter Tap Setting

Reduced Voltage Starter Transition Time Setting

Special Controls and Remarks (Thermistor and Relay Type, Capacitors and where connected, etc.

ELECTRICAL EQUIPMENT AND SYSTEMS
DEMONSTRATION AND INSTRUCTION

SYSTEM COMPLETION AND COMMISSIONING

SYSTEM:

The above system is installed as per the drawings and specifications, is complete and has been commissioned.

Electrical Contractor

Signed by: Dated:

General Contractor

Signed by: Dated:

Deficiencies Attached ZD?
@DY

This system has been reviewed by:

The Contract Administrator

Signed by: Dated

The City's personnel have been instructed in the operation and maintenance of the above system:

The City

Signed by: Dated

The above does not constitute a waiver of any of the requirements of the Contract Documents.

ELECTRICAL CONTRACTOR	GENERAL CONTRACTOR

Address:

Phone:

END OF SECTION

1. GENERAL

1.1 Requirements of Work

.1 Supply, install, commission, provide Warranty and fully document a complete I&C system as shown on the Drawings and as specified herein. The I&C system contains vendor component subsystems specified in this and other Sections of the Specification.

.2 Component subsystems of the I&C system will include, but are not limited to, the following:

.1 Primary elements and transmitters

.2 Final control elements

.3 I&C field devices

.4 I&C junction boxes

.5 Instrumentation cabling

.6 Instrumentation power supplies

.7 Conduit and cable tray

.8 System marshalling panel with Uninterruptible Power Supply

.9 Rail car unloading control panel

.10 Truck unloading control panel

.3 The Contractor's responsibility also includes receiving, uncrating, examining for shortages or damage, assembling, field fitting, installing, mounting, wiring and testing of vendor supplied component subsystems.

.4 Where packaged, stand-alone control systems are supplied under other Divisions of this Specification, provide cabling to connect to the required remote monitoring and/or control functions. Provide end-to-end Commissioning of all required remote monitoring and/or control functions. Ensure the correct functionality of any equipment supplied under other Divisions of this Specification.

.5 Documentation referred to in 1.1.1 to include as a minimum:

.1 Equipment descriptive data

.2 Equipment installation, service manuals, Operation and Maintenance Manuals and recommended spare parts lists

.3 Schematics and interconnecting wiring diagrams

.4 Records of conductor identification, field terminals, changes, etc.

.5 Instrumentation and control panel Shop Drawings, face layouts, schematics and point-to-point wiring diagrams

.6 Records of as-built information for the complete instrumentation system.

.6 Documentation provided is formatted as follows:

.1 *Process and Instrumentation Diagrams (P & IDs)* – depict the general intent of the control systems and are to be used as the governing document for the scope of Work.

.2 *Instrument Index* – an index of the detailed information for the devices shown on the P & IDs. The index lists the appropriate support documentation for the devices' supply and installation. The instrument index is the controlling document for the supply of materials.

.3 *I/O Index* – an index of the control system I/O points shown on the P & IDs, giving the supporting documentation as per the instrument index.

.4 *Instrument Specification Sheets* - detail the relevant data for the supply of devices.

.5 *ILD* – show typical interconnections and hook-up of devices. The Contractor is to reproduce an ILD for each device and record all relevant as-built information on each sheet for submission at the completion of the Work. Fill in all terminal and wiring numbers etc. from the Shop Drawings as they become available. A set of 'B' size (11 x 17) CAD Drawings and associated files will be made available to the successful tenderer. Where an ILD is not shown for wiring of simple devices provide a legible sketch for as-built information.

.6 *Location Drawings* - indicate in plan and elevation views where the instrument elements are physically located. These Drawings are provided to assist the Contractor in estimating the amount of cable and ducting required.

.7 *Standard Details* – provide a reference for installation, operation and other instructions pertinent to a particular device.

.8 *Detailed Specification* – lists qualifications, quality of materials and workmanship, and supplementary information.

.7 Definitions

.1 Interpret specialized terms not explicitly defined herein in accordance with The ISA S51.1, NEMA ICS 1, ANSI/IEEE Std 100, and The Communications Standard Dictionary, by Martin H. Weik.

.8 References

.1 This Specification contains references to the following Documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed Documents, the requirements of this Section prevail.

Reference	**Title**
API RP550-86	Manual on Installation of Refinery Instruments and Control Systems, Part I--Process Instrumentation and Control Sections 1 Through 13
ASME Section VII-89	Rules for Construction of Pressure Vessels
ASTM B68-86	Seamless Copper Tube
ASTM D883-89	Terms Relating to Plastics
IEEE 100-88	Dictionary of Electrical and Electronic Terms
ISA RP7.1-56	Pneumatic Control Circuit Pressure Test
ISA RP12.6-87	Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations
ISA S5.4-76	Instrument Loop Diagrams
ISA S18.1-79	Annunciator Sequences and Specifications
ISA S51.1-79	Process Instrumentation Terminology
NEMA 250-85	Enclosures for Industrial Controls and System
NEMA ICS 1-88	General Standards for Industrial Control and Systems
NEMA ICS 2-88	Industrial Control Devices, Controllers, and Assemblies
NFPA 70-90	National Electrical Code
SAMA PMC 17-10-63	Bushings and Wells for Temperature Sensing Elements
UBC-88	Uniform Building Code
UL 1012-89	Power Supplies
UL 94-80	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
Weik, Martin H.	Communications Standard Dictionary, Van Nostrand Reinhold Co., 1983

.9 Related Work

.1 Process: Division 11

.2 Mechanical: Division 15

.3 Electrical: Division 16

.10 Qualifications

.1 The Contractor shall be a firm normally engaged and fully competent in the type of Work described in this Section of the Specification. The firm shall have been continuously and successfully engaged in this business for at least five years.

.2 Submit, in accordance with B10.1, a list of similar projects recently completed and resumes of the personnel proposed for the project. Resumes shall include evidence of journeyman status and CET registration.

.3 The instrumentation Subcontractor must be experienced in the process and instrument requirements of this Contract.

.4 The Contractor must show that it maintains a fully equipped and qualified organization, capable of performing the present Work and of providing Warranty service to the system after installation.

.5 Perform all instrument hook-ups, calibrations and checkouts with qualified journeyman instrument mechanics that are licenced and have CET registration. Instrument mechanics must be familiar with the devices being installed.

.6 Perform all control wiring installation and connections with qualified journeyman electricians.

.11 Codes, Rules, Permits and Fees

.1 Comply with all laws, ordinances, rules, regulations, codes and orders of all authorities having jurisdiction relating to this Work.

.2 Comply with all rules of the Electrical Safety Act of the Province, CSA Standards, ULC and the applicable building codes, whether specifically shown on drawings or not.

.3 Give all required notices, submit drawings, obtain all permits, licenses and certificates and pay all fees required for this Work.

.4 Furnish a certificate of final inspection and approvals from an inspection authority to the Contract Administrator.

.12 Standards of Workmanship

.1 Execute all Work in a manner which will result in the completed installation presenting an acceptable appearance, to a level of quality defined in the General Conditions of this Specification.

.2 Employ a competent supervisor and all necessary licensed tradesmen to complete the Work in the required time.

.3 Arrange and install Products to fit properly into designated building spaces.

.13 Install Products in accordance with the recommendations and ratings of the Product Manufacturers, unless otherwise specified or shown.

.1 Supply and execute installation of all instrumentation control tubing in accordance with Division 17.

.14 Contract Drawings and Specifications

.1 Refer to Division 1.

.2 Supply and install all items and accessories specified by the Drawings or the Specification in the quality and quantity required. Perform all operations as designated by the Specification according to the methods prescribed, complete with all necessary labour and incidentals.

.3 Treat any item or subject omitted from this Division's Specifications or Drawings, but which is mentioned or reasonably specified in other Divisions' Specifications or Drawings and pertains to the instrumentation and control system, as being integral to the overall system. Provide such specified items or subjects.

.4 Provide all minor items and Work not shown or specified but which are reasonably necessary to complete the Work.

.5 If discrepancies or omissions in the Drawings or Specifications are found, or if intent or meaning is not clear, consult the Contract Administrator for clarification before submitting Bid.

.6 The responsibility to determine which Division provides various Products and Work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of Specifications.

1.2 Equipment

.1 Submittals

.1 After Award of Contract, submit an equipment list indicating the type and make of all equipment and materials proposed for this project.

.2 Receiving, Storing, and Protection of Components During Construction

.1 Examine each component upon delivery to Site. Report all damage noted to the Contract Administrator prior to accepting or rejecting delivery. All instrumentation primary elements, control components, panels, etc. shall be placed in a secure, dry, heated storage building. Maintain the space temperature above 10°C and the space relative humidity below 50 percent.

.2 Perform a preliminary examination upon delivery to ensure that:

.1 All instrumentation and control components supplied for this project under this Section of the Specification comply with the requirements stated in the instrument Specification sheets.

.2 All instrumentation and control components supplied under other Sections of this Specification, to be connected to instrumentation and control components supplied under this Section of the Specification, comply with the requirements stated in the Contract Documents.

.3 Itemize all non-conformities noted above and forward them to the Contract Administrator. Any delays in construction resulting from the delivery to Site of non-conforming instrumentation and control components to be borne by the Contractor.

.4 Do not install primary elements or other sensitive equipment until construction is sufficiently completed to provide an "operating condition" environment. Notify the Contract Administrator prior to installing any equipment of this type.

.5 Ensure that covers where required are properly installed on all equipment. Provide all covers, padding, guards, etc. as required to guard any equipment against damage.

.6 Return all damaged equipment to the factory for total corrective repairs. If deemed necessary by the Contract Administrator, the damaged equipment shall be replaced with new Product. The Contractor shall bear any costs due to construction delays resulting from the delay in delivery of acceptable equipment.

1.3 Site

.1 Classification of Plant Areas

.1 Refer to Division 16

1.4 Documentation

.1 Bid Submissions

.1 Submit a schedule within 30 days of award of Contract to the Contract Administrator showing projected ordering and delivery dates of all Products to meet the required construction schedule. Provide all necessary information regarding ordering and delivery dates for whose delivery affects the construction schedule.

.2 Submit Shop Drawings for all Products supplied under this Division. Submit Shop Drawings for review prior to delivery of any Products or equipment to Site and sufficiently in advance to allow ample time for checking.

.3 Contractor to review, modify, and approve the Shop Drawings prior to submitting Shop Drawings to the Contract Administrator for review. Contractor approval of a Drawing indicates the following:

.1 The Drawing has been checked by the person making the approval.

.2 The equipment or material complies in all respects with the requirements of the Specifications and Drawings.

.3 The quantities, if indicated on the Drawing, are correct.

.4 The physical dimensions of the components are such that they can be installed without interference with the building structure or other equipment, and that, after installation, there are sufficient clearances on all sides for maintenance, servicing and operation of the equipment.

.5 The points of attachment are clearly indicated, i.e. TOP, BOTTOM, SIDE, etc.

.6 The arrangement and location are properly oriented.

.7 The Product is suitable for its intended use.

.4 Stamp and sign the Shop Drawing to show approval, indicating the above has been complied with. If Contractor revisions are too extensive, return the submission to the supplier for revision, then repeat the Shop Drawing approval process before submitting them to the Contract Administrator.

.5 Manufacture of Products shall conform to Shop Drawings marked as reviewed by the Contract Administrator and returned to the Contractor.

.6 Keep one (1) complete, maintained set of Shop Drawings at the job Site during the construction period, record Site modifications.

.7 Refer to Division 1 for further Shop Drawing requirements.

.2 Operations and Maintenance Manuals

.1 Refer to Division 1 for general Operation and Maintenance Manual submittal requirements.

.2 In addition to the requirements specified in Division 1, provide the following information:

.1 Table of Contents: Arrange contents sequentially by systems under Section numbers.

.2 Systems Descriptions: A brief synopsis of each system typed and inserted at the beginning of each section. Include sketches and diagrams where appropriate.

.3 Maintenance and operating instructions for all equipment and controls: These operating instructions need not be Manufacturer's data but may be typewritten instructions in simple language to guide the City in the proper operations and maintenance of his installation.

.4 A copy of all wiring diagrams complete with wire coding.

.5 Set of final reviewed Shop Drawings.

.3 Record Drawings

.1 Maintain on-site a complete set of as-built Drawings as listed in Division 1 of this Specification.

.2 In addition to the requirements as stated in Division 1, record on the Drawings the following information:

.1 Mark all change orders, alterations or additions

.2 Show all instrumentation cable and control tubing

.3 Show all changes to the numbers and location of outlets, motors, panels and end devices that may occur during the course of the Work.

.3 Before requesting the final completion certificate make any necessary final corrections to the Drawings, sign each print as a certification of accuracy and deliver all sets to the Contract Administrator for approval.

2. PRODUCTS

2.1 General

.1 Refer to the requirements of Division 1

.2 Selected Products and Equivalent

.1 Provide Products and materials that are new and free from all defects.

.2 Products and materials called for on the Drawings or in the Specifications by trade names, Manufacturer's name and catalogue reference are those, which are to be used as the basis for the Bid.

.3 The design has been based on the use of the first-named Product, where applicable equivalent Products are listed.

.4 Provide the Products specified unless a proposal for an alternative or substitute Product has been accepted by the Contract Administrator.

.3 Alternate Products

.1 Refer to B6: Substitutes for consideration of alternate Products.

.2 Alternate Products and materials to those specified will only be considered by the Contract Administrator if they are shown in the Bid as a material variation, and if they are submitted with an appropriate price adjustment. The Contract Administrator will reserve the right to accept or reject any alternative without explanation.

.3 The alternate submission shall provide sufficient information to enable the Contract Administrator to determine whether the alternate is acceptable or unacceptable.

.4 Provide complete information on required revisions to other Work and Products to accommodate each alternate Product.

.5 The Contractor assumes full responsibility when providing alternate Products or materials that all space, weight, connections, power and wiring requirements etc. are considered and compensated for. Any costs incurred for additional components, changes to other services, structural or space requirements, layouts and plans, etc. that may arise from the use of the alternate to be borne by the Contractor.

.6 Materials or equipment rejected by the Contract Administrator to be immediately removed from the Site.

.4 Review of Products

.1 Immediately after notification of award of Contract, review with the Contract Administrator the list of Products to be provided by this Division

.2 After agreement on Product list has been reached, no subsequent changes will be permitted except as specified hereafter.

.5 Substitution of Products After Contract Award

.1 After acceptance of the list of Products, no substitution of any item will be permitted unless the approved item cannot be delivered in time to comply with the Work schedule.

.2 To receive acceptance, proposed substitute Products are to equal or exceed the quality, finish and performance of those specified or shown, and not to exceed the physical space requirements allotted, as shown on the Drawings.

.3 Provide to the Contract Administrator documentary proof of equality, difference in price (if any) and delivery dates, in the form of certified quotations from Suppliers of both specified items and proposed substitutions.

.4 Include costs for any required revisions to other structures and Products to accommodate such substitutions.

.6 Quality of Products

.1 All Products provided to be CSA Approved, and ULC approved where applicable.

.2 If Products specified are not CSA approved, obtain approval of the relevant provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

.3 Refer to Division 1 of this Specification for further information.

.7 Uniformity of Manufacture

.1 Unless otherwise specifically called for in the Specification, uniformity of manufacture to be maintained for similar Products throughout the Work.

.8 Product Finishes

.1 Products to be Manufacturers' standard finish. Where special finishes are specified refer to Division 9 for details on quality and workmanship of the finishes.

.9 Use of Products During Construction

.1 Any equipment used for temporary or construction purposes to be approved by the Contract Administrator and in accordance with Division 1 of this Specification. Clean and restore to "as new" condition all equipment prior to the time of substantial completion.

.2 The Warranty period does not begin until the date of Substantial Completion of the Work.

2.2 Instrumentation

.1 General

.1 Instruments to be suitable for the environmental conditions in which they are to be installed.

.2 Determine where injurious conditions may be expected to occur and make proper provision to protect the instruments to ensure their proper and reliable operation.

.3 Provide power surge protectors, heating cables and devices to protect instruments, equipment and lines from being functionally impaired or damaged by power surges or environmental conditions such as moisture or freezing.

2.3 Identification

.1 Refer to Division 16 for general identification requirements. Provide lamicoid nameplates with 5 mm white lettering on black background. Identify the loop tag number (where applicable) and the device name, function, and instrument range or setpoint value on the nameplate.

.2 Where it is not possible to attach a lamicoid nameplate to a field instrument component, provide the component with a stainless steel metal tag firmly wired to the device and identified with the loop tag number.

.3 Identify all wires where they terminate at the marshalling panels, junction boxes and field devices with a heat shrink sleeve with machine printed labeling.

.4 Clearly mark all panels, pull boxes, junction boxes, etc. to indicate the nature of service.

.5 Provide neatly typed circuit directories for panel power distribution systems to indicate loops or devices powered by the circuit and the fuse size.

.6 Identify all exposed control conduits at all pull box locations, where the conduits enter or leave a room, and 13 m on centre throughout the room. This shall apply to conduits above removable ceilings. Use Thomas & Betts TY-RAP 5532-M labels for conduit identification.

.7 For direct current wiring use black for positive and white for negative.

.8 For thermistor wiring to motors use red and blue coloured, insulated wire.

3. EXECUTION

3.1 Site Examination

.1 Refer to the requirements of Division 1.

.2 No additional compensation will be given for extra Work due to existing conditions that a Site examination prior to Bid should have disclosed.

3.2 Coordination With Other Divisions

.1 Examine the Drawings and Specifications of all Divisions and become fully familiar the Work. Before commencing Work, obtain a ruling from the Contract Administrator on any

conflicting issues between Divisions. No compensation will be made for any costs arising from conflict not identified before Work has commenced.

.2 Coordinate the Work to be performed under this Section of the Specification with all Divisions installing equipment to ensure that there are no conflicts.

.3 Install anchors, bolts, pipe sleeves, hanger inserts, etc. required in ample time to prevent delays to other Division's installation Work.

.4 Lay out the Work and equipment with due regard to architectural, structural and mechanical features. Architectural and structural Drawings take precedence over electrical Drawings regarding locations of walls, doors and equipment.

.5 Structural members shall not be cut without prior approval of the Contract Administrator.

.6 Examine previously constructed Work and notify the Contract Administrator of any conditions, which prejudice the proper completion of this Work.

3.3 Product Handling

.1 Use all means necessary to protect the Products included in this Division before, during and after installation, and to protect Products and installed Work of all other trades.

.2 Any damage to the Products or installed Work shall be repaired or replaced by the Contractor at no additional cost to the City, and to the approval of the Contract Administrator.

.3 Remove advertising labels from all Products installed that have such labels attached. Identification or CSA labels are not to be removed.

.4 Remove dirt, rubbish, grease, etc. resulting from Work performed under this Section of the Contract from all surfaces.

3.4 Separation of Services

.1 Maintain separation between the electrical wiring system, building piping, ductwork, and the instrumentation cables so that each system is isolated (except at approved connections to such systems) to prevent galvanic corrosion. In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is unacceptable.

.2 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings are not to be used for the support of wiring.

3.5 Wire And Cable

.1 Refer to Section 17124.

3.6 Equipment Connections

.1 Prior to the connection of signal wiring to process control and instrumentation devices check the device voltage rating and polarity for compatibility with the corresponding loop and/or schematic diagram. Where device and circuit characteristics are found to be incompatible, the connections are not to be made. Report the condition immediately to the Contract Administrator.

.2 All control-wiring diagrams illustrate typical control circuits applicable to the type of equipment specified. Control circuits may vary with different Manufacturers equipment. Verify all control circuits with the suppliers of the equipment and make any corrections to the control wiring diagrams that may be required.

.3 Provide power disconnect terminals in the marshalling panels for all devices or PLC/DCS input/outputs sourced from the panel.

.4 Provide local power disconnect switches for all 120 VAC power instruments, mounted adjacent to the instrument.

.5 Provide a disconnecting means in the cable connecting each ultrasonic transponder to the transmitter. This disconnect shall consist of a terminal strip in a local WP junction box within approximately 3 m of cable from the transponder.

3.7 Wiring To Equipment Supplied By Others

.1 Equipment supplied by the City or by other Divisions, that have external- or field-mounted control devices, are to be installed, wired and commissioned by this Division.

3.8 Access Panels

.1 Provide access panels where instrumentation and control system junction boxes are concealed. Panels to be of adequate size for servicing of the concealed junction box and complete with necessary frames and hinged doors held closed with captive fasteners. The type and size of panels are to be coordinated with the Contract Administrator.

.2 In removable ceiling areas provide markers on ceiling tile to locate equipment requiring access. Use a 25 mm diameter blue circle painted on the access panel to indicate that it is for instrumentation and control system access.

3.9 Instrument Mounting Stands

.1 Supply and install instrumentation mounting stands as required. Stands are to be either floor or wall mounted. The mounting stands are to be fabricated from aluminum or galvanized steel.

.2 Provide additional corrosion inhibiting coatings on mounting stands in areas where aggressive chemicals are handled or stored.

.3 Supply and install protective drip shields for any exterior stand-mounted instrumentation equipment. Drip shields are to extend 50 mm past the front and side faces of the equipment. Drip shields are to be fabricated from aluminum.

3.10 Sealing Of Wall And Floor Openings

.1 Seal all conduit and cable entries passing through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade.

.2 Seal openings after all wiring entries have been completed.

.3 Sealing material shall be fire resistant and shall not contain any compounds that could chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations, if required, are to be sealed. Acceptable methods are Canstrut "Fire Stop", Electrovert "Multi-Cable Transit" or Dow Corning RTV Silicone Foam.

3.11 Sleeves

.1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.

.2 For walls, partitions and ceilings the ends shall be flush with the finish on both sides. For floors the ends shall extend 100 mm above finished floor level.

.3 Fill the space between the sleeve and the conduit with fire stop material. Caulked around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound. Ensure that the seal is compatible with the floor and ceiling finishes.

.4 Locate the sleeves and position exactly prior to construction of the walls and floors.

.5 Failure to comply with the above requirements shall be remedied at the Contractor's expense.

3.12 Connections to Mechanical, Electrical and Existing Systems

.1 Refer to Division 16 for the required tie-in procedures.

3.13 Testing of Instrumentation Loops

.1 After all devices within a loop have been connected, check the loop for correct functioning and interaction with other loops, where applicable. Provide written notice to the Contract Administrator when the loops are going to be tested so that the tests may be witnessed at the Contract Administrator's discretion.

.2 Check the operation of final control elements such as solenoid valves, actuators, etc. by manual control before checking with automatic control.

.3 Test all tubing for leaks in compliance with ISA RP7.1. Isolate all instruments when tubing is being tested to protect against over pressure.

.4 Perform tests and record results on test data forms, which are included in this Section. Develop additional or more detailed test forms as necessary to suit more complex instrumentation.

.5 Sign and date all test reports. Submit the test reports to the Contract Administrator within five (5) working days of testing.

.6 Coordinate and cooperate with City staff and the equipment suppliers to test control system I/O points during loop testing.

3.14 Calibration

.1 Instruments to be factory pre-calibrated and the calibration verified in-place after installation. Provide a printed record of the factory calibration parameters for "smart" devices.

.2 Prior to calibration completely program all "smart" transmitters including entries of the appropriate range and tag number. Provide a printed record of smart device parameters, configuration, serial numbers, and assigned tag number.

.3 Instruments to be set up and calibrated by an accredited instrument technician working under the approval of the instrument Manufacturer.

.4 Calibrate all instruments to an accuracy of 0.5 percent of full range, or to the Manufacturer's stated accuracy of the instrument whenever an accuracy of 0.5 percent is not achievable.

.5 Prior to instrument installation perform the following applicable calibration for each instrument and its associated signal conditioning equipment:

.1 Calibrate all inline flowmeters by a draw-down test. Where this is not possible, supply accurate portable test meter for on-line comparison.

.2 Calibrate all density meters by lab samples

.3 Calibrate all vacuum and pressure instruments by manometer or accurate test instrument and hand test pump

.4 Calibrate gas detectors using standard gas samples

.5 Calibrate temperature instruments against a standard lab thermometer.

3.15 Commissioning

.1 Refer to the requirements of Division 1 for additional Commissioning requirements.

.2 Inspections

.1 Provide two weeks' written notice to the Contract Administrator prior to energizing any system to allow for inspection by the Contract Administrator of the following:

.1 Proper mounting.

.2 Proper connections.

.2 During Commissioning demonstrate to the Contract Administrator proper calibration and correct operation of instruments and gauges

.3 Commissioning of the instrumentation and control system to include but not be limited to the following.

.1 Installation of components, wiring connections, and piping connections.

.2 Wiring continuity and pipe leak tests.

.3 Verify instrument calibration and provide written report.

.4 Function check and adjust under operational conditions the instruments and control equipment.

.5 Coordinate instruments and control equipment supplier's service personnel as required for complete system testing.

.6 Instruct plant personnel in correct method of operation of instruments and control equipment.

.7 Direct plant personnel at handover as to final adjustment of the system for correct operation of plant.

.8 Ensure that the instrumentation and control equipment suppliers cooperate to complete the Work of this Section.

.9 Verify signal levels and wiring connections to all instrumentation and control equipment.

.10 Coordinate and cooperate with City staff and the equipment suppliers to commission control system I/O points during equipment Commissioning.

3.16 Training

.1 Provide training, described in detail in Division 1, as required by the plant's personnel to become fully competent in the proper operation and maintenance of all control devices, control valves, and ancillary instrumentation described under this Section of the Specification.

3.17 Test Forms

.1 ITR: Instrument Test Report

.2 LCR: Loop Check Report

LOOP CHECK REPORT

☐ CHECKED OUT OK
☐ NOT APPLICABLE
☐ FURTHER ACTION REQUIRED

	INSTRUMENT TAG NO.								
LOOP NO. _____ SHEET NO. _____ P&ID NO. _____									
INSTALLATION COMPLETE									
Primary Element									
Impulse Lines									
Block and Drain Valves									
Air Supply/Filter/Reg.									
Wiring									
Tracing/Insulation/Housing									
Mounting and Location									
PLC/SCADA I/O & Status									
CALIBRATED									
Impulse Lines Press. Tested									
LOOP CHECKED									
Element To Receiver									
X Mtr. to Receiver									
X Mtr./Trans. to Receiver									
X Mtr./Trans. to Switches									
Switches to Annunciator									
Interlocking Circuit									
Controller to Valve									
Controller Action D or R									

REMARKS:

READY FOR START-UP

DATE: _____

Installed by: _____

Checked by _____

INSTRUMENT TEST REPORT

SYSTEM: _____ _____

SERVICE: _____ TAG NO._____

LOCATION: _____ _____

MAKE: _____ MODEL: _____

SERIAL NO.: _____ CSA: _____

ELEMENT: _____ RANGE: _____

DESIGN SETTING/RANGE: _____ CONTACT TO: _____ ON: _____

SIGNAL IN:_____ OUT:_____ ASSOCIATED INSTRUMENT: _____

INSTRUMENT CONDITION: _____ CONFORM TO SPEC: _____

PROJECT NO.:_____ DATA SHEET: _____

	TEST 1				TEST 2			
TEST METHOD								
	INPUT		**OUTPUT**		**INPUT**		**OUTPUT**	
PROCESS	**INC.**	**DEC.**	**INC.**	**DEC.**	**INC.**	**DEC.**	**INC.**	**DEC.**
TEST POINT 1								
TEST POINT 2								
TEST POINT 3								
TEST POINT 4								
TEST POINT 5								
COMMENTS								
GRAPHS								

TESTED BY: _____ CHECKED BY: _____

DATE: _____ DATE: _____

END OF SECTION

ENCLOSURES

1. GENERAL

1.1 References - General

.1 Suppliers, Equipment, Products, and Execution must meet all requirements detailed in Section 17010.

2. PRODUCTS

2.1 General

.1 Unless otherwise specified, provide outside finishes on all enclosures in ANSI 61 Grey as specified in Division 9.

.2 The enclosures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors without any warpage.

2.2 Enclosures

.1 Provide EEMAC Type 1A gasketted enclosures in MCC rooms and control rooms.

.2 All enclosures for mounting outside of MCC rooms and control rooms to be EEMAC Type 4, watertight except where otherwise specified.

.3 Provide EEMAC 7/3R enclosures for equipment in and around classified areas such as sumps.

.4 Enclosures for certain equipment in corrosive atmospheres to be EEMAC 4X approved for the classification (e.g. chemical cleaning).

.5 Enclosures for mounting field control indicator lamps and switches in unclassified areas to be Allen Bradley model 800T-xTZ die cast enclosures.

.6 Enclosures for mounting field control indicator lamps and switches in Class 1 areas to be Allen Bradley model 800H-xHHX7 cast aluminum enclosures.

2.3 Panel Enclosures

.1 Fabricate panel enclosures from 11 gauge steel panels complete with necessary stiffening to form a rigid free-standing lineup. The structures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors. Provide removable top and bottom cable entry plates.

.2 Provide panels with front access only. Doors shall be key lockable and fitted with 3-point heavy duty latching assemblies. Provide a continuous piano hinge and a pneumatic hold open device on each door.

.3 Finish the interior of the enclosure with white paint. Provide a switched fluorescent light fixture and 120 VAC duplex convience receptacle inside the enclosure.

2.4 Marshaling and Control Panels

.1 Supply, fabricate, checkout, layout, document and deliver to Site fully equipped and functional panels**.**

.2 Supply all components contained on or within the panels fully wired under this Section of the Specification.

.3 The Selection of all accessories, materials and methods for fabrication not covered by this Specification, but which are necessary to complete the fabrication of the control panels, is the responsibility of the panel fabricator.

.4 Marshalling and control panels shall be adequately sized to facilitate a professional, uncluttered arrangement. Provide adequate internal and external space to accommodate a 20 percent increase in each type of component used. Allow space for future installation of at least one (1) additional PLC or DCS rack as appropriate.

2.5 Wiring and Accessories

.1 Provide wiring inside the panels according to the following Specifications:

.1 Control wiring to be a minimum of #16 AWG tinned stranded copper; insulation rated at 600 V.

.2 Wiring for power distribution shall be a minimum of #14 AWG tinned stranded copper; insulation rated at 600 V.

.3 Refer to Division 16 for cable routing requirements.

.2 Tag each wire at both ends with a heat shrink sleeve that is machine printed.

.3 Wiring systems with different voltage levels or types shall be suitably segregated within the panel, according to relevant electrical codes.

.4 Run all wiring in enclosed plastic wireways such as Panduit. Size all wireways so that the total cross sectional area of the insulated wire and cable does not exceed 40 percent of the cross sectional area of the wireway.

.5 Provide a minimum clearance of 40 mm between wireways and any point of wire termination.

.6 Terminate all wiring, incoming and outgoing, at terminal strips mounted inside the panels. Identify each terminal strip with a terminal strip number, defined as follows:

.1 Wire identification to use the connected field device tag name with the wire's corresponding terminal number appended to it.

.2 Identify every joint and terminal of the above wire run with the same identifier until the wire meets another tagged device, at which point the wire identifier will change to use the new device name and terminal number.

.3 For example, pressure transmitter K4-PT-100A located in the field has a 2CTPSH cable connected to it. The cable runs through a junction box to a marshaling panel. The wire identifiers for the pair of wires would be K4-PT-100A all the way to the marshaling panel.

.4 Identify spare wires by using the destination identifier, i.e. the location and terminal identifier of the opposite end of the wire are combined to form the wire tag.

.7 Provide a 120 VAC panel power distribution system and a 24 VDC power distribution system in each panel. Provide additional power supplies within each cabinet as required to accommodate installed devices. Provide a thermal magnetic circuit breaker on each main power circuit and a fused terminal block for each branched circuit off the main. Where two or more 120 VAC circuits are specified for a marshalling or control panel, one circuit shall be dedicated to the UPS system supplying control circuits, one circuit shall be dedicated to panel lighting and utility receptacle, and remaining circuits are either spare or as noted on the drawings.

.8 Provide disconnect type terminal blocks Wieland WK4TSK/U type to isolate field wiring that is powered sourced from the panel.

.9 Provide sufficient terminals so that not more that two wires are connected under the same terminal. Provide 20 percent spare terminal capacity at each terminal block assembly.

.10 Terminals shall be Wieland Type WK4/U color coded as follows:

.4 Red: positive 24 VDC

.5 Black: 0 VDC common and analog signal plus

.6 White: analog signal common and VAC neutral

.7 Grey: 120 VAC

.8 Green: ground

.11 Provide nameplates for each device on or within the panels and enclosures. Nameplates shall be black lamicoid with white lettering, a minimum of 25 mm x 75 mm in size with up to three lines of 5 mm lettering. Securely fasten nameplates in and situate them in a visible location.

.12 All conductors entering a panel and all installed PLC and/or DCS I/O points must be terminated at terminal blocks and spares must be appropriately labeled. Terminal blocks shall be grouped according to I/O type and I/O card number. Each I/O point shall be

individually fused with blown-fuse indicators and analog loops shall contain a disconnect type terminal block for testing purposes.

2.6 Panel Grounding

.1 Provide a ground system for the instrumentation circuits, isolated from the main power system ground to each marshaling panel.

.2 Provide grounding lugs for each panel, suitable for termination of up to #2 AWG copper grounding conductor.

.3 Provide in each marshaling panel an isolated grounding bus bar 6 x 25 x 600 mm, equipped with necessary lugs for accepting two #2 AWG grounding conductors.

.4 Firmly bond all panel-mounted devices on or within the panels to ground. Provide supplementary bonding conductors for backpanels and doors. Attach a separate bonding conductor to all devices that are not firmly fastened to the panels with screws for such devices as case mounted instruments, meters, etc.

3. EXECUTION

3.1. References - General

.1 Refer To Section 17010, Part 3.

3.2 Mounting Heights

.1 Unless otherwise specified or a conflict exists, mount all panels, starters and disconnects 2000 mm to top of cover.

END OF SECTION

INSTRUMENTATION CABLE

1. GENERAL

1.1 Product Data

.1 Submit Product data in accordance with Division 1 and Division 16.

1.2 Related Work

.1 Refer to Division 16.

1.3 Inspection

.1 Provide adequate notice to the Contract Administrator so that all cable installations can be inspected prior to connecting equipment.

1.4 Standards

.1 All wire and cable shall be CSA approved.

2. PRODUCTS

2.1 Twisted Pair Shielded Cables (TPSH)

.1 TPSH shall be constructed as follows:

.1 Two (2) copper conductors, stranded, minimum #18 AWG, PVC insulated, twisted in nominal intervals of 50 mm.

.2 Insulated for 600 V, 90°C.

.3 100 percent coverage aluminum foil or tape shield.

.4 Separate bare stranded copper drain wire, minimum #18 AWG.

.5 Overall flame retardant PVC jacket to CSA-C22.2.

.6 The entire cable assembly to be suitable for pulling in conduit or laying in cable tray.

.7 Shaw Type 1751-CSA or Beldon equivalent.

.2 Where multiconductor TPSH cables are called for, each pair shall be individually shielded, continuous number coded, and the cable assembly shall have an overall shield and overall flame retardant PVC jacket.

2.2 RTD And Multi Conductor Shielded Cable

.1 RTD cables shall be CSA approved and shall be constructed as follows:

.1 Three or more copper conductors, stranded, minimum #18 AWG.

.2 PVC insulated for 600 V.

.3 100 percent coverage aluminum foil or tape shield.

.4 Separate bare stranded copper drain wire.

.5 Overall flame retardant PVC jacket to CAS-C22.2

2.3 Teck Cables

.1 As per Division 16.

2.4 Wire

.1 As per Division 16.

2.5 Fiber Optic Cables

.1 Provide fiber optic cable assemblies where indicated in the Specification and Drawings.

.2 Fiber optic cables shall be constructed with specified quantity of 62.5/125 µm multi-mode glass fibers with individual and overall PVC jacket, spiral interlocked armour, and outer PVC jacket FT4 rated.

.3 Provide terminations for fiber optic cables including; buffer tube fan out kits, connectors, termination panels, and wall mount enclosure.

.4 Provide fiber optic jumpers 62.5/125 µm multi-mode for inter-cabinet connections.

3. EXECUTION

3.1 Analog Signals

.1 Use TPSH cable for all low level analog signals such as 4-20 mA, 1-5 VDC, 0-10 VDC, pulse type circuits 24 VDC and under, and other signals of a similar nature.

.2 Use RTD cable for connections between RTDs and transmitters or control system RTD inputs.

3.2 Digital Signals

.1 Use TPSH cable for all low level input (24 V and below) and output signals to the control system.

.2 Use Teck cable or wire and conduit for power to instruments, for 120 V signals other than those mentioned above and as otherwise indicated on the Drawings. Use stranded wire and cable to supply power to instruments.

3.3 Installation

.1 Install instrumentation cables in conduit systems or in cable trays. Use a minimum of 300 mm length of liquid tight flexible conduit to connect the field sensors to the conduit.

.2 Where non-armoured instrumentation cables are installed in cable trays, provide barriers in the tray to separate instrumentation cables from power cables.

.3 At each end of the run leave sufficient cable length for termination.

.4 Do not make splices in any of the instrumentation cable runs. Where splices are required, obtain approval from the Contract Administrator prior to installing the cable.

.5 Where splices are necessary in instrumentation cables other than coaxial cables, perform such splices on terminal blocks in terminal boxes. Keep splices in instrumentation cable to a minimum and separated physically from power circuits. Cable shields shall be terminated on insulated terminals and carried through to the extent of the cable.

.6 Where splices are made to coaxial cables, use standard coaxial cable connectors

.7 Ground cable shields at one end only. Unless otherwise specified, ground the shields at the marshalling panel.

.8 Protect all conductors against moisture during and after installation.

3.4 Conductor Terminations

.1 All equipment supplied shall be equipped with terminal blocks to accept conductor connections.

.2 Instrumentation conductors, where terminated at equipment terminals other than clamping type terminal blocks, shall be equipped with Burndy-YAE-2 or STA-KON, self-insulated, locking type terminators, sized as required to fit conductors and screw terminals.

.3 Terminations of fiber optic cables shall be performed by factory trained technicians with appropriate tools and testing equipment.

3.5 Testing

.1 Test all conductors for opens, shorts, or grounds. Resistance values shall not be less than those recommended by the cable Manufacturer.

.2 Test all fiber optic cables and terminations for signal integrity and Manufacturer's Specifications.

3.6 Identification

.1 Identify all instrumentation cables.

.2 Identify each conductor with wire numbers using a machine printed heat shrink wire marker, similar to Raychem TMS or equivalent.

END OF SECTION

POWER SUPPLIES

1. GENERAL

1.1 References - General

.1 Refer To Section 17010.

2. PRODUCTS

2.1 Power Supply and Conditioning Equipment

.1 General

.1 Provide all DC power supplies as required for all instrument circuits. All circuits to be powered from the marshalling panels. Power supplies to be equal to Hammond or G.F.C., complete with an overvoltage protection module.

.2 Provide redundant configurations for power supply equipment serving more than one instrument loop, so that failure of a single unit will not disable all or any shared part of the instrumentation and communication system. Provide diode isolation for redundant direct current supply units, and ground the negative terminal of the power supply.

.3 Power supplies and transmitters feeding circuits that run in non-armoured cable in cable tray shall meet the requirements for Class 2 circuits as defined under Section 16 of the Canadian Electrical Code Part I.

.4 Unless otherwise required, all DC power supplies to be rated 28 VDC, adjustable plus or minus 5 percent, and set to provide 26.4 V on the panel direct current bus. Size the power supply for two times the connected load, minimum size is 2 A.

2.2 Noise Suppression

.1 Provide power conditioners in each panel to power AC instrumentation and control loads. Power conditioners are Oneac Series CX.

2.3 UPS Power Supply

.1 Provide an UPS in each panel to power the control system equipment. All UPS systems shall be true on-line types, switching types will not be accepted.

.2 All UPS systems shall include automatic bypass feature that will pass utility power to the load(s) in the event of internal system failure.

.3 Provide a UPS for each computer workstation. Connect the workstation and its associated peripherals such as network concentrators, printers, etc. to the UPS.

.4 Size UPS standby capacity for 30 minutes at full load rating.

.5 Provide on-line units from Exide, Oneac, Toshiba or Best.

3. EXECUTION

3.1 References - General

.1 Refer To Section 17010, Part 3.

END OF SECTION

SWITCHES AND RELAYS

1. GENERAL

1.1 References - General

.1 Refer To Section 17010.

2. PRODUCTS

2.1 General

.1 Use normally closed contacts for alarm actuation which open to initiate the alarm.

.2 Use normally open contacts to control equipment. The contacts close to start the equipment.

.3 Contacts monitored by solid state equipment to be hermetically sealed and adequately rated for the connected load.

.4 Contacts monitored by electromagnetic devices such as mechanical relays to be rated NEMA ICS 2, designation B300.

.5 Provide double barriers between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.

.6 Switch electrical enclosures to be rated EEMAC 4, minimum.

2.2 Indicators, Pushbuttons and Selector Switches

.1 All control indicator lamps, pushbutton switches and selector switches in unclassified or non-corrosive areas to be Allen Bradley 800T or 800E series items.

.2 All control indicator lamps, pushbutton switches and selector switches in classified or corrosive (includes outdoors) areas to be Allen Bradley 800H series items.

.3 Enclosures to be as specified under Section 17110.

2.3 Relays

.1 The quality and type of relays shall be based on Omron types.

.2 120 VAC relays to be Model LY 4PDT, plug-in, complete with test button and operation indicator, and surge suppressor.

.3 24 VDC relays to be Model MY 2PDT plug-in, complete with test button and operation indicator, and surge suppressor diode.

.4 Time delay relays for behind panel mounting to be Model H3BA, 2PDT, plug-in, and programmable for 16 time ranges and 4 operation modes.

.5 Time delay relays for flush panel mounting and operator accessible timing range modifications to be Model H5BR, SPDT, screw terminals, programmable for 5 timing ranges and 8 operation modes, complete with digital display, module for time settings and flexible protective cover.

.6 Where the contact ratings of the relays listed are insufficient for the application select an appropriate type from an approved Manufacturer with the same quantity of contacts as was originally specified.

.7 Provide relay plug-in sockets for DIN mounting complete with stacked screw clamp terminals.

3. EXECUTION

3.1 References - General

.1 Refer To Section 17010.

END OF SECTION

SIGNAL CONDITIONING MODULES

1. GENERAL

1.1 References - General

.1 Refer To Section 17010.

2. PRODUCTS

2.1 Signal Conditioning Modules

.1 Where required, provide signal conditioning modules which comply with the following requirements, unless otherwise specified:

.1 Analog signal inputs: 4-20 mA DC into 500 ohms

.2 Analog signal outputs: 4-20 mA DC into 500 ohms

.3 Discrete output contacts: SPDT rated 5A

.4 Arrange electronic trips so that output contact opens in case of loss of signal or loss of power supply.

.5 Modules to be rated for continuous operation in an ambient temperature of 0 to 80°C. Ambient temperature effect not to exceed plus or minus 0.01 percent per degree C within that range.

.6 Span and zero adjustments to be made by front accessible multi-turn potentiometers or keypad.

.7 Provide electronic trip modules with LED indicators for relay status.

.8 Modules to withstand 30 V per metre radio frequency radiation between 200 and 500 MHz with not more than 0.25 percent calibration effect. Provide modules with traps on the terminals to shunt conducted radio frequency interference to ground.

.9 Galvanically isolate signal and power supply terminals from the case.

.2 All modules specified in this Section to be the Product of a single Manufacturer.

2.3 Current to Pneumatic (I/P) Converters

.1 Not used.

3. EXECUTION

3.1 References - General

.1 Refer To Section 17010, Part 3.

END OF SECTION

PANEL INSTRUMENTS

1. GENERAL

1.1 References - General

.1 Equipment, Products and Execution shall conform to Section 17010.

2. PRODUCTS

2.1 Electronic Panel Instruments

.1 Provide panel instruments with the following requirements, unless otherwise specified:

.1 Analog instruments to be miniature-case drawout type nominally 150 mm high by 75 mm wide by not more than 350 mm deep.

.2 Make the operator, tuning and configuration adjustments accessible without disconnecting the instrument from the process.

.3 Analog signal indicators to be solid-state, LED or gas-discharge type, including bar-graph displays with not less than 200 segments. Backlit LCD indication is also acceptable.

.4 Analog signal inputs to be 4-20 mA VDC.

.5 Analog signal outputs to be 4-20 mA VDC into 500 ohms.

.6 Galvanically isolate the signal and power supply from the instrument case.

.2 Panel instruments specified in this Section are to be the Product of a single Manufacturer, and to match and line up to form an integrated appearance and operator interface strategy.

3. EXECUTION

3.1 References - General

.1 Refer To Section 17010.

END OF SECTION

MISCELLANEOUS PANEL DEVICES

1. GENERAL

1.1 References - General

.1 Equipment, Products and Execution must meet all requirements detailed in Section 17010.

2. PRODUCTS

2.1 Miscellaneous Panel Devices

.1 Pilot Lights

.1 Provide pilot lights of the LED transformer type for extended lamp life, oil tight, push to test, complete with appropriate colour lenses. Normal colours used are run=red, stop=green unless otherwise depicted elsewhere. Refer to Division 16 for additional information

.2 Terminals

.1 Provide strap screw type terminal blocks rated for 600 volts.

.2 Identify each terminal block within an enclosure with a unique machine printed terminal block number. Cabinet chassis grounding terminal blocks to be identified by the electrical ground symbol.

.3 Connections to screw terminals to be locking fork tongue insulated crimp type wire connectors.

.4 Terminals to be Weidmuller or approved equal.

.5 Provide a group of terminals for each of 120 VAC hot and neutral and 24 VDC positive and negative power. Distribution wiring to have a thermal magnetic circuit breaker upstream of all major blocks of loads, adequately sized to protect the connected load while not causing nuisance tripping.

.6 Provide Weidmuller disconnect type terminal blocks for each load or loop powered from the marshalling panels.

.3 Nameplates

.1 Refer to Section 17010 for nameplate Specification.

2.2 Signal Current Isolator

.1 Isolator to provide galvanic isolation of milliampere transmission signals from transmitters with inadequately isolated output circuits.

.2 Isolator to be housed in a NEMA 250, Type 4/7 conduit body and derive its operating power from the signal input circuit.

.3 Input and output signals to be 4 to 20 mA, with an error not exceeding 0.1 percent of span. Input resistance will not exceed 550 ohms with an output load of 250 ohms.

.4 Isolator to be Moore Industries.

2.3 Intrinsic Safety Barriers and Relays

.1 Provide intrinsic safety barriers where required for two-wire transmitters of the active, isolating, loop powered type: MTL Type MT3042, Stahl 9005/01-252/100/00, P+F ZG series, or equal.

.2 Provide dual type intrinsic safety barriers for process switches; MTL 787, Panalarm 201-BR2.

.3 Intrinsic safety relays to be Gems, or Warrick.

2.4 Industrial Ethernet Switches

.1 Switches shall comply with IEEE 802.3, 802.3u, 802.3x, 802.1D.

.2 Switches shall include a minimum of 6 10/100 Base T(x) RJ45 Ports and 2 multimode 100 Base FX Fiber ports.

.3 Switches shall include one (1) relay output alarm contact rated for 1 A at 24 VDC.

.4 Input power shall be capable of ranging from 9 to 32 VDC with redundant inputs.

.5 Switches shall be fast spanning for a sub-second recovery in a ring configuration.

.6 Switches shall be Eagle Technology ED6008 Series or approved equal.

2.5 NTSC Fiber Transmitters/Receivers

.1 Models shall have a minimum of four (4) NTSC compliant channels and one (1) multimode fiber channel.

.2 Transmitters and receivers shall be supplied with a regulated switching power supply with a 120 VAC input.

.3 Transmitters and receivers shall be Pelco FT8304MSTR and FR8304MSTR respectively.

3. EXECUTION

3.1 References - General

.1 Refer To Section 17010, Part 3.

END OF SECTION

CONTROL AND OPERATOR INTERFACE REQUIREMENTS

1. GENERAL

1.1 General Requirements

.1 Design, supply, and installation of an ABB INFI 90 Termination Cabinet complete with I/O termination units, wiring, and related ancillaries to interface with the existing DCS. This new termination cabinet(s) will be sized to accommodate the new inputs and outputs associated with the Phosphorus Removal Facility as defined herein and Section 17600 DCS I/O Index. The cabinet and related internal components shall be supplied complete, wired, tested, and ready for connection of main power supply and communication circuits.

.2 The new termination cabinet(s) will be located in the existing Dewatering Building Control Room adjacent to existing DCS termination cabinets.

.3 Cooperate with other contractors, the Contract Administrator, and City staff to complete the interface of the Phosphorus Removal Facility with the existing DCS.

.4 Assist with the start-up and commissioning of the complete control system and associated field devices and wiring.

2. PRODUCTS

2.1 ABB INFI 90 Termination Cabinet and I/O Hardware

.1 General

.1 All new control system equipment to be based on the ABB Harmony family as applicable (no substitutions allowed).

.2 Control system logic configuration shall be done on the existing Plant DCS system by City personnel.

.3 All communication equipment required to interface to the existing Plant DCS system shall be supplied and installed.

.4 New termination cabinet(s) shall be selected and painted to match existing termination cabinets in the Dewatering Building control room.

.5 Provide at least 20 percent spare I/O of each type in each panel assembly.

.6 Provide all necessary DIN rail, mounting bases, power supplies, cables, communication cards, and accessories.

.7 Provide spares of all ABB system components (minimum of one of each exact type) supplied including: power supplies, communication modules, input/output modules, and termination units.

.8 Provide redundant power supplies and 25 percent spare power supply capacity for each panel assembly.

2.2 System Integration Requirements

.1 Cooperate and coordinate activities with other contractors, City staff, and the Contract Administrator to facilitate installation, testing, and commissioning of the Phosphorus Removal Facility.

.2 Supply, install, test and commission the Phosphorus Removal Facility's control panel(s) as specified in this Division and as shown on the Drawings.

.3 Assist the City and equipment vendor to establish interface between the new termination cabinet(s) and the existing DCS. Assist in the testing of all new system inputs and outputs.

.4 All equipment testing and commissioning responsibilities must be carried out while at the same time maintaining the Plant DCS. Any equipment outage requirements are to be kept to a minimum and are to be scheduled with the Contract Administrator prior to implementation.

3. EXECUTION

3.1 Performance – General

.1 Refer to Section 17010, Part 3

3.2 Installation

.1 Provide hardware in accordance with the foregoing requirements in sufficient quantity to satisfy the performance requirements defined in this and other Divisions of the Specification.

.2 Provide all necessary documentation to define the control system including details for all hardware.

.3 Commission and start up the system as defined herein.

.4 Provide all documentation and training as defined herein.

.5 Maintain existing plant operation during entire duration of the Work. Refer to the requirements of Division 1.

END OF SECTION

DCS INPUT/OUTPUT INDEX

1. GENERAL

1.1 References - General

.1 Refer To Section 17010.

1.2 PLC I/O Index

.1 The following spreadsheet gives an itemized list of the I/O between the DCS and the field devices. It is intended to serve as an aid for determining the cabling requirements for the Work specified in this Division.

2. PRODUCTS

.1 Not used.

3. EXECUTION

.1 Not used.

DCS INPUT/OUTPUT INDEX

NO.	REV. NO.	TAG NAME					DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION					
		PCU		DEVICE			FUNCTION	SERVICE		ENG. UNITS	SCALE / SP LOW-HIGH	ALARMS		I/O POINT TYPE	I/O POINT NO.
		AREA	PNL	TAG								LO / 0	HI / 1		
1	0	W	26	W695	PAH		High air pressure alarm	Ferric Chloride unloading air pressure	CI1.01	Kpa	175	Alarm	Off	DI	
2	0	W	26	W695	PIT		Air pressure transmitter	Ferric Chloride unloading air pressure	CI1.01	Kpa	0-350	105	175	AI	
3	0	W	26	W695	VD		Valve open/close control	Ferric Chloride unloading air supply valve	CI1.01					DO	
4	0	W	26	W695	YS		Remote Selected	Ferric Chloride unloading air supply valve	CI1.01					DI	
5	0	W	26	W696	HS	1	Start unloading	Ferric Chloride rail unloading panel	CI1.01					DI	
6	0	W	26	W696	HS	2	Emergency Shutdown	Ferric Chloride rail unloading panel	CI1.01			ESD	Off	DI	
7	0	W	26	W696	HS	4	Emergency Shutdown	Ferric Chloride storage area	CI2.01			ESD	Off	DI	
8	0	W	26	W696	YA		Stop unloading audible signal	Ferric Chloride rail unloading panel	CI1.01					DO	
9	0	W	26	W696	YL	2	Ready to unload	Ferric Chloride rail unloading panel	CI1.01					DO	
10	0	W	26	W697	HS	1	Start unloading	Ferric Chloride truck unloading panel	CI1.01					DI	
11	0	W	26	W697	HS	2	Emergency Shutdown	Ferric Chloride truck unloading panel	CI1.01			ESD	Off	DI	
12	0	W	26	W697	YA		Stop unloading audible signal	Ferric Chloride truck unloading panel	CI1.01					DO	
13	0	W	26	W697	YL	2	Ready to unload	Ferric Chloride truck unloading panel	CI1.01					DO	
14	0	W	26	W700	TA		Fire alarm signal	Ferric Chloride area	CI4.01			Alarm	Normal	DI	
15	0	W	26	W700	UA		Fire alarm panel Fault	Ferric Chloride area	CI4.01			Alarm	Normal	DI	
16	0	W	26	W701	FQ		Flow totalizer pulse	Ferric Chloride unloading	CI2.01	TBA	TBA	TBA	TBA	DI	
17	0	W	26	W701	FT		Flow rate	Ferric Chloride unloading	CI2.01	TBA	TBA	TBA	TBA	AI	
18	0	W	26	W702	FS	1	Water flow detected	Ferric unloading emerg. Shower/eyewash	CI1.01			Alarm	Off	DI	
19	0	W	26	W702	FS	2	Water flow detected	Ferric storage emerg. Shower/eyewash	CI2.01			Alarm	Off	DI	
20	0	W	26	W703	ZS	1	Motion detected	Ferric Chloride rail shelter	CI4.01			Motion	Normal	DI	
21	0	W	26	W703	ZS	3	East door open	Ferric Chloride rail shelter	CI4.01			Open	Closed	DI	
22	0	W	26	W703	ZS	4	West door open	Ferric Chloride rail shelter	CI4.01			Open	Closed	DI	
23	0	W	26	W704	ZS	1	Motion detected	Ferric Chloride storage area	CI4.01			Motion	Normal	DI	
24	0	W	26	W704	ZS	2	Door open	Ferric Chloride storage area	CI4.01			Open	Closed	DI	
25	0	W	26	W705	VB		Valve close command	Ferric storage tank #710 supply valve	CI2.01			Off	FTC*	DO	
26	0	W	26	W705	VD		Valve open command	Ferric storage tank #710 supply valve	CI2.01			Off	FTO*	DO	
27	0	W	26	W705	YS		Remote Selected	Ferric storage tank #710 supply valve	CI2.01					DI	
28	0	W	26	W705	ZSB		Valve closed limit	Ferric storage tank #710 supply valve	CI2.01			Off	FTC*	DI	
29	0	W	26	W705	ZSD		Valve open limit	Ferric storage tank #710 supply valve	CI2.01			Off	FTO*	DI	
30	0	W	26	W706	VB		Valve close command	Ferric storage tank #720 supply valve	CI2.01			Off	FTC*	DO	

DCS INPUT/OUTPUT INDEX

NO.	REV. NO.	TAG NAME					DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION					
		PCU		DEVICE			FUNCTION	SERVICE		ENG. UNITS	SCALE / SP LOW-HIGH	ALARMS		I/O POINT TYPE	I/O POINT NO.
		AREA	PNL	TAG								LO / 0	HI / 1		
31	0	W	26	W706	VD		Valve open command	Ferric storage tank #720 supply valve	CI2.01			Off	FTO*	DO	
32	0	W	26	W706	YS		Remote Selected	Ferric storage tank #720 supply valve	CI2.01					DI	
33	0	W	26	W706	ZSB		Valve closed limit	Ferric storage tank #720 supply valve	CI2.01			Off	FTC*	DI	
34	0	W	26	W706	ZSD		Valve open limit	Ferric storage tank #720 supply valve	CI2.01			Off	FTO*	DI	
35	0	W	26	W710	LF		Level transmitter fault	Ferric storage tank #710	CI2.01				Alarm	DI	
36	0	W	26	W710	LT	1	Liquid level indication	Ferric storage tank #710	CI2.01	M	TBA	TBA	TBA	AI	
37	0	W	26	W710	LT	2	Liquid level indication	Ferric storage tank #710	CI2.01	M	TBA	TBA	TBA	AI	
38	0	W	26	W715	VB		Valve close command	Ferric storage tank #710 discharge valve	CI3.01			Off	FTC*	DO	
39	0	W	26	W715	VD		Valve open command	Ferric storage tank #710 discharge valve	CI3.01			Off	FTO*	DO	
40	0	W	26	W715	YS		Remote Selected	Ferric storage tank #710 discharge valve	CI3.01					DI	
41	0	W	26	W715	ZSB		Valve closed limit	Ferric storage tank #710 discharge valve	CI3.01			Off	FTC*	DI	
42	0	W	26	W715	ZSD		Valve open limit	Ferric storage tank #710 discharge valve	CI3.01			Off	FTO*	DI	
43	0	W	26	W720	LF		Level transmitter fault	Ferric Chloride rail unloading panel	CI2.01				Alarm	DI	
44	0	WC	26	W720	LT	1	Liquid level indication	Ferric storage tank #720	CI2.01	M	TBA	TBA	TBA	AI	
45	0	WC	26	W720	LT	2	Liquid level indication	Ferric storage tank #720	CI2.01	M	TBA	TBA	TBA	AI	
46	0	WC	26	W725	VB		Valve close command	Ferric storage tank #720 discharge valve	CI3.01			Off	FTC*	DO	
47	0	WC	26	W725	VD		Valve open command	Ferric storage tank #720 discharge valve	CI3.01			Off	FTO*	DO	
48	0	WC	26	W725	YS		Remote Selected	Ferric storage tank #720 discharge valve	CI3.01					DI	
49	0	WC	26	W725	ZSB		Valve closed limit	Ferric storage tank #720 discharge valve	CI3.01			Off	FTC*	DI	
50	0	WC	26	W725	ZSD		Valve open limit	Ferric storage tank #720 discharge valve	CI3.01			Off	FTO*	DI	
51	0	WC	26	W731	LAH		High level switch	Ferric Chloride spill containment sump	CI2.01			Alarm	Normal	DI	
52	0	WC	26	W740	FQ		Flow totalizer pulse	Ferric Chloride dosing pump W740	CI3.01	TBA	TBA	TBA	TBA	DI	
53	0	WC	26	W740	FT		Flow rate	Ferric Chloride dosing pump W740	CI3.01	TBA	TBA	TBA	TBA	AI	
54	0	WC	26	W740	MF		Failed	Ferric Chloride dosing pump W740	CI3.01			Failed	Normal	DI	
55	0	WC	26	W740	MM		Running	Ferric Chloride dosing pump W740	CI3.01					DI	
56	0	WC	26	W740	MN		Start/stop control	Ferric Chloride dosing pump W740	CI3.01					DO	
57	0	WC	26	W740	PAH		High pressure alarm	Ferric Chloride dosing pump W740 Discharge	CI3.01			Alarm	Off	DI	
58	0	WC	26	W740	SC		Speed control	Ferric Chloride dosing pump W740	CI3.01	RPM	TBA			AO	
59	0	WC	26	W740	ST		Speed indication	Ferric Chloride dosing pump W740	CI3.01	RPM	TBA			AI	
60	0	WC	26	W740	YS		Computer selected	Ferric Chloride dosing pump W740	CI3.01					DI	

I/O POINT TYPES: AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output, MB = Modbus, TCP/IP = Ethernet

DCS INPUT/OUTPUT INDEX

NO.	REV. NO.	TAG NAME					DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION					
		PCU		DEVICE			FUNCTION	SERVICE		ENG. UNITS	SCALE / SP LOW-HIGH	ALARMS		I/O POINT TYPE	I/O POINT NO.
		AREA	PNL	TAG								LO / 0	HI / 1		
61	0	WC	26	W750	FQ		Flow totalizer pulse	Ferric Chloride dosing pump W750	CI3.01	TBA	TBA	TBA	TBA	DI	
62	0	WC	26	W750	FT		Flow rate	Ferric Chloride dosing pump W750	CI3.01	TBA	TBA	TBA	TBA	AI	
63	0	WC	26	W750	MF		Failed	Ferric Chloride dosing pump W750	CI3.01			Failed	Normal	DI	
64	0	WC	26	W750	MM		Running	Ferric Chloride dosing pump W750	CI3.01					DI	
65	0	WC	26	W750	MN		Start/stop control	Ferric Chloride dosing pump W750	CI3.01					DO	
66	0	WC	26	W750	PAH		High pressure alarm	Ferric Chloride dosing pump W750 Discharge	CI3.01			Alarm	Off	DI	
67	0	WC	26	W750	SC		Speed control	Ferric Chloride dosing pump W750	CI3.01	RPM	TBA			AO	
68	0	WC	26	W750	ST		Speed indication	Ferric Chloride dosing pump W750	CI3.01	RPM	TBA			AI	
69	0	WC	26	W750	YS		Computer selected	Ferric Chloride dosing pump W750	CI3.01					DI	
70	0	WC	26	W760	FQ		Flow totalizer pulse	Ferric Chloride dosing pump W760	CI3.01	TBA	TBA	TBA	TBA	DI	
71	0	WC	26	W760	FT		Flow rate	Ferric Chloride dosing pump W760	CI3.01	TBA	TBA	TBA	TBA	AI	
72	0	WC	26	W760	MF		Failed	Ferric Chloride dosing pump W760	CI3.01			Failed	Normal	DI	
73	0	WC	26	W760	MM		Running	Ferric Chloride dosing pump W760	CI3.01					DI	
74	0	WC	26	W760	MN		Start/stop control	Ferric Chloride dosing pump W760	CI3.01					DO	
75	0	WC	26	W760	PAH		High pressure alarm	Ferric Chloride dosing pump W760 Discharge	CI3.01			Alarm	Off	DI	
76	0	WC	26	W760	SC		Speed control	Ferric Chloride dosing pump W760	CI3.01	RPM	TBA			AO	
77	0	WC	26	W760	ST		Speed indication	Ferric Chloride dosing pump W760	CI3.01	RPM	TBA			AI	
78	0	WC	26	W760	YS		Computer selected	Ferric Chloride dosing pump W760	CI3.01					DI	
79	0	WC	26	W790	MM		Running	Ferric unloading make-up air unit W790-MAU	CI4.01					DI	
80	0	WC	26	W790	TT		Ambient air temperature	Ferric Chloride rail unloading building	CI4.01	Deg. C	0-50	5	40	AI	
81	0	WC	26	W790	UA		Failed	Ferric unloading make-up air unit W791-MAU	CI4.01			Failed	Normal	DI	
82	0	WC	26	W791	MM		Running	Ferric unloading exhaust fan W791-EF	CI4.01					DI	
83	0	WC	26	W791	UA		Failed	Ferric unloading exhaust fan W791-EF	CI4.01			Failed	Normal	DI	
84	0	WC	26	W795	MM		Running	Ferric storage make-up air unit W795-MAU	CI4.01					DI	
85	0	WC	26	W795	TT		Ambient air temperature	Ferric Chloride storage building	CI4.01	Deg. C	0-50	5	40	AI	
86	0	WC	26	W795	UA		Failed	Ferric storage make-up air unit W795-MAU	CI4.01			Failed	Normal	DI	
87	0	WC	26	W796	MM		Running	Ferric storage exhaust fan W796-EF	CI4.01					DI	
88	0	WC	26	W796	UA		Failed	Ferric storage exhaust fan W796-EF	CI4.01			Failed	Normal	DI	

END OF SECTION

INSTRUMENT INDEX

1. GENERAL

1.1 References - General

.1 Refer To Section 17010.

1.2 Instrument Index

.1 The following spreadsheet gives an itemized list of the instrumentation included as part of this Work.

2. PRODUCTS

.1 Not used.

3. EXECUTION

.1 Not used.

INSTRUMENT INDEX

RECORD NO.	REV. NO.	TAG NAME				DESCRIPTION		REFERENCES				
						INSTRUMENT TYPE	SERVICE	SPEC. SHEET or SECTION	P&ID DRAWING	WIRING REF.	LOCATION DWG	SUPPLY CODE
1	0	W	695	HS		Open-Close-Remote selector switch	Ferric unloading air supply valve control	17216	CI1.01	ILD-04	CI5.01	CON
2	0	W	695	PI		Pressure gauge	Ferric unloading air supply	17701-I114	CI1.01	N/A	CI5.01	CON
3	0	W	695	PIT		Pressure indicating transmitter	Ferric unloading air supply	17701-I110	CI1.01	ILD-07	CI5.01	CON
4	0	W	695	PSH		High pressure switch	Ferric unloading air supply	17701-I109	CI1.01	ILD-05	CI5.01	CON
5	0	W	695	SV		Three-way pilot operated solenoid valve	Ferric unloading air supply valve	17701-I113	CI1.01	ILD-05	CI5.01	CON
6	0	W	696	HS	1	Pushbutton switch	Rail car unloading panel	17216	CI1.01	ILD-04	CI5.01	CON
7	0	W	696	HS	2	Mush. head maintained pushbutton switch	Rail car unloading panel Emergency Shutdown	17216	CI1.01	ILD-04	CI5.01	CON
8	0	W	696	HS	3	Mush. head maintained pushbutton switch	Ferric Unloading Emergency Shutdown	17216	CI1.01	ILD-05	CI5.01	CON
9	0	W	696	HS	4	Mush. head maintained pushbutton switch	Ferric storageUnloading Emergency Shutdown	17216	CI2.01	ILD-05	CI5.02	CON
10	0	W	696	HS	5	Pushbutton switch	Rail car unloading panel	17216	CI1.01	ILD-04	CI5.01	CON
11	0	W	696	XA		Electronic audible signal	Rail car unloading panel	17701-I112	CI1.01	ILD-04	CI5.01	CON
12	0	W	696	YL	1	Pilot light	Rail car unloading panel	17216	CI1.01	ILD-04	CI5.01	CON
13	0	W	696	YL	2	Pilot light	Rail car unloading panel	17216	CI1.01	ILD-04	CI5.01	CON
14	0	W	697	HS	1	Pushbutton switch	Truck unloading panel	17216	CI1.01	ILD-13	CI5.02	CON
15	0	W	697	HS	2	Mush. head maintained pushbutton switch	Truck unloading panel Emergency Shutdown	17216	CI1.01	ILD-13	CI5.01	CON
16	0	W	697	HS	5	Pushbutton switch	Truck unloading panel	17216	CI1.01	ILD-13	CI5.01	CON
17	0	W	697	XA		Electronic audible signal	Truck unloading panel	17701-I112	CI1.01	ILD-13	CI5.02	CON
18	0	W	697	YL	1	Pilot light	Truck unloading panel	17216	CI1.01	ILD-13	CI5.02	CON
19	0	W	697	YL	2	Pilot light	Truck unloading panel	17216	CI1.01	ILD-13	CI5.02	CON
20	0	W	701	FI	2	Digital process flow indicator	Truck unloading panel	17701-I111	CI2.01	ILD-13	CI5.02	CON
21	0	W	701	FI	1	Digital process flow indicator	Rail car unloading panel	17701-I111	CI2.01	ILD-04	CI5.01	CON
22	0	W	701	FIT		Magnetic flow tube and transmitter	Ferric unloading flow	17701-I106	CI2.01	ILD-08	CI5.02	CON
23	0	W	702	FS	1	Thermal flow switch	Ferric unloading emergency shower/eyewash	17701-I108	CI1.01	ILD-06	CI5.01	CON
24	0	W	702	FS	2	Thermal flow switch	Ferric storage emergency shower/eyewash	17701-I108	CI2.01	ILD-06	CI5.02	CON
25	0	W	703	ZS	1	Infra-red motion sensor	Rail car shelter east	17701-I102	CI4.01	ILD-10	CI5.01	CON
26	0	W	703	ZS	2	Infra-red motion sensor	Rail car shelter west	17701-I102	CI4.01	ILD-10	CI5.01	CON
27	0	W	703	ZS	3	Door switch	Rail car shelter east door	17701-I103	CI4.01	ILD-10	CI5.01	CON
28	0	W	703	ZS	4	Door switch	Rail car shelter west door	17701-I103	CI4.01	ILD-10	CI5.01	CON
29	0	W	704	ZS	1	Infra-red motion sensor	Ferric chloride storage area	17701-I102	CI4.01	ILD-10	CI5.02	CON
30	0	W	704	ZS	2	Door switch	Ferric chloride storage area	17701-I103	CI4.01	ILD-10	CI5.02	CON

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RECORD NO.	REV. NO.	TAG NAME				DESCRIPTION		REFERENCES				
						INSTRUMENT TYPE	SERVICE	SPEC. SHEET or SECTION	P&ID DRAWING	WIRING REF.	LOCATION DWG	SUPPLY CODE
31	0	W	705	HS	1	Local-Off-Remote selector switch	Ferric storage tank #710 supply valve	11125	CI2.01	ILD-01	CI5.02	PKG
32	0	W	705	HS	2	Open switch	Ferric storage tank #710 supply valve	11125	CI2.01	ILD-01	CI5.02	PKG
33	0	W	705	HS	3	Close switch	Ferric storage tank #710 supply valve	11125	CI2.01	ILD-01	CI5.02	PKG
34	0	W	705	ZSB		Closed limit switch	Ferric storage tank #710 supply valve	11125	CI2.01	ILD-01	CI5.02	PKG
35	0	W	705	ZSD		Open limit switch	Ferric storage tank #710 supply valve	11125	CI2.01	ILD-01	CI5.02	PKG
36	0	W	706	HS	1	Local-Off-Remote selector switch	Ferric storage tank #720 supply valve	11125	CI2.01	ILD-01	CI5.02	PKG
37	0	W	706	HS	2	Open switch	Ferric storage tank #720 supply valve	11125	CI2.01	ILD-01	CI5.02	PKG
38	0	W	706	HS	3	Close switch	Ferric storage tank #720 supply valve	11125	CI2.01	ILD-01	CI5.02	PKG
39	0	W	706	ZSB		Closed limit switch	Ferric storage tank #720 supply valve	11125	CI2.01	ILD-01	CI5.02	PKG
40	0	W	706	ZSD		Open limit switch	Ferric storage tank #720 supply valve	11125	CI2.01	ILD-01	CI5.02	PKG
41	0	W	710	LE		Ultrasonic level transducer	Ferric storage tank #710	17701-I101	CI2.01	ILD-02	CI5.02	CON
42	0	W	710	LI	1	Digital process level indicator	Rail car unloading panel	17701-I111	CI2.01	ILD-04	CI5.01	CON
43	0	W	710	LI	2	Digital process level indicator	Truck unloading panel	17701-I111	CI2.01	ILD-13	CI5.02	CON
44	0	W	710	LI		Level sight gauge	Ferric storage tank #710	13501	CI2.01	N/A	CI5.02	CON
45	0	W	710	LIT		Ultrasonic level transmitter	Ferric storage tank #710	17701-I101	CI2.01	ILD-02	CI5.02	CON
46	0	W	710	LT		Submersible liquid level transmitter	Ferric storage tank #710	17701-I107	CI2.01	ILD-07	CI5.02	CON
47	0	W	715	HS	1	Local-Off-Remote selector switch	Ferric storage tank #710 discharge valve	11125	CI3.01	ILD-01	CI5.02	PKG
48	0	W	715	HS	2	Open switch	Ferric storage tank #710 discharge valve	11125	CI3.01	ILD-01	CI5.02	PKG
49		W	715	HS	3	Close switch	Ferric storage tank #710 discharge valve	11125	CI3.01	ILD-01	CI5.02	PKG
50	0	W	715	ZSB		Closed limit switch	Ferric storage tank #710 discharge valve	11125	CI3.01	ILD-01	CI5.02	PKG
51	0	W	715	ZSD		Open limit switch	Ferric storage tank #710 discharge valve	11125	CI3.01	ILD-01	CI5.02	PKG
52	0	W	720	LE		Ultrasonic level transducer	Ferric storage tank #720	17701-I101	CI2.01	ILD-02	CI5.02	CON
53	0	W	720	LI	1	Digital process level indicator	Rail car unloading panel	17701-I111	CI2.01	ILD-04	CI5.01	CON
54	0	W	720	LI	2	Digital process level indicator	Truck unloading panel	17701-I111	CI2.01	ILD-13	CI5.02	CON
55	0	W	720	LI		Level sight gauge	Ferric storage tank #720	13501	CI2.01	N/A	CI5.02	PKG
56	0	W	720	LIT		Ultrasonic level transmitter	Ferric storage tank #720	17701-I101	CI2.01	ILD-02	CI5.02	CON
57	0	W	720	LT		Submersible liquid level transmitter	Ferric storage tank #720	17701-I107	CI2.01	ILD-07	CI5.02	CON
58	0	W	725	HS	1	Local-Off-Remote selector switch	Ferric storage tank #720 discharge valve	11125	CI3.01	ILD-01	CI5.02	PKG
59	0	W	725	HS	2	Open switch	Ferric storage tank #720 discharge valve	11125	CI3.01	ILD-01	CI5.02	PKG
60	0	W	725	HS	3	Close switch	Ferric storage tank #720 discharge valve	11125	CI3.01	ILD-01	CI5.02	PKG

SUPPLY CODES: CON = Contractor Supply, OWN = Owner Suppy, PKG = Part of Equipment Package, Trojan = UV Vendor Supply

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RECORD NO.	REV. NO.	TAG NAME				DESCRIPTION		REFERENCES				
						INSTRUMENT TYPE	SERVICE	SPEC. SHEET or SECTION	P&ID DRAWING	WIRING REF.	LOCATION DWG	SUPPLY CODE
61	0	W	725	ZSB		Closed limit switch	Ferric storage tank #720 discharge valve	11125	CI3.01	ILD-01	CI5.02	PKG
62	0	W	725	ZSD		Open limit switch	Ferric storage tank #720 discharge valve	11125	CI3.01	ILD-01	CI5.02	PKG
63	0	W	731	LSH		Liquid level switch	Spill containment sump	17701-I105	CI2.01	ILD-06	CI5.02	CON
64	0	W	740	FIT		Magnetic flow tube and transmitter	Ferric dosing pump #740 flow rate	17701-I106	CI3.01	ILD-14	CI5.02	PKG
65	0	W	740	HS	1	Computer-Off-Hand selector switch	Ferric dosing pump #740 drive	11315	CI3.01	ILD-03	CI5.02	PKG
66	0	W	740	HS	2	Lock-Off-Stop pushbutton switch	Ferric dosing pump #740 drive	11315	CI3.01	ILD-03	CI5.02	PKG
67	0	W	740	PI		Pressure gauge	Ferric dosing pump #740 discharge	11315	CI3.01	N/A	CI5.02	PKG
68	0	W	740	PSH		High pressure switch	Ferric dosing pump #740 discharge	17701-I115	CI3.01	ILD-06	CI5.02	CON
69	0	W	750	FIT		Magnetic flow tube and transmitter	Ferric dosing pump #750 flow rate	17701-I106	CI3.01	ILD-14	CI5.02	PKG
70	0	W	750	HS	1	Computer-Off-Hand selector switch	Ferric dosing pump #750 drive	11315	CI3.01	ILD-03	CI5.02	PKG
71	0	W	750	HS	2	Lock-Off-Stop pushbutton switch	Ferric dosing pump #750 drive	11315	CI3.01	ILD-03	CI5.02	PKG
72	0	W	750	PI		Pressure gauge	Ferric dosing pump #750 discharge	11315	CI3.01	N/A	CI5.02	PKG
73	0	W	750	PSH		High pressure switch	Ferric dosing pump #750 discharge	17701-I115	CI3.01	ILD-06	CI5.02	CON
74	0	W	760	FIT		Magnetic flow tube and transmitter	Ferric dosing pump #760 flow rate	17701-I106	CI3.01	ILD-14	CI5.02	PKG
75	0	W	760	HS	1	Computer-Off-Hand selector switch	Ferric dosing pump #760 drive	11315	CI3.01	ILD-03	CI5.02	PKG
76	0	W	760	HS	2	Lock-Off-Stop pushbutton switch	Ferric dosing pump #760 drive	11315	CI3.01	ILD-03	CI5.02	PKG
77	0	W	760	PI		Pressure gauge	Ferric dosing pump #760 discharge	11315	CI3.01	N/A	CI5.02	PKG
78	0	W	760	PSH		High pressure switch	Ferric dosing pump #760 discharge	17701-I115	CI3.01	ILD-06	CI5.02	CON
79	0	W	790	TIT		Temperature Indicating Transmitter	Ferric chloride rail shelter	17701-I104	CI4.01	ILD-07	CI5.01	CON
80	0	W	795	TIT		Temperature Indicating Transmitter	Ferric chloride storage area	17701-I104	CI4.01	ILD-07	CI5.02	CON

END OF SECTION

INSTRUMENT SPECIFICATION SHEETS

1. GENERAL

1.1 References - General

.1 Refer To Section 17010.

1.2 Instrument Specification Sheets

.1 The following data sheets provide information for instruments included as part of this Work.

.2 All instruments described on each instrument Specification sheet are to be from a single source. Design has been based on the first named Product.

2. PRODUCTS

.1 Not used.

3. EXECUTION

.1 Not used.

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:		I101
DEVICE:		Liquid Level Transmitter
TAG:		LE/LIT-W710 LE/LIT-W720
TYPE:		Ultrasonic
SERVICE:		Level measurement of Ferric Chloride
RANGE:		Approximately 4.0 m, to be confirmed
INACCURACY:		0.25 percent of program range
OUTPUT:		4 to 20 mA DC into 500 OHM load 5 configurable alarm relays
POWER SUPPLY:		120 VAC, 60 Hz
ENCLOSURE:		NEMA 4X Transmitter Housing NEMA 4X Sensor
MOUNTING:	**(TRANSMITTER)** **(SENSOR)**	Wall Mount Mount sensor on flanged PVC pipe stilling well where shown on the drawings. Provide stilling well in accordance with manufacturers instructions.
ACCESSORIES:		One (1) hand-held programmer
MANUFACTURER AND MODEL:		Milltronics Multiranger 100/200 with flanged XPS-15 transducer.

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I102
DEVICE:	Motion Detector
TAG:	W703-ZS-1 W703-ZS-2 W704-ZS-1
TYPE:	Combination Infra-red and microwave
CALIBRATION:	User adjustable detection patterns
OUTPUT:	Form C Reed Relay rated 500 mA at 300 VDC
POWER SUPPLY:	9 to 30 VDC
MOUNTING:	Surface Mount
MANUFACTURER AND MODEL:	C&K Systems DT-450C

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I103
DEVICE:	Door Switch
TAG:	W703-ZS-3 W703-ZS-4 W704-ZS-2
TYPE:	Electronic
DISPLAY:	LED Status Indicator
OUTPUT:	SPDT Contact suitable for 120 VAC pilot duty
POWER SUPPLY:	120 VAC, 60 Hz
ENCLOSURE:	Surface Mount

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I104
DEVICE:	Humidity and Temperature Transmitter
TAG:	W790-TIT W795-TIT
SERVICE:	Ambient Air Temperature Transmitter with built-in Humidity Transmitter.
RANGE:	0°C to 50°C
DISPLAY:	Three digit LED display with one decimal point.
OUTPUT:	4 to 20 mA DC Humidity 4 to 20 mA DC Temperature
ENCLOSURE:	NEMA 4X.
MOUNTING:	Wall
MANUFACTURER AND MODEL:	EE10 Series model EE10 FT6D04

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I105
DEVICE:	Float Switch
TAG:	W731-LSH
SERVICE:	Refer to Instrument Index and P&IDs.
OUTPUT:	SPDT Contacts
ENCLOSURE:	Polypropylene float casing with preterminated signal cable.
MOUNTING:	Provide strain relief-type connectors to suspend float at desired location. Fabricate mounting brackets from fiberglass or PVC.
MANUFACTURER AND MODEL:	Flygt ENM-10

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I106
DEVICE:	Magnetic Flow Meter
TAG:	W701-FIT W740-FIT W750-FIT W760-FIT
SERVICE:	Ferric chloride unloading and dosing lines
SIZE AND MATERIAL:	Refer to Process Drawings for flow meter size and piping materials
END CONNECTIONS:	Flanged
LINER MATERIAL:	Teflon
ELECTRODES:	Bullet Nose – Titanium
GROUNDING:	Grounding Rings or probes – Titanium
RANGE:	Refer to Process Drawings
INACCURACY:	± 1 % of range or better
OUTPUT:	4 to 20 mADC into 500 ohm load Scaled pulse output
POWER SUPPLY:	120 VAC, 60 HZ
INDICATION	Local indication of flow rate and totalized flow
ELECTRONIC ENCLOSURE:	NEMA 4X rated remote wall-mount
MANUFACTURER AND MODEL:	Rosemount ABB E&H Promag 33 Rosemount – Fisher 8700

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I107
DEVICE:	Submersible Level Transmitter
TAG:	W710-LT W720-LT
SERVICE:	Ferric chloride
TYPE:	Loop-powered, submersible level transmitter complete with cable
RANGE:	Approximately 7 m, to be confirmed
POWER SUPPLY:	12 to 28 VDC
OUTPUT:	4 to 20 mADC
CONSTRUCTION:	Titanium suitable for immersion in ferric chloride
CABLE:	Preterminated 7 m cable suitable for immersion in ferric chloride.
MOUNTING:	Suspend from PVC or fiberglass brackets and provide strain relief connector for the cable.
ACCESSORIES:	Nylon as recommended by manufacturer
MANUFACTURER AND MODEL:	Ametek Druck

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I108
DEVICE:	Flow Switch
TAG:	W702-FS1 W702-FS2
TYPE:	Thermal Dispersion
SERVICE:	Emergency shower/eye wash water supply
RANGE:	0 to 5 m/s
OUTPUT:	SPDT contacts rated 10 Amps at 120 VAC
POWER SUPPLY:	120 VAC, 60 Hz, 1 phase
ENCLOSURE:	NEMA 4X rating
MOUNTING:	0.75 inch NPT with 1 inch insertion length
MANUFACTURER AND MODEL:	Magnetrol Dwyer Kobold

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I109
DEVICE:	Pressure Switch
TAG:	W695-PSH
SERVICE:	Process Air Supply
PROGRESS CONNECTION:	0.5 inch NPTF
SENSOR:	Brass bellows
RANGE:	0 to 700 kPa
MOUNTING:	Bottom, stem mounted
ENCLOSURE:	NEMA 4X
OUTPUT:	Form C Contacts rated 5 amps at 120 VAC
MANUFACTURER AND MODEL:	United Electric

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I110
DEVICE:	Pressure Transmitter with preterminated cable
TAG:	W695-PIT
SERVICE:	Process Air Supply
PROCESS CONNECTIONS:	0.50 inch NPTF
RANGE:	0-700 kPa Gage
INACCURACY:	±1 percent of span or lower
OUTPUT:	4 to 20 mADC into 500 OHM or more
POWER SUPPLY:	Loop powered 24 VDC
CONSTRUCTION:	Titanium or manufacturer's standard with anti-corrosion coating.
ELECTRONIC ENCLOSURE:	NEMA 4X
ACCESSORIES:	
MANUFACTURER AND MODEL:	Ametek Druck

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I111
DEVICE:	Indicator (Panel mount)
TAG:	W701-FI1-1 W701-FI2-2 W710-LI1-1 W710-LI2-2 W720-LI1-1 W720-LI2-2
INPUT:	4 to 20 mA
DISPLAY:	4 digit, 20 mm LED
CALIBRATION:	Zero and span adjustable Digital readout scaled in engineering units
INACCURACY	±1 percent or less
POWER SUPPLY:	Loop powered
MOUNTING:	Flush Panel Mount, NEMA 4X
MANUFACTURER AND MODEL:	Precision Digital Action Instruments

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I112
DEVICE:	Electronic Buzzer
TAG:	W696-XA W697-XA
TYPE:	Piezo Electric Buzzer with Continuous tone, 70 dBA at 600 mm
SERVICE:	Rail Car and truck unloading panels
POWER SUPPLY:	120 VAC, 60 Hz
ENCLOSURE:	Flush panel mount, NEMA 4X
MANUFACTURER:	Mallory

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I113
DEVICE:	Solenoid Valve
TAG:	W695-SV
TYPE:	Pilot operated 3-way spool valve
SERVICE:	Compressed Air
PRESSURE:	200 kPa working 700 kPa maximum
PORTS:	1 inch NPT
BODY:	Stainless steel with anti-corrosion coating suitable for ferric chloride exposure
ELECTRICAL:	120 VAC coil, NEMA 4X enclosure with 20 mm connection
MANUFACTURER:	Asco Parker Davis

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I114
DEVICE:	Pressure Gauge
TAG:	W695-PI
SERVICE:	Process Air Supply
PROGRESS CONNECTION:	0.5 inch NPTF
SENSOR:	Brass bellows
RANGE:	0 to 700 kPa
MOUNTING:	Bottom, stem mounted
ENCLOSURE:	NEMA 4X
MANUFACTURER AND MODEL:	Ashcroft H O Trerice Budenberg

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I115
DEVICE:	Pressure Switch Gauge
TAG:	W740-PSH W750-PSH W760-PSH
SERVICE:	Ferric Chloride Dosing
PROGRESS CONNECTION:	0.5 inch NPTF
RANGE:	0 to 700 kPa
MOUNTING:	Bottom, stem mounted
ENCLOSURE:	NEMA 4X
OUTPUT:	Form C Contacts rated 5 amps at 120 VAC
MANUFACTURER AND MODEL:	Ashcroft H O Trerice Budenberg

END OF SECTION

INSTRUMENT LOOP DRAWINGS

1. GENERAL

1.1 References - General

.1 Refer To Section 17010.

1.2 Instrument Loop Drawings

.1 The following Drawings show typical instrument loop wiring diagrams. One (1) Drawing per loop will be completed and submitted for approval after award of Contract. The following 11 Drawings are an integral part of this Specification Section:

ILD-01	Typical Motorized Valve Actuator
ILD-02	Typical Ultrasonic Level Transmitter
ILD-03	Typical Variable Speed Pump Drive
ILD-04	Typical Ferric Chloride Railcar Unloading Panel
ILD-05	Rail Car Unloading Solenoid Valve
ILD-06	Typical Process Variable Switch
ILD-07	Typical 4-20 mA Transmitter
ILD-08	Magnetic Flow Meter W701-FIT
ILD-09	Typical HVAC Make-up Air Unit or Exhaust Fan
ILD-10	Intrusion Alarms
ILD-11	Fire Alarm Panel
ILD-12	Typical CCTV Camera
ILD-13	Typical Ferric Chloride Truck Unloading Panel
ILD-14	Typical Magnetic Flow Meter

2. PRODUCTS

.1 Not used.

3. EXECUTION

.1 Not used.