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DIVISION 1

FIELD ENGINEERING

1. GENERAL

1.1 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

1.2 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.

1.3 Survey Requirements

.1 Employ a Manitoba Land Surveyor to establish two 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

1.4 Records

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

1.5 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 with Contract Documents.

2. PRODUCTS

.1 Not used

3. EXECUTION

.1 Not used

END OF SECTION

SCOPE OF WORK

1. GENERAL

1.1 Description of Work

.1 The Work to be performed under this Contract shall include the labour, equipment, and materials required to complete the Biological Nutrient Removal Upgrade to the West 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 construction, supply, installation, testing, commissioning of the following elements:

.1 Construction of new structures with associated mechanical and electrical systems for:

.1 Two DAF thickeners

.2 Two polymer makeup systems

.3 One ferric chloride storage and feed systems

.4 Two primary sludge fermenters, complete with flat aluminum covers and attached common pump room

.5 One secondary clarifier, complete with mechanism and fibreglass dome cover

.6 Odour control system, including a thermal oxidizer unit complete with supply and exhaust fans, ducting, controls, and all required accessories and appurtenances

.2 Renovation of two existing aeration tanks to reconfigure as biological nutrient removal bioreactors, including construction, supply, installation, testing, commissioning of:

.1 New internal concrete walls

.2 Mixers, pumps, piping, and other mechanical devices as specified herein and shown on the Drawings

.3 Fine-bubble aeration diffuser system (supplied by City)

.4 Construction of a new electrical room

.3 Replacement of mechanisms of two existing secondary clarifiers with new mechanisms, requiring partial or complete dismantling and reinstallation of existing dome covers.

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

.5 Upgrades and modifications to the distributed control system (DCS) to control new systems.

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

.7 Heating, Ventilation, and Air Conditioning (HVAC) systems.

.8 Installation of shoring and/or other measures necessary for the protection of excavation, personnel and existing structures.

.9 Installation and operation of a groundwater pumping system as specified.

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

1.2 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.

1.3 General Sequence of Construction

.1 Bioreactor 2 Renovation

.1 Bioreactor 2 is presently not in service. Renovation of this structure shall be performed first. Other Work may be performed concurrently as described subsequently.

.2 Secondary Clarifier 3

.1 Secondary Clarifier 3 can be constructed concurrently with Bioreactor 2 renovation; notwithstanding, it shall be constructed, tested, commissioned, and placed in service prior to renovated Bioreactor 2 being put into service.

.3 Ferric Chloride System (see 1.3.4 below)

.1 Ferric chloride will be required during commissioning of the bioreactor; therefore the ferric chloride system shall be installed and commissioned prior to placing the renovated Bioreactor 2 in service.

.4 DAF Thickener Building

.1 The DAF thickener building houses the DAF thickeners, the polymer makeup systems, and the ferric chloride storage and feed systems.

.2 The DAF Thickener Building should be constructed concurrently with the Bioreactor 2 renovation, in order that the DAF thickeners can be commissioned as a system with Bioreactor 2 and the Primary Sludge Fermenters.

.5 Primary Sludge Fermenters

.1 The Primary Sludge Fermenters should be constructed concurrently with the Bioreactor 2 renovation, in order that it can be commissioned as a system with Bioreactor 2 and the DAF Thickeners.

.6 Bioreactor 1 Renovation

.1 Bioreactor 2, the DAF Thickeners, Primary Sludge Fermenters, and Secondary Clarifier 3 shall be in operation prior to shutdown and renovation of Bioreactor 1.

.2 With Bioreactor 2 in operation, influent to Bioreactor 1 may be diverted to Bioreactor 2, and Bioreactor 1 drained and made ready for renovation.

.7 Secondary Clarifier 2 and 3 mechanism replacement

.1 Only one secondary clarifier may be out of service at any time. With Bioreactor 2 and Secondary Clarifier 3 in service and operating, the existing Secondary Clarifiers 1 and 2 can be taken out of service (individually) and their mechanisms replaced. This Work can be performed concurrently with renovation of Bioreactor 1

1.4 Contractor Use of Premises

.1 Generally restrict operations to the designated construction and Contractor laydown areas indicated on the Drawings. With the exception of performing control system Work, access to the operating areas of the WEWPCC will not be permitted.

.2 The City will make reasonable efforts to accommodate the Work of the Contractor. However, the WEWPCC 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 rights-of-way.

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

1.5 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.

2. PRODUCTS

.1 The fine bubble aeration diffuser equipment for installation in the bioreactors is being supplied under City of Winnipeg Bid Opportunity 602-2005.

3. EXECUTION

.1 Not used

END OF SECTION

SITE CONDITIONS

1. GENERAL

1.1 Site Conditions and Limits

.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.

1.2 Documents and Instructions

.1 Documents Provided

.1 Upon award of the Contract, the Contractor will be provided with five (5) complete sets of the Bid Documents (including Drawings) and five (5) copies of any revised Drawings or Addenda to the Bid Documents, which may have been issued during the Bid Period. Should the Contractor require additional sets of Drawings or documents, these will be supplied to him at cost.

.2 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.

.3 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.

.4 Changes to the Work

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

.2 Contemplated Change Notice: 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 days after receipt of Contemplated Change Notice 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: 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 shall be included (unit price, cost plus, or time basis).

.4 Authorization for Contract Change: after receipt of the statement of cost adjustment and the City's approval, the Contract Administrator will inform the Contractor in writing to proceed with the Work and issue an Authorization for Contract Change in the amount of the approved cost adjustment. Alternatively we will notify the Contractor that the proposed change is cancelled.

.5 Field Instructions: 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.

1.3 Subsurface Conditions

.1 A copy of the Geotechnical Report with respect to the project is included 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 the Work.

1.4 Site Preparation

.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.

1.5 Construction Methods

.1 Use of Public Roads and Rights-of-Way

.1 Maintenance

.1 It shall be the responsibility of the Contractor to keep public roads and rights-of-way 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 rights-of-way shall be picked up promptly and continuously at the Contractor's expense.

.3 Any damage to public roads and rights-of-way 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 rights-of-way 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 rights-of-way 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 repair Work related 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 shall be permitted to these areas by the Contractor or Contractor's personnel without the Contract Administrator's permission.

1.6 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 c.16

.2 Transportation of Dangerous Goods Act and Regulations c.34

.2 Provincial

.1 The Dangerous Goods Handling and Transportation Act D12

.2 The Endangered Species Act E111

.3 The Environment Act c.E125

.4 The Fire Prevention Act F80

.5 The Manitoba Nuisance Act N120

.6 The Public Health Act c.P210

.7 The Workplace Safety and Health Act W120

.8 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 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/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 major spills of petroleum products or other hazardous substances 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.

2. PRODUCTS

.1 Not used

3. EXECUTION

.1 Not used

END OF SECTION

REGULATORY REQUIREMENTS

1. GENERAL

1.1 Permits and Inspections

.1 The City shall obtain and pay for the Building Permit; the Contractor shall obtain and pay for all other 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.

1.2 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 Bid closing date.

.3 Confine apparatus, the storage of products, and the operations of workers to limits indicated, bylaws, 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.

1.3 Safety

.1 General

.1 In case of an emergency the Contractor shall immediately contact the shift operator at 204-479-5300 (7:00 AM to 4:30 PM) or the North End Water Pollution Control Centre After Hours Emergency Contact Number 204-794-4468 (4:30 PM to 7:00 AM).

.2 Observe and enforce all construction safety measures required by code, Workers' Compensation Board, Manitoba Workplace Safety and Health, 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 workers 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.

.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.

1.4 Noise Control On-Site

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

.2 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.

.3 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.

1.5 Dust Control

.1 Perform dust control measures to minimize dust generation.

1.6 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.

1.7 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 Work.

1.8 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 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.

2. PRODUCTS

.1 Not used

3. EXECUTION

.1 Not used

END OF SECTION

PROJECT MEETINGS

1. GENERAL

1.1 Preconstruction Meeting

.1 Within 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 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 Agenda to include the following:

.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 Authorization for Contract Changes 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 As-Constructed Drawings

.13 O&M Manuals

.14 Commissioning, acceptance, and handover

.15 Warranties

.16 Monthly progress claims, administrative procedures, 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 Photographs

.24 Emergency telephone numbers

.25 Other items as arise at the meeting

1.2 Progress Meetings

.1 The Contract Administrator shall schedule and administer progress meetings once a week during construction and through the commissioning period.

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

.3 Representatives of the City, Contract Administrator, Contractor, and major sub-contractors must be in attendance. Arrange for the attendance of other trades and suppliers as necessary to address issues on the agenda.

.4 Representatives of the Contractor, sub-contractors, and suppliers attending meetings must be qualified and authorized to act on behalf of the party each represents.

.5 Agenda for construction progress meetings to include the following:

.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, Field Orders, Authorization for Contract Change, and Field Instructions

.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

.6 The Contract Administrator will preside at the meetings.

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

.8 The Contract Administrator reserves the right to cancel any progress meeting or call additional meetings whenever he deems necessary.

1.3 Special Meetings

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

2. PRODUCTS

.1 Not used

3. EXECUTION

.1 Not used

PROJECT MEETINGS

END OF SECTION

SUBMITTALS

1. GENERAL

1.1 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 The Contractor shall 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, weights, dimensions, 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 The Contractor shall 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 The Contractor shall submit a Shop Drawings delivery schedule and provide Shop Drawings 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 AND 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 Manitoba. Calculations shall be submitted for review, if requested, and sealed by a qualified Professional Engineer.

.16 Only two 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.

1.2 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.

1.3 Operating And Maintenance Manuals

.1 For the guidance of the City's operating and maintenance personnel, the Contractor shall prepare O&M 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 for review and comments. A maximum of eight weeks after review, six (6) copies of the final manuals shall be submitted. 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 operating and maintenance of this installation.

.4 In addition to hardcopies specified above, submit one (1) O&M Manual in electronic format (MS Word for text; Acrobat PDF for graphics). 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, structural 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 and prices, and special tools requirements and prices

.8 Any specific product or maintenance manual requirements from the Specifications

.3 Reviewed Shop Drawings of all equipment

.4 As-Constructed 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 equipment 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.

1.4 As-Constructed Drawings

.1 After award of Contract, the Contract Administrator will provide a complete set of Drawings for the purpose of maintaining Project As-Constructed 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 As-Constructed 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 weeks prior to final inspection, submit As-Constructed Drawings to Contract Administrator for review.

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

1.5 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.

1.6 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.

2. PRODUCTS

.1 Not used

3. EXECUTION

.1 Not used

END OF SECTION

QUALITY ASSURANCE

1. GENERAL

1.1 Inspection and Testing of Work

.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 Independent Inspection and Testing 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

QUALITY ASSURANCE

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
CPMA	Canadian Paint Manufacturers' Association
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.

QUALITY ASSURANCE

1.4 Design Standards and 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

1.6 Procedures

.1 Notify the Contract Administrator two 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 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.

2. PRODUCTS

.1 Not used

3. EXECUTION

.1 Not used

END OF SECTION

TEMPORARY FACILITIES

1. GENERAL

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 Contract Administrator's Office

.1 Provide a separate facility for the Contract Administrator's office.

.2 Provide and maintain in a clean condition, during the entire progress of the Work, two (2) lockable offices, and one (1) multi-purpose space for conducting meeting general progress meetings. These spaces shall be adequately lighted, heated, and ventilated, for use by the Contract Administrator or designate. The general meeting room shall be sized to suit the requirements of the regular progress meetings.

.3 Locate where directed by the Contract Administrator.

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

.5 The offices are to be a minimum of 20 square metres each, with a minimum of 2.4 m headroom, and a minimum of two (2) 900 mm x 1200 mm sash windows per office.

.6 Furnish each office with a drawing layout table, desk, chair, and lockable file cabinet with minimum dimensions of 1800 mm high x 400 mm wide by 450 mm deep.

.7 Furnish the general meeting room with table and chairs adequate to accommodate the progress meetings.

.8 All finishes including walls, ceilings, and floors to be finished in a manner acceptable to the Contract Administrator.

.9 The Contractor shall supply and maintain the toilet and washroom in the Contract Administrator's trailer adjacent but separate from the office and meeting room spaces. The toilet and washroom 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.

.10 Provide and pay for all heating, lighting, telephone, and communications services.

.11 Provide one fire extinguisher in each office space.

1.3 City Project Manager's Office

.1 Provide a separate office facility for the use of the City's Project Manager.

.2 Provide and maintain in a clean condition, during the entire progress of the Work, one (1) lockable office, and one (1) multi-purpose space. These spaces shall be adequately lighted, heated, and ventilated, for use by the Contract Administrator or designate. The multi-purpose space shall be sized to suit the requirements of the regular progress meetings.

.3 Locate where directed by the Contract Administrator.

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

.5 The offices are to be a minimum of 20 square metres each, with a minimum of 2.4 m headroom, and a minimum of two (2) 900 mm x 1200 mm sash windows per office.

.6 Furnish each office with a desk, chair, and lockable file cabinet with minimum dimensions of 1800 mm high x 300 mm wide by 450 mm deep.

.7 Furnish the multi-purpose room with table and chairs adequate to accommodate the progress meetings.

.8 All finishes including walls, ceilings, and floors to be finished in a manner acceptable to the Contract Administrator.

.9 Provide and pay for all heating, lighting, telephone, and communications services.

1.4 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 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.

1.5 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.

1.6 Contractor's Trailers

.1 The Contractor shall provide construction power at 120/240 V, 1 phase, and 600 V, 3 phase to the service points designated at the Work Site and to the Contractor's and Contract Administrator'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 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. Storage of fuel will not be permitted in the vicinity of the Work.

.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.

1.7 Toilets and Washrooms

.1 Washroom facilities are not available at the WEWPCC 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.

1.8 Disposal of Waste Materials

.1 Spoiled and 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.

1.9 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.

1.10 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 storage facility shall be temperature controlled to provide a minimum interior temperature of 10°C, and be large enough to provide access to equipment for periodic maintenance.

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

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

.6 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.

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

1.11 Access to Site Office and Storage Facilities

.1 The Contractor shall provide vehicular access 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.

.4 Provide adequate parking for Contract Administrator staff (minimum three spaces).

1.12 Water Supply

.1 The WEWPCC has no potable water service. All potable water must be transported to the Site.

.2 The Contractor shall supply water, potable water and the sodium hypochlorite for super chlorinating of secondary effluent used for construction purposes. The Contractor shall be responsible for conveying the water (hook-ups, pipes, maintenance, etc.) to the construction Site from the source.

.3 The Contractor shall be responsible for super chlorinating the Site's secondary effluent for the purpose of the watertightness testing as indicated in Section 03300. Provide the following minimum ratios for super chlorination:

.1 Area S – Secondary Clarifier 3: 2,400 liters of sodium hypochlorite.

.2 Area F – Primary Sludge Fermenters: 600 liters of sodium hypochlorite.

.3 Area D – DAF Thickener Building: 27 liters of sodium hypochlorite.

1.13 Heating and Hoarding

.1 The Contractor shall:

.1 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 a minimum 10°C in the temporary facilities, unless indicated otherwise in Specifications. Properly ventilate all heated areas.

.2 Pay for all costs in maintaining and providing temporary heat to the temporary facilities.

.3 Be responsible for any damages to the Work due to failure in providing adequate heat and protection during construction.

1.14 Power and Light

.1 The Contractor shall provide temporary power and light for own use and for the Contract Administrator's office. Install in accordance with regulations of governing authorities.

.2 Provide and pay for all temporary power required during Construction for temporary lighting and the operations, including power required for the Contract Administrator's office.

.3 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.

1.15 Telephone and Internet

.1 The Contractor shall provide for two (2) temporary telephone lines, fax, and high-speed internet service including services to the Contract Administrator's offices.

1.16 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 WEWPCC without obtaining permission from the Contract Administrator.

1.17 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 buildings.

1.18 Guard Rails and Barricades

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

1.19 Site Security

.1 The City does not normally provide security forces to the plant Site. The gate is normally open during the day and closed at night.

.2 The Contractor shall provide chainlink fencing adequate to control all access of authorized and unauthorized personnel and vehicles to all working, storage, and construction areas at all times including after working hours, nights, weekends, and holidays.

1.20 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.

1.21 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.

1.22 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.

1.23 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.

1.24 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.

1.25 Public Traffic Flow

.1 Provide and maintain flag persons, traffic signals, barricades, and flares, lights, and 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.

1.26 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.

1.27 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 L capacity and be ULC labelled.

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

.5 Remove combustible debris from Site daily.

1.28 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.

1.29 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.

1.30 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, 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.

1.31 Access to Site and Building

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

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

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

1.32 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. The Site is unmanned at all other times.

.2 The Contract Administrator shall be informed at least 48 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.

1.33 Site Security 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.

1.34 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.

2. PRODUCTS

.1 Not used

3. EXECUTION

.1 Not used

END OF SECTION

MATERIALS 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 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.

1.3 Availability of Materials

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

.2 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.

1.4 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.

1.5 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.

1.6 Transportation Costs of Materials

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

2. PRODUCTS

.1 Not used

3. EXECUTION

3.1 Workmanship

.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.

3.2 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.

3.3 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.

3.4 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.

3.5 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.

3.6 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.

3.7 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.

.3 Protect all Stainless steel components from

3.8 Cleaning

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

END OF SECTION

EQUIPMENT INSTALLATION

1. GENERAL

1.1 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 supply, installation, testing, operation, and performance verification of the specified equipment.

1.2 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.

1.3 Expertise and Responsibility

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

.2 Should the Contract Administrator issue a Field Order, Authorization for Contract Change, 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 days.

2. PRODUCTS

.1 Not used

3. EXECUTION

3.1 Equipment Delivery

.1 The equipment shall be delivered to the WEWPCC construction Site to the Contractor who shall be responsible for taking delivery of the equipment. Written acceptance of receipt, at delivery, by the Contractor shall constitute "Delivery to Site" under this Contract. A representative from each of the following groups will be in attendance at the time of delivery: the supplier, Contractor, and Contract Administrator. A duly executed "Certificate of Equipment Delivery" (Form 100) shall be completed. Any damage identified during the inspection shall be repaired as per the manufacturer's recommendations by the Contractor at no cost to the City. Any severe damage will be grounds for rejection of the equipment. The severely damaged equipment will be replaced at no cost to the City.

.2 Ten days before delivery, notice shall be given to the Contract Administrator so that arrangements for receipt and for inspection can be made. The shipping lists of materials will be carefully checked by the supplier in the presence of the Contract Administrator and the Contractor.

.3 The Contractor shall be responsible for receiving, off-loading, and placing into storage all equipment at the Site.

.4 The Contractor shall ensure that he is fully informed of precautions to be taken in the unloading of equipment and its subsequent storage.

3.2 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 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.

3.3 Installation

.1 The Contractor shall install all equipment including equipment supplied by the City as defined in the specifications. 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.

3.4 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 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 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 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-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 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 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 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 tests 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. GENERAL

1.1 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 Unless specified otherwise, as a minimum, the Contractor is to allow at least four sessions of four hours of training for each item of equipment or system. Note the City operates a three shift system at the WEWPCC.

.4 The intent is that the City should receive sufficient training on the equipment and systems 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.

1.2 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 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 trainers proposed by the Contractor shall be experienced in training plant operators and shall have relevant experience in similar Work.

1.3 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 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.

1.4 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 is to take place in the boardroom in the WEWPCC Administration Building. The Contract Administrator may direct the classroom training to take place at another suitable location.

1.5 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 10 copies of necessary training manuals, handouts, visual aids, and reference materials at least two weeks prior to each training session.

1.6 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

1.7 Video Recording

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

2. PRODUCTS

.1 Not used

3. EXECUTION

3.1 General Requirements

.1 Conduct training in conjunction with the equipment testing period. 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 hours of classes scheduled for any one shift.

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

3.2 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

3.3 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

3.4 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.

3.5 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

3.6 Equipment and Systems for Training

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

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

3.7 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).

.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 form is to be used for each item of equipment or system for which training has been provided.

.4 Form T2: To be completed for training during the warranty period. One form is to be used for each equipment/system 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

COMMISSIONING

1. GENERAL

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 water supply system to meet the water demands at the time.

.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.

1.2 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.

1.3 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 28 days, the last seven 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.

1.4 Commissioning Team

.1 The Work of commissioning will be conducted by 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 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.

1.5 Commissioning Plan

.1 Develop a detailed methodology for the commissioning of each system at least 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 handover with information indicating their qualifications for this Work.

.2 The commissioning plan shall be reviewed prior to its implementation. The Contract Administrator shall be the final arbiter.

1.6 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 shall be executed for each item.

.2 As required in Section 01300 – Submittals, O&M 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.

1.7 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.

1.8 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.

1.9 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.

1.10 Operating Descriptions

.1 Operating descriptions shall be prepared by the Contract Administrator for the plant systems. Other information outlining the operating requirements shall also be 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.

1.11 Design Parameters

.1 Design parameters for the systems to be commissioned shall be as defined in the Specifications and/or the operating descriptions. 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.

2. PRODUCTS

.1 Not used

3. EXECUTION

3.1 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.

3.2 Sequence

.1 Systems shall be commissioned in accordance with the Genearl Sequence of Construction (see Section 01010). Unless specified otherwise, upstream components shall be commissioned first to the degree possible.

.2 For each system, the following sequence of events shall be followed:

.1 O&M Manuals shall be available as per the requirements of Section 01300 at least 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 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 28 days. The equipment shall operate continuously and successfully through the last seven 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 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 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.

3.3 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.

3.4 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 28 days, the last seven 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 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. GENERAL

1.1 Final Cleaning

.1 When the Work is Substantially Performed, remove surplus products, tools, construction machinery, and equipment not required for the performance 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 process commences.

1.2 Site Restoration

.1 The Contractor shall remove the temporary Site office 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.

2. PRODUCTS

.1 Not used

3. EXECUTION

.1 Not used

END OF SECTION

OPERATING AND MAINTENANCE DATA

1. GENERAL

1.1 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.

1.2 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 120 days before the date of Substantial Performance.

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

1.3 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.

2. PRODUCTS

.1 Not used

3. EXECUTION

3.1 Contents and Organization

.1 Arrange the O&M Manual 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 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 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.

.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 Provide descriptions and schedules for manufacturer's recommended routine preventative maintenance procedures including specific lubrication recommendations. Indicate service intervals: daily, weekly, monthly, quarterly, semiannually, annually, or after "X" 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, 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".

3.2 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.

3.3 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 (compact disc or DVD) of the above documents scanned into electronic format.

3.4 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

TABLE OF CONTENTS

DIVISION 2

GEOGRID SOIL REINFORCEMENT

1. GENERAL

1.1 Work Included

.1 Supply and installation of geogrid soil reinforcement fabric for construction of new access roadway.

1.2 Definitions

.1 Minimum Average Roll Value (MARV): property value calculated as typical minus two standard deviations. Statistically, yielding a 97.7 percent degree of confidence that any sample taken during quality assurance testing will exceed value reported.

1.3 Submittals

.1 Certification: the Contractor shall provide to the Contract Administrator a certificate stating the name of the manufacturer, product name, style number, chemical composition of the product and other pertinent information to fully describe the geosynthetic. The Certification shall state that the goesynthetic meets the MARV requirements of the Specification as evaluated under the manufacturer's quality control program. The Certification shall be attested to by a person having legal authority to bind the manufacturer.

1.4 Delivery, Storage and Handling

.1 Geosynthetic labeling, shipment and storage shall follow ASTM D 4873. Product labels shall clearly show the manufacturer or supplier name, style name and roll number.

.2 Each geosynthetic roll shall be wrapped with a material that will protect the geosynthetic from damage due to shipment, water, ultraviolet light, sunlight and contaminants. During storage the geosynthetic rolls shall be elevated off the ground and adequately covered to protect them from damage.

2. PRODUCTS

2.1 Materials

.1 Polymers used in the manufacture of geogrids shall consist of long-chain synthetic polymers, composed of at least 95 percent by weight of polyolefins, polyesters or polyamides. They shall be formed into a stable network such that the ribs, filaments or yarns retain their dimensional stability relative to each other, including selvages.

.2 Geogrid soil reinforcement supplied shall be Mirafi BasXgrid 12 or approved equal.

2.2 Properties

.1 The geogrid supplied shall have the following properties, all numeric values represent MARV in the specified direction:

Reinforcement Properties	**Test Method**	**Units**	**Required Value Machine Direction (MD)**	**Required Value Cross Machine Direction (CD)**
Tensile Strength @ 1% Strain	ASTM D 6637	kN/m	4.3	6.6
Tensile Strength @ 2% Strain	ASTM D 6637	kN/m	7.3	10.9
Tensile Strength @ 5% Strain	ASTM D 6637	kN/m	13.4	19.7
Tensile Modulus @ 1% Strain	ASTM D 6637	kN/m	437	656
Coefficient of Interaction- Ci (sand)	ASTM D 5321	--	0.8	
Suvivability Index Values			**MD**	**CD**
Ultimate Tensile Strength	ASTM D 6637	kN/m	29.2	58.4
Ultraviolet Stability (after 500 hrs)	ASTM D 4355	%	70	

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 Subgrade Preparation

.1 Prepare the subgrade to design subgrade elevation prior to installation of the geogrid. Ensure the subgrade is true and even prior to placement and that all depressions or protrusions of the subgrade are filled in or bladed smooth. Notify the Contract Administrator after completion of subgrade preparation operations for inspection of the subgrade prior to placement of the geogrid.

3.3 Geogrid Installation

.1 The geogrid shall be laid smooth without wrinkles or folds on the prepared subgrade in the direction of construction traffic. Adjacent rolls shall be overlapped between 600 to 1000 mm.

.2 Prior to covering the geogrid with subbase material the geogrid shall be inspected by the Contract Administrator to ensure that the geogrid has not been damaged during installation. Damaged geogrid shall be replaced or repaired immediately. Patches shall extend beyond the damaged area by the previously indicated overlap amount.

.3 The Contractor shall place the subbase material over the geogrid by end dumping onto the geogrid from the edge of the geogrid. The Contractor shall place a minimum of 300 mm of subbase material prior to any equipment being allowed to travel over the subbase. Sudden braking and sharp turning shall be avoided. At no time will equipment be allowed to travel directly on the geogrid.

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 Excavation to construct the Work

.2 Disposal of surplus excavated material

.3 Drain tile, drain pipe, and appurtenances

.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 Submittals

.1 Submit an excavation plan sealed and signed by a qualified Professional Engineer registered in the Province of Manitoba in accordance with Section 01300.

.2 Submit shoring, bracing, soil anchors and related structural work plans sealed and signed by a qualified Professional Engineer registered in the Province of Manitoba in accordance with Section 01300.

.3 Submit 75 kg sample of Type 1, 2 and 3 materials for analysis by testing laboratory.

.4 Submit 30 kg sample of Type 4 materials for analysis by testing laboratory.

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

.6 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.

.2 The City will pay for the first series of tests only, on the area being evaluated. Contractor to pay for costs for additional testing, if required, if Work is not in accordance with the Contract Documents.

.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 reviewed.

.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 reviewed 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: well graded pit run gravel graded in accordance with Type 1 in Table CW 2030.1 – Grading Requirements for Imported Backfill.

.2 Type 2: the granular drain material shall consist of clean, crushed white crystalline limestone aggregate or a processed granular material (pea-gravel), ranging in size from 5 mm to 19 mm. Softer buff or yellow dolomite and dolostone will not be accepted. The material shall be free from sod, roots, organics, snow, and any other deleterious material.

.3 Type 3: base course consisting of well graded granular or crushed limestone material in accordance with Table CW3110.2-Base Course Material Grading Requirements.

.4 Type 4: sand, free from silt, clay, loam, friable, or soluble material and vegetable matter, graded in accordance with Sand in Table CW 2030.1 – Grading Requirements for Imported Backfill.

.4 Suitable excavated material from the Site shall be free from organic material and rocks larger than 150 mm in size and building debris and is not to be frozen. Fill under landscaped areas to be free from alkali, salt, petroleum products, and other materials detrimental to plant growth and is not to be frozen.

.5 Suitable excavated clay material from the Site shall be free from organic material and rocks larger than 150 mm in size and building debris and is not to be frozen. Provide at areas where clay cap is indicated in the Drawings.

.6 Drain Tile to be 150 mm nominal inside diameter perforated Goldline pipe complete with knitted polyester continuous seamless sleeve as manufactured by Prinsco. Drain pipe from drain tile to sump pit is to be 150 mm nominal inside diameter non-perforated Goldline pipe as manufactured by Prinsco. Appurtenances by same drain tile manufacture.

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.

.2 Protection

.1 Before starting Work, locate all utilities crossing 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, 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. If data or monuments are displaced or lost, immediately replace at no additional cost to the City.

.3 Place drain tile and drain pipe to indicate elevations.

3.3 Excavation

.1 Three 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 Workplace Safety and Health and authorities have jurisdiction.

.3 Excavate to noted limits and as required for the Work. Stockpile material to be used for backfilling on-site as directed by the Contract Administrator. Excess material is to be disposed of immediately.

.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° bearing support under any foundation or structure.

.8 Slopes for the excavation of the existing embankments is not to exceed a gradient of 2 horizontal to 1 vertical and as indicated in the Geotechnical Report. Do not undermine the existing backfill below any structure.

.9 Prepare areas around piles for adequate support of piling equipment.

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

.11 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 or undermining of the existing and new 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 if used unless otherwise permitted by Contract Administrator.

.7 If shoring, bracing, and sheet piling are allowed 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 Surface water: 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.

.2 Ground water: Contractor shall anticipate ground water in excavations and provide measures during construction to address the water.

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 Place Type 2 material to avoid damage to drain tile. Hand level the material to ensure uniform placement.

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

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

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

.6 Do not backfill against foundation walls until the floor slabs have been completed and without the prior permission of the Contract Administrator. The wall and floor concrete must have attained the 28 day minimum compressive strength before backfilling.

.7 After sub-grade has been reviewed 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.

.8 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 are based on ASTM D698 for Standard Proctor Density.

.2 Type 1 Fill to be placed in lifts not greater than 200 mm in thickness around the structures and compacted to a density of at least 95 percent Standard Proctor. Do not compact backfill within 300 mm of building or tank wall. From 300 to 1500 mm away from wall, compact backfill with a walk-behind vibratory roller with maximum weight of a Bomag BW 75S or equivalent.

.3 Type 2 granular drain material, first lift to be placed to a depth of 300 mm above the crown of the drain tile, subsequent lifts to be placed in lifts not greater than 150 mm in thickness and compacted to a density of at least 95 percent Standard Proctor Density to ASTM D698. Surround the perforated pipes as shown on the Drawings.

.4 Type 3 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.

.5 Type 4 Fill to be placed in areas as required to bring grade to required levels under structural slabs.

.6 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 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 Remove and dispose of all snow within the Work area as required to complete the Work.

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

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

END OF SECTION

EARTHWORK

1. GENERAL

1.1 Work Included

.1 Placement of suitable Site fill material for embankment construction adjacent to proposed structures.

2. PRODUCTS

2.1 Materials

.1 Suitable Site fill material shall be in accordance with Specification CW 3170-R3.

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 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 Fill Placement

.1 The Contractor shall place suitable Site fill material stockpiled from excavation operations for the proposed structures to create embankments adjacent to the structures. Placement of suitable Site fill material and embankment construction shall be completed in accordance with Specification CW 3170-R3.

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 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 with proven performance in local conditions for piles of the same size specified for this project will be accepted for use on this project. For other hammers the driveability analysis as outlined in the following paragraphs shall be submitted to the Contract Administrator for review prior to driving piles.

.2 Hammers to be selected on basis of driveability analysis using wave equation theory, performed to show that piles can be driven to levels indicated.

.3 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.

.4 Driveability analysis shall be submitted to the Contract Administrator for review of the hammer or hammers.

.5 When required criteria cannot be achieved with the proposed hammer, use larger hammer and take other measures as required.

.6 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 by the Contract Administrator, 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-boring of holes may be acceptable to facilitate pile alignment control. Submit plan and procedures prior to commencing pile driving operations to the Contract Administrator for review.

3.3 Field Measurement

.1 Contractor shall cooperate with the Contract Administrator and shall allow access by inspection and testing firm engaged by the City during pile installation operations to facilitate all the field measurements to be performed expeditiously.

.2 Records of driving for each pile will include:

.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 and date driven

.4 Sequence of driving piles in group

.5 Number of blows per metre for entire length of pile and number of blows per 25 mm (1 inch) for last 150 mm (6 inches)

.6 Final tip, cutoff, and grade elevations

.7 Re-driving records

.8 Pile plumbness upon completion of driving

.9 Other pertinent information such as interruption of continuous driving and pile damage

.10 Record elevation taken on adjacent piles during, before, and after driving of each pile

.11 If requested by the Contract Administrator, all measurements, observation, and calculations associated with pile driving analyzer and wave equation analysis

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 the axis of the 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 days. Do not drive piles within 30 m of masonry or concrete which has been in place less than one 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 chipped 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 and 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 bear the signature and stamp of qualified 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 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 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 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 geotechnical information and required cut-off elevations.

.2 Fabricate piles to following finish tolerances:

.1 Length: ±3 mm/m of length.

.2 Cross section:

.1 Solid hexagon sections: -5 to +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: -3 to +5 mm; spiral: 10 mm

.3 Pre-stress 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

GROUNDWATER DEPRESSURIZATION SYSTEM

1. GENERAL

1.1 References

.1 ANSI/AWWA A100-90, Water Wells

.2 CAN/CSA A5-M93, Portland Cement

.3 ASTM F480-90, Specification for Thermoplastic Water Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), Sch 40 and Sch 80

1.2 Qualifications

.1 The Work described in this Section to be performed by a qualified well drilling and development contractor.

1.3 Description of Work

.1 This Section describes the Specifications for the supply, installation, operation and decommissioning of a groundwater depressurization system. The actual pumping rates required will be dependant on the natural groundwater levels at the time of construction. The required total pumping rate is up to76 L/s (1205 USgpm) which will be withdrawn from three pumping wells.

.2 The pumping wells to be used in this groundwater depressurization system will consist of an existing 152 mm well (PW-2), an existing 127 mm well (OW-2), and a 254 mm well (PW-3) to be installed under this Contract. Tasks covered under this Section include:

.1 Further development and testing of the existing 152 mm well and the supply and installation of a groundwater pump with a performance curve suitable for the post-development capacity of the well.

.2 Further development and testing of the existing 127 mm well and the supply and installation of a groundwater pump with a performance curve suitable for the post-development capacity of the well.

.3 The drilling, construction and development of a new 254 mm pumping well and the supply and installation of a groundwater pump with a performance curve suitable for the post-development capacity of the well. The location of the new well will be confirmed with the Contract Administrator prior to the start of construction and will be located as shown on the drawing or closer to the excavation.

.4 The supply, installation and operation of all necessary pumps, controls, piping, valves, appurtenances and power supply to pump groundwater at the rates specified by the Contract Administrator and discharge the water to the existing lagoons. This item includes the provision of a back-up generator and pumps, and the provision of a full time (24 hours per day) system operator for the duration that pumping will be required.

.3 The City will obtain a Letter of Authorization to operate the Groundwater Depressurization System from Manitoba Water Stewardship as well as any environmental approvals from Manitoba Conservation.

.4 The Contractor shall notify the Contract Administrator at least 72 hours before the start of any operation of the groundwater depressurization system. The Contract Administrator will be performing monitoring of the groundwater levels throughout the duration of the Work and will provide the Contractor with instructions on the rates of pumping from each well. The Contractor shall cooperate and provide the Contract Administrator with any and all assistance required to complete this monitoring.

.5 The Contractor will be responsible for providing access for the drill rig and support vehicles at the time of any work on the wells.

1.4 Specific Items to be Furnished by the Contractor

.1 Scope of Work includes provision of all material, equipment, and labour for completing the tasks identified in Clause 1.2 of this Specification Section.

.2 Prior to starting the Contractor shall submit a detailed description of the Work methodology. The methodology shall include a description of the equipment to be provided and the method of operation to ensure that groundwater levels are continuously maintained at the desired level, including contingency plans in the event of a pump or power failure.

1.5 Local Conditions

.1 Drillers reports for wells previously drilled at this site are available. Stratigraphy in the area consists of approximately 9.4 m of clay underlain by approximately 0.5 m of till. The bedrock surface was encountered at a depth of approximately 10.4 m below natural grade. The bedrock consists of fractured limestone and dolomite with fractures distributed throughout the profile to the depth of investigation of 24.1 m. It should be assumed that the new wells installed under this contract will need to be drilled to a maximum depth of 30 m. The actual depth of drilling may be less and will be as directed by the Contract Administrator who will supervise all well construction operations.

1.6 Adherence to Guidelines, Codes, and Regulations

.1 The work described herein shall be conducted in such a manner so as to comply with all applicable by-laws, ordinances, codes, and regulations, including all those pertaining to environmental and safety matters.

1.7 Reports

.1 On completion of the Work, submit to the Contract Administrator reports containing:

.1 A description of the stratigraphy encountered in each borehole, including the depths of changes in stratigraphy

.2 The size and length of each casing section installed, including the total depth of installation and the length of stick-up

.3 Grouting details

.4 Records of all static and pumping water level measurements, times at which they were taken and the corresponding pumping rate

.5 Well development data

2. PRODUCTS

2.1 Well Casing

.1 Nominal 254 mm diameter Schedule 40 PVC well casing to ASTM F480 or approved equal. PVC to be manufactured from virgin resin. Use fittings and appurtences of same standard. Provide cap for sealing well when not in use.

2.2 Pumps

.1 Provide pumps capable of pumping at combined rate of up to 76L/s (1205 USgpm) from the pumping wells. Pumps are to be sized to suit the capacity of each well and to have performance curves suitable to allow the combined system to be operated at a rate 76 L/s (1205 USgpm). The current static water level is 3.6 m below grade and the expected pumping water level is approximately 10 m below grade. The current indicated capacity of the 152 mm well is approximately 31 L/s (500 USgpm). The existing 127 mm well has not been tested. A suitable back-up pump shall be available on the site as a contingency.

.2 Hydroelectric or diesel generator power is to be supplied by the Contractor. A suitable back-up generator shall be available on-site as a contingency.

2.3 Drop Piping, Connections, Valves, Flow Meters and Discharge Hose

.1 Threaded steel drop piping to meet the pump manufacturer’s recommendations.

.2 Well head connections compatible with the drop pipe and discharge piping, complete with a control valve and flow meter of suitable size.

.3 Flexible, collapsible discharge hoses of sufficient length to direct the discharge to the access manhole to the outflow pipe.

2.4 Bentonite/Cement Grout Backfill

.1 Bentonite/Cement Grout backfill shall consist of Enviroplug Grout or approved equal, normal Portland cement and potable water mixed in the following proportions:

.1 Enviroplug Grout: 45.45 kg (100 lbs)

.2 Normal Portland Cement: 22.76 kg (50 lbs)

.3 Potable Water: 113.4 L (30 US gallons)

3. EXECUTION

3.1 Well Installation

.1 The 254 mm diameter well shall be installed by a licensed water well driller to a nominal depth of 30 m below grade at the locations shown on the contract drawings or as directed by the Contract Administrator.

.2 Drill holes plumb and straight. Dispose of drill cuttings as directed by the Contract Administrator.

.3 Ensure drilling methods do not impair production from aquifers encountered. The Contractor shall select drilling equipment, methods, fluids and additives that do not restrict or prevent flow within the aquifers.

.4 Maintain log of all bore holes including the depths of changes in stratigraphy, a description of the stratigraphy encountered, loss of drilling fluid or other indications of permeable strata.

.5 Conduct well development and pumping tests and obtain clear water samples as directed by the Contract Administrator. Well development methods will vary depending on the conditions encountered and may include, but not be limited to, air lift pumping (including surge pumping) to remove loose material, and the use of surge blocks or jetting tools. The scope for this well development is limited to an eight hour expected level of service.

.6 Re-drill holes lost due to caving or abandoned due to loss of drilling tools downhole at no cost to the City. Seal abandoned holes by approved methods.

3.2 Well Casing Installation

.1 Clean casing pipe and fittings prior to installation.

.2 Seat casing firmly into bedrock. Ensure that flow in any upper fractures is not cut off by the casing.

.3 Center casing by using centering brackets as required and install so that variance from vertical does not exceed two thirds internal diameter of casing per 30 m of depth.

.4 Seal annular space between casing and borehole wall by grouting to prevent entrance of surface water or other deleterious material.

.5 After grouting is complete, cut off casing squarely and neatly a maximum of 450 mm above ground level. Cover casing with cap to approval of Contract Administrator.

.6 Maintain accurate records of casing lengths and sizes installed.

3.3 Grouting and Sealing

.1 Seal casing of well extending through unconsolidated formation below 3 m by grouting with bentonite/cement grout.

.2 Seal casing of well in upper 3 m with bentonite.

.3 Place grout from bottom up by methods approved by the Contract Administrator. Place grout in one continuous operation.

.4 Use retainer, packer or plug at bottom of casing as necessary to ensure grout does not leak into the well.

.5 When further drilling is required after grouting, do not drill until 24 hours after complete placement of grout.

3.4 Well Capacity Test

.1 Following completion of the construction and development of the well, conduct a one hour well capacity test on the well using suitable pumping equipment, flow measurement and water level measurement devices.

.2 After pumping commences, record the flow rate every five minutes and record water levels in the well at the following intervals: every minute for the first 10 minutes; every 2 minutes for the next 10 minutes; and every 5 minutes for the next 40 minutes.

.3 After test pumping has ceased, record water level at same time interval for an additional one hour.

.4 Should test pump fail during the pumping test, allow water to reach static level prior to recommencing test. No payment shall be made for pump time prior to such failure.

3.5 System Installation

.1 Install pumps, drop pipes, well head connections, valves and flow meters as required to provide a fully functioning system.

.2 Provide and install discharge hose as necessary to discharge the water to the lagoons. Lay discharge hoses so as not to interfere with access or activities at the site, or provide suitable crossing structures to maintain access.

3.6 System Operation

.1 If needed, the Contractor shall maintain the groundwater depressurization system on a 24 hour per day basis for the duration of the construction period requiring lowered groundwater levels. This will include the provision of a full time operator 24 hours per day who will be capable of repairing the system or otherwise taking actions to ensure that lowered groundwater levels are maintained at all times. Damages to the construction site or the equipment and materials at the site due to the failure of the system will be the responsibility of the Contractor.

.2 If needed, the Contractor shall monitor water levels during system operation and provide the information to the Contract Administrator on a daily basis. The Contract Administrator will advise the Contractor as to the required pumping rates.

3.7 System Decommissioning

.1 Upon completion of the Work, the Contractor shall remove all system equipment and repair any damage caused by the system (erosion, etc.).

.2 The Contractor shall not decommission any wells unless specified by the Contract Administrator. The lower portion of the wells within the bedrock will be backfilled with clean fill. The upper portion of the well within the casing will be backfilled with bentonite/cement grout to the top of the well. Following completion of the grouting, the casing will be cut off a minimum of 300 mm below grade.

END OF SECTION

CRUSHED STONE PAVING

1. GENERAL

1.1 Work Included

.1 Construction of new bioreactor access roadway includes; excavation, supply and installation of base and sub-base materials, ditch grading, placement of topsoil and sod, geogrid, and miscellaneous items.

1.2 References

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

.1 CW3010-R4 Clearing and Grubbing

.2 CW3110-R7 Sub-Grade, Sub-Base and Base Course Construction

.3 CW 3510-R8 Sodding

.4 CW 3610-R3 Installation of Culverts

.5 CW3710-R4 Products Approved for Use in Surface Works

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

.3 Division 2 General Requirements of the City 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 Standard Construction Specifications and in these specifications.

.2 Properties of base course and sub-base course material to be in accordance with CW 3110-R7.

.3 Properties of culverts to be in accordance with CW 3610-R3.

.4 Sod and topsoil to be in accordance with CW 3510-R8, sod for general park areas, boulevards, medians, and interchange areas.

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 Strip topsoil in accordance with CW-3110 R7 in all areas on-site where proposed new gravel access roadway and ditches are to be constructed. Haul all stripped material off-site.

.2 Grub out all roots within paving limits in accordance with CW-3010 R4. Dispose of off-site.

.3 Excavate to the lines and grades shown on the Drawings and Surface Works Standard Details in accordance with CW-3110 R4. Dispose of all excavated material off-site.

3.3 Subgrade Preparation

.1 Prepare subgrade in accordance with CW-3110 R4. Upon approval of the excavation bottom by the Contract Administrator, compact subgrade to 95 percent Standard Proctor Density.

.2 Prior to installation of Geogrid, 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 geogrid in accordance with Section 02071 Geogrid Soil Reinforcement as indicated on the Drawings and Surface Works Standard Details.

3.4 Installation of Culverts

.1 Supply and install culverts to the line and grade as shown on the Drawings and in accordance with CW-3610-R3.

3.5 Sodding

.1 Place topsoil prior to sodding as indicated on the Drawings, sod to be placed and mainatianed in accordance with CW 3510-R8.

3.6 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 R4 for roadways and approaches.

END OF SECTION

PORTLAND CEMENT CONCRETE PAVING

1. GENERAL

1.1 Work Included

.1 Construction of new DAF building Portland cement concrete approaches.

1.2 References

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

.1 CW3240-R5 Renewal of Existing Curbs

.2 CW3310-R9 Portland Cement Concrete Pavement Works

.3 CW 3510-R8 Sodding

.4 CW3710-R4 Products Approved for Use in Surface Works

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

.3 Division 2 General Requirements of the City 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 Standard Construction Specifications.

.2 Properties of base course and sub-base course material to be in accordance with CW 3110-R7.

.3 Properties of Portland Cement Concrete to be in accordance with CW 3310-R9.

.4 Properties of Reinforcing Steel to be in accordance with CW 3230-R4 and CW 3310-R9.

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 Strip topsoil in accordance with CW 3110-R7 in all areas on-site where proposed new concrete approaches are to be constructed. Haul all stripped material off-site.

.2 Grub out all roots within paving limits in accordance with CW 3010-R4. Dispose of off-site.

.3 Sawcut 150 mm from the face of curb and remove existing lip curb in accordance with CW-3240-R5.

.4 Excavate to the lines and grades shown on the Drawings and Surface Works Standard Details in accordance with CW-3110 R4. Dispose of all excavated material off-site.

3.3 Subgrade Preparation

.1 Prepare subgrade in accordance with CW-3110 R4. Upon approval of the excavation bottom by the Contract Administrator, compact subgrade to 95 percent Standard Proctor Density.

3.4 Sub-base and Base Course Construction

.1 Supply and install culverts to the line and grade as shown on the Drawings and in accordance with CW-3610-R3.

3.5 Installation of Drilled Tie-Bars

.1 Install 20 M epoxy coated drilled tie-bars at the edge of the existing concrete pavement, where the curb has been removed, in accordance with CW 3230-R4.

3.6 Placement and finishing of Portland Cement Concrete

.1 Supply, place, and finish Portland Cement Concrete to the line and grades as shown on the Drawings and in accordance with CW-3310-R9.

END OF SECTION

CHAIN LINK FENCES AND GATES

1. GENERAL

1.1 Work Included

.1 Supply and installation of security chain link fencing.

2. PRODUCTS

2.1 Materials

.1 All material shall be supplied in accordance with the City Standard Specification CW 3550-R2 fence height to match exsitng.

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 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 Fence Installation

.1 Chain link fencing shall be installed in accordance with the City Standard Construction Specification CW 3550-R2 and as shown on the Drawings. Fence height to match existing fence height.

END OF SECTION

SUPPLY AND INSTALLATION OF STEEL BOLLARDS

1. GENERAL

1.1 Work Included

.1 Supply and installation of steel bollards as shown on the Drawings at the proposed DAF Building.

2. PRODUCTS

2.1 Materials

.1 The steel bollards shall be supplied in accordance with ASTM A53, DN 150, 168.3 mm O.D. (Weight Class XS, 10.97 mm wall thickness) galvanized pipe.

.2 Concrete for filling the steel bollards shall be 30 MPa Normal Portland Type 10 supplied in accordance with CW 3310-R10

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 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 Installation

.1 The steel bollards shall be installed as shown on the Drawings.

END OF SECTION

SOD

1. GENERAL

1.1 Work Included

.1 Supply and installation of imported topsoil and sod on newly constructed embankments and ditches.

2. PRODUCTS

2.1 Topsoil

.1 All topsoil shall be supplied in accordance with the City Standard Specification CW 3510-R8.

2.2 Sod

.1 All sod shall be supplied in accordance with the City Standard Specification CW 3510-R8, sod for general park areas, boulevards, medians and interchange areas.

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 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 Topsoil and Sod Installation

.1 All topsoil and sod shall be installed in accordance with the City Standard Construction Specification CW 3510-R8 and as shown on the Drawings.

END OF SECTION

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DIVISION 3

CONCRETE FORMWORK

1. GENERAL

1.1 Work Included

.1 Forms for all concrete and supporting falsework including design.

.2 Formliner for interior wall surfaces of liquid retaining structures and containment.

.3 Wood and steel forms for all cast-in-place concrete.

.4 Void forms between structural elements and soil below where indicated.

.5 Shoring, bracing, and anchorage.

.6 Form openings for other trades.

.7 Coordinate installation of concrete accessories.

.8 Set anchor bolts, anchors, sleeves, frames, and other items supplied by other trades.

.9 Clean erected formwork prior to concrete placement.

.10 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.

1.4 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01300.

.2 Clearly indicate sizes, methods of construction, materials, arrangement of joints, ties and shores, location and size of falsework, schedule of erection and stripping, restoring, etc.

.3 Shop Drawings and design briefs are to bear the seal of a Professional Engineer, registered in the Province of Manitoba.

.4 Formwork, falsework and reshoring are to be reviewed by the same Professional Engineer prior to each concrete pour.

.5 Professional Engineer to report, in writing, that reviewed formwork, falsework and reshoring are in accordance with the design, prior to each concrete pour.

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:

.1 Moisture-resistant treated paper faces; bio-degradable, structurally sufficient to support weight of wet concrete mix and construction loads until initial set under slabs, walls and beams unless noted.

.2 Below structural slabs of the Fermenter 1, Fermenter 2 and Clarifier 3; Geo Void expanded polystyrene as manufactured by Plasti-Fab.

2.5 Accessories

.1 Plain formliner: Zemdrain MD Type III by Dupont or accepted alternate.

.2 Form ties for water retaining structures: shall be cone-fast coil tie type or she bolt type as manufactured by Dywidag, to provide a 50 mm deep cone pocket for grouting after use. The portion of the form tie that remains in the concrete wall shall be plated and shall utilize a hydrophylic O ring waterstop at midspan. As an alternate to these ties, a tapered removable form tie may be employed. The hole to be grouted after removal must be mechanically cleaned to remove al remnants of release or debonding agents.

.3 Form ties for non-water retaining elements: removable snap-off metal type, fixed length, minimum working strength of 13 kN when assembled and that leave a minimum cutback of 25 mm. Use plastic cone snap type or screw type on exposed surfaces. Wire ties are not permitted.

.4 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.

.5 Corner fillets or chamfers: mill finished pine, 20 mm by 20 mm, maximum possible lengths, mitre ends.

.6 Reglets: mill finished pine, shaped to required cross-section, maximum possible lengths, mitre ends.

.7 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 Divisions 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 Formliner shall be used on all interior wall surfaces of liquid containing structures and containments. It shall be installed in strict accordance with the manufacturer's instructions. The manufacturer's representative shall be on-site at the beginning of the formliner installation and as required to ensure recommended procedures are followed; a written report shall be submitted for each Site visit. Wrinkles or folding of the formliner during concrete placement will not be accepted.

3.8 Form Removal

.1 Notify Contract Administrator prior to removing formwork.

.2 Do not remove forms and falsework until concrete has gained either sufficient strength to carry its own weight plus construction loads and design loads that 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 Synthetic Fibers

.1 Fibrillated polypropylene with minimum length of 19mm to ASTM C1116-03 Standard Specification for Fiber-Reinforced Concrete and Shotcrete

2.3 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 to be non-corrosive PVC chairs or purpose made concrete chairs. Steel bar chairs, galvanized bar chairs, concrete bricks, broken concrete blocks, or wood supports are not acceptable.

.4 Side form spacers to be non-corrosive PVC spacers, purpose made. PVC chairs, steel bar chairs, galvanized bar chairs, concrete bricks, broken concrete blocks, or 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: +0, -25 mm

.2 Stirrups, ties, and spirals: +0, -10 mm

.3 Other bends: +0, -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 re-bent 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. Chairs supporting 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 unless noted otherwise; main steel: 50 mm.

.2 Slabs (top and bottom): 50 mm

.3 Column ties: 40 mm; main steel: 50 mm

.4 Walls: 50 mm unless noted otherwise

.5 Concrete formed against earth (including bottom of slab on grade): 75 mm

.4 Maintain alignment tolerances as follows:

.1 Slabs: ±5 mm

.2 Other structural members: ±10 mm

.3 Rebar bends and ends: ±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 Premoulded Joint Fillers

.2 Resilient Filler

.3 Backer Rods

.4 Joint sealants

.5 Vapour Barrier

.6 PVC Waterstop

.7 Expansive waterstop

.8 Non-ferrous grout

.9 Latex patching agent

.10 Epoxy bonding agent

.11 Curing and sealing compounds

.12 Curing compound

.13 Moisture retention film

.14 Repair Mortar

1.2 Qualifications

.1 All waterstopping and sealant installations are to be done by an established firm having at least five years of proven, satisfactory experience in this trade and employing skilled personnel.

.2 Submit proof of qualifications in writing to the Contract Administrator prior to commencement of Work.

2. PRODUCTS

2.1 Materials

.1 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.

.2 Resilient Filler: conforming to ASTM D1752, sizes as indicated on Drawings, greater than ninety percent (>90 percent) recover after fifty percent (50 percent) compression; closed cell foam joint filler, such as W.R. Meadows Sealthight Ceramar, and Sika Flexcell by Sika.

.3 Backer Rod: closed cell vinyl foam.

.4 Joint sealants for non liquid retaining areas: 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.

.5 Joint sealants for liquid retaining areas: non-staining, non-sagging, grey two-part, polyurethane elastomeric sealant shall be suitable for submerged service such as Sikaflex 2c NS/SL. Polysulphide sealants shall not be used

.6 Vapour barrier: 0.15 mm clear polyethylene film, with self-adhesive polyethylene or polyvinylchloride tape for sealing joints. Vapour barrier to CAN/CGSB-51.34-M86.

.7 PVC Waterstop: to conform to CGSB 41-6P-35M polyvinyl chloride, edges wire looped for tying. Acceptable product is Wirestop CR-9380 by Paul Murphy. Factory fabricated and tested PVC waterstop vertical and horizontal cross, L amd T shaped junction sections are to be used.

.8 Expansive Waterstop: SikaSwell S-2 by Sika and CS-231 Controlled Expansion Waterstop by ConSeal Concrete Sealants to be used at specific locations indicated on drawings or as directed by the Contract Administrator.

.9 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.

.10 Latex Patching Agent: Duraweld-C Latex Bonding Agent, or accepted alternate.

.11 Epoxy Bonding Agent: Master Builders Concresive 1001 LPL, Dural Duralbond, Sikadur 32 HI-bond, or accepted alternate.

.12 Curing and Sealing Compounds: conforming to ASTM C309, such as Master Builders Masterseal, Sika Florseal, or accepted alternate.

.13 Curing Compound: conforming to ASTM C309.

.14 Moisture Retention Film: Master Builders Confilm or accepted alternate.

.15 Repair Mortar: Meadow-Crete H by W.R. Meadows or accepted alternate.

3. EXECUTION

3.1 Installation

.1 Pre-installation conference for waterstoping and sealant products: Prior to installation of waterstoping and sealant products, conduct a meeting with applicator, installers of Work adjacent to or that penetrates the waterstop or sealant products, the Contract Administrator and manufacture's technical representative to review the following:

.1 General project requirements.

.2 Manufacture's product data sheets and installation guides.

.3 Substate conditions and procedures for substate preparation and product installations.

.4 The manufacture's technical representative is to issue reports to the Contract Administrator identifying that the substate conditions and installation procedures are being followed for each area were the specific product is being utilized.

.5 Responsibility and costs associated with verification and correlation of field dimensions, fabrication processes, techniques of construction, installation and coordination of Work and manufactures technical representative for all parts of the Work rests with the Contractor.

.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. Concrete slabs shall be moist cured as per Section 03300.

.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 all joints in a continuous and inter-connected manner for liquid retaining structures and containment unless indicated otherwise on the Drawings.

.2 All waterstop joints other than straight butt joints shall be factory fabricated and tested 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 Expansive Waterstop

.1 Apply expansive waterstop where specifically indicated on the Drawings or as directed by the Contract Administrator.

.2 Prepare surfaces and apply beads sized to manufacturer's instructions.

.3 Protect expansive waterstop from contact with water prior to concrete placement. Replace waterstop if it has come in contact with water and has begun to absorb water.

.9 Latex patching agent is to be used for patching formed concrete surfaces where required.

.10 Repair Grout

.1 Apply repair grout where existing concrete is to be removed as indicated on the Drawings or as directed by the Contract Administrator.

.2 Prepare surfaces and apply repair mortar to manufacturer's instructions. Use pea gravel to extend the mixture in accordance with the manufacturer's instructions.

.11 Vapour Barrier

.1 Provide vapour barrier below all slabs cast on granular material and void forms.

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, Subcontractors and Contract Administrator.

1.3 Qualification

.1 Concrete flatwork finishing is to be done by an established firm having at least five years of proven, satisfactory experience in this trade and employing skilled personnel.

.2 Submit proof of qualifications in writing to the Contract Administrator prior to commencement of Work.

1.4 Inspection and Testing

.1 Notify the Contract Administrator at least 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.

.6 Tests of cement and aggregates may be performed to ensure conformance with requirements stated herein.

.7 Notify the Contract Administrator and Concrete Testing Firm at least 24 hours in advance of any concrete placement.

.8 A minimum of three (3) concrete test cylinders will be taken for every 50 or less cubic meters of each class of concrete placed. The Contract Administrator may increase the testing requirements as required to ensure concrete is in accordance with the Specification. Contractor to adjust scheduling of concrete as required allowing for testing as required by the Contract Administrator.

.9 At least three 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 Repair all areas where concrete surfaces were tested.

.13 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.

.14 The Contractor is to pay costs for required retesting due to defective materials or workmanship.

.15 If accepted by the Contract Administrator, the Contractor may arrange and pay for additional tests for use as evidence to expedite construction.

.16 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 for 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, 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 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 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 four weeks prior to concrete casting.

.2 Provide concrete mixed in accordance with requirements of CAN/CSA-A23.1-00 and attached Table A (see below at end of this Section). The attached Table A requirements 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 to cementitious material 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 24 hours prior to casting concrete. Under no circumstances cast 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, 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 dowels, and pack solidly with non-shrink grout.

.13 A minimum of three days shall elapse between adjacent castings 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 12 hours preceding the cast. This equipment shall not be used during placing or for 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. Record date, location of cast, quantity, air temperature, and test samples taken.

3.3 Cold Weather Concreting

.1 The requirements of this section shall be applied to all concreting operations if the mean daily temperature falls below 5°C during placing or curing.

.2 Supplementary equipment is to 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 days and be kept above freezing temperature for at least an additional seven days. 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 -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 -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 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 casting. The curing record shall include date and location of the cast, 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 to the tolerances indicated below:

.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.

.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 top slab surfaces conforming to CAN/CSA-A23.1-00, Clause 22 as indicated below:

.1 Main and Gallery Level floors in the Areas – F, S and T: Class B unless indicated otherwise.

.2 Mezzanine and platform floors in all Areas: Class A unless indicated otherwise.

.3 Structural slabs with concrete topping slabs in liquid retaining structures or containment areas in all Areas: Maintain surface flatness of maximum 6 mm in 3 m. Bull float surface only.

.4 Concrete topping slabs in liquid retaining structures or containment areas in all Areas: Maintain surface flatness of maximum 6 mm in 3 m. Bull float and hand trowel concrete topping slabs only. Use the process mechanism blade to screed the topping for proper alignment.

.2 Finish bottom of Area – F, Fermenter Pump Room roof slab to Smooth-Formed Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.6.

.3 Finish top of Area – F, Fermenter Pump Room roof slab: Maintain surface flatness of maximum 3 mm in 3 m. Bull float and hand trowel concrete roof slabs.

.4 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. Bull float air entrained concrete surfaces using magnesium bull float.

.2 Complete bull floating before any excess moisture or bleed water is visible on surface.

.5 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.

.6 Trowelling

.1 Trowel non-air entrained concrete floor surfaces with mechanical trowelling machines fitted with steel blades. Hand trowel non-air entrained concrete with steel blades. Hand trowel entrained air concrete using magnesium trowel.

.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.

3.8 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.

3.9 Finishing Formed Surfaces

.1 Formed vertical concrete surfaces:

.1 Formliner finish as indicated in Section 03100 on the liquid or containment side of concrete surfaces of liquid retaining structures and containment areas for all Areas unless indicated otherwise.

.2 Formliner finish as indicated in Section 03100 on both surfaces for liquid retaining structures and containment areas were the concrete surface will be visible from the non-liquid or non containment side. Repair surface defects on all visible concrete surfaces to Smooth Rubbed Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.7.2.

.3 Finish other visible surfaces to Smooth Rubbed Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.7.2.

.4 Surfaces to receive insulation or roofing material are to be finished to Smooth-Formed Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.6.

.5 Other non visible surfaces to be finished to Rough-Formed Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.5.

3.10 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 days. One 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 days, shall not require any additional curing (except as specified for hot weather). If the formwork is removed in less than seven days, the concrete shall receive a moist curing as above or until seven 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.

3.11 Concrete Toppings

.1 Place bonded toppings to thickness and elevations indicated on Drawings, in accordance with CAN/CSA-A23.1-00 unless noted.

.2 Remove all laitance, dirt, dust, debris, grease and other substances from base slab.

.3 Prepare the base slab profile to an ICRI (International Concrete Repair Institute) CSP-5 profile.

.4 Saturate the base slab to an SSD (saturated surface dry) condition for a minimum of 24 hours prior to casting of the concrete topping.

.5 Utilize a cement/sand grout in accordance with the requirements of Clause 23.4.2 in CAN/CSA-A23.1-00.

.6 Tensile testing of the bonded topping will be preformed in accordance with CSA-A23.2-00.

3.12 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.

3.13 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 reviewed 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 visible horizontal and vertical edges.

.4 Clean excess concrete from metal frames, inserts, weld plates, etc. Clean and tool concrete around the above noted items.

3.14 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.

3.15 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 The Contract Administrator shall have the right to require one or more of the following all of which will be at the Contractor's expense:

.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.

3.16 Watertightness Testing

.1 All water retaining structures shall be watertight and all precautions shall be taken, especially joint treatment, to construct watertight structures.

.2 Perform watertightness testing for all water retaining compartments. Watertightness testing shall be performed in accordance with ACI 350.1 Designation HST-100 except as described in the following clauses.

.3 Notify the Contract Administrator at least two working days before commencing the watertightness test.

.4 The structures, when full, shall be reviewed over a 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 and the roof, where applicable has obtained 75 percent of the design strength. Fill the tanks with clean water 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 cooperate with and assist the Contract Administrator with the leakage measurements during the next 48 hour period. With the water at maximum operating level for 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 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 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.

3.17 Construction Joints

.1 Construction joint locations shall be as shown on the Drawings.

.2 Joints not indicated on the Drawings shall be located so as to least impair the strength of the structure. The location of these joints shall be subject to prior review and acceptance by the Contract Administrator. Joints shall be in accordance with CAN/CSA-A23.1-00, or as indicated on the Drawings.

.3 The surface of hardened concrete shall be thoroughly cleaned of foreign matter and laitance by sand blasting, and shall be thoroughly wetted with water, but not saturated, and the forms shall be re-tightened against the face of the hardened concrete before depositing additional concrete. Any concrete splatter on reinforcing bars shall be removed by sand blasting.

3.18 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. Cementing Material Content (kg/m^3)	Max. Water Cementing Material Ratio	Nominal Aggregate Size (mm)	Slump (mm)	Entrained Air Content (%)	Min. Synthetic Fibers ($kg/m^{3)}$
1	Liquid retaining structural concrete or structural slabs , walls, grade beams, and concrete beams Class of exposure: C-1	35	50	335	0.40	20 to 5	65 ± 25	5 to 8	--
2	Topping slabs Class of exposure: C-1	35	50	335	0.40	10 to 5	40 ± 20	4 to 7	0.9
3	Non-liquid retaining or non containment structural concrete in contact with soil, backfill or exposed to weather – pile caps, grade beams, exterior pads Class of exposure: C-1	35	50	--	0.40	20 to 5	80 ± 20	5 to 8	--
4	Interior structural concrete Class of exposure: N	30	10	--	0.50	20 to 5	80 ± 20	Less than 3	--
5	Miscellaneous concrete – curbs, equipment bases, pipe supports, benching Class of exposure: N	25	10	--	0.50	20 to 5	80 ± 20	Less than 3	--
6	Grout or Concrete used in Masonry infill	20	10	--	--	10 to 2.5	150 ± 30	Less than 3	--

END OF SECTION

TABLE OF CONTENTS

DIVISION 4

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 Laboratory test reports to certifying compliance of masonry units and mortar ingredients with Specification requirements.

1.4 Samples

.1 If requested by the Contract Administrator, submit the following Samples in accordance with Section 01300.

.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 jobsite 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 5°C and 50°C 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 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.

.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 Support of Loads

.1 Use concrete to Section 03300, where concrete fill is indicated, 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.

3.8 Provision for Movement

.1 Leave a minimum of 60 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.

3.9 Control Joints

.1 Construct continuous control joints as indicated on the Drawings.

3.10 Expansion Joints

.1 Build-in continuous expansion joints as indicated.

3.11 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 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 all Work specified in this Section.

2.3 Mortar Types

.1 Mortar for all masonry:

.1 Type S based for load bearing and non-load bearing construction.

3. EXECUTION

3.1 Mixing

.1 Do masonry mortar and grout Work in accordance with CSA A179 except where specified otherwise.

.2 Incorporate admixtures into mixes in accordance with manufacturer's instructions.

.3 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. Sample costs will be the responsibility of the Contractor.

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 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 and Tapcon

.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.

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 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 Metal connector to be: Slotted Block Tie, Type 1, complete with Insulation Clip as manufactured by FERO Corporation when connecting to concrete block.

.4 Metal connector to be: Slotted RAP Tie, complete with Insulation Clip as manufactured by FERO Corporation when connecting to concrete and steel.

3.3 Reinforced Lintels and Bond Beams

.1 Reinforce masonry lintels and bond beams as indicated.

.2 Place and cast 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 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 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

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, CSA 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 Masonry Construction for Buildings.

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.

1.6 Submittals

.1 Submit three (3) samples of each type of architectural concrete masonry unit in accordance with Section 01300.

2. PRODUCTS

2.1 Materials

.1 Architectural Concrete Masonry Units: to CSA A165.1, normal weight, type H/15/A/M, modular size of 390 mm x 90 mm x 90 mm, split-face, colour 591 "Manitoba Stone" manufactured by CCI Tallcrete, finish to match existing buildings.

.2 Architectural Concrete Masonry Units: to CSA A165.1, normal weight, type H/15/A/M, modular size of 39 0mm x 190 mm x 90 mm and 390 mm x 90 mm x 90 mm smooth-face scored, colour 591 "Manitoba Stone" manufactured by CCI Tallcrete, finish to match existing buildings.

.3 Standard Concrete Masonry Units: to CSA A165.1, normal weight, type H/15/A/M, modular size of 390 mm x 190 mm x 190 mm, 390 mm x 240 mm x 190 mm, and 390 mm x 290 mm x 190 mm, refer to Drawings for locations of different sizes; units to be manufactured by CCI Tallcrete.

.4 Special Shapes: provide Type H/15/A/M Bull-Nosed units for exposed corners.

.5 Provide purpose made knock out blocks for bond beams and lintes unless noted. At door and windows openings provide purpose made bond beam shapes for lintels.

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 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 4 feet 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 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 for concrete masonry units, 100 mm for one block and one joint for split-face and smooth face scored half high units.

.2 Use bull-nosed units for exposed external corners, door and window jambs, etc. 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 concrete for two 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 7.6 m o.c.

.2 Form control joints as detailed. Stop masonry reinforcing 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 wire reinforcing in every second block bed joint.

.2 Place wire 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 wire 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.

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 with reinforcing bars as indicated on the Drawings placed in bottom, and fill with concrete.

3.11 Reinforced Block Lintels

.1 Install reinforced concrete block lintels at openings where steel lintels are not indicated.

.2 Cast and cure lintels in place complete with shoring.

.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 days before removing shores.

.4 Minimum bearing shall be 400 mm each side of openings unless noted elsewhere.

3.12 Nailing Inserts

.1 Install nailing inserts as required for wall strapping set in mortar joints at 400 mm centres each way, to manufacturer's instructions.

3.13 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.

3.14 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. Check masonry unit manufacturer for acceptable solution. Clean trial test area and obtain permission to proceed with Contract Administrator.

.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 to the Contract Administrator.

END OF SECTION

TABLE OF CONTENTS

DIVISION 5

STRUCTURAL STEEL

1. GENERAL

1.1 Work Included

.1 Structural framing columns, beams, girders, purlins, hollow sections, channels.

.2 Support channels and angles attached to structural framing.

.3 Baseplates, bearing plates, anchor bolts, vertical and horizontal bracing.

.4 Bearing plates, angles with anchors and anchor bolts for joists.

.5 Plate, angle and channel door and opening frames attached to structural steel.

.6 Structural supports around openings in metal deck over 450 mm in any dimension.

.7 Crane girders, runway beams and monorails.

.8 Welds, bolts, washers, nuts, and shims.

.9 Shear stud connectors.

.10 Prime and galvanized structural steel members and appurtenances.

.11 Field touch up of primed and galvanized surfaces including field welding.

1.2 Design Standards, Code Requirements

.1 Conform to requirements of CAN/CSA S16.1, CAN/CSA-S136, the Canadian Institute of Steel Construction (CISC) "Code of Standard Practice for Buildings" and the Provincial Construction Safety Act.

.2 Use loads, load combinations and stress levels shown on drawings and in accordance with the National Building Code of Canada.

.3 Connections are to be designed by a Professional Engineer registered in the Province of Manitoba. Design connections for loads indicated on the Drawings as a minimum.

.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 2.

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 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.

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 Shop drawings and design briefs are to bear the seal of a Professional Engineer, registered in the Province of Manitoba.

.4 Submit Shop Drawings for review in accordance with Section 01300.

.5 Clearly indicate profiles, sizes, spacing and locations of structural members, connections, attachments, reinforcing, anchorage, framed openings, size and type of fasteners, cambers and loads, accessories, column anchor bolt locations, setting details.

.6 Include erection drawings, elevations and details.

.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.

1.6 Materials

.1 All materials shall be new.

.2 Beam End Plates, Ledger Angles and Miscellaneous Steel: to CAN/CSA-G40.2l, Grade 300W with minimum yield strength of 300 MPa.

.3 Base and Cap Plates: to CAN/CSA-G40.2l, Type 300W with minimum yield strength of 300 MPa.

.4 Structural steel wide flange sections (W shapes): conforming to CAN/CSA-G40.21, Grade 350W with minimum yield strength of 350 MPa, or conforming to ASTM A992 or A572, Grade 50 with minimum yield strength of 345 MPa.

.5 Structural monorail sections (S shapes): conforming to ASTM A992 or A572, Grade 50 with minimum yield strength of 345 MPa.

.6 Structural Channels (C shapes): conforming to CAN/CSA-G40.21, Grade 300W with minimum yield strength of 300 MPa.

.7 Hollow Structural Sections: conforming to CAN/CSA-G40.21, Grade 350W Class 'C' with minimum yield strength of 350 MPa. Hollow structural sections conforming to ASTM A500 Grade C will not be acceptable unless approved by the Contract Administrator.

.8 Bolts, nuts, and washers: conforming to ASTM A325; galvanized or painted to match fastened items.

.9 Welding Materials: conforming to CSA W59.

.10 Interior structural steel primer: CISC/CPMA 2-75.

.11 Stud Shear Connectors: conforming to ASTM A108; Nelson Studs as manufactured by TRW Inc.

.12 Concrete Anchors: as manufactured by Hilti (Canada) Ltd. where indicated.

.13 Galvanizing: conforming to CAN/CSA-G164; minimum 610 g/m squared.

.14 Touch-up galvanizing with minimum 2 coats of zinc rich primer.

.15 Provide and install decals for each side of each Crane runway girder reading, "MAXIMUM LOAD 907 kg", in black letters minimum 100 mm in height.

.16 Provide and install decals for each side of each monorails reading, "MAXIMUM LOAD XXXX kg", in black letters minimum 100 mm in height. Coordinate exact loading designations with Contract Administrator.

1.7 Fabrication

.1 Fabricate structural steel members in accordance with CAN/CSAS16.1 and CAN/CSA S136.

.2 Verify all drawing dimensions prior to commencing fabrication.

.3 Provide openings and punched holes 10 - 30 mm in diameter in structural members for other building components. Reinforce openings with steel plates sized and welded in place, to restore members to original design strength. Locate holes so as to cause no appreciable reduction in strength of members.

.4 Provide connections for loads indicated on the Drawings as a minimum.

.5 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.

.6 Accurately cut and mill column ends and bearing plates to assure full contact of bearing surfaces prior to welding.

.7 Close and weatherproof all gaps, butt joints and connections exposed to exterior of building. Grind all exposed welds flush with surface of welded members.

.8 Weld shear studs in place with stem perpendicular to member, in full fusion weld.

.9 Design and detail connections for structural steel so that corrosion potential is minimized. Cap and seal weld all exposed ends of HSS sections.

.10 Weld reinforcing bars to structural steel where acceptable to the Contract Administrator or as shown on Drawings in accordance with CSA W186.

1.8 Shop Painting

.1 Clean all members, remove loose mill scale, rust, oil, dirt and other foreign matter. Prepare surfaces according to SSPC SP SP7 unless indicated otherwise.

.2 Clean all members receiving galvanizing material to SSPC SP SP-10 "Near-White Blast Cleaning".

.3 Apply one 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.

.4 Faying surfaces of friction-type connections.

.5 Surfaces to receive sprayed fireproofing.

.4 Apply paint under cover, on dry surfaces only and when surface and air temperatures are above 5°C.

.5 Maintain dry condition and 5°C minimum temperature until paint is thoroughly dry.

.6 Patch paint bolts, nuts, sharp edges and corners one coat before full prime coat is applied.

.7 Apply paint by brush or spray to a dry film thickness of 0.05 mm minimum.

2. EXECUTION

2.1 Examination

.1 Before starting erection, take field measurements and examine other Work 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.

2.2 Damaged Members

.1 Repair or replace members damaged during transit or erection, before securing in position.

2.3 Erection

.1 Erect structural steel in accordance with CAN/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 Set column bases and other vertical members to design elevations on levelling nuts or steel wedges. Do not use wood wedges.

.8 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.

.9 Erection error is not to exceed requirements of CAN/CSA S16.1.

.10 Obtain Contract Administrator's written permission prior to field cutting or altering structural members.

.11 After erection field prime welds, nuts, bolts, washers and touch up abrasions and damage to shop primed surfaces.

.12 Touch up all damaged shop finish paint, prime and finish paint all welds, nuts, bolts and washers.

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.

.5 Live load deflection criteria to L/240 for all intermediate joists and L/400 for joists adjacent and parallel to continuous support walls and for joist supporting crane loadings .

.6 Live load defection criteria to L/600 for joists supporting crane loadings.

.7 Joists and connections are to be signed and sealed by a Professional Engineer registered in the Province of Manitoba.

.8 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 2.

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 Indicate welded connections using welding symbols in compliance with CISC Welding Standards. Clearly indicate net weld lengths.

.7 Shop Drawing review by the Contract Administrator is solely to ascertain conformance to the general design concept.

.8 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 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.

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 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, 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 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 the 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 maintain the bearing within the middle 1/3 of the steel supports flange.

.3 Extend bearing chords on 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 and abrasions and damage to shop primer.

END OF SECTION

METAL DECK

1. GENERAL

1.1 Work Included

.1 Metal roof and floor 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, CSA-S16.1 and CSSBI standards for Steel Roof or Floor Deck. 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 to provide building stability through diaphragm action.

2. PRODUCTS

2.1 Materials

.1 Metal: galvanized sheet steel conforming to ASTM A653M SS Grade 230 with zinc coating of Z275 galvanized

2.2 Deck and Related Accessories

.1 Roof and floor deck: minimum 0.76 mm thickness base sheet steel, minimum three span continuous, 38 mm deep profile.

.2 Closure strips, flashing, and cover plates: minimum 0.76 mm thickness base sheet steel, of required profiles and sizes as determined by deck suppliers engineer.

.3 Roof deck to be style RD938 as manufactured by Vicwest or style P-3615 as manufactured by Canam Group.

.4 Floor deck to act in composite with concrete slab and be style HB 938 as manufactured by Vicwest or style P-3615 Composite as manufactured by Canam Group.

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 (3) 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.

METAL DECK

.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 o.c. maximum.

.9 Mechanically fasten sidelaps at 600 mm o.c. by button punch.

.10 Install angle or channel closures full length on all deck edges at perimeter, walls, and openings.

.11 Install closure strips at slab edges of thickness of slab as required to contain cast concrete. Ensure closures are of sufficient strength to maintain in place without distortion.

.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, cut edges, and damaged areas of zinc coating with minimum two (2) costs of zinc rich primer.

END OF SECTION

METAL 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 and channels

.2 Interior masonry wall lateral support angles

.3 Exterior masonry supports (galvanized)

.4 Loose lintels (galvanized)

.5 Ladders (galvanized)

.6 Mechanical supports

.7 Boot scrapers (galvanized)

.8 Anchors, plates, bolts, nuts, screws, brackets, etc. required for work of this section

.9 Bearing plates and angles for metal deck

.10 Safety davit assembly

.11 Safety full body harnesses

.12 Stainless steel davit sleeves

.13 Pallet Jack

1.2 Design Code, Quality Assurance

.1 Design and fabricate stairs, landings, handrails, and balustrades to 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 2.

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 Include erection drawings, elevations and details where applicable.

.4 Indicate welded connections using CISC standard welding symbols. Clearly indicate net weld lengths.

.5 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 unless specified otherwise

.4 Safety Davit Assembly: provide in this contract one portable man-hoist, lightweight fold-up hoist for easy transport, complete with one winch, and carrying case with 762/914 mm offset mast, reversible elbow and centre post.

.1 Acceptable products; model number PNUH3036 as manufactured by Pelsue.

.2 Winch acceptable products; model number PLPS806MR-70 stainless steel cable with winch as manufactured by Pelsue.

.3 Winch bracket acceptable products; model number PNUH-PLPS-F winch bracket as manufactured by Pelsue.

.5 Safety Full Body Harnesses: provide in this contract one medium and one extra large full body harness.

.1 Acceptable products; model number 1101642: size, medium and model number 1101644: size, extra largemodel as manufactured by DBI/SALA

.6 Stainless Steel Davit Sleeves:

.1 At all sump pit locations and as indicated on the drawings: model number PNUS102A-SS complete with sleeve cap model number PNUS106-SS as manufactured by Pelsue.

.2 At all new Bioreactor Hatches: model number PNUS100-CM-SS complete with sleeve cap model number PNUS106-SS as manufactured by Pelsue. Use stainless steel 304 or 316 bolts, nuts, plates and washers for mounted sleeves through existing pre cast tee flange.

.7 Access Hatch Accessories: provide accessories as shown on the Drawings including lift assists, hold open arms, hinges, and locks, constructed of stainless steel or other corrosion resistant materials designed for exterior use.

.8 Pallet Jack: provide in this contract one Caterpillar 2267 kg capacity pallet jack with, 685mm x1220mm forks, 74mm lowered height, adjustable push rods, polyurethane steer and load wheels.

2.2 Finishes

.1 Primer: CISC/CPMA 2-75

.2 Galvanizing: conforming to CAN/CSA-G164; minimum 610 g/m squared.

.3 Touch-up galvanizing with minimum two (2) coats of zinc rich primer.

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. Counter-sink all exposed fastenings. 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 the 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. Exposed welds shall be smooth and flush; 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 to be same as shop primer. Touch up galvanized surfaces with two coats of zinc rick primer.

.9 Supply, to appropriate sections, items required to be cast into concrete and built into masonry, complete with necessary setting templates.

END OF SECTION

ALUMINUM FABRICATIONS

1. GENERAL

1.1 Work Included

.1 Access hatches, frames, and covers

.2 Platforms, stairs and grating

.3 Stainless steel bolts for bolted connections

.4 Stainless steel anchor bolts and anchorages for all aluminum equipment supplied

1.2 Design Standards, Code Requirements

.1 CSA/CAN 3-S157-M83 Strength Design in Aluminum

.2 CSA W59.2, Welded Aluminum Construction

.3 CSA S244, Welded Aluminum Design and Workmanship

.4 CSA W47.2 Certification of Companies for Fusion Welding of Aluminum

.5 ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile

.6 ASTM A 325M, Specification for High-Strength Bolts for Structural Steel Joints

.7 ASTM F 593 Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

.8 CAN/CSA-G164, Hot Dip Galvanizing of Irregularly Shaped Articles

.9 Aluminum Association Standard SSA-46

.10 Use loads, load combinations and stress levels shown on Drawings and in accordance with the National Building Code of Canada.

.11 Connections are to be designed by a Professional Engineer registered in the Province of Manitoba. Design connections for loads indicated on the Drawings as a minimum.

1.3 Qualifications

.1 All Work is to be performed by a firm certified by the Canadian Welding Bureau to the requirements of CSA W47.2 in Division 2.

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 copies of mill test reports, properly correlated to materials actually used.

.5 Welds are to be considered defective if they fail to meet quality requirements of CSA W59.2 and CSA S244.

.6 Additionally, all welds are to be visually inspected.

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 Shop Drawings and design briefs are to bear the seal of a Professional Engineer, registered in the Province of Manitoba.

.4 Submit Shop Drawings for review in accordance with Section 01300.

.5 Clearly indicate profiles, sizes, spacing and locations of structural members, connections, attachments, reinforcing, anchorage, framed openings, size and type of fasteners, cambers and loads, accessories, column anchor bolt locations, setting details.

.6 Include erection Drawings, elevations and details.

.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.

1.6 Maintenance Data

.1 Provide maintenance data for cleaning of aluminum fabrications complete with pertinent details, and warnings against harmful maintenance materials and practices for incorporation into maintenance manual.

2. PRODUCTS

2.1 Materials

.1 All materials shall be new.

.2 Aluminum to CSA/CAN 3-S157-M83, 6061-T6 aluminum alloy. All aluminum shapes to be anodized in accordance with Aluminum Association Standard SSA-46, designation A41, clear (natural) coating, Architectural Class 1, 18 uM (0.007 mils). Structural design based on Alcan structural shapes.

.3 Aluminum grating: to style 30-102M as manufactured by Fisher & Ludlow using 6063-T6 aluminum alloy for bearing bars and 6063-T5 aluminum alloy for cross bars. Provide serrated grating for exterior applications.

.4 Aluminum stair treads: to style Type A-Checker Plate Nosing, width 278 mm wide as manufactured by Fisher & Ludlow using 6063-T6 aluminum alloy for bearing bars and 6063-T5 aluminum alloy for cross bars. Provide serraded grating for exterior applications.

.5 Nuts, bolts, and fastening devices connecting aluminum parts to aluminum, concrete, or other materials: Stainless steel to Series 300 as specified in AISI Steel Products manual No. 12, with appropriate isolation devices.

.6 Welding materials: conforming to CSA W59.2

.7 Bituminous Paint: to MPI (Master Paint Institute) EXT 5.5D, without thinner

.8 Concrete Anchors: Stainless Steel Hilti Kwik Bolts, manufactured by Hilti (Canada) Ltd. where indicated

.9 Galvanizing: conforming to CAN/CSA-G164; minimum 610 g/m squared

.10 Touch-up galvanizing with minimum 2 coats of zinc rich primer

2.2 Fabrication

.1 Fabricate aluminum members in accordance with CSA/CAN 3-S157 Strength Design in Aluminum using Alcan structural shapes.

.2 Conform to requirements of CSA W59.2 for recommended filler alloy and welding.

.3 Verify all Drawing dimensions prior to commencing fabrication.

.4 Provide connections for loads indicated on the Drawings as a minimum

.5 Provide bolted connections wherever possible. Bolted connections shall be bearing-type connections with the thread excluded from the planes of shear. Welded connections will not be permitted unless approved by the Contract Administrator. Inform Contract Administrator if required welding procedures will negatively influence the original yield strength of the members at the compression or tension flange. Adjust welding procedures as required by the Contract Administrator at no additional cost.

.6 Accurately cut and mill column ends and bearing plates to assure full contact of bearing surfaces prior to welding.

.7 Close and weatherproof all gaps, butt joints and connections exposed to exterior of building. Grind all exposed welds flush with surface of welded members.

.8 Design and detail connections for aluminum so that corrosion potential is minimized. Cap and seal weld all exposed ends of HSS and Pipe sections.

.9 Provide perimeter banding of same size as bearing bars for grating.

.10 Provide banding of same size as bearing bars for all required openings through grating as required unless noted. Contractor to coordinate location of openings prior to Shop Drawing submission.

.11 Match position of bearing bars and cross bars in adjacent panels to preserve a continuous appearance.

.12 Provide removable hold down clip style Type D complete with appurtenances for all grating. At locations were Type D clip is impractical provide Type C clip. All clips as manufactured by Fisher & Ludlow.

.13 Provide two (2) hold-down clips at each end of the panels if not detailed on the Drawings.

.14 Clip adjacent grating panels edges together at 1500 mm spacing to prevent differential vertical movement.

.15 Provide checker plate nosing along grating sections within areas of stairs for width of stair opening.

3. EXECUTION

3.1 Examination

.1 Before starting erection, take field measurements and examine other Work 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 aluminum in accordance with CSA/CAN 3-S157-M83 and Drawings.

.2 Field connections are to be bolted wherever possible. Field welding of aluminum will not be permitted unless approved by the Contract Administrator.

.3 Perform required field welding. Visible field welds to be smooth, grind or file as required. Touch up galvanizing as required.

.4 Obtain the Contract Administrator's permission prior to Site cutting or making adjustments which are not part of the scheduled Work.

.5 Install items plumb, square and level; fit accurately, and maintain free from distortion or defects detrimental to appearance and performance.

.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 Set column bases and other vertical members to design elevations on levelling nuts or stainless steel wedges. Do not use wood wedges.

.8 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.

.9 Obtain Contract Administrator's written permission prior to field cutting or altering structural members.

.10 After erection field prime welds, nuts, bolts, washers and touch up abrasions and damage to bituminous coatings and galvanizing.

.11 Provide anchors for setting in concrete with minimum 100 embedment.

.12 Paint aluminum surfaces in contact with concrete with two (2) coats of alkali-resistant bituminous paint.

.13 Prevent electrolysis between aluminum and dissimilar metals in contact with appropriate isolation devices.

END OF SECTION

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DIVISION 6

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 percent 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

PRE-ENGINEERED FIBREGLASS REINFORCED PLASTIC DOMES

1. GENERAL

1.1 Scope

.1 This Section specifies the supply and installation of one fibreglass dome as outlined herein and shown on the Drawings. It is the intent of this Specification to purchase domes of existing design standard which has been in service and performing satisfactorily for a period of not less than five years.

1.2 Related Work

.1 Cast-in Place Concrete: Section 03300

1.3 Submittals

.1 In addition to the submittals specified in Section 01300, provide the following:

.1 Certification of Materials

.1 Provide the Contract Administrator with data showing the characteristics of the materials to be used. This will be for resin (4.1.2), gel coat (4.1.4) and glass (4.1.6). The complete assembly shall conform to Class 'A' Type 1 U.L. Guidelines for classified flame spread rating of less than 25 and a smoke density of less than 50.

.2 Certification of Laminates

.1 Provide the Contract Administrator with actual laboratory test results by a qualified independent testing laboratory to confirm the values used in the design. These results shall not be older than three years.

.2 Calculations

.1 Complete set of design calculations are to be submitted to the Contract Administrator upon request, complete with the stamp of the Professional Engineer responsible for design.

1.4 Guarantee

.1 The manufacturer is to provide a minimum written guarantee for workmanship and materials for a period of one year.

2. PRODUCTS

2.1 General

.1 The manufacturer shall be responsible for the design of the domes and anchorage to the structure. The design shall provide for expansion and contraction due to climatic change without damage to the dome. The dome shall be so designed as to be self-supporting on the outside concrete tank wall.

.2 Panels shall be designed to be interlocking to provide a completely weather-tight seal. A suitable gasket material shall be installed in the interlocking joint and where the panels rest on the outside tank wall. These gaskets shall be joined to provide a weather tight seal.

.3 Dome Support

.1 When the tank wall is required to provide tensile and horizontal restraint for the dome, due to snow and wind loads, all loads to be transferred into the tank wall shall be provided to the Contract Administrator prior to construction of the concrete tanks and FRP dome.

.4 Insulation

.1 The domes shall consist of two concentric fibreglass skins, with R10, urethane foam, sandwiched between.

.5 Panel Jointing

.1 Molds shall be so designed that each panel can be laminated in one piece without joining of member by either bonding or bolting unless shown otherwise on Contract Drawings.

2.2 Acceptable Manufacturers

.1 Known acceptable manufacturers based on fabrication methods, design, and experience are:

.1 Nemato Composites Inc.1605 McEwen Drive, Whitby Ontario, L1N 7L4

.2 FiberGlass Reinforced Plastic Systems Ltd., 804 MacDonell Street, Thunder Bay, Ontario, P7B 4A6

.3 Fiber-Tech Engineering Inc., 611 Rock Springs Road, Escondido, California, 92025

2.3 Loading Conditions

.1 Design Loads

.1 The entire dome cover structure shall be designed to sustain the working loads specified herein with a factor of safety of 4.0.

.2 Dead Load

.1 The dead load shall be defined as the weight of the structure and all materials and equipment attached to and supported by the structure.

.3 Live Load

.1 The uniform load shall be assumed to act vertically upon the area of the dome cover projected upon a horizontal plane. The value of the live load shall be based on a ground snow load (Ss) of 1.7 kPa (unfactored) in accordance with the 1995 National Building Code of Canada.

.4 Unbalancing Load

.1 Unbalancing snow load to be calculated in accordance with Figure H-2, User's Guide – National Building Code 1995, Structural Commentaries (Part 4)

.5 Wind Load

.1 The wind loads shall be based on a 1/100 hourly wind pressure of 0.49 kPa (unfactored) in accordance with the National Building Code of Canada and User's Guide – National Building Code 1995, Structural Commentaries (Part 4) and to be assumed acting in any direction.

.6 Additional Considerations

.1 Air Diffuser

.1 The air diffuser hung from the centre of dome shall be supported from the dome centre.

.2 Confirm FRP duct loading with supplier.

.3 Weights and fastening details are to be obtained from diffuser manufacturer, and the dome structure designed accordingly.

.2 Internal Pressure

.1 The air handling equipment within the dome cover may subject the dome to an internal pressure of 0.05 kPa less than atmospheric pressure.

.3 Temperature Range

.1 The domes shall be designed to accommodate the climatic temperature range of +40°C to -40°C, plus effects of differential solar heating.

2.4 Materials

.1 Resin: Characteristics

.1 All resins shall be chemical resistant resins containing light stabilizers such as Halogenated Isophthalic Resin. The resins shall be suitable for service in temperature ranging from -40°C to +40°C and also capable of withstanding continuous exposure to the internal environment.

.2 Gel Coat Characteristics

.1 The gel coat shall consist of thermosetting polyester designed for constant exposure to the outside environment and capable of resisting UV degradation. The use of tints and pigments in the resin will not delete the need for a gel coat.

.2 Colour: Match colour to existing FRP Dome

.3 Glass Reinforcing Characteristics

.1 Fibreglass reinforcement shall consist of alternate layers of chopped strand mat and woven roving, shall be equal to Owens Corning, and shall be treated with a finish compatible to the resin being used.

2.5 Material Characteristics

.1 Ultimate Tensile Strength: ASTM D-638-84, 170 MPa minimum

.2 Ultimate Flexural Strength: ASTM D-790-84, 170 MPa minimum

.3 Ultimate Compressive Strength: ASTM D-695-85, 136 MPa minimum

.4 Modulus of Elasticity: ASTM D-790-84, 6800 MPa minimum

.5 Glass content: 25 percent minimum

.6 Linear coefficient of expansion: $15x10^{6}$ per °F

.7 Flame spread: 25 maximum

.8 Smoke development: 50 maximum

2.6 Process

.1 All panels shall be formed on suitable moulds to ensure constant and accurate dimensions. The mould surface shall be coated with resin rich pigmented coat containing proper amounts of wax to ensure complete cure of laminate. Alternate layers of chopped strand mat and woven roving will then be placed to the design thickness. The outer surface shall be coated with a gel-coat (12-15 mils) and cured.

.2 A 1000 x 1000 mm insulated sample panel is to be made under the supervision of the Contract Administrator and submitted for acceptance before fabrication begins.

.3 Each dome panel shall be insulated consisting of a sandwich construction utilizing two (2) fibreglass skins bonded to an insulating core material of R10 urethane foam which is to follow the contour of the panel, and completely fill space between outer layers.

.4 Dome panels to be complete with custom interior and exterior integral drip-edges as indicated on the Drawings.

.5 The removal of the finished laminates from the moulds shall be achieved by utilizing air jets and lifting devices which will prevent fracturing or distortion of the panels. Prior to erection all panels shall be stored and supported with adequate protection to prevent warping and fracturing.

.6 Access openings into the dome covers shall be provided as indicated on Drawings.

.7 A 900 mm x 900 mm internal dimension fibreglass supply air ventilation duct complete with stainless steel air diffuser shall be constructed and fixed to the underside of the domes. The dome manufacturer shall design, fabricate and install the above mentioned duct, air diffuser and connection to domes accordingly.

2.7 Storage

.1 The Contractor will be responsible for storing the panels off the ground on a level surface to prevent warping or fracturing.

2.8 Instructions

.1 The manufacturer will provide construction Drawings and installation instructions to the Contractor and Contract Administrator prior to erection.

2.9 Assembly

.1 The domes shall be erected following procedures established by the dome manufacturer.

.2 The manufacturer is to have a suitably experienced and qualified supervisor, acceptable to the Contract Administrator, in attendance full time for the duration of the erection of all domes.

.3 All bolted connections shall be stainless steel type of a size and quality shown on the manufacturer's drawings.

.4 All anchorage to the periphery wall shall be done on-site after the panels are in their final position by setting suitable stainless steel anchor bolts, acceptable to the Contract Administrator, in the periphery wall. Location of reinforcement is to be determined prior to boring by use of a suitable cover meter. Care is to be taken not to bore through any reinforcement. Washers of a suitable size shall be utilized to avoid stresses in bolting.

END OF SECTION

FRP FABRICATIONS

1. General

1.1 Work Included

.1 Supply and installation of fibreglass reinforced plastic (FRP) grating, angles, and accessories.

1.2 References

.1 ASTM D-635: Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position

.2 ASTM E 84: Surface Burning Characteristics of Building Materials

1.3 Design Criteria

.1 Member sizes shown on the Drawings are a minimum.

1.4 Submittals

.1 Submit Shop Drawings in accordance with Section 01300

.2 Submit two (2) 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 five years successful installation and if requested by the Contract Administrator can provide a list of completed projects.

.2 The installation Contractor shall be an erector approved by the manufacturer and shall have completed a course in the method of erection. The installation Contractor 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 21 and 29°C until they are required.

2. PRODUCTS

2.1 Materials

.1 FRP products to be resistant to ferric chloride (38 percent) and hydrochloric acid (<5 percent) at a temperature range of 10 to 30°C. FRP products to be manufactured with vinyl ester resins with chemical formulations as necessary to provide the corrosion resistance, strength and other physical properties as required**.**

.2 All FRP products shall have a tested flame spread rating of 25 or less per ASTM E-84 Tunnel Test. The FRP products shall also have tested burn time of less than 30 seconds and an extent of burn rate of less than or equal to 10 millimeters per ASTM D635.

.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, meniscus 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 grating products: Fibregrate Vi-Corr by StonCor Firbergrate.

.9 Acceptable concrete embedded structural shapes: EZ Angle, 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 FRP Installation

.1 FRP products 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 Apply shop applied edge banding around openings in the grating and discontinuous grating panels. Edge banding shall be a minimum of the full profile of the attached grating or larger as required by the manufacturer.

.4 The Contractor shall 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.

.5 Each grating section shall be readily removable. Grating supports shall be provided at openings in the grating by Contractor where necessary to meet load-deflection requirements specified herein.

.6 Grating openings which fit around protrusions (pipes, tanks, cables, machinery, etc.) shall be discontinuous at approximately the centerline of opening so each section of grating is readily removable.

.7 Gratings shall be fabricated free from warps, twists, or other defects which affect appearance and serviceability.

.8 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

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Division 7

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 Air/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. Secure with thermostuds @ 600mm O/C.

.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

3.4 Board Insulation – Walls above Floor Level

.1 Install insulation vertically. Secure with thermostuds @ 600mm O/C.

.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.

.5 Provide cuts in outside foil face to permit vapour migration.

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 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 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: 13 mm. 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 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 Galvanized Base Skirting

.4 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; 22 gauge core steel; shop precoated; Colour as per Contract Administrator.

.3 Galvanized Skirting: ASTM A446: G90 zinc coating; 16 gauge core steel; shop precoated.

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: Flashings

.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.

3.4 Skirting

.1 Install skirting in accordance with CRCA recommendations and as indicated on Drawings.

.2 Secure skirting 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 Secure with thermostuds @ 600mm O/C.

.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.

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 percent.

.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 6 mm 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

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Division 8

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/Suppliers

.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, three (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 COILING DOORS

1. GENERAL

1.1 Work Included

.1 The rolling doors will be Thermotite as manufactured by Kinnear/Wayne-Dalton Corp.

1.2 Related Work

.1 Opening preparation, miscellaneous or structural metal Work, access panels, finish or field painting, filed electrical wiring, wire, conduit, fuses, and disconnect switches are in the Scope of Work of other Divisions of trades.

2. PRODUCTS

2.1 Curtain

.1 Curtain will be composed of interlocking steel galvanized prime painted #14 flat slats with galvanized prime painted 24 gauge back panels. The area between #14 slat and back panel will be filled by foaming-in-place with polyurethane insulation, R-value of 6.7. Curtain designed per ASTM standards and capable of withstanding 20 PSF windload. Ends of alternate slats to be fitted with metal windlocks.

.2 Bottom bar to be comprised of two equal sized structural steel angles, minimum 1/8” thick, fitted with vinyl bottom weatherseal. When additional security is required, provide cylinder locks on the bottom bar operable from both sides.

2.2 Guides

.1 Guides will be of roll-formed steel channels and angles or structural angles of steel to form a slot of sufficient depth to retain curtains in guides to resist 20 PSF windload. Guides will be provided with integral windlock bars and vinyl weatherstripping.

2.3 Brackets

.1 Brackets will be of steel plates, 3/16 inch minimum, with permanently sealed ball bearings. Designed to enclose ends of coil and provide support for counterbalance pipe at each end.

2.4 Counterbalance

.1 Curtain to be coiled on a pipe of sufficient size to carry door load with deflection not to exceed .03 inches per foot of door span and to be evenly balanced by helical springs, oil tempered torsion type designed with a 25 percent safety factor. Cast iron barrel plugs will be used to anchor springs to tension shaft and pipe.

2.5 Hood

.1 Hood will be minimum 24 gauge galvanized sheet metal, flanged at top for attachment to header and flanged at bottom to provide longitudinal stiffness. Hood will enclose curtain coil and counterbalance mechanism. Includes neoprene hood baffle.

2.6 Finish

.1 Shop coat of rust inhibitive primer on galvanized and non-galvanized surfaces and operating mechanisms. Guides and bracket plates will be coated with a flat black prime paint. Manufacturer's finish to be white.

2.7 Operation

.1 Door will be operated by means of motor operation. Electric safety edge to be attached to bottom bar to stop the door when it contacts an object during the closing cycle.

2.8 Weatherstripping

.1 Lintel weatherstripping will be of nylon, weatherseal to effectively reduce air infiltration at lintel, and will be fitted with aluminum extrusion for easy attachment to header.

2.9 Locking

.1 Electric-motor operation doors will lock through the operator gearing, and electric interlocks will be provided. Cylinder locks will be provided with the doors.

3. EXECUTION

3.1 Install

.1 Install the doors in accordance with Wayne-Dalton instructions and standards. Installation will be by an authorized Wayne-Dalton representative.

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 2200 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 (by hardware supplier) to allow for a grand master key system to match existing system by Medeco to be installed @ a later date. Upon completion of the works and on handover to the City, have the lock cylinder on the UV Disinfection Building changed by N.H. Brown Locksmith Ltd., - 164 Fort Street, Winnipeg, MB R3C 1C9, Telephone 942-4747. The City of Winnipeg has a key system hierarchy that is provided exclusively by "Medeco" Lock which is supplied by N.H. Brown's Locksmith Ltd.

.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 the City.

.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

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DIVISION 9

EPOXY FLOOR COATING

1. GENERAL

1.1 Related Sections

.1 Cast-In-Place Concrete: Section 03300

.2 Concrete Unit Masonry: Section 04220

.3 Joint Sealers: Section 07900

1.2 References

.1 Reference is made to spec standards produced by various organizations to conform to edition of standards specified, or, if not specified, to last edition as amended and revised to date of Contract.

.2 Cure rate (at 25°C) allow 4 to 5 hours for tack free surface, 24 hours for normal operations

.3 Fire resistance of dry film: Self-extinguishing

.4 Heat resistance limitation: 60°C (for continuous exposure); 93°C (for intermittent exposure)

.5 Percent solids: 100 percent

.6 Pot life at 25°C: 35 minutes

1.3 Submittals

.1 Product Data: submit manufacturer's technical data, installation instructions, and general recommendations for each epoxy flooring material required.

.2 Samples: submit, for verification purposes, 300 mm x 300 mm square sample of each type of epoxy flooring required, applied to a rigid backing, in colour and finish indicated.

1.4 Quality Assurance

.1 Single source responsibility: obtain primary epoxy flooring materials including primers, resins, hardening agents, finish or sealing coats from a single manufacturer with not less than ten years of successful experience in manufacturing and installing principal materials described in this Section. Contractor must have completed at least five projects of similar size and complexity. Stonhard or approved equal. Provide secondary materials only of type and from source recommended by manufacturer of primary materials.

.2 Arrange a meeting not less than 30 days prior to starting Work.

1.5 Delivery, Storage, and Handling

.1 Deliver material to jobsite. Flooring Contractor will check material for completeness and shipping damage prior to job start.

.2 All materials must be factory pre-weighed and pre-packaged in single, easy to manage batches to eliminate on-Site mixing errors. No on-site weighing or volumetric measurements allowed.

.3 Store material in a dry, enclosed area protected from exposure to moisture. Temperature of storage area shall be maintained between 16°C and 32°C.

1.6 Mock-up

.1 At Site, under manufacturer's supervision, apply for approval 9 m^2 of complete floor finish in area designated, to match submitted samples. When approved, Site applied sample to be standard for appearance, colour, texture, workmanship, etc., and all Work to conform to this sample.

1.7 Project Conditions

.1 Environment Requirements:

.1 Concrete substrate must be properly cured for a minimum of 30 days.

.2 Temperature: utilities, including electric, water, heat (air temperature between 16°C and 32°C) and finished lighting to be supplied by General Contractor. Maintain ambient temperature of not less than 18°C and a floor temperature of not less than 16°C from seven days before installation to at least 48 hours after completion of Work and maintain relative humidity not higher than 40 percent during same period.

.3 Moisture: ensure substrate is within moisture limits prescribed by flooring manufacturer.

.4 Safety: comply with requirements of WHMIS regarding the use, handling, storage, and disposal of hazardous materials.

.5 Job area to be free of other trades during, and for a period of 24 hours, after floor installation.

.6 Protection of finished floor from damage by subsequent trades is the responsibility of the General Contractor.

.7 Manufacturer's representative must be on jobsite at start of installation.

2. PRODUCTS

2.1 Colours

.1 "Silver Gray" as listed by manufacturer

2.2 Epoxy Floor Coating

.1 100 percent solids, 0 VOC, two-component general service epoxy coating complete with broadcast texture. Acceptable Manufacturer: Stonhard, STONKOTE GS4.

3. EXECUTION

3.1 Preparation

.1 Substrate: prepare concrete by mechanical means by using a shot blast machine for removal of bond inhibiting materials such as curing compounds or laitance.

3.2 Application

.1 Coating: mix coating with broadcast according to Manufacturer's recommended procedures.

.2 Coved Mortar Base: height: 150mm; trowelled epoxy mortar with coating, feathered to meet floor".

.3 Provide Stonhard texture #2 to Consultants approval.

3.3 Field Quality Control

.1 The right is reserved to invoke the following material testing procedure at any time, and any number of times during period of flooring application.

.2 The City will engage the service of an independent testing laboratory to sample materials being used on the jobsite. Samples of material will be taken, identified and sealed, and certified in the presence of the Contractor.

.3 Testing laboratory will perform tests for any of the characteristics specified, using applicable testing procedures referenced herein, or if non-referenced, in manufacturer's product data.

.4 If test results show materials being used do not comply with specified requirements, Contractor may be directed by the City to stop Work; remove non-complying materials; pay for testing; reapply flooring materials to properly prepared surfaces which had been previously coated with unacceptable materials.

3.4 Curing, Protection, and Cleaning

.1 Cure epoxy flooring materials in compliance with manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process. Close area of application for a minimum of 24 hours.

.2 Protect epoxy flooring materials from damage and wear during construction operation. Where temporary covering is required for this purpose, comply with manufacturer's recommendations for protective materials and methods of application. The Contractor is responsible for protection and cleaning of surfaces after final coats.

.3 Cleaning: Remove temporary covering and clean epoxy flooring just prior to final inspection. Use cleaning materials and procedures recommended by epoxy flooring manufacturer.

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 24 hours before, during and 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 Primer Manufacturer for galvanized surfaces: Carboline

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.

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 (Division 11), Mechanical (Division 15), and Electrical (Division 16) 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 Galoseal WB

.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 Galoseal WB

.2 Two (2) coats Carbogard 890 by Carboline

.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 COATINGS FOR CONCRETE AND STEEL

1. GENERAL

1.1 Work Included

.1 Supply and installation of specialty coatings for concrete and metal used on the liquid retaining side of structures.

.2 Supply and installation of specialty coatings for concrete and metal used on the liquid side of secondary containment areas and cast-in-place sump pits.

.3 Supply and installation of specialty coatings for concrete and metal used for other areas as indicated on the Drawings.

1.2 Qualification

.1 Installation is to be done by an established firm having at least ten (10) years of proven, satisfactory experience in this trade and employing skilled personnel. The firm is to be authorized by the coating manufacturer to install the specified product and product line.

.2 Submit proof of qualifications and authorization in writing to the Contract Administrator, four (4) weeks prior to commencement of Work.

1.3 Design Standards, Code Requirements

.1 Conform to requirements of Steel Structures Painting Council (SSPC) Publications and visual standards, explanatory notes, comments and appendixes:

.1 SSPC-PA-1 Shop, field and maintenance painting.

.2 SSPC-SP-1 Solvent cleaning

.3 SSPC-SP-2 Hand cleaning

.4 SSPC-SP-3 Power tool cleaning

.5 SSPC-SP-5 White Metal Blast Cleaning

.6 SSPC-SP-6 Commercial blast cleaning

.7 SSPC-SP-7 Brush off blast cleaning

.8 SSPC-SP-10 Near white metal blast cleaning

.9 SSPC-SP-13 Surface Preparation of Concrete

1.4 Submittals

.1 Submit Submittals in accordance with Section 01300.

.2 Submit colour samples of coating, minimum colour sample size 50 mm x 100 mm.

.3 Indicate location of where the specific coating is to be applied.

.4 Submit manufacturer's product data sheets and installation guides. A minimum of one (1) copy of the reviewed product data sheets and installation guides shall remain on-site at all times for all to view.

.5 Prepare 300 mm x 200 mm samples of each coating type to Contract Administrator. Apply finishes on identical type materials to which they will be applied.

1.5 Inspection and Testing

.1 Allow ample time for notification, review, and corrective Work, if required, before scheduling coating installation.

.2 Inspection, and testing is to be performed by a CSA and SSPC certified inspection and testing firm. Testing of substrate required to be preformed prior to the application of the coating and while the coating is being applied and curing is to be paid for by the Contractor. Testing of coating once the coating is cured, will be paid for by the City. Provide unencumbered access to all portions of Work and cooperate with appointed firm.

.3 Notify the Contract Administrator at least 48 hours in advance of any coating installation or final substrate preparation.

.4 Repair all areas where concrete surfaces and coatings were tested.

.5 Testing of concrete will be performed in accordance with the indicated SSPC design standards. Test results are to be issued to the Contractor, the Contract Administrator, and the City.

.6 The Contractor is to pay costs for required retesting due to defective materials or workmanship.

.7 A minimum of four (4) complete SSPC tests are to be preformed on each Area F – Primary Sludge Fermenters.

.8 A minimum of two (2) complete SSPC tests are to be preformed in the Ferric Chloride secondary containment pit in Area T- DAF Thickener Building for each different substrate being coated.

.9 A minimum of one (1) complete SSPC test is to be preformed in each Polymer secondary containment pit in Area T- DAF Thickener Building.

.10 A minimum of one (1) complete SSPC test is to be preformed for each cast-in-place sump pit, pre-engineered or pre-cast sump pit for each different substrate being coated.

1.6 Maintenance Data

.1 Provide maintenance data for coatings complete with pertinent details, data sheets, and warnings against harmful maintenance materials and practices for incorporation into maintenance manual.

2. PRODUCTS

.1 The same manufacture is to be used for the entire project.

.2 Colours to be selected by the City from submitted samples.

.3 Abbreviations; P = primer, I = intermediate coat and F = finish coat, DFT = dry film thickness, WFT = wet film thickness.

.4 Coating Formulas:

.1 Liquid side of cast-in-place concrete for waste water retaining structures - Formula 20.

.2 On liquid side of cast-in-place concrete sump pits - Formula 20.

.3 Liquid side of cast-in-place concrete for secondary containment areas - Formula 25.

.4 Metal within secondary containment areas and areas indicated on the Drawings - Formula 30.

.3 Formula Designations

.5 Formula 20

.1 Preparation: SSPC-13, Table 1, Severe Service.

.2 Coating option:

.1 Fill and seal the surface with Carboguard 501.

P = Carboguard 671, 5 mils DFT.

F = Polbrid 705, 80 mils DFT.

Carbogard 501, Carbogard 671 and Polibrid 705 as manufactured by Carboline.

.6 Formula 25

.1 Preparation: SSPC-13, Table 1, Severe Service.

.2 Coating option:

.1 Fill and seal the surface with Carboguard 501.

P = Carboguard 671, 5 mils DFT.

F = Polbrid 705, 80 mils DFT.

Carbogard 501, Carbogard 671 and Polibrid 705 as manufactured by Carboline.

.7 Formula 30

.1 Preparation: SSPC-SP5, White Metal Blast, minimum 3-5 mil angular profile.

.2 Coating option:

.1 P = Carboguard 671, 5 mils DFT.

F = Polbrid 705, 80 mils DFT.

Carbogard 671 and Polibrid 705 as manufactured by Carboline.

3. EXECUTION

3.1 Pre-Installation Conference

.1 Pre-installation conference for specialty coating products: prior to installation of specialty coating products, conduct a meeting with applicator, installers of Work adjacent to or that penetrates the specialty coating products, the Contract Administrator and manufacture's technical representative to review the following:

.1 General project requirements.

.2 Manufacture's product data sheets and installation guides.

.3 Substrate conditions, moisture content, procedures for substrate preparation, and product installations.

.4 The manufacture's technical representative is to issue reports to the Contract Administrator confirming that the substrate conditions and installation procedures are being followed for each area were the specific product is being utilized.

.5 Responsibility and costs associated with verification and correlation of field dimensions, fabrication processes, techniques of construction, installation, and coordination of Work and manufacture's technical representative for all parts of the Work rests with the Contractor.

3.2 General

.1 Notify the Contract Administrator of any conditions which would prejudice proper installation of this Work.

.2 The concrete areas will be tested for water tightness. The facilities flushing water will be used for this purpose as indicated in Section 01500.

.3 Commencement of this Work implies acceptance of existing conditions.

.4 Apply each coat of paint as a continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.

.2 Remove weld spatter, weld slag and flux from metal before painting.

.3 Remove concrete spatter and droppings before coating is applied.

.4 Remove defective or damaged coatings as required by the Contract Administrator. Cost for defective or damaged coating removal and replacement will be at the Contractor's expense.

.5 Relative humidity of the concrete surface is to conform to SSPC-SP13 Table 1- Severe Service, using the ASTM F 2170 test method except that the relative humidity is to be less than 50 percent after surface preparation.

.6 Concrete surface tensile strength shall be 2.1 MPa minimum. Remediation of the concrete for values lower then 2.1 MPa will be at the Contractor's expense.

.7 pH readings following final rinse is not to be more than 1.0 lower or 2.0 higher that the pH of the rinse water tested at the beginning and end of the final rinse cycle.

.8 Provide a 19 deep saw cut at the termination points of the coating on a concrete surface.

3.3 Protection

.1 Protect other surfaces from substrate preparation, coatings and damage. Repair damage.

.2 Furnish drop cloths, shields, and protective methods to prevent spray or droppings from disfiguring other surfaces.

.3 Collect waste, cloths and material which may constitute a fire hazard, place in closed metal containers and remove daily from Site.

3.4 Brush Application

.1 Where spray applications is not practical, work paint into cracks, crevices and corners and paint surfaces by brush.

.2 Brush out runs and sags.

.3 Remove runs, sags and brush marks from finished Work and repaint.

3.5 Spray Application

.1 Provide and maintain specialized equipment that is suitable for intended purpose, capable of properly atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.

.2 Provide traps or separators to remove oil and water from compressed air and drain periodically during operations.

.3 Keep paint ingredients properly mixed in spray pots or containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.

.4 Apply paint in uniform layer, with overlapping at edges of spray pattern.

.5 Brush out immediately runs and sags.

.6 Use brushes to work paint into cracks, crevices and places which are not adequately painted by spray. In areas not accessible to spray gun, use brushes, daubers or sheepskins.

.7 Remove runs, sags and brush marks from finished Work and repaint.

3.6 Shop Painting

.1 Do shop painting after fabrication and before damage to surface occurs from weather or other exposure.

.2 Do not shop paint metal surfaces which are to be embedded in concrete.

.3 Copy previous erection marks and weight marks on areas that have been shop painted as required.

3.7 Field Painting

.1 Paint steel structures as soon as practical after erection.

.2 Touch up metal which has been shop coated with same type of paint and to same thickness as shop coat. This touch-up to include cleaning and painting of field connections, welds, rivets, nuts, washers, bolts, and damaged or defective paint and rusted areas.

.3 Field paint surfaces which are accessible before erection but which are not to be accessible after erection.

.4 Do not apply specialty coatings until concrete work is completed and cured as required by the coating manufacturer, except as directed by Contract Administrator. If concreting or other operations damage paint, clean and repaint damaged area.

3.8 Warranty

.1 Provide a 5 (five) year warranty against delamination of the coating, delamination of the coating from the concrete substrate, defective coating application and defects in the coating. The warranty shall not be voided by the use of the flushing water used for leakage testing purposes prior to the application of the coating.

END OF SECTION

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DIVISION 11

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DIVISION 11

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, by-laws, 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 all Drawings and become fully familiar with the Work of other trades in all Divisions under this Contract.

.3 Cooperate with all other trades. Pay particular attention 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, by-laws, 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 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 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 1 m; 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 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 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.

1.20 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 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.

1.21 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 20 working days of Contract award. These delivery dates may be altered by mutual agreement between the Contractor and the Contract Administrator.

1.22 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.

1.23 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.

1.24 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 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. The Contractor shall be responsible for all costs not identified.

.3 Where special tools are required for the maintenance 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.

2. PRODUCTS

.1 Not used

3. EXECUTION

.1 Not used

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 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's 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 200 mm deep unless lesser height is 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 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 the final alignment to the Contract Administrator and manufacturer's representative.

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 ±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/sec shall be considered acceptable. Undertake corrective action where unfiltered velocities exceed 5 mm/sec.

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 m.

.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 1000 mm. 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 Section 01670 for the forms.

END OF SECTION

1. GENERAL

1.1 Description

.1 This Section specifies modification, relocation, and decommissioning of existing plant equipment.

.2 This Section shall be read in conjunction with the Drawings. Any items not listed herein but shown on the Drawings shall be deemed to be included in this Specification.

.3 Conform to the requirements of Section 11005

.4 Conform to the requirements of Division 1

1.2 Equipment List

.1 Modification, relocation, and decommissioning includes, but is not necessarily limited to, the following items

.1 WAS Pumps 1 and 2

.2 RAS Pumps 1, 2, and 3

.3 RAS Discharge Piping

.4 Secondary Clarifier 1 Influent Pipe

.5 Secondary Clarifier Mechanisms 1 and 2

.6 Secondary Clarifier Scum Pumps 1 and 2

.7 Primary Clarifier Scum Pump Piping and Appurtenances

.8 Primary Clarifier Dewatering Pump

.9 Bioreactors 1 and 2

.10 Sludge Transfer-Recirculation Pumps 1 and 2

.2 Refer to the Drawings for full scope of modification, relocation, and decommissioning of existing equipment.

1.3 Submittals for Review

.1 Provide submittals for significant modifications or additions to existing equipment. Equipment which is relocated may not require new submittals.

.2 Provide submittals in accordance with Section 11005 and with Section 01300.

.3 Provide submittals for the modified systems.

2. PRODUCTS

2.1 General

.1 Refer to the Drawings for locations of all pieces of equipment.

.2 Remove, protect, and deliver the decommissioned equipment to location designated by Contract Administrator.

.3 Provide any parts and procedures required for the modification or relocation of the equipment in accordance with manufacturers' recommendations.

.4 Refer to the Drawings for further details on the modifications to each piece of existing equipment.

2.2 WAS Pumps 1 and 2

.1 The two existing WAS Pumps (S810-WAP, S820-WAP) located in the Secondary Clarifier Pump Room shall be removed. All suction and discharge WAS piping in the room shall be removed and capped as shown on the Drawings.

.2 Refer to the Drawings to determine the full scope of modification work required.

2.3 RAS Pumps 1, 2, and 3

.1 The three existing RAS pumps (S710-RAP, S720-RAP, S730-RAP) located in the Secondary Clarifier Pump Room shall be removed, and replaced with new RAS pumps (S710-RAP, S720-RAP, S730-RAP). Existing suction and discharge piping to the extent shown on the Drawings shall be retained, except where adjustments may be required to accommodate the new pumps.

.2 Refer to the Drawings to determine the full scope of modification work required.

2.4 RAS Discharge Piping

.1 The existing two 300 mm diameter RAS discharge header pipes (S741-300-RAS-ST2, S741-300-RAS-ST2) shall be removed and replaced with a new single 400 mm diameter header pipe (S740-400-RAS) where shown on the Drawings. New discharge piping from RAS Pumps 1, 2, and 3, complete with valves, flowmeters, fittings and other appurtenances shall be installed as shown on the Drawings to connect to this new 400 mm diameter RAS header pipe.

.2 The existing bioreactors are each serviced by two RAS inlets. The modified bioreactor configuration requires only one RAS inlet. Remove and cap the unused RAS inlets as shown on the Drawings.

.3 Refer to the Drawings to determine the full scope of modification work required.

2.5 Secondary Clarifier 1 Influent Pipe

.1 The elbow of the 900 mm diameter mixed liquor inlet pipe feeding Secondary Clarifier 1 (S510-900-ML-ST2) shall be removed. The horizontal portion of the pipe, complete with valves and flowmeters, shall remain in place. A new 900 mm elbow shall be fabricated, and the inlet pipe reconnected to the mixed liquor channel at the existing flange directly in line with it, as shown on the Drawings.

.2 Refer to the Drawings to determine the full scope of modification work required.

2.6 Secondary Clarifier Mechanisms 1 and 2

.1 The existing "organ-pipe" collectors are to be replaced with suction tube collector to match with the mechanism specified for new Secondary Clarifier 3. All components shall be removed and the mechanisms replaced in their entirety.

.2 The replacement mechanism shall be provided by the same manufacturer as the new mechanism in Secondary Clarifier 3.

.3 The RAS collection system in the existing clarifiers must be modified to accommodate the new configuration. The additional components include, but are not necessarily limited to, the following:

.1 Lower influent box (CDM): a circular chamber with the special sludge collection branches and it mounts on the column anchors and the shortened column mounts on this box. This box delivers the sludge to the RAS pipe under the clarifier. Manufacturer to submit Shop Drawings showing necessary modifications.

.2 Sludge Manifold: this connects below the cage and is the connection between the suction ducts and the cage. It receives sludge from the suction arms and delivers the sludge to the CDM.

.3 Upper and lower seals: these seal the rotating sludge collection manifold.

.4 Lower neoprene connection with band clamps: connects the RAS outlet pipe to the CDM.

.4 Refer to the Drawings to determine the full scope of modification work required.

2.7 Secondary Clarifier Scum Pumps 1 and 2

.1 The two existing Secondary Clarifier Scum Pumps (S850-SP, S860-SP) located in the Secondary Clarifier Pump Room shall be removed. All appurtenances, suction piping, and discharge piping in the room shall be removed and capped.

.2 Refer to the Drawings to determine the full scope of modification work required.

2.8 Primary Clarifier Scum Pump Piping and Appurtenances

.1 The piping and instrumentation located at the north wall of the Primary Clarifier Pump Room must be moved and realigned to allow the construction of a passageway into the new Fermenter Pump Room, as shown on the Drawings.

.2 Refer to the Drawings to determine the full scope of modification work required.

2.9 Primary Clarifier Dewatering Pump

.1 Remove and reinstall the Primary Clarifier Dewatering Pump in the realigned position as shown on the Drawings. This provides space to install the new Primary Sludge Pumps.

.2 Refer to the Drawings to determine the full scope of modification work required.

2.10 Bioreactors 1 and 2

.1 Aeration Basin 1 and Aeration Basin 2 are presently configured as complete-mixed, single zone aeration basins, with two influent points and two RAS inlets each. The list of modifications includes, but is not necessarily limited to, the following:

.1 Removal of existing aeration diffusers from the floor of each reactor. In each basin, the existing aeration equipment consists of seven (7) diffuser assemblies, evenly spaced at 6170 mm intervals, each comprised of:

.1 One (1) 12 gauge stainless steel dropleg, 150 mm diameter, consisting of a 1245 mm long horizontal segment at an elevation of 241.800 m, and a 6200 mm long vertical segment, approximately 1500 mm from the wall.

.2 One (1) 18850 mm long 12 gauge stainless steel horizontal aeration header, consisting of one (1) 3048 mm long 150 mm diameter segment, one (1) 305 m long eccentric reducer, and one (1) 15949 mm long 100 mm diameter segment. The header is supported at an elevation of approximately 235.471 m by 5 support saddles anchored to the floor, and one wall-mount fixed support at the upstream end.

.3 Fourteen (14) pairs of stainless steel Sanitaire "D-24" coarse bubble diffusers, evenly spaced at 1450 mm intervals along the entire length of the horizontal header. Each pair of diffusers extends approximately 610 mm to either side of the header.

.2 Cutting rectangular holes in the existing reinforced concrete double-tee roof to allow equipment removal, inspection, and access to the bioreactors.

.3 Addition of two new primary effluent inlet points in each reactor, for a total of four inlets per reactor.

.4 Cutting of a temporary access way through the exterior wall of each basin to facilitate construction of the required internal modifications and installation of equipment.

.5 Construction of interior walls to separate each tank into a three-pass, eight-cell BNR bioreactor.

.6 Restoration of the exterior wall openings described in the preceding clause to a watertight condition after completion of the internal modifications.

.2 Refer to the Drawings to determine the full scope of modification work required.

2.11 Sludge Transfer-Recirculation Pumps 1 and 2

.1 The two existing Sludge Transfer-Recirculation Pumps (S410-STP, S420-STP) located in the pump pit adjacent to the Sludge Tanks shall be removed, and replaced with 2 new pumps. Existing suction and discharge piping to the extent shown on the Drawings shall be retained, except where adjustments may be required to accommodate the new pumps.

.2 Refer to the Drawings to determine the full scope of modification work required.

2.12 Finishes

.1 Repair damage to coatings in accordance with Section 11901.

3. EXECUTION

3.1 Installation

.1 For all equipment requiring relocation or modification, connect and install all equipment in accordance with the manufacturers' written instructions.

.2 Refer to Division 1

3.2 Testing

.1 Refer to Division 1

3.3 Commissioning

.1 Refer to Division 1

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 systems.

.2 Use the general requirements specified in this Section integrally with the more specific requirements listed in Section 11055 – Detailed Piping Specification Sheet.

.3 Piping supports are generally not shown on the process 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 Labour and Immigration.

.5 Standard of Acceptance: items specified by manufacturer's 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 450 mm 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, Pre-stressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids

.98 AWWA C303, Reinforced Concrete Pressure Pipe - Steel Cylinder Type, Pre-tensioned, 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 inches 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. Manitoba Department of Labour and Immigration 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 pipes 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 Department of Labour and Immigration 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, and 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 three component alpha-numeric code, (Line Label) as follows:

.1 The first component of the code indicates the number.

.2 The second component of the code indicates the nominal line size.

.3 The third component of the code identifies the process fluid being conveyed, (Commodity).

.4 The process fluid (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 are to be certified under the Manitoba Department of Labour and Immigration and Regulations. 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 percent 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 Labour and Immigration.

.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 National Plumbing Code. For small piping not described by the National Plumbing Code, 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 three 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 ductile iron fittings that conform to AWWA C110 or 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 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 rings 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 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.

.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.

2.12 Insulation

.1 Provide insulation in accordance with Section 11059 and Section 02513. 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.

2.13 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:

.1 200 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 only isolated voids permitted due to casting anomalies and which represent less than 0.01 percent of the total glassed surface. 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 and 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 V 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 more than isolated voids due to casting irregularities which represent more than 0.01 percent of the total glassed surface (no more than one to two pinholes per fitting or an average of five or less per 6 m pipe spool). Rejected pipe shall be evaluated for additional coating with porcelain enamel or for total reblasting, reprocessing, and retesting.

2.14 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.

2.15 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.

2.16 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).

2.17 Grout

.1 Non-shrink grout: conform to Section 03300.

2.18 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 6 m on center.

.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 Department of Labour and Immigration. Fabricate and install domestic hot and cold water piping, sanitary piping, and storm drainage piping in accordance with the National Plumbing Code.

.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 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 (3) 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 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 6mm 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 or 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 two 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 5 m 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 Piping 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 National Plumbing Code.

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, and/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 medium:

Pipe Size Specified	Test 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
0 - 25	1.5
30 - 75	6.25
80 - 150	12.5
>150	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 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.

.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 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 or AWWA 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 General Requirements:

.1 Centre 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.

.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.

.2 Unless specifically shown otherwise use Type I flexible couplings where a flexible coupling is shown or required, Contractor will determine the which class, A, B, or C as described below.

.1 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 38

.2 Ford Meter Box FC1

.3 Robar 1408

.4 Rockwell Type 411

.5 Viking Johnson Quick-Fit

.2 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 Style 128

.2 Ford Meter Box FCA

.3 Robar 7808

.4 Rockwell Type 913

.5 Viking Johnson Quickfit Flange Adapter

.3 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 Style 62

.2 Robar 1408

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 11050.

.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 dips 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 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 thick type 304 stainless steel with a 6.4 mm 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 Provide fabrication tolerances as follows:

.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 maximum

.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-center 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 three 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 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.

.2 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 Specifications in Division 3.

.3 Construct of fabricate as indicated in the Drawings or use approved commercial systems as indicated above.

END OF SECTION

DETAILED PIPING SPECIFICATION

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.

1.2 Process Piping Commodity Summary

.1 Process Fluids and Pipe Materials

SUB	DAF Subnatant	Mild Steel, (CW, ERW or Seamless); Stainless Steel, Std Wt (304)
ELW	Elutriation Water	Copper (L Hard), Galvanized or Mild Steel, (ERW or Seamless), PVC
FC	Ferric Chloride	PVC (Sch80)
FE	Final Effluent	Copper (L Hard), Galvanized or Mild Steel, (ERW or Seamless), PVC
FW	Flushing Water (Final Effluent)	Copper (L Hard), Galvanized or Mild Steel, (ERW or Seamless), PVC
FSL	Fermenter Sludge	Ductile Iron (Glass Lined)
FSU	Fermenter Supernatant	Mild Steel, (CW, ERW or Seamless); Stainless Steel, Std Wt (304)
IA	Instrument Air	
ML	Mixed Liquor	Mild Steel, (CW, ERW or Seamless); Stainless Steel, Std Wt (304)
PA	Process Air	Stainless Steel (304L)
PE	Primary Effluent	Mild Steel, (CW, ERW or Seamless); Stainless Steel, Std Wt (304)
PO	Process Overflow	PVC (Sch80)
POL	Polymer Solution	PVC (Sch80)
PS	Primary Sludge	Ductile Iron (Glass Lined)
PWD	Process Waste Drain	PVC (Sch80)
RAS	Return Activated Sludge	Mild Steel, (CW, ERW or Seamless); Stainless Steel, Std Wt (304)
SE	Secondary Effluent	Copper (L Hard), Galvanized or Mild Steel, (ERW or Seamless), PVC
TBS	Thickened Bottom Sludge	Mild Steel, (CW, ERW or Seamless); Stainless Steel, Std Wt (304)
TWAS	Thickened Waste Activated Sludge	Mild Steel, (CW, ERW or Seamless); Stainless Steel, Std Wt (304)
WAS	Waste Activated Sludge	Mild Steel, (CW, ERW or Seamless); Stainless Steel, Std Wt (304)

2. PRODUCTS

2.1 Schedule

.1 Pages 3 to 14 following.

DETAILED PIPING SPECIFICATION

FC / POL / PO

GENERAL

PROCESS FLUID	SYMBOL	MAXIMUM CONDITIONS		TEST CONDITIONS	
		PRESSURE (kPa)	TEMP. (°C)	PRESSURE (kPa)	DURATION (Min.)
Ferric Chloride Polymer Solution Process Overflow	**FC** **POLY** **PO**	750	30	1000	120

PIPE

LOCATION	SIZE (mm)	MATERIAL	RATING	SPECIFICATIONS	REMARKS
All	10 – 200	PVC	Schedule 80	ASTM D1785, CSA 137.3	

COATINGS

LOCATION	SIZE (mm)	MATERIAL	SPECIFICATIONS	REMARKS
All	10 – 200	N/A		

LININGS

LOCATION	SIZE (mm)	MATERIAL	SPECIFICATIONS	REMARKS
All	10 – 200	N/A		

JOINTS

LOCATION	SIZE (mm)	TYPE	MAXIMUM SPACING	SPECIFICATIONS	REMARKS
All	10 – 65 10 – 65 ≥75 ≥75	Solvent Weld Unions Solvent Weld Flanges	N/A 12 m N/A 12m	ASTM D2467, D2564 ASTM D2467 ASTM D2467, D2564 ASTM D2467	 Note 1 Note 1

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATIONS	REMARKS
Flanges	10 – 200	PVC	Schedule 80		
ELL - Short Radius ELL - Long Radius, Couplings, Tees, Reducers, Reducing Outlets and Laterals	10 – 200	PVC	Schedule 80	ASTM D2467, Solvent Weld	
Plug	10 – 200	PVC	Schedule 80	ASTM D2467, Solvent Weld	
Cap	≥75	PVC	Blind Flange Schedule 80		
Flange Gaskets		Bl. Neoprene, Viton		ASTM F477	Note 3
PVC Solvent				ASTM D2564	Note 3

VALVES

TYPE	SIZE (mm)	VALVE SPECIFICATION (SECTION 11105)	REMARKS
Butterfly	-	N/A	
Ball	All	BV06	
Check	All	CV06	
Globe	-	N/A	
Gate	All	GV02	
Needle	-	N/A	
Plug	-	N/A	

NOTES

1. Provide Unions or flanges as shown on Drawings to allow for pipe disassembly.
2. Where pipe crosses a structural joint, install at the joint location an EPDM lined elastomer spherical moulded type expansion joint capable of 0.25 degrees angular movement and ±20 mm axial movement.
3. Gaskets and solvent material to be compatible with designated chemical solution.
4. Drains from FOA blowers to meet this detailed piping specification.

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DETAILED PIPING SPECIFICATION

DSUB / FSU / ML / PE / RAS / TBS / TWAS / WAS

GENERAL					
		OPERATING LIMITS		TEST CONDITIONS	
PROCESS FLUID	SYMBOL	PRESSURE (kPa)	TEMP. (°C)	PRESSURE (kPa)	DURATION (Min.)
DAF Subnatant Fermenter Supernatant Mixed Liquor Recycle Activated Sludge Thickened Waste Waste Activated Sludge	**SUB** **FSU** **ML** **RAS** **TWAS** **WAS**	0-750	5-30	1200	120
PIPE					
LOCATION	SIZE (mm)	MATERIAL	RATING	SPECIFICATIONS	REMARKS
Tunnels, Pumphouses, and Buildings	≥75	Mild Steel (CW or ERW) or Stainless Steel 304L	Std. Wt. Std. Wt.	ASTM A53, Grade B ASTM A312	
Underground	≥75	Mild Steel (CW or ERW) or Stainless Steel 304L	Std. Wt. Std. Wt.	ASTM A53, Grade B ASTM A312	
Below Structures	≥75	Mild Steel (CW or ERW) or Stainless Steel 304L	Std. Wt. Std. Wt.	ASTM A53, Grade B ASTM A312	
Submerged	≥75	Stainless Steel 304L	Std. Wt.	ASTM A312	Note 1.
Sample Lines	25-75	PVC	Schedule 80	ASTM D1785, CSA 137.3	Note 3.
COATINGS					
LOCATION	SIZE (mm)	MATERIAL		SPECIFICATIONS	REMARKS
Tunnels, Pumphouses, and Buildings	≥75 (Steel) ≥75 (304L SS)	Paint – E1 N/A			Note 2.
Underground	≥75 (Steel) ≥75 (304L SS)	Yellow Jacket N/A			
Below Structures	≥75 (Steel) ≥75 (304L SS)	Concrete Surround Concrete Surround			
Submerged	≥75 (304L SS)	N/A			
Sample Lines	25-75	N/A			
LININGS					
LOCATION	SIZE (mm)	MATERIAL		SPECIFICATIONS	REMARKS
Tunnels, Pumphouses, and Buildings	≥75 (Steel) ≥75 (304L SS)	Liquid Epoxy – E2a N/A		AWWA C210	Note 2.
Underground	≥75 (Steel) ≥75 (304L SS)	Liquid Epoxy – E2a N/A		AWWA C210	
Below Structures	≥75 (Steel) ≥75 (304L SS)	Liquid Epoxy – E2a N/A		AWWA C210	
Submerged	≥75 (304L SS)	N/A			
Sample Lines	25-75	N/A			
JOINTS					
LOCATION	SIZE (mm)	TYPE	MAXIMUM SPACING	SPECIFICATIONS	REMARKS
Tunnels, Pumphouses, and Buildings	75 – 600 >600	Butt Weld Grooved Joint Grooved Joint Flanged	N/A 20 m 20 m	 AWWA C606 AWWA C606	
Underground	≥75	Butt Weld	N/A		
Below Structures	≥75	Butt Weld	N/A		
Submerged	≥75	Butt Weld Grooved Joint	N/A 20 m	 AWWA C606	
Sample Lines	25-75	Solvent Weld / Unions	N/A / 12 m	ASTMD2467, D2564	Note 4.

DETAILED PIPING SPECIFICATION

DSUB / FSU / ML / PE / RAS / TBS / TWAS / WAS continued

FITTINGS AND APPURTENANCES					
ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATIONS	REMARKS
Flanges, FF or RF	≥75	Mild Steel or 304L Stainless Steel	Class 150	Material: ASTM A181, Gr. 1 Dimensions: ANSI B16.5 ANSI B16.9	
Sample Lines	25-75	PVC	Schedule 80		
ELL – Short Radius ELL – Long Radius, Tees, Reducers, Reducing Outlets, Laterals and Caps	≥75	Mild Steel, Seamless or 304L Stainless Steel	Same as Pipe	Material: ASTM A234, WPB Dimensions: ANSI B16.9	
Sample Lines	25-75	PVC	Schedule 80		
3 Pce ELL	350	Mild Steel or 304L Stainless Steel	Same as Pipe	Material: Same as Pipe Dimensions: AWWA C208	
4 Pce ELL, Tees, Reducers, Crosses, Laterals	>600	Mild Steel or 304L Stainless Steel	Same as Pipe	Material: Same as Pipe Dimensions: AWWA C208	
Plug	≥75	Mild Steel or 304L Stainless Steel	Class 150 Blind Flange	Material: ASTM A181, Gr. 1 Dimensions: ANSI B16.5	
Sample Lines	25-75		Schedule 80	ASTM D2467, Solvent Weld	
Flanged Adaptors	≥75	Same as Pipe	Same as Pipe	Flange: ANSI B16.5	
Flanged Gaskets		Bl. Neoprene			
Sample Lines		Bl. Neoprene, Viton		ASTM F477	Note 6
Grooved Joint Gaskets	≥75			AWWA C606	
Sample Lines PVC Solvent				ASTM D2564	Note 6

VALVES			
TYPE	SIZE (mm)	SPECIFICATIONS	REMARKS
Butterfly	≥75	BF04, BF02	
Ball	<75 ≥75	BV02 BV03	
Check	≥75	CV02	
Globe	N/A	-	
Gate	N/A	-	
Needle	<75	NV01	

NOTES

1. Piping located in the headspace of tanks is considered "submerged".
2. Refer to Section 09905.
3. Not Applicable.
4. Provide unions or flanges to allow for pipe disassembly.
5. Where pipe crosses a structural joint, install at the joint location an EPDM lined elastomer spherical moulded type expansion joint capable of 0.25 degrees angular movement and ±20 mm axial movement.
6. Gaskets and solvent material to be compatible with designated chemical solution.

DETAILED PIPING SPECIFICATION

FE / SE / FW

GENERAL					
		OPERATING LIMITS		TEST CONDITIONS	
PROCESS FLUID	SYMBOL	PRESSURE (kPa)	TEMP. (°C)	PRESSURE (kPa)	DURATION (Min.)
Final Effluent Secondary Effluent Flushing Water	**FE** **SE** **FW**	0-750	5-30	1200	120
PIPE					
LOCATION	SIZE (mm)	MATERIAL	RATING	SPECIFICATIONS	REMARKS
Tunnels, Pumphouses, and Buildings	<75 ≥75	Copper PVC Mild Steel, ERW or Seamless	Type L. Hard Sch. 80 Std. Wt.	ASTM B88 CSA 137.3, ASTM D1785 ASTM A53, Grade B	Note 1.
Exposed, Aboveground	<75 ≥75	Galvanized Steel, ERW or Seamless Mild Steel, ERW or Seamless	Std. Wt. Std. Wt.	ASTM A53, Grade B ASTM A53, Grade B	
Underground	<75 ≥75	Copper PVC	Type K. Soft	ASTM B88 AWWA C-900	 Note 1.
Below, Structures	≥75	Mild Steel, ERW or Seamless	Std. Wt.	ASTM A53, Grade B	
Submerged	<75 ≥75	304L SS 304L SS	Sch 10 Pipe or Gauge 12 Tube Std. Wt.		Note 2.
COATINGS					
LOCATION	SIZE (mm)	MATERIAL		SPECIFICATIONS	REMARKS
Tunnels, Pumphouses, and Buildings	≥75	Paint – E1			
Exposed, Aboveground	<75 ≥75	Galvanizing Paint			
Underground	<75 ≥75	N/A N/A			
Below Structures	≥75	Concrete Surround			
Submerged	<75 ≥75	N/A N/A			
LININGS					
LOCATION	SIZE (mm)	MATERIAL		SPECIFICATIONS	REMARKS
Tunnels, Pumphouses, and Buildings	<75 ≥75	N/A Liquid Epoxy – E2a		 AWWA C210	
Exposed, Aboveground	<75 ≥75	Galvanizing Liquid Epoxy – E2a		 AWWA C210	
Underground	<75 ≥75	N/A N/A			
Below Structures	≥75	Liquid Epoxy – E2a		AWWA C210	
Submerged	<75 ≥75	N/A N/A			

DETAILED PIPING SPECIFICATION

FE / SE / FW continued

JOINTS

LOCATION	SIZE (mm)	TYPE	MAXIMUM SPACING	SPECIFICATIONS	REMARKS
Tunnels, Pumphouses, and Buildings	<75 ≥75	Soldered Couplings Unions Grooved Joint Butt Welded	N/A 12 m N/A	ANSI B16.22 ASTM D2467 AWWA C606	
Exposed, Aboveground	<75 ≥75	Threaded Couplings Grooved Joint Butt Welded	N/A N/A	ASTM A197, ANSI B16.3 AWWA C606	
Underground	<75 ≥75	Soldered Couplings Unions Bell & Spigot	N/A 12 m N/A	ANSI B16.22 AWWA C900	
Below Structures	≥75	Grooved Joint Butt Welded	N/A	AWWA C606	
Submerged	<75 ≥75	Socket Welding Grooved Joint	N/A 12 m	 ASTM D2467	

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATIONS	REMARKS
Flanges, FF or RF	≥75	Mild Steel	Class 150	Material: ASTM A181, Gr.1 Dimensions: ANSI B16.5	
ELL - Short Radius, ELL - Long Radius, Tees, Reducers, Reducing Outlets, Laterals and Caps	10 - 65 ≥75	Bronze, Socket Welded PVC Mild Steel, Seamless	Class 250 Sch. 80 Same as Pipe	ANSI B16.22 ASTM D2467, Solvent Weld Material: ASTM A234, WPB Dimensions: ANSI B16.9	
Plug	≥75	Mild Steel	Class 150 Blind Flange	Material: ASTM A181, Gr.1 Dimensions: ANSI B16.9	
Flanged Adaptors	≥75	Same as Pipe	Same as Pipe	Flange: ANSI B16.5	
Expansion Couplings					
Flange Gaskets	≥75	Bl. Neoprene			
Grooved Joint Gaskets	≥75			AWWA C606	
Solder	<75	Lead Free		ASTM B32	
Spray Nozzles	13	Brass		John Brooks: FullJet Square spray nozzle, ½ QJJA body, QHA18SQ tip	

VALVES

TYPE	SIZE (mm)	VALVE SPECIFICATION (SECTION 11105)	REMARKS
Butterfly	≥75	BF02	Default isolation valve, ≥75
Ball	<75 ≥75	BV01 BV03, BV05 (Note 3)	Default isolation valve, <75
Check	<75 ≥75	CV01 CV02	
Globe	<75 ≥75	GL01 GL01	
Gate	<75 ≥75	GV01 KV01	Do not use except with Contract Administrator's permission.
Mud	≥75	MV01	
Needle	<75	NV01	
Three Way	<75	TW01	

NOTES

1. See civil yard piping details for construction beyond 0.45m outside building limits and connection to PVC pipe. Tapewrap all metallic pipe outside building and provide appropriate pipe end (flange, plain end, as required).
2. Tubing or piping located in the headspace of tanks is considered "submerged".

DETAILED PIPING SPECIFICATION

FSL / PS

GENERAL					
PROCESS FLUID	SYMBOL	OPERATING LIMITS		TEST CONDITIONS	
		PRESSURE (kPa)	TEMP. (°C)	PRESSURE (kPa)	DURATION (Min.)
Fermented Sludge Primary Sludge	**FSL** **PS**	0-750	5-30	1200	120
PIPE					
LOCATION	SIZE (mm)	MATERIAL	RATING	SPECIFICATIONS	REMARKS
Tunnels, Pumphouses, and Buildings	≥75	Ductile Iron, Seamless	Std. Wt.	ANSI A21.51 Class 53, AWWA C151	
Exposed, Aboveground	≥75	Ductile Iron, Seamless	Std. Wt.	ANSI A21.51 Class 53, AWWA C151	
Underground	≥75	Ductile Iron, Seamless	Std. Wt.	ANSI A21.51 Class 53, AWWA C151	Note 6
Below Structures	≥75	Ductile Iron, Seamless	Std. Wt.	ANSI A21.51 Class 53, AWWA C151	
Submerged	≥75	Ductile Iron, Seamless	Std. Wt.	ANSI A21.51 Class 53, AWWA C151	
Sample Lines	25-75	PVC	Schedule 80	ASTM D1785, CSA 137.3	
COATINGS					
LOCATION	SIZE (mm)	MATERIAL		SPECIFICATIONS	REMARKS
Tunnels, Pumphouses, and Buildings	≥75	Paint – E1			
Exposed, Aboveground	≥75	Liquid Epoxy – E2a		AWWA C210	
Underground	≥75	Yellow Jacket			
Below Structures	≥75	Concrete Surround			Note 1
Submerged	≥75	Liquid Epoxy		AWWA C210	
Sample Lines	25-75	N/A			
LININGS					
LOCATION	SIZE (mm)	MATERIAL		SPECIFICATIONS	REMARKS
Tunnels, Pumphouses, and Buildings	≥75	Glass Lining			Note 2
Exposed, Aboveground	≥75	Glass Lining			Note 2
Underground	≥75	Glass Lining			Note 2
Below Structures	≥75	Glass Lining			Note 1, 2
Submerged	≥75	Glass Lining			Note 2
Sample Lines	25-75	N/A			
JOINTS					
LOCATION	SIZE (mm)	TYPE	MAXIMUM SPACING	SPECIFICATIONS	REMARKS
Tunnels, Pumphouses, and Buildings	≥75	Grooved Joint	N/A	AWWA C110 Dimensions: AWWA C606	
Exposed, Aboveground	≥75	Grooved Joint	N/A	AWWA C110 Dimensions: AWWA C606	
Underground	≥75	Grooved Joint	N/A	AWWA C110 Dimensions: AWWA C606	
Below Structures	≥75	Grooved Joint	N/A	AWWA C110 Dimensions: AWWA C606	
Submerged	≥75	Grooved Joint	N/A	AWWA C110 Dimensions: AWWA C606	
Sample Lines	25-75	N/A			

DETAILED PIPING SPECIFICATION

FSL / PSL continued

FITTINGS AND APPURTENANCES					
ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATIONS	REMARKS
Flanges, FF	≥75	Ductile Iron	Class 125	Material: ANSI A21.51 Class 53 Dimensions:ANSI B16.1 AWWA C110	
ELL - Short Radius ELL - Long Radius, Tees, Reducers, Reducing Outlets, Laterals	≥75	Ductile Iron, Seamless	Same as Pipe	Material: ANSI A21.51Class 53 ASTM A536 Dimensions: AWWA C606 AWWA C110	
3 Piece ELL	>350	Ductile Iron	Same as Pipe	Material: Same as Pipe Dimensions: AWWA C110	
Plug	≥75	Ductile Iron	Class 125 Blind Flange	Material: Same as Pipe Dimensions:ANSI B16.1	
Cap, Grooved	≥75	Ductile Iron	Class 125	Material: Same as Pipe Dimensions: AWWA C606	
Sockolet					
Threadolet					
Flange Adaptors	≥75	Same as Pipe	Same as Pipe	Flange: ANSI B16.1 Grooved End: AWWA C606	
Flanged Gaskets		Bl. Neoprene			
Grooved Joint Gaskets	≥75			AWWA C606	Note 3

VALVES			
TYPE	SIZE (mm)	VALVE SPECIFICATION (SECTION 11105)	REMARKS
Butterfly	N/A	-	
Ball	<75 ≥75	BV04 BV05	
Check	≥75	CV02	Note 5
Globe	N/A	-	
Gate	N/A	-	
Knife	≥75	KV03, KV01	Note 5
Mud	N/A	-	
Plug	≥75	PV01	Note 5
Needle	<75	NV01	

NOTES

1. For Concrete Surround linings, refer to Division 2 and 3 specifications and drawings.
2. Glass Lining shall be Vitco SG-14, 0.25 mm thickness minimum, or equivalent.
3. Comply with the manufacturer's recommendations for grooved joint gaskets.
4. Follow manufacturer's recommendations for procedures and repair of glass lining for any field cuts or field taps.
5. Glass lined valves are acceptable.
6. Refer to civil drawings for concrete pipes greater than 1000 mm.

DETAILED PIPING SPECIFICATION

IA

GENERAL

PROCESS FLUID	SYMBOL	OPERATING LIMITS PRESSURE (kPa)	OPERATING LIMITS TEMP. (°C)	TEST CONDITIONS PRESSURE (kPa)	TEST CONDITIONS DURATION (Min.)
Instrumnet Air	IA	750	150	1000	120

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 N/A

LININGS N/A

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	

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATION	REMARKS
Couplings ELL – Short Radius ELL – 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 PIPING SPECIFICATION

PA

GENERAL						
PROCESS FLUID	SYMBOL	OPERATING LIMITS		TEST CONDITIONS		
		PRESSURE (kPa)	TEMP. (°C)	PRESSURE (kPa)	DURATION (Min.)	
Process Air	**PA**	0-115	-40 to 150	175	120 See Note 6	
PIPE						
LOCATION	SIZE (mm)	MATERIAL	WALL THICKNESS	SPECIFICATIONS	REMARKS	
Tunnels, Pumphouses, and Buildings	<100 100 - 200 250 - 300 350 - 450 500 - 1200	304L Stainless Steel 304L Stainless Steel 304L Stainless Steel 304L Stainless Steel 304L Stainless Steel	2.03 mm 14 Gauge 12 Gauge 11 Gauge 10 Gauge	ASTM A240 ASTM A778 with scale removed or ASTM 312	Note 1 Note 7	
Exposed, Aboveground	<100 100 - 200 250 - 300 350 - 450 500 - 1200	304L Stainless Steel 304L Stainless Steel 304L Stainless Steel 304L Stainless Steel 304L Stainless Steel	2.03 mm 14 Gauge 12 Gauge 11 Gauge 10 Gauge			
Underground	<100 100 - 200 250 - 300 350 - 450 500 - 1200	304L Stainless Steel 304L Stainless Steel 304L Stainless Steel 304L Stainless Steel 304L Stainless Steel	2.03 mm 14 Gauge 12 Gauge 11 Gauge 10 Gauge			
Submerged	<100 100 - 200 250 - 300 350 - 450 500 - 1200	304L Stainless Steel 304L Stainless Steel 304L Stainless Steel 304L Stainless Steel 304L Stainless Steel	2.03 mm 14 Gauge 12 Gauge 11 Gauge 10 Gauge			
COATINGS						
LOCATION	SIZE (mm)	MATERIAL		SPECIFICATIONS	REMARKS	
Tunnels, Pumphouses, and Buildings	>25	Insulation and Recovering		See drawings	Note 2	
Exposed, Aboveground	>25			See drawings	Note 8	
Underground	>25	N/A		See drawings		
Submerged	>25	N/A		See drawings		
LININGS						
LOCATION	SIZE (mm)	MATERIAL		SPECIFICATIONS	REMARKS	
Tunnels, Pumphouses, and Buildings	>25	N/A				
Exposed, Aboveground	>25	N/A				
Underground	>25	N/A				
Submerged	>25	N/A				
JOINTS						
LOCATION	SIZE (mm)	TYPE	MAXIMUM SPACING	SPECIFICATIONS	REMARKS	
Tunnels, Pumphouses, and Buildings	>25	Butt Welded Flanged	N/A 24 m	ANSI B16.9 ASTM 351, ASTM 403 or ASTM A774 with scale removed.	Note 7	
Exposed, Aboveground	>25	Butt Welded Flanged	N/A At anchors			
Underground	>25	Butt Welded	N/A			
Submerged	>25	Butt Welded	N/A			

DETAILED PIPING SPECIFICATION

PA continued

FITTINGS AND APPURTENANCES

ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATIONS	REMARKS
Van Stone Flanges, Rolled Angle,	>50	Same as pipe, with Galvanized Steel Back-Up Ring	Class 150	Pipe Material: ASTM A240 Flanges: ASTM 285 Fabrication: ASTM A351, A403 or A774 with scale removed Pattern: ANSI B16.9	Note 7
ELL – Short Radius ELL - Long Radius, Tees, Reducers, Reducing Outlets, Laterals and Caps	>50 <450	Same as Pipe	Same as Pipe	General: MSS SP 43 Material: ASTM A351, A403 or A774 with scale removed Dimensions: MSS SP43	Note 3 Note 7
5 piece ELL	450 - 1200	Same as Pipe	Same as Pipe	Material: ASTM A351, A403 or A774 with scale removed Dimensions: ANSI B16.9	Note 7
Cap	≥50	Same as Pipe	Same as Pipe	Material: ASTM A351, A403 or A774 with scale removed. Dimensions: MSS SP43	
Plug					
Sockolet					
Threadolet	10 - 40	Same as Pipe			
Expansion Joints	>50	EPDM Flange, with Galvanized Steel Back-Up Ring	Same as Pipe		Note 4
Expansion Couplings Flange Gaskets	N/A	N/A Compressed Kevlar With Neoprene Binder Free of Carbon Black	N/A	N/A	Not Acceptable Full face gaskets are allowed for Van Stone & raised face flanges over 100 mm ND.

VALVES

TYPE	SIZE (mm)	VALVE SPECIFICATION (SECTION 11105)	REMARKS
Butterfly	≥75	BF10	
Ball	<75	N/A	
Check	≥75	CV04	
Globe	-	N/A	
Gate	-	N/A	
Mud	-	N/A	
Needle	<75	N/A	
Vee Ball	-	N/A	

NOTES

1. All structural penetrations shall consist of a type 304L stainless steel schedule 10s thimble.
2. 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. Refer to Section 15059 for pipe insulation and recovering.
3. Fabricate mitered elbows from pipe sections, except as indicated in section 15050.2.4.
4. Where the exposure is buried or submerged and when shown in the drawings, use stainless steel bellows type expansion joints.
5. Provide isometric drawings and thermal analysis stamped and signed by a professional engineer as per Section 15050. In the design, take into account the surging pressure for the piping. Information provided by the blower manufacturer indicates that for these blowers, surging consists of rapid cycles of discharge from the blower to the process air piping system at the bioreactor from a low of 14 to 21 kPa to highs of 84 to 102 kPa. The rapid cycling between these low and high pressures, almost instantaneous, lasts for approximately 10 seconds when the blower is in automatic.
6. Test pressure shall be applied and sustained for 120 min, then all joints shall be tested with soapy water.
7. Thoroughly remove all internal and external scale or other surface deposits from pipe and fittings before welding.
8. Provide stenciled warning on outdoor piping as follows: "WARNING – EXTREMELY HOT".

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 Division 17 and the Standard Detail Drawings 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 Sodium Hypochlorite Strainers

.1 Provide Y-pattern sodium hypochlorite strainers with a PVC body.

.2 Provide PVC Filter Screen with 0.8 mm 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 City standard; two lug, malleable iron, female NPT. Sizes as shown. Acceptable products are: for water service, provide products to City 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 sodium hypochlorite 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 are:

.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.

3.2 Testing

.1 Refer to 11050 3.10

3.3 Pressure Testing of Liquid Lines

.1 Refer to 11050 3.11

3.4 Pressure Testing of Gas, Air and Vapour Lines

.1 Refer to 11050 3.12

3.5 Cleaning and Flushing

.1 Refer to 11050 3.13

3.6 Disinfection

.1 Refer to 11050 3.14

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 plumbing systems, HVAC systems, 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°.

.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:

Pipe Size Nominal (mm)	Maximum Spacing (m)		
	Iron	PVC	Steel or Stainless Steel
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 Provide additional supports at any valves or other heavy piping element.

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 (un-insulated) - 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 (un-insulated) - 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 un-insulated 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 (un-insulated) - 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 (un-insulated) - 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 (un-insulated) - 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 (un-insulated) - B-Line 2007, Powerstrut PS1100, or Unistrut P1009 Series:

Pipe Diameter mm	Thickness mm
10 and 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 (un-insulated) 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 and 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 (un-insulated) - 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 (un-insulated) - 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 (un-insulated) - B-Line 3090 or Grinnell Figure 259

.3 Cast and ductile iron pipe - B-Line 3090 NS or Grinnell Figure 259

.4 Copper pipe (un-insulated) - 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 configuration 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 (un-insulated) - 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 (un-insulated) - 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. 8

.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 (un-insulated) - 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 (un-insulated) - 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)
50	10
75	12
100	16
150	20
200	22
250	25
300	25
400	29
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 (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 25 mm 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 and/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

1.2 Quality Assurance

.1 Install insulation employing skilled workers 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, labeled 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 smouldering, 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 labeled.

.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 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.

.6 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.

.7 Recovery jackets: 0.9 mm smooth aluminum sheet or paintable canvas for all new insulated piping.

.8 Cold and hot water piping up to 115°C: 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

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 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 fireproof, 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		Insulation Thickness (fibreglass) mm	Insulation Thickness (closed cell phenolic) mm	Recovery Jacket
Insulated Process Piping, as shown on drawings	15 to 50 Over 50	25 * 50 *	25 * 25 *	As noted in 2.2

* Unless stated otherwise elsewhere in Sections 11050, 11055, 11100 or 11105, or on drawings.

END OF SECTION

PROCESS VALVES

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 and/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 15 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/or 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 O&M Manual, as specified in Section 01730. 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 Canadian Registry Number (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 Section 01600 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 for the Work.

.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 pad lockable 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 handwheels, clearly show the direction of opening in raised lettering and symbols.

.3 Handwheel 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 handwheel 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 handwheel 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, handwheel; equal to or greater than 300 mm, gear operator.

.2 Knife Gate Valves: less than 300 mm, handwheel; equal to or greater than 300 mm, gear operator.

.3 Globe and Needle Valves: less than 200 mm, handwheel; equal to or greater than 200 mm, gear operator.

.5 Match existing operating nuts. Provide 2 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 Length of Lever (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 2-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 handwheel and a visual indicator of the valve position. Equip operators with adjustable mechanical stop-limiting devices to prevent overtravel of the disc/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 gearboxes 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 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 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

DETAILED VALVE SPECIFICATION

1. GENERAL

1.1 Description

.1 This Section provides 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 This Specification Section is comprehensive; some commodities and valve types may not be applicable to the Work.

.3 Table 1 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.

.4 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.

.5 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:

BF	Butterfly Valve
BV	Ball Valve
CV	Check Valve
GL	Globe Valve
GV	Gate Valve
KV	Knife Valve
MV	Mud Valve
NV	Needle Valve
PRV	Pressure Regulating Valve
PSV	Pressure Safety Valve (pressure relief valve)
PV	Plug Valve
PI	Pinch Valve
SV	Solenoid valve
TW	Two-way and Three-way Multiport Valve

2. PRODUCTS

.1 See Section 11100 for Valve Cross-reference Table

.2 Detailed Valve Specification Sheets follow

3. EXECUTION

.1 Not used

DETAILED VALVE SPECIFICATION

Table 1 – Valve Cross-reference Summary

Commodity	Size	Valve Function			Location	Valve Code	Notes
		Manual Isolation	Modulating	Check Valve			
ELW	10 to 65	X			Pumphouses, Tunnels	BV01	
			NA				
ELW	75 to 300	X			Pumphouses, Tunnels	BF02/BV05	(BV05 over 150mm)
			X			GL02/PRV05	Electric actuator
				X		CV02	
FC	10 to 65	X			Pumphouses, Tunnels	BV06	
			NA				
				X		CV03	PVC, threaded ends
FC	75 to 100	X			Pumphouses, Tunnels	BV07	
			NA				
				X		CV09	PVC check valve, flanged
FSU	75 to 750	X			Pumphouses, Tunnels	PV01	Glass lined
			NA				
				X		CV02	
ML	20 to 65	X			Pumphouses, Tunnels, Exterior	BV06	
			NA				
				X		CV03	
ML	75 to 150	X			Pumphouses, Tunnels, Exterior	PV04	
			NA				
				X		CV02	
ML	>150	X			Pumphouses, Tunnels, Exterior	BF02	
			NA				
				X		CV02	
ML	>450	NA			Submerged		
			NA				

DETAILED VALVE SPECIFICATION

Table 1 – Valve Cross-reference Summary

Commodity	Size	Valve Function			Location	Valve Code	Notes
		Manual Isolation	Modulating	Check Valve			
				X		CV08	
PA	<20	X			Pumphouses, Tunnels, Exterior	BV02	
			NA				
				X		CV07	
PA	20 to 65	X			Pumphouses, Tunnels, Exterior	BV02	
			X			PRV02	Pressure regulator
				X		CV07	
PA	75 to 600	X			Pumphouses, Tunnels, Exterior	BF01	
			X			BF07 / PRV03	Pressure regulator
				X		CV04	
PA	>600	X			Pumphouses, Tunnels, Exterior	BF12	Wafer, large B/F
			NA				
				NA			
PS	75 to 750	X			Pumphouses, Tunnels	PI01 / PV01	PV01 Glass lined
			NA				
				X		CV02	
RAS	20 to 65	X			Pumphouses, Tunnels, Exterior	BV04	
			NA				
				X		CV01	
RAS	75 to 150	X			Pumphouses, Tunnels, Exterior	PV04	
			NA				
				X		CV02	
RAS	150 to 600	X			Pumphouses, Tunnels, Exterior	BF02	
			NA				
				X		CV02	
RAS	=>600	X			Pumphouses, Tunnels, Exterior	BF08	
			X			BF08	
SE/FW	10 to 65	NA			Pumphouses, Tunnels	BV01	
			NA				
				X		CV01	
SE/FW	75 to 600	X			Pumphouses, Tunnels	BF02	
			NA				
				X		CV02	

DETAILED VALVE SPECIFICATION

Table 1 – Valve Cross-reference Summary

Commodity	Size	Valve Function			Location	Valve Code	Notes
		Manual Isolation	Modulating	Check Valve			
SE/FW	>600	X			Pumphouses, Tunnels	KV01	
			NA				
				NA			
SUB	10 to 65	X			Pumphouses, Tunnels	BV01	
			NA				
				X		CV01	
SUB	75 to 150	X			Pumphouses, Tunnels	BV05	
			NA				
				X		CV02	
SUB	200 to 600	X			Pumphouses, Tunnels	BF02	
			NA				
				X		CV02	
SUB	>600	X			Pumphouses, Tunnels	KV01	
			NA				
				NA			
FSL	75 to 750	X			Pumphouses, Tunnels	PV01	Glass lined
			NA				
				X		CV02/CV09	(CV09 as per dwgs)
PS	75 to 750	X			Pumphouses, Tunnels	PV01	Glass lined
			NA				
				X		CV02	
TWAS	75 to 750	X			Pumphouses, Tunnels	PV01/PV03	Glass lined. (PV03 w/ DI3 piping)
			NA				
				X		CV02/CV10	CV10 w/ DI3 piping
WAS	20 to 65	X			Pumphouses, Tunnels, Exterior	BV04	
			NA				
				X		CV01	
WAS	75 to 150	X			Pumphouses, Tunnels, Exterior	PV01	Glass Lined
			NA				
				X		CV02	
WAS	> 150	X			Pumphouses, Tunnels, Exterior	PV01	
			NA				
				X		CV02	

DETAILED VALVE SPECIFICATION

BF01

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Butterfly Valve	**BF01**	Air	75	5-120	850	120

TYPICAL SERVICE
PA

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Cast Iron / Ductile Iron	Size Range	50 mm to 600 mm
Disc	Ductile Iron	Rating	850 CWP
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 15100.
4. See Division 17.
5. Provide valves for CWP 1400 kPag on IA, CA services.
6. Provide valves with 304 stainless steel body and disc for PA system submerged locations.

ACCEPTABLE PRODUCTS			
	Bray Series 31	DeZurik BRS	
Nibco LD2000	Grinnell Series 8000	Crane Resilient Seat	
Kitz 5112 or 5141	Victaulic Vic 300 Masterseal	Victaulic Vic series 763 (submerged service)	

DETAILED VALVE SPECIFICATION

BF02

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Butterfly Valve	**BF02**	Liquid	600	5-30	1350	50

TYPICAL SERVICE
ELW, ML, RAS, SE, FSU, SUB

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Cast Iron	Size Range	50 mm to 600 mm
Disc	Ductile Iron	Rating	1350 CWP
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	Note 4
		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 15100.
4. Refer to Division 17.

ACCEPTABLE PRODUCTS			
	Bray Series 31H	DeZurik BRS	
Kitz 5112 or 5141	Nibco LD2000		Crane

DETAILED VALVE SPECIFICATION

BF07

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Butterfly Valve	**BF07**	Air	75	5-120	850	120

TYPICAL SERVICE
PA

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 15100.
2. Refer to Division 17

ACCEPTABLE PRODUCTS

Fisher 8560	Neles Jamesbury 815W		Bray Series 31

DETAILED VALVE SPECIFICATION

BF08

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Butterfly Valve	**BF08**	Liquid	600	5-30	1350	50

TYPICAL SERVICE
RAS

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Cast Iron	Size Range	600 mm to 1050 mm
Disc	Ductile Iron	Rating	1350 CWP
Disc Trim	Bronze or Nickel (Note 1)	Body/Valve Ends	Flanged
Seats	Buna-N	Type of Disc	
Shaft	Stainless Steel (416)	Operator	Note 1
		Actuator	Note 2
		Lining	
		Coating	

NOTES

1. See Section 15100.
2. Refer to Division 17.

ACCEPTABLE PRODUCTS

	Bray Series 36	DeZurik BAW	Nibco LD1100DF
Watt BF-03-DF			

DETAILED VALVE SPECIFICATION

BV01

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Valve	**BV01**	Liquid/Air	600	5-120	850	120

TYPICAL SERVICE
ELW, SE, FSU, SUB

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	Note 4

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 15100.
3. Provide threaded end cap and chain when used for drain service.
4. See division 17 for actuator specifications where required.

ACCEPTABLE PRODUCTS

Newman Hattersley Fig. 1969	Crane 9302	Nibco 560/580	Watts B6100/B6000
Kitz Fig 58	Toyo Fig 5044A	American Valve	

DETAILED VALVE SPECIFICATION

BV02

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Valve	**BV02**	Liquid/Gas	910	5-120	1400	120

TYPICAL SERVICE
PA

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 15100.
3. For NG service, stainless steel body not required.
4. For valves 50mm and larger in DG (digester gas) service, provide Class 150 flanged connections.
5. For valves smaller than 50mm in DG (digester gas) service, provide socketweld end connections to pipe; and provide socketweld x NPT end connections for valves used for purging, venting, drains, and instrument connections. Provide plugs in purge valves, vent valves and drain valves.
6. Use fire safe valve tested to API 607 for NG and DG service.

ACCEPTABLE PRODUCTS			
Crane 9501	Kitz Type 600 UTKM	Neles Jamesbury 3000M	Watts
American Valve			

DETAILED VALVE SPECIFICATION

BV04

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Valve	**BV04**	Liquid	1000	5 to 30	1400	50

TYPICAL SERVICE
ML, RAS, WAS

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	American Valve	

DETAILED VALVE SPECIFICATION

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	50

TYPICAL SERVICE

ELW, SUB, WAS

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 15100.
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 Series 6000/9000
American Valve Model 4000			

DETAILED VALVE SPECIFICATION

BV06

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Valve	**BV06**	Liquid	100 – 750	5 to 40	1000	60

TYPICAL SERVICE
FC, POL

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	(Note 5)

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. Use EPDM in chlorine solution service (CS).
5. Ensure valve bonnet and actuator are compatible.

ACCEPTABLE PRODUCTS

Chemline Type 21 or 26	Hayward True Union	Nibco Tru-Bloc PVC	Fabco Super Bloc

DETAILED VALVE SPECIFICATION

BV07

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Valve	**BV07**	Liquid	600	5 to 40	850	60

TYPICAL SERVICE
FC, POL

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.

ACCEPTABLE PRODUCTS			
Chemline Type 21	Hayward True Union	Nibco Tru-Bloc PVC	Fabco Super Bloc

DETAILED VALVE SPECIFICATION

CV01

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Check Valve	**CV01**	Liquid	600	5-30	850	50

TYPICAL SERVICE
FW, PE, RAS, RS, SE, FSU, SUB, WAS

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 1707	Newman Hattersley A60	Kitz No. 22	Jenkins 996
Toyo 236			

DETAILED VALVE SPECIFICATION

CV02

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Check Valve	**CV02**	Liquid	600	5-30	850	50

TYPICAL SERVICE
ELW, FSU, FW, ML, PE, PSL, RAS, SE, SUB, FSL, TWAS, WAS

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			

DETAILED VALVE SPECIFICATION

CV03

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Check Valve	**CV03**	Liquid	600	5-30	700	50

TYPICAL SERVICE
FC, POL

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	PVC	Size Range	10 mm to 60 mm
Ball / Disc	PVC	Rating	Class 150
		Valve Ends	True Union or Flanged
Seats	Viton	Type of Check	Swing Check (note 2)
		Operator	
		Actuator	
		Lining	
		Coating	

NOTES
1. Threaded ends under 65mm.
2. Use Ball check under 20mm.

ACCEPTABLE PRODUCTS			
Chemline BT	Hayward True Check		

DETAILED VALVE SPECIFICATION

CV04

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Check Valve	**CV04**	Air&Digester Gas	100	5-100	400	150

TYPICAL SERVICE
PA

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	Note 3
Body	Stainless Steel	Size Range	75 mm to 750 mm
Disc	Stainless Steel	Rating	Class 125
Seats		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 15100.

ACCEPTABLE PRODUCTS			
APCO 9000	Val-Matic 8000	Proquip Twin Flapper	Mission 12 HMP
Gulf MB12-5-0-9-1-5-F	CenterLine Series 800		

DETAILED VALVE SPECIFICATION

CV07

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Check Valve	**CV07**	Air	700	50	1000	100

TYPICAL SERVICE
PA

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	ANSI B2.1
Body	316 Stainless Steel	Size Range	10 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	

DETAILED VALVE SPECIFICATION

CV09

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Check Valve	**CV09**	Liquid	350			
TYPICAL SERVICE						
FSL						
VALVE MATERIALS			**VALVE DESCRIPTION**			
ITEM	MATERIAL		Reference Document			
Body	Cast Iron		Size Range		150 mm	
Ball	Buna n		Rating		Class 125	
Seats			Valve Ends		Flanged	
			Operator			
			Actuator			
NOTES						
ACCEPTABLE PRODUCTS						
Danfoss Flomatic 408						

DETAILED VALVE SPECIFICATION

CV10

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Check Valve	**CV10**	Liquid	2100	5-30	2400	50

TYPICAL SERVICE
TWAS

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Cast Iron	Size Range	150 mm
Disc	Cast or Ductile Iron	Rating	Class 250
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			

DETAILED VALVE SPECIFICATION

GL02

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Globe Valve	**GL02**	Liquid	750	-5 to 115	1000	120

TYPICAL SERVICE
ELW

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	Note 1

NOTES
1. See Division 17 for actuator specifications.

ACCEPTABLE PRODUCTS	
Kitz	Newman Hattersley
Grinnell	Spirax Sarco

DETAILED VALVE SPECIFICATION

GV02

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Gate Valve	**GV02**	Liquid	600	5-30	850	50

TYPICAL SERVICE
FC, POL

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 GT50	Chemline CGA		

DETAILED VALVE SPECIFICATION

KV01

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Knife Gate Valve	**KV01**	Liquid	600	5-30	850	50

TYPICAL SERVICE
PE, SE, FW, FSU, SUB

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 15100.
2. Provide bonnet with stainless steel (304) stem extension for below grade and submerged services.

ACCEPTABLE PRODUCTS			
DeZurik Series L	Fabri-Valve Fig. 37	Red Valve Series G	Orbinox Series 10

DETAILED VALVE SPECIFICATION

MV01

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Mud Valve	**MV01**	Liquid	100	5-30	150	50
TYPICAL SERVICE						
PE, SE, FW						

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	ASTM A 276, ASTM D2000 Gr. 2
Frame	Stainless Steel	Size Range	0-300 mm
Disc	Stainless Steel	Rating	
Flange and Yoke	Stainless Steel	Valve Ends	Flanged
Seals	Neoprene	Type of Seats	Tapered
Stem	Stainless Steel	Operator	50 mm square nut
		Actuator	
		Lining	
		Coating	

NOTES			
ACCEPTABLE PRODUCTS			
H. Fontaine	Armtec		

DETAILED VALVE SPECIFICATION

NV01

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Needle Valve	**NV01**	Liquid/Air	800	5-100	1000	140

TYPICAL 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

Swagelok JN Series	Anderson, Greenwood H Series	Lunkenheimer 1732	Parker
	Century CM2		

DETAILED VALVE SPECIFICATION

PI01

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Pinch Valve	**PI01**	Liquid	600	5-30	850	50

TYPICAL SERVICE
PE, PS, TWAS

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Cast Iron	Size Range	50 mm to 900 mm
Sleeve	EPDM	Rating	Class 150
Shaft	Steel	Valve Ends	FF Flanges
		Type of mechanism	Double acting closure
		Operator	See note 2
		Actuator	

NOTES

1. See Section 15100.
2. Refer to Division 17.

ACCEPTABLE PRODUCTS

Onyx DHC	Red Valve 75		

DETAILED VALVE SPECIFICATION

PRV01

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Pressure regulator Valve	**PRV01**	Liquid				

TYPICAL SERVICE
ELW, FW

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Bronze	Size Range	10 mm to 65 mm
Sleeve		Rating	
Shaft		Valve Ends	FNPT
		Type of mechanism	Diaphragm
		Operator	
		Actuator	

NOTES

1. See Section 15100.

ACCEPTABLE PRODUCTS			
Fisher Regulator			

DETAILED VALVE SPECIFICATION

PRV02

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Pressure Regulator Valve	**PRV02**	Gas				

TYPICAL SERVICE
PA

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Stainless Steel	Size Range	10 mm to 65 mm
Sleeve		Rating	
Shaft		Valve Ends	FNPT
		Type of mechanism	Diaphragm
		Operator	
		Actuator	

NOTES

1. See Section 15100.
2. Natural Gas service may be Carbon Steel.

ACCEPTABLE PRODUCTS			
Fisher Regulator			

DETAILED VALVE SPECIFICATION

PRV03

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Pressure Regulator Valve	**PRV03**	Gas				

TYPICAL SERVICE
PA

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Stainless Steel	Size Range	75 mm to 100 mm
Sleeve		Rating	Class 150
Shaft		Valve Ends	RFWN Flange ANSI 150#
		Type of mechanism	Diaphragm
		Operator	
		Actuator	

NOTES

1. See Section 15100.

ACCEPTABLE PRODUCTS			
Fisher Regulator			

DETAILED VALVE SPECIFICATION

PRV05

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Pressure Regulating Valve	**PRV05**	Water	850	5-25	1050	40

TYPICAL SERVICE
ELW, FW

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Ductile Iron	Size Range	100 mm
Disc	EPDM or Buna N	Rating	Class 150
Disc Trim	None	Body/Valve Ends	Flanged
Seats	316 Stainless Steel	Pilot valves	Bronze with SS internals
Shaft	Stainless Steel (316)	Operator	NA
Bushings	Brass or bronze	Actuator	NA
Spring	302 Stainless Steel	Lining	Epoxy
Fastenings	SS	Coating	Epoxy

NOTES
1. Suitable for use with reclaimed water with residual suspended solids.

ACCEPTABLE PRODUCTS			
Singer 106-PR			

DETAILED VALVE SPECIFICATION

PSV01

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Pressure Safety Valve	**PSV01**	liquid				

TYPICAL SERVICE
FC, POL

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	PVC	Size Range	10 mm to 150 mm
Spring	Stainless Steel	Rating	
Disc assembly	PVC	Valve Ends	True union
Seals	Viton or EPDM	Type of mechanism	Spring
		Operator	
		Actuator	

NOTES

1. See Section 15100.

ACCEPTABLE PRODUCTS			
Hayward	Chemline		

DETAILED VALVE SPECIFICATION

PV01

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Plug Valve	**PV01**	Liquid	600	5-30	850	50

TYPICAL SERVICE
FSU, FSL, PS, TWAS, WAS

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Cast Iron	Size Range	75 mm to 600 mm
Plug	Cast Iron (see plug coating)	Rating	Class 150
Seats	Removed	Valve Ends	Victaulic or Flanged
Seals	Multiple Packing	Type of Plug	Eccentric
Shaft	Steel	Operator	Square nut (Note 1)
Bearings	Stainless Steel	Actuator	
		Lining	Glass lined
		Plug Coating	Buna-N, Al-Clad, or Hycar
		Coating	

NOTES
1. See Section 15100.

ACCEPTABLE PRODUCTS			
Victaulic Series 365	Pratt Ballcentric		

DETAILED VALVE SPECIFICATION

PV03

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Plug Valve	**PV03**	Liquid	2100	5-30	2800	100

TYPICAL SERVICE
TWAS

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Cast Iron	Size Range	75 mm to 600 mm
Plug	Cast Iron (see plug coating)	Rating	Class 250
Seats	Removed	Valve Ends	Victaulic or Flanged
Seals	Multiple Packing	Type of Plug	Eccentric
Shaft	Steel	Operator	Square nut / chain operator
Bearings	Stainless Steel	Actuator	
		Lining	Glass lined
		Plug Coating	Buna-N, Al-Clad, or Hycar
		Coating	

NOTES
1. See Section 15100.

ACCEPTABLE PRODUCTS			
Milliken 602 (ANSI 250 Flanged)			

DETAILED VALVE SPECIFICATION

PV04

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Plug Valve	**PV04**	Liquid	600	5-30	850	50

TYPICAL SERVICE
FW, ML, RAS, WAS

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Cast Iron	Size Range	50 mm to 600 mm
Plug	Cast Iron (see plug coating)	Rating	Class 150
Seats	Nickel	Valve Ends	Victaulic
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 15100.

ACCEPTABLE PRODUCTS			
Victaulic Style			

DETAILED VALVE SPECIFICATION

SV01

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Solenoid Valve	**SV01**	Liquid	1000	5 to 30	1400	50

TYPICAL SERVICE
FW

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	Carbon Steel or Stainless Steel	Size Range	10 mm to 64 mm (Note 2)
Plug	Stainless Steel (304)	Rating	CWP 1400 kPag
Seats	PTFE or RTFE	Body/Valve Ends	Female Threaded
Shaft	Stainless Steel (304 or 315)	Pattern	
	(Note 2)	Operator	
		Actuator	

NOTES

ACCEPTABLE PRODUCTS			
ASCO			

DETAILED VALVE SPECIFICATION

TW01

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
2-Way Multiport	**TW01**	Liquid	300	-5 to 115	1720	120

TYPICAL SERVICE

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 threaded; 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	

DETAILED VALVE SPECIFICATION

TW03

GENERAL						
			OPERATING LIMITS		DESIGN LIMITS	
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
3-Way Multiport	**TW03**	Gas	15-240	5-120	500	150
TYPICAL SERVICE						

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 15100.
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 15100.
4. Stainless steel body not required for NG service

ACCEPTABLE PRODUCTS

NEO Model #1-AS-80118	Newman Millikan 200M

END OF SECTION

PROCESS MOTORS LESS THAN 150 KW

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, the manufacturer of the driven equipment is to provide electric motors as an integral component of the driven equipment, as specified in Section 11005.

.4 This section specifies 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, in accordance with Section 01060:

.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 NEMA Std. MG1, Motors and Generators

.6 IEEE 112, Polyphase Induction Motors and Generators - Testing

.7 IEEE 114, Single Phase Induction Motors - Testing

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 for each 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 centreline 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 characteristic

.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 of all motors

.21 Class, division, group, and UL frame temperature limit code for explosion-proof motors

.2 Operating and Maintenance Data: Provide for incorporation in O&M Manual of the related item of process equipment as specified in Section 01735.

1.4 Coordination

.1 For motors fed via VFD, communicate motor requirements to the VFD manufacturer, and comply with drive requirements of the VFD manufacturer in accordance with Division 16.

1.5 Quality Assurance

.1 Build motors in accordance with CSA C22.2 No. 100, CSA C22.2 No. 145, NEMA Standard MG1, and to the requirements specified.

1.6 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 Description

.1 Unless specified otherwise, provide motors suitable for continuous operation at an elevation of 220 m above sea level.

.2 Provide motors suitable for continuous operation in a 40°C ambient temperature.

2.2 Acceptable Manufacturers

.1 Baldor

.2 General Electric

.3 GEC Alsthom

.4 Reliance

.5 Siemens

.6 Toshiba

.7 U.S. Motors

.8 Westinghouse

2.3 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 Cast metal fan blades and shrouds

.3 Stainless steel hardware

.4 Nonhygroscopic windings

2.4 Components

.1 Bearings

.1 Provide sealed ball 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.

.2 Provide adequately sized, diagonally split, gasketted, EEMAC 4 terminal boxes complete with threaded hub for conduit entry for ODP and TEFC motors.

.3 Provide adequately sized, diagonally split, gasketted EEMAC 7 terminal boxes complete with threaded hub for conduit entry for explosion-proof motors.

.4 Provide a ground connection and lifting eyes or lugs.

.5 Align and balance the motor with the related equipment in the shop to minimize vibration and undue stresses.

.6 Where specified, equip motors with anti-condensation heaters suitable for connection to 120 V, single phase, 60 Hz power supply.

.7 Current Imbalance

.1 Do not exceed the values listed 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.

.8 Winding Overtemperature Protection

.1 Provide stator winding overtemperature protection on all motors rated 45 kW and larger.

.2 Provide stator winding overtemperature protection on motors rated less than 45 kW, when required by the specific equipment specification section, or if recommended by the driven equipment manufacturer.

.3 Overtemperature 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 overtemperature protection. Provide one detector 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.

2.5 High Efficiency Motors

.1 Use motors that have efficiencies that conform to or exceed the requirements of EPACT.

.2 Where vertical motors are specified or provided, ensure efficiency is within 0.5 percent of the values specified 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.

2.6 Motors Smaller Than 0.25 kW

.1 General

.1 Unless otherwise specified, provide squirrel cage, single phase, capacitor start, induction run type motors 0.25 kW and smaller.

.2 Provide single phase motors with Class F insulation.

.3 Small fan motors may be split-phase or shaded pole type.

.4 Provide copper windings.

.2 Rating

.1 Unless specified otherwise, provide motors rated for operation at 120/1/60 VAC, 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 (TEFC) or totally enclosed non-ventilated (TENV) enclosures.

.2 Where explosion-proof motors are specified or required, provide explosion-proof motors bearing the UL label for Class I, Division 1, Group D hazardous locations.

.3 Provide advice in the enclosure to detect overtemperature and automatically de-energize the motor.

2.7 Motors 0.25 kW to 150 kW

.1 General

.1 Unless otherwise specified, provide 3-phase, squirrel cage, full voltage start, high efficiency induction type motors.

.2 Rating

.1 Unless otherwise specified, provide heavy duty, high efficiency, and TEFC motors for all motors which run continuously.

.2 Unless otherwise specified, provide squirrel cage induction type motors, with a service factor of 1.15 at 40°C ambient, Class F insulation and non-hygroscopic windings.

.3 Provide motors with EEMAC Design B torque characteristics. Size motors to satisfy the driven equipment's starting torque requirements. For special high-torque applications such as sweep arm drives, motors with Design C characteristics may be specified or provided subject to the Contract Administrator's acceptance.

.4 Rated for 600 V 3 phase 60 Hz service

.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 Motors with a service factor of 1.0 to operate at no more than 90 percent of their nameplate current rating and motors with a service factor of 1.15 to operate at not more than 100 percent of their nameplate current rating.

.7 Ensure sufficient capacity to operate the driven load and associated devices under all conditions of operation without overloading.

.3 Enclosure and Insulation

.1 Classify motors as:

.1 Type 1 (General Duty)

.2 Type 2 (Process)

.3 Type 3 (Explosion-proof)

.2 Enclosures and insulation systems are specified in the following clauses. Temperature rise for all motor types not to exceed that permitted by Note II, paragraph 12.42, NEMA MG1.

.3 Provide non-hygroscopic insulation.

.4 Type 1 Motors (General Duty): Unless specified otherwise, provide TEFC enclosures with Class F insulation.

.5 Type 2 Motors (Process): Provide TEFC enclosures, with Class F insulation, suitable for moist and corrosive environment. Provide Class F insulation with Class B temperature rise for motors rated 7.5 kW and larger. Coat all internal surfaces with an epoxy paint. Aluminum frame motors are permitted. Steel frame motors are permitted for motors with frames 184 and smaller.

.6 Type 3 Motors (Explosion-proof): Provide motors to be rated for operation in a Class 1, Division 1, Group D hazardous location in accordance with CSA C22.1. Provide Class F insulation. Steel frame motors are not permitted. Provide an approved breather/drain device in the motor drain hole.

2.8 Motors for Variable Frequency Drives

.1 Comply with the characteristics of the intended variable frequency drives.

.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 Motors for variable frequency systems are not to deliver more than 80 percent of the motor's service factor 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.

2.9 Vertical Motors

.1 Unless otherwise specified, provide full voltage vertical motors with a Type P base specifically designed for vertical installation.

.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.

2.10 Two-Speed Motors

.1 Provide two-speed motors with separate windings. Single winding two speed motors are not acceptable.

2.11 Power Factor Correction Capacitor Sizing

.1 Confirm the maximum capacitor size which may be connected to motors 37.5 kW and larger, on constant speed drives.

2.12 Finishes

.1 Factory paint motors as specified in Section 11900.

2.13 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 AFBMA 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.

2.14 Spare Parts

.1 Provide maintenance materials and spare parts in accordance with Section 01750.

3. EXECUTION

3.1 Manufacturers Representative

.1 All motors are supplied as an integral component of some other item of equipment. The manufacturer's representative for that equipment is responsible for the supervision of installation, site testing, and commissioning of the motor as part of the equipment as specified in other sections. Ensure that the motor manufacturer's representative informs both the representative for the equipment and the installer of requirements for the motor, installation, testing, and commissioning.

3.2 Installation

.1 Dry the 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 manufacturer's 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.

3.3 Testing

.1 Perform tests and document results in accordance with Division 16.

3.4 Testing and Commissioning

.1 Ensure the motor operates as intended during testing of the individual equipment and during process commissioning.

END OF SECTION

PROCESS MOTORS GREATER THAN 150 kW

1. GENERAL

1.1 Work Included

.1 This Section specifies alternating current induction motors, greater than 150 kW.

.2 This Section does not specify specialty motors such as submersible, hoist, valve operator, torque rated, or inverter duty motors.

.3 Provide motors for starting and accelerating the driven load up to operating speed and for developing sufficient torque to fulfil the acceleration and the steady state requirements of the driven equipment without exceeding the normal operating limits of the system.

.4 Unless specified otherwise, the manufacturer of the driven equipment is to provide electric motors as an integral component of the driven equipment, as specified in Section 11005.

1.2 Reference Standards

.1 Conform to the following reference standards, in accordance with Section 01060:

.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 EEMAC M2-1, Lead Marking and Connections for Single Phase and Poly Phase Induction Motors

.6 NEMA Std. MG1, Motors and Generators

.7 IEEE 112, Polyphase Induction Motors and Generators - Testing

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 for each size or type of motor driven equipment.

.1 Overall dimensions of motor

.2 Shaft centreline to base dimension

.3 Shaft extension diameter and keyway, coupling dimensions and details

.4 Fixing support dimensions

.5 Terminal box location and size of terminals

.6 Arrangement and dimensions of accessories

.7 Diagram of connections

.8 Speed/torque characteristic

.9 Weight of motor

.10 Installation data

.11 Rotation direction

.12 Starting restrictions (time between starts)

.13 Terminal leads marking

.14 Bearing data (including part numbers)

.15 Recommended lubricant

.16 Design ambient temperature

.17 The AFBMA L-10 rated life for the motor bearings

.18 The nominal efficiency for all motors

.19 Class, division, group and UL frame temperature limit code for explosion-proof motors.

.2 Operating and Maintenance Data: provide for incorporation in O&M Manual of the related item of process equipment as specified in Section 01735.

1.4 Coordination

.1 Ensure motor is compatible with all anticipated loads and equipment operating conditions.

1.5 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 Description

.1 Unless specified otherwise, provide motors suitable for continuous operation at an elevation of 220 m above sea level.

.2 Provide motors suitable for continuous operation in a 40°C ambient temperature.

2.2 Acceptable manufacturers

.1 ASEA - Brown Boveri

.2 Baldor

.3 General Electric

.4 GEC Alsthom

.5 Reliance

.6 Siemens

.7 Toshiba

.8 U.S. Motors

.9 Westinghouse

2.3 General

.1 Unless otherwise specified, provide 3-phase, squirrel cage, full voltage start, high efficiency, induction type motors.

2.4 Rating

.1 Provide motors for continuous operation, heavy duty service, high efficiency.

.2 Provide squirrel cage induction type, form wound, Class F insulation, non-hygroscopic winding motors, for severe moisture and corrosive environment.

.3 Design for EEMAC Design B torque characteristics.

.4 Provide motors rated for 600 V 3 phase 60 Hz 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 Service factor: 1.15 (for sinusoidal 60 Hz) designed for operation in a 40°C ambient temperature.

.7 Ensure sufficient capacity to operate the driven load and associated devices under all operating conditions without overloading.

2.5 Efficiency

.1 Provide high efficiency horizontal motors

.2 Where vertical motors are specified or provided, ensure efficiency is within 0.5 percent of values specified for horizontal motors.

.3 Test motor efficiency in accordance with CSA C390, or equivalent, which accounts for stray load losses and measures them indirectly based on the IEEE method.

2.6 Materials

.1 Motors: to EEMAC M1-7

.2 Lead markings: to EEMAC M2-1

.3 Unless specified otherwise, provide all motors with:

.1 Cast iron frame

.2 Cast metal fan blades and shrouds

.3 Stainless steel hardware

.4 Nonhygroscopic windings

2.7 Motor Windings and Winding RTDs

.1 Design the motor to permit the removal of the rotor and shaft without removal of the stator.

.2 Provide copper stator form wound windings.

.3 Provide windings vacuum, pressure impregnated and capable of passing tests equal to the EEMAC water immersion test.

.4 Provide motor thermal overload protection by embedding six flat, laminated 100 ohm platinum RTDs (two per phase winding); fit in slots between stator windings and locate near the hottest point of the winding.

.5 Provide each RTD complete with three insulated stranded copper leads. Terminate RTD leads in a separate instrument termination box.

2.8 Motor Noise Abatement

.1 The maximum pressure level from the motors must not exceed 85 dBA at a distance of one metre from the motor surface.

.2 Determine the sound level in accordance with IEEE standards.

2.9 Motor Anchoring

.1 Mount the motor on the supporting stand.

.2 Provide mounting stand-to-motor attachment hardware as recommended by the manufacturer, subject to review.

2.10 Motor Vibration Sensors

.1 Provide sensors installed on motors to monitor the following:

.1 Inboard bearing vibration

.2 Outboard bearing vibration

.3 Case vibration

.2 Include all provisions for mounting the vibration sensors in accordance with the manufacturer's requirements.

2.11 Motor Enclosures

.1 Provide open drip-proof guarded motor enclosures.

.2 Protect the air intake and discharge openings with stainless steel metal guard screens.

.3 Equip all moving or energized parts with adequate guards or other suitable enclosure to prevent accidental contact.

2.12 Motor Grounding

.1 Provide the motor frames with a grounding termination pad located in the main power lead conduit box.

.2 Provide grounding pads with tapped holes, matching bronze bolts, and copper cable lugs.

2.13 Motor Bearings and Bearing RTDs

.1 Provide anti-friction ball or roller bearings fitted with inner bearing caps for the protection of the bearings.

.2 Provide grease fittings for lubrication during operation, and grease discharge or relief opening.

.3 Design bearings for a minimum AFBMA B-10 life of 100,000 hours under the most severe operating conditions.

.4 Design motor to protect against circulating shaft current.

.5 Furnish motor with 100 ohm platinum RTD temperature sensors on upper and lower bearings, wired to instrument terminal box.

.6 Provide each RTD sensor complete with stainless steel fluid seal spring-loaded holder 12 NPT motor connection and 20 NPT enclosure connection, tip-sensitive stainless steel 100 ohm platinum RTD (three stranded, insulated copper leads) and copper-free aluminum connection head complete with terminals with 20 NPT connection.

2.14 Motor Lifting Lugs

.1 Provide the motors with lifting lugs or other approved means to allow installation and maintenance of the motors.

.2 Make the lifting lugs compatible with the appropriate hoists and cranes.

2.15 Current Imbalance

.1 Do not exceed 10 percent phase current imbalance when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system:

.2 Base imbalance as a percentage of the lowest phase current measured.

2.16 Motor Terminal Box

.1 Furnish the motors with extra large terminal boxes having sufficient size to accommodate cables as detailed on the electrical drawings, with provision for stress cones.

.2 Provide air seals where leads pass through the motor enclosure and frame.

.3 Do not locate terminal boxes in air intake or discharge paths.

.4 Provide separate terminal boxes as required for space heater leads and all other required instrumentation and control connections.

2.17 Power Factor Correction Capacitor Sizing

.1 Confirm the maximum capacitor size which may be connected to motor.

2.18 Finishes

.1 Factory paint motors as specified in Section 11900.

2.19 Mounting

.1 Supply all motors integrally with the related equipment.

.2 Factory align and balance the motor with the related equipment to minimize vibration and undue stresses.

2.20 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 Permanently fasten nameplates to the motor frame and position to be easily visible for inspection.

2.21 Spare Parts

.1 Provide maintenance materials and spare parts in accordance with Section 01750.

3. EXECUTION

3.1 Manufacturers Representative

.1 All motors are supplied as an integral component of some other item of equipment. The manufacturer's representative for that equipment is responsible for the supervision of installation, Site testing, and commissioning of the motor as part of the equipment as specified in other Sections. Ensure that the motor manufacturer's representative informs both the representative for the equipment and the installer of requirements for the motor, installation, testing and commissioning.

3.2 Installation

.1 Ensure the motor is properly installed to provide satisfactory service.

3.3 Testing and Commissioning

.1 Ensure the motor operates as intended during testing of the individual equipment and during process commissioning.

END OF SECTION

SUBMERSIBLE MOTORS

1. GENERAL

1.1 Work Included

.1 Supply and supervision of the installation, testing, and commissioning of submersible motors.

1.2 Submittals

.1 Shop Drawings: submit with the related item of process equipment in accordance with Section 01300 and Section 11005. In addition, submit the following details:

.1 Submit efficiency and power factor information at 100 percent and 75 percent load for each motor size and type required.

.2 Operating and Maintenance Data: provide for incorporation in O&M Manual of the related item of process equipment as specified in Section 01300.

1.3 Coordination

.1 For motors fed via variable frequency drives (VFDs), communicate motor requirements to the VFD manufacturer and comply with drive requirements of the VFD manufacturer in accordance with Division 16.

1.4 Quality Assurance

.1 Build motors in accordance with CSA C22.2 No. 100, CSA C22.2 No. 145, NEMA Standard MG1, and to the requirements specified.

1.5 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 Description

.1 Unless specified otherwise, provide motors suitable for continuous operation at an elevation of 220 m above sea level.

.2 Provide motors suitable for continuous operation in a 40°C ambient temperature.

2.2 Acceptable Manufacturers

.1 Siemens

.2 General Electric

.3 Toshiba

.4 Westinghouse

.5 Reliance Electric

.6 Flygt

2.3 Exposure Classification

.1 The exposure classification for each motor is specified with the related equipment.

.2 Provide as a minimum TEXP motors for areas where dangerous gases may occur or which are to be immersed in flammable liquids.

.3 In all other areas, provide totally enclosed, waterproof motors.

2.4 Motors - Sewage Application

.1 Provide motors suitable for heavy duty service.

.2 Squirrel cage induction type with non-hygroscopic windings. Insulation temperature rise not to exceed Class F. Insulation to be moisture resistant.

.3 For starting and torque characteristics, conform to EEMAC Design B.

.4 316, 416, or 417L stainless steel motor shafts.

.5 For services 0.37 kW and greater provide motors nameplate rated for 600 V, 60 Hz, 3 phase service unless otherwise specified.

.6 Design motors for full voltage starting and capable of running successfully when terminal voltage is from +10 percent to -10 percent of nameplate voltage. Motors with a service factor of 1.0 shall run at not more than 90 percent of nameplate current rating and motors with a service factor of 1.15 shall operate at not more than 100 percent of nameplate current rating.

.7 Provide motors capable of ten evenly spaced starts per hour on a continuous basis without temperature rises which would harm insulation and windings.

.8 Design motors for semi-continuous immersion in liquid with an ambient temperature of 40°C unless higher temperatures are noted. Design casing for adequate heat rejection. Designs utilizing the circulation of the pumping liquid are not permitted.

.9 Where motors are designated for intermittent immersion, provide cooling fins, sealed fan units, or other devices suitable for the function.

.10 Provide thermal protection. Two bimetallic sensors shall sense when the motor temperature rises above 140°C. The motor shall automatically restart after cool-down. For TEXP motors, calibrate the two bimetallic sensors to shut down the motor at 120°C. Include three additional thermistors which shut down the motor if a temperature of 140°C is sensed. On sensing this condition, the motor will be shut down and held until reset. Use the thermal switches in conjunction with and supplemental to external thermal motor overload protection.

.11 For motors greater than 10 kW, provide a moisture sensing device in the stator housing.

.12 Attach an oil-filled reservoir to the bottom of the motor. Prohibit the ingress of moisture with inner and outer single mechanical seals. Mechanical seals to be tungsten carbide or sintered silicon carbide, both faces.

.13 Place a moisture sensing device in the reservoir to indicate seal failure.

.14 Provide sealed ball bearing type bearings with an AFBMA B10 life of 100,000 hours.

.15 Provide 304 or 316 stainless steel hardware.

.16 Ensure motors used with variable speed drives have adequate cooling capacity when operating through the entire speed range capacity of the drive.

2.5 Cable

.1 Supply submersible motors with a minimum length of cable to reach the pump's control panel and starter, and capable of continuous submergence under water without loss of watertight integrity to a depth of 20 m.

.2 Provide cable that contains power and ground wires, copper, of sufficient size for the service and in compliance with applicable codes.

.3 Provide cable that contains instrument leads, shielded as necessary to prevent electrical interference.

.4 Provide heavy duty cable, water tight and capable of withstanding operating loads.

.5 Seal end of cable prior to shipping to prevent ingress of moisture.

2.6 Finishes

.1 Factory paint submersible motors as specified in Section 11900.

2.7 Mounting

.1 Supply all motors integrally with the related equipment.

.2 Factory align and balance the motor with the related equipment to minimize vibration and undue stresses.

3. EXECUTION

3.1 Manufacturer's Representative

.1 All motors are supplied as an integral component of some other item of equipment. The manufacturer's representative for that equipment is responsible for the supervision of installation, Site testing, and commissioning of the motor as part of the equipment as specified in other Sections. Ensure that the motor manufacturer's representative informs both the representative for the equipment and the installer of requirements for the motor, installation, testing, and commissioning.

3.2 Installation

.1 Ensure the motor is properly installed to provide satisfactory service.

3.3 Testing and Commissioning

.1 Ensure the motor operates as intended during testing of the individual equipment and during process commissioning.

END OF SECTION

PROCESS PUMPS – GENERAL REQUIREMENTS

1. GENERAL

1.1 Description

.1 This Section defines the general requirements for the supply, 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 and 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 Institute 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 O&M 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 sufficiently 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, provide gauges for the inlet and outlet of each pump.

.3 For submersible pumps, provide only one gauge for mounting on the discharge of the pump on a weldolet installed outside, but within 2 m of the wetwell.

.4 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.

.5 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

.6 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 and diaphragm isolators 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 Materials 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, Fermenter Sludge	316 or 317L Stainless Steel	316 or Hastelloy C	Viton	Tungsten Carbide on Sintered Silicon Carbide

.4 Approved manufacturers

.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 five 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 5 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 ±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 to be within 5 percent of the actual flows by a qualified Professional Engineer.

.4 Pressure Monitoring

.1 Do not use permanent gauges for pressure monitoring during tests. Where possible, temporary test gauges can be connected to the permanent gauge taps. In cases where the permanent gauge taps cannot be used (eg in line-isolated gauges) provide an additional tap for the test gauge.

.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 three 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

HORIZONTAL SOLIDS HANDLING CENTRIFUGAL PUMPS

1. GENERAL

1.1 Work Included

.1 This Section specifies the supply, installation, testing, and commissioning of horizontal solids handling centrifugal pumps:

2. PRODUCTS

2.1 Description

.1 Use horizontal solids handling centrifugal pumps for applications where some solids are present, total suspended solids below 1 percent, and stringy and abrasive materials are absent.

2.2 Detailed Pump Specification Sheets

.1 Specific pumps are listed in detailed specification sheets. Required performance characteristics and ancillary requirements are presented. Complete data where information has not been input to the specification sheets.

2.3 Acceptable Manufacturers

.1 Aurora Pump

.2 Chesterton

.3 Cornell

.4 Fairbanks Morse

.5 Ingersoll Dresser

.6 ITT A-C Pump

.7 Morris

.8 Peerless

2.4 Impellers

.1 Provide two- or three-vane, semi-enclosed, one piece single suction impellers.

.2 Provide impellers designed with large passageways, vanes with well rounded leading edges, and thick hydrofoil shape to prevent trapping of stringy and solid material.

.3 Fabricate impellers of ASTM A48 cast iron, with no less than 3 percent nickel.

.4 Factory balance impellers, statically and dynamically.

2.5 Casings

.1 Fabricate casing of one piece ASTM A48 cast iron with no less than 3 percent nickel.

.2 For suction and discharge greater than 50 mm, provide a flanged end suction inlet and a flanged vertical centreline discharge outlet.

.3 For suction and discharge less than 50 mm, provide threaded nozzles.

.4 Provide thick-walled constant velocity volutes to channel flow away from the impeller vanes into the circular flow areas of the impeller passageways and casing to assure passage of large solids and long stringy materials.

.5 Pressure test casings at 1.5 times the pressure developed by the pump at shut off head.

.6 Provide tapped and plugged holes for priming and draining. Use stainless steel plugs.

.7 Make the casing bore large enough to permit back pullout of the impeller without disturbing the motor, casing, or suction and discharge piping.

2.6 Wearing Rings

.1 Fit the casing with a bronze wear ring to minimize abrasive and corrosive wear. Provide a radial type wear ring, press fitted into the casing.

2.7 Cleanouts

.1 Supply each pump with a hand sized cleanout either integral with the casing or on a suction spool piece attached to the casing.

2.8 Shafts

.1 Fabricate pump shafts of ASTM A 276 Type 416 or 420, Brinnell Hardness of 450 minimum

.2 Make the shaft of sufficient diameter to assure rigid support of the impeller and to transmit loads without slip, vibration or undue deflection at operating loads. Maintain L^3/D^4 less than than 60, where L is impeller overhang and D is shaft diameter.

.3 Provide turned, ground, and polished shaft of proportions suitable for use in constant speed or variable speed pumping applications.

.4 Key the impeller to the shaft, and secure by an impeller bolt. Design the assembly to prohibit loosening of the connection due to torque developed during operation. Design the assembly to allow a smooth flow path without causing the accumulation of stringy material.

.5 Do not use shaft sleeve.

2.9 Bearings

.1 Provide oil-lubricated duplex thrust angular contact and roller, anti-friction type pump bearings.

.2 AFBMA B-10 bearing life: 100,000 hours minimum, at maximum efficiency as specified in Section 11005

.3 Design radial and thrust bearings for the worst combination of loading developed at all operating conditions for a bearing life of 100,000 hours.

2.10 Flexible Coupling

.1 Connect the pump shaft and the motor shaft with a flexible coupling. Refer to Section 11005.

2.11 Motor Mount

.1 Connect motor to pump through a C-Flange connection.

.2 Design pump casing supports to ensure that they are capable of supporting the cantilevered motor load.

2.12 Motors

.1 Motor types, voltages, service conditions and power ratings are indicated in the Detailed Pump Specification Sheets.

.2 Where variable speed drives are to be used, ensure compatibility of drive with pump and motor combination. Identify minimum compatibility requirements in the submittals.

.3 Comply with the provisions of Section 11205.

2.13 Bases

.1 Manufacture pump bases of cast iron or fabricated steel. Extend bases below motors.

.2 Provide grouting holes, a minimum of one at the centre and one at each corner, of sufficient size to allow for the pouring of grout into the annular space.

.3 Bases are to have square corners in all three directions, with parallel surfaces.

.4 Provide mounting blocks such that one size greater motor frame may be accommodated by replacing the mounting blocks.

2.14 Finishes

.1 Factory prime and paint in accordance with Section 11901

2.15 Spare Parts

.1 Provide spare parts in accordance with Section 11300

3. EXECUTION

3.1 Manufacturer's Representative

.1 Manufacturer's representative is to attend the site to train installation personnel; and to witness installation and testing to ensure the equipment is installed and operated as intended.

3.2 Installation Training

.1 Instruct the installer in the methods and precautions to be followed in the installation of the pump(s).

.2 The manufacturer's representative shall verify the installer's understanding by completing Form 101, included in Section 01650.

3.3 Installation

.1 Ensure that each pump is installed and aligned in accordance with Section 11020, as required to provide satisfactory service.

.2 Cooperate with the installer to fulfill the requirements for a successful installation.

3.4 Testing

.1 Ensure that each pump, including all component parts, operates as intended.

.2 Cooperate with the installer to fulfill the requirements for successful testing of the equipment, as documented by Form 103 included in Section 01650.

.3 Refer to Section 11300 for testing requirements.

3.5 Training

.1 Allow for a minimum of two days of operation and maintenance training as outlined in Section 01664.

3.6 Commissioning

.1 Attend during commissioning of the process systems which include the pumps specified in this section to ensure that each pump functions as intended in the process system.

END OF SECTION

DETAILED PUMP SPECIFICATION

Description:	Return Activated Sludge Pump
Tag Number:	S-710-RAP; S-720-RAP; S-730-RAP; S-740-RAP; S-750-RAP

Design Conditions:

Liquid:	Return Activated Sludge
Liquid Temperature:	10^{o}C to 20^{o}C
Solids Content:	5,000 to 20,000 mg/L
Atmospheric Press:	101 kPa
Solids Passing:	100 mm

Rating Point:

Design Flow (each pump):	120 - 230 L/s
Total Dynamic Head (gauge):	7.5 m
Suction head	3.3 m
NPSH available:	12.5 m

Construction:

Suction Connection:	250 mm
Discharge Connection:	250 mm
Flange Rating:	125# F.F.
Seals:	Single Mechanical
Impeller Type:	Mixed (angle) flow, enclosed, solids-handling
Impeller Material:	Cast Iron
Impeller wear ring:	Stainless steel (Brinnell 300 to 350)
Casing Material:	Cast Iron

Driver:

Drive Type:	Variable Speed Drive
Exposure Rating:	TEFC
Voltage/Phase/Frequency:	575 V/ 3 phase/ 60 Hz
Minimum Motor Size:	22.5 kW
Speed:	900 RPM

Acceptable Manufacturers:

See 11304

END OF SECTION

DOUBLE SUCTION HORIZONTAL SPLIT CASE PUMPS

1. GENERAL

1.1 Work Included

.1 Supply and supervision of the installation and commissioning of horizontally-mounted double suction split case centrifugal pumps.

1.2 Submissions

.1 Shop Drawings: submit in accordance with Section 01300. Shop Drawings shall include control schematics and wiring diagrams for power.

.2 Operating and Maintenance Data: provide for incorporation in O&M Manual as specified in Section 01300. Include complete description of operation together with general arrangement and detailed Drawings, wiring diagrams for power and control schematics, parts catalogues with complete list of repair and replacement parts with section drawings, illustrating the connections and identifying numbers.

1.3 Delivery and Storage

.1 Ship preassembled to the degree practicable.

.2 Identify special storage requirements in addition to those of Section 11005 and 11300.

1.4 Coordination

.1 Coordinate with other Divisions to ensure there are no conflicts in the Work.

2. PRODUCTS

2.1 Detailed Specification Sheets

.1 Specific pump requirements are listed in the detailed specification sheets attached to the end of this Section.

.2 The flushing water pump shall be of the double suction horizontal split case design. Each unit shall include a pump, base, coupling, coupling guard, electric motor, and necessary fittings.

2.2 Impellers

.1 Impellers shall be of the enclosed type and constructed of cast iron.

2.3 Casings

.1 Casings shall be cast iron to ASTM A30 with stainless steel casing wearing rings.

.2 Casings shall be pressure tested at 1.5 times the pressure developed by the pump at shut-off head.

.3 Casings shall be designed to permit some disassembly so that the impeller may be withdrawn without disturbing the discharge piping.

.4 Suction and discharge nozzles equal to or greater than 50 mm shall be flanged, faced, and drilled to conform to ASTM B16.5, 125#.

2.4 Shafts

.1 Pumps shafts shall be AISI 1045 or 1141 or equivalent steel. The shaft section shall have no reduction for sleeves.

.2 The shaft shall be of sufficient diameter to assure rigid support to the impeller and to transmit loads without slip, vibration or undue deflection at operating loads. Maintain L^3/D^4 less than 80 where L is impeller overhang and D is shaft diameter,

.3 The impeller shall be keyed securely to the shaft. The assembly shall be designed to prohibit loosening of the connection due to torque developed during operation. The assembly shall provide a smooth flow path without causing the accumulation of stringy material.

2.5 Shaft Sleeve

.1 Shaft sleeves shall be series 416 stainless steel.

.2 Shaft sleeves shall prohibit contact between the process fluid and the shaft, and shall extend through the stuffing box or seal.

.3 Shaft sleeves shall be accurately fitted after shaft grinding and secured in place.

2.6 Seals

.1 Pump seals shall be single mechanical seals.

.2 Mechanical seal materials of construction shall be:

.1 Metal parts: 316 stainless steel

.2 Faces: tungsten carbide

.3 O-rings: Buna N or Viton

.4 Springs: 316 stainless steel

.3 Acceptable manufacturers of mechanical seals are:

.1 Durametallic

.2 John Crane

2.7 Bearings

.1 Pump bearings shall be duplex thrust (angular contact), anti-friction type

.2 ABFMA B-10 bearing life shall be 40,000 hours

.3 Oil or grease lubricated

2.8 Motors

.1 Motor shall be TEFC type with 1.15 service factor and wound for 3-phase, 60 Hz and 575 V.

.2 Motor shall be of the across-the-line type starting and sized so as not to exceed the permissible loading limits of NFPA 20 at any point on the pump performance curve.

2.9 Controller

.1 The electric motor controller shall be arranged to start the emergency water pump motor automatically on loss of system pressure with manual stop. It shall be supplied with a circuit breaker rated not less than 22,000 AIC at 3-phase, 60 Hz and 575 V.

.2 The magnetic starting contactor shall be of the auto transformer type.

2.10 Accessories

.1 The flushing water pump shall be furnished with the following fittings:

.1 89 mm diameter dial compound suction gauge with 6.4 mm diameter gauge valve

.2 89 mm diameter dial discharge pressure gauge with a 6.4 mm diameter gauge valve

.3 12.7 mm diameter dial automatic air release valve

.4 19 mm circulation relief valve

2.11 Bases

.1 Pump bases shall be manufactured of cast iron of fabricated steel.

.2 Cast iron bases shall have grouting holes, a minimum of one at the centre and one at each corner, of sufficient size to allow for the pouring of grout into the annular space.

.3 Bases are to have square corners in all three directions, with parallel surfaces.

.4 Motor mounting blocks shall be provided such that the next greater motor frame size may be accommodated by replacing the mounting blocks.

2.12 Balancing

.1 All pumps are statically and dynamically balanced. For all pumps equal to or greater than 14 kW, and smaller units where specified, provide the manufacturer's balancing certificate.

2.13 Finishes

.1 Pumps shall be shop primed in accordance with Section 13901.

2.14 Spare Parts

.1 For each pump specified, provide the following spare parts:

.1 Seals

.2 Motor bearings

.3 Pump bearings

.4 Couplings

3. EXECUTION

3.1 Manufacturer's Representative

.1 Manufacturer's representative shall be required to attend as specified in Section 11020 and Section 11025.

.2 Specific time periods, where identified, are denoted in the pump schedule. Otherwise, the periods shall be sufficient to supervise the installation, testing and commissioning of each pump.

.3 Connect sensing line to pressure switch in controller. Mount controller adjacent to pump.

3.2 Installation

.1 Cooperate with the installer to fulfill the requirements for a successful installation as documented by Form 101, included in Section 01650.

3.3 Testing

.1 Ensure that each pump, including all component parts, operates as intended.

.2 Test the pump in accordance with Section 11300.

.3 Cooperate with the installer to fulfill the requirements for successful testing of the equipment as documented by Form 102, included in Section 01650.

3.4 Commissioning

.1 Attend during commissioning of the process system which includes the pump specified in this Section to ensure that each pump functions as intended in the process system. Execute Form 103, included in Section 01650.

END OF SECTION

DETAILED PUMP SPECIFICATION

Description:	Flushing Water Pump
Tag Number:	S220-P

Design Conditions:

Liquid:	Effluent Water
Liquid Temperature:	10^{o}C to 20^{o}C
Solids Content:	<50 mg/l
Atmospheric Pressure:	101 kPa
Solids Passing:	

Rating Point:

Design Flow:	40 L/s
Total Dynamic Head:	60 m
Suction Head:	3.0 m
NPSH available:	12.5 m

Construction:

Suction Connection:	150 mm
Discharge Connection:	150 mm
Flange Rating:	125# F.F.
Seals:	Single Mechanical
Impeller Type:	Enclosed
Impeller Material:	Cast Iron
Casing Material:	Cast Iron

Driver:

Drive Type:	Fixed Speed
Exposure Rating:	TEFC
Phases/Voltage/Frequency:	3 Phase/575 V/60 Hz
Minimum Motor Size:	- kW
Speed:	1770 RPM

Acceptable Manufacturers:

Aurora, Fairbanks Morse

END OF SECTION

HORIZONTAL AXIAL FLOW PROPELLER PUMPS

1. GENERAL

1.1 Work Included

.1 This Section specifies the supply and supervision of the installation, testing, and commissioning of horizontally mounted, submersible, axial flow impeller pumps with submersible motors and all associated appurtenances.

.2 VFDs are supplied under Division 16

1.2 Submittals

.1 Submit in accordance with Section 11300

1.3 Coordination

.1 For pumps requiring VFDs, coordinate design, supply and installation of pumps and motors with VFD manufacturer.

1.4 Shipment, Protection, and Storage

.1 Identify any special storage requirements. Store on-site until ready for incorporation into the Work using methods recommended by the manufacturer to prevent damage, undue stress or weathering.

2. PRODUCTS

2.1 Description

.1 Use these pumps for pumping large volumes of water or dilute sludge (total suspended solids less than 20,000 mg/L) against low heads.

.2 Include a specially designed propeller, mounted in a horizontal flow inducing tube. The motor may either be in-line, or at a right angle to the propeller shaft, submerged in the fluid. Provide a guide rail lifting system to allow removal and replacement of the pump. Provide a lifting davit for each pump.

.3 The pump automatically connects to the discharge pipe when lowered into place, and is easily removed for inspection or service without the need for personnel to enter the tank.

2.2 Acceptable Manufacturers

.1 Supply products, modified as necessary by the manufacturer to provide the specified features and to meet the specified operating conditions. Refer to Section 11005.

.2 Design Standard:

.1 Flygt

.2 KSB

.3 ABS

2.3 Capacities and Performance

.1 Specific pumps are listed in the detailed specification sheets at the end of this Section.

2.4 Materials

.1 Fabricate propellers of corrosion- and abrasion-resistant stainless steel

.2 Fabricate casings of solid stainless steel

.3 Fabricate shafts of 420 or 329 stainless steel conforming to ASTM A276

2.5 Propeller

.1 Provide three-blade propellers with fixed blade angles. Backward curve the leading edges to allow shedding of fibrous material.

.2 Provide propeller assembly with a cylindrical OD fit so that the propeller may be pulled and serviced without the need to break and disassemble the pump flanges.

2.6 Casings

.1 Machine mating surface to discharge pipe flange, and fit with nitrile rubber O-ring to provide a watertight seal.

2.7 Shaft

.1 Connect the motor directly to the shaft.

.2 Design the shaft with sufficient strength and diameter to withstand whip and deflection.

2.8 Motor

.1 Provide submersible motors and the associated shafts, bearings, and seals in accordance with Section 11207.

.2 Provide variable speed drives and controllers in accordance with Division 16.

2.9 Gear Drives

.1 For designs that employ gear drives to achieve the appropriate propeller speed, design to AGMA standards for continuous heavy duty service.

.2 Seal gear drives in watertight enclosures and provide permanent oil lubrication.

.3 Use bearings with AFBMA B10 bearing life of 100,000 hours.

2.10 Accessories

.1 Provide each pump with dual 50 mm diameter guide bars, complete with all mounting brackets and fasteners. Fabricate all components of stainless steel.

.2 Provide a stainless steel cable, shackle, and hook for each pump.

.3 Provide power cable.

.4 Portable lifting davit

.1 Provide one lifting davit for each submerged pump. Make the lifting davit portable and include mast, adjustable boom, winch assembly suitable for manual or electrically powered operation and associated chains, cables, sheaves, hooks, handles and fasteners.

.2 Provide 100 mm x 100 mm square tube mast, a minimum 2100 mm long.

.3 Design the boom to adjust from a minimum extension of 1200 mm to a maximum extension of 1800 mm and capable of vertical adjustment from horizontal to 45 degrees from horizontal. Design the boom to rotate horizontally through a sweep of 270 degrees of arc. Provide boom handles to assist in horizontal rotation.

.4 Design the lifting davit to support the weight of the pump at all angles from horizontal up to 45 degrees, between minimum and maximum extension of the boom.

.5 Each winch assembly should have the capability of being powered by an electric powered device. Provide winch complete with 6.35 mm diameter by 12 m long lifting cable.

.6 Make the combination of winch and electrical driving device so that they can raise and lower the load at approximately 3 m/min. Also supply a ratchet for manual operation.

.5 Provide as the powered lifting device, a reversible electric right angle drill complete with adaptor for connection to the winch assembly. Supply a drill rated at 0.75 kW, minimum, suitable for 600 V/3 phase/60 Hz power supply. Include 9 m of extension cord.

.6 Provide one floor socket per pump, fabricated of 304 stainless steel matched to the lifting davit and complete with mounting hardware for anchoring to concrete platforms.

.7 All anchor bolts to be stainless steel.

2.11 Spare Parts

.1 Provide one shelf spare horizontal axial propeller pump.

3. EXECUTION

3.1 Manufacturer's Representative

.1 Arrange for a technically qualified manufacturer's representative to attend the installation work, certify correct installation, 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.

3.2 Installation

.1 Verify satisfactory delivery of the equipment by completing Form 100, included in Section 01650.

.2 Instruct installer in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, included in Section 01650.

3.3 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the manufacturer and as indicated in the Contract Documents.

.2 The Contractor shall ensure the equipment is installed as required to provide satisfactory service.

.3 Cooperate with the Contractor to fulfill the requirements for a successful installation as documented by Form 102, included in Section 01650.

3.4 Testing

.1 Ensure that each pump, including all component parts, operates as intended.

.2 Demonstrate satisfaction of requirements specified herein.

.3 Cooperate with the Contractor to fulfill the requirements for successful testing of the equipment as documented by Form 103, included in Section 01650.

.4 Refer to Section 11300 for testing requirements.

3.5 Commissioning

.1 Attend during commissioning of the process system that includes the equipment specified in this section to ensure the equipment functions as intended in the process system as documented by Form 104. Provide assistance as required for system programming, startup and troubleshooting. Conform to the requirements of Section 01670.

.2 Refer to Section 11300 for testing requirements.

3.6 Training

.1 Provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Forms T1 and T2. Conform to the requirements of Section 01664. Provide not less than two sessions of at least two hours training each.

END OF SECTION

DETAILED PUMP SPECIFICATION

Description: Mixed Liquor Recycle Pumps

Tag Number: S770-P; S771-P

Rating Point:

Design Flow, L/s:	1100
TDH, m:	0.6

Propeller:

Type:	Medium speed, fixed blade
Number of blades:	Three
Maximum propeller speed:	900 RPM

Construction:

Blade material:	304 stainless steel
Propeller housing:	304 stainless steel
Stator housing:	304 stainless steel
Shaft:	420 or 329 stainless steel
Discharge connection:	900 mm
Flange rating	Class 125
Seals	Dual Mechanical

Driver:

Drive Type:	Fixed Speed
Motor Type:	Submersible, totally enclosed
Voltage/Phase/Frequency:	575/3/60
Motor Size:	- kW
Motor Speed:	900 RPM

Accessories:

Double mast, stainless steel guide bars complete with all mounting brackets.
12m lifting chain per pump
20m power/control cable per pump
One hoist mount pedestal per pump

Acceptable Manufacturer:

ITT Flygt, KSB, ABS

END OF SECTION

GEAR PUMPS, SKID-MOUNTED

1. GENERAL

1.1 Work Included

.1 Supply, 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 O&M 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 and other Divisions to ensure there are no conflicts in the Work.

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 The system includes metering pumps, strainers, controls, calibration column, backpressure valves, pressure relief valves, ball valves, pressure gauges, low flow switches, check valves, and all associated piping and fittings, in accordance with the Drawings.

.2 The whole system shall take into account the specific gravity, viscosity, corrosivity, and temperature of the fluid being pumped.

.3 Four pumps draw from a common ferric chloride storage tank. The four pumps make up two systems, the Bioreactor System and the Odour Control and Primary Clarifier System.

.1 Bioreactor System

.1 Ferric chloride is added to the bioreactors as needed

.2 Tag numbers

.1 T141-P

.2 T142-P

.3 T141-P normally meters ferric chloride to Bioreactor 1 only; T142-P normally meters ferric chloride to Bioreactor 2 only. A cross-connection allows each pump to service the other bioreactor if required

.2 Odour Control and Primary Clarifier System

.1 Ferric chloride is added to the headworks influent and to the sludge storage tanks as needed

.2 Tag numbers

.1 T143-P

.2 T144-P

.3 T143-P normally meters ferric chloride to the headworks influent channel only; T144-P normally meters ferric chloride to the sludge storage tanks only. A cross-connection allows each pump to assume the other's service if required

2.2 Design Standard

.1 Micropump

2.3 Capacities and Performance

.1 Ferric chloride solution 38 to 46 percent dry ferric chloride by weight (8 to 14 percent Fe,) density of 1.26 kg/L to 1.48 kg/L (at 20° C), viscosity of 12 cps.

.2 Design pumps to handle abrasive crystals that may form in the solution.

.3 Fluid temperature: 5° C to 35° C

.4 Supply pumps with a turn-down range of 100:1.

.5 Supply pumps suitable for continuous operation.

.6 Pumps shall be capable of local and remote operation.

.7 T141-P; T142-P: 0.5 L/hr minimum; 50 L/hr maximum

.8 T143-P; T144-P: 1.5 L/hr minimum; 150 L/hr maximum

2.4 Materials

.1 Fabricate pumps of titanium

.2 Fabricate pipes and valves of PVC

.3 Fabricate skid of FRP or black PVC

2.5 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.

2.6 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.

2.7 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 low flow 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 VFD.

.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 VFDs, 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 120 V/1 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 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.

2.8 Piping and Valves

.1 Provide Schedule 80 PVC piping and flanges in accordance with Sections 15050, 15051 and 15055. 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 15056, 15100, and 15105.

.3 Provide instrumentation and flow meters in accordance with Division 17.

.4 Isolation valves to be ball valves. Refer to Section 15105, 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 34 to 520 kPa (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.

2.9 Control Panel

.1 Provide remotely-mounted VFD 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 VFDs, transformer, relays, line reactors, fused disconnect, wireway-lamicoid nameplates, etc.

.2 Each panel to be suitable for 120 V, 1 phase, 60 Hz power supply.

.3 Factory finished NEMA 4, 316 plastic 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 120 V terminal strip for connection to wiring by Division 16 and Division 17.

2.10 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.

2.11 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.

2.12 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 by 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

CENTRIFUGAL CHOPPER PUMPS

1. GENERAL

1.1 Description

.1 This Section specifies the supply, installation, testing, and commissioning of two centrifugal, dry mounted horizontal chopper pumps and all appurtenances as specified. The pump shall be specifically designed to pump waste solids at heavy consistencies. Materials shall be macerated and conditioned by the pump as an integral part of the pumping action. The pump must have demonstrated the ability to chop through and pump high concentrations of solids such as plastics, heavy rags, grease and hair balls, wood, paper products and stringy materials without plugging, both in tests and field applications.

2. PRODUCTS

2.1 Design Standard

.1 Vaughan Co Model HE6U-8CS

.2 It is the express intent of these specifications to accurately describe equipment that is a regular production item of the specified manufacturer, and that has a proven record of performance in identical (not just similar) applications in other treatment facilities. The chopper pump manufacturer shall have a minimum of twenty (20) years of documented experience in the design and production of chopper pumps of all types, and not less than five (5) years of experience in the production of the exact equipment as specified herein.

2.2 Capacities and Performance

.1 Specific pumps are listed in the detailed specification sheets. Required performance data and system curves are presented.

2.3 Casing and Back Pull-Out Adapter Plate

.1 The pump casing shall be of semi-concentric design, with the first half of the circumference being cylindrical beginning after the pump outlet, and the remaining circumference spiraling outward to the 150 lb. flanged centerline discharge. Back pull-out adapter plate shall allow removal of pump components from above the casing, and allow external adjustment of impeller-to-cutter bar clearance. Casing and adapter plate shall be ductile cast iron with all water passages to be smooth, and free of blowholes and imperfections for good flow characteristics.

2.4 Impeller

.1 Semi-open type with pump out vanes to reduce seal area pressure. Chopping and maceration of materials shall be accomplished by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings, with a set clearance between the impeller and cutter bar of 0.010 inch to 0.015 inch. Impeller shall be

cast steel heat treated to minimum Rockwell C 60 and dynamically balanced. The impeller shall be keyed to the shaft and shall have no axial adjustments or set screws required.

2.5 Cutter Bar Plate

.1 Shall be recessed into the pump bowl and shall contain at least 2 shear bars extending diametrically across the intake opening to within 0.010 to 0.015 inch of the rotating cutter nut tooth, for the purpose of preventing intake opening blockage and wrapping of debris at the shaft area. Chopper pumps utilizing individually mounted shear bars shall not be acceptable. Cutter bar shall be T1 plate steel heat-treated to minimum Rockwell C 60.

2.6 Cutter Nut

.1 The impeller shall be secured to the shaft using a special cutter nut, designed to cut stringy materials and prevent binding. The cutter nut shall be cast steel heat treated to minimum Rockwell C 60.

2.7 Upper Cutter

.1 Shall be threaded into the back pull-out adapter plate above the impeller, designed to cut against the pump-out vanes and the impeller hub, reducing and removing stringy materials from the mechanical seal area. Upper cutter shall be cast steel heat treated to minimum Rockwell C 60.

2.8 Pump Shafting

.1 The pump shaft and impeller shall be supported by ball bearings. Shafting shall be heat-treated steel, with a minimum diameter of 1.5 inches in order to minimize deflection during solids chopping.

2.9 Bearings

.1 Shaft thrust in both directions shall be taken up by two back-to-back mounted single-row angular contact ball bearings. Two single-row radial bearings shall also be provided. Bearings shall be rated with a minimum B10 bearing life of 100,000 hours.

2.10 Bearing Housing

.1 Shall be cast iron, and machined with piloted bearing fits for concentricity of all components. Bearing housing shall have oil bath lubrication using ISO Gr. 46 turbine oil and a side mounted site glass to provide a permanently lubricated assembly. Viton® double lip seals riding on stainless steel shaft sleeves are to provide sealing at each end of the bearing housing.

2.11 Seal

.1 Flushed mechanical seal with throttle bushing, 316 SS with Nickel-Chrome-Boron coated shaft sleeve and water fitting for seal water flush.

2.12 Inlet Manifold

.1 The pump assembly shall be mounted horizontally with a 150 lb. standard inlet flange, drain, cleanout and mounting feet.

2.13 Shaft Coupling

.1 Bearing housing and motor stool design is to provide accurate, self-aligning mounting for a C-flanged electric motor. Pump and motor coupling shall be T.B. Woods Sureflex elastomeric type.

2.14 Belt Drive

.1 Adjustable brackets shall be used to support an over-head mounted motor. Sheaves and belts shall be properly sized for horsepower ratings, and all guards are to be supplied with the belt drive system.

2.15 Motors

.1 Motor types, voltages, service conditions, and power ratings are indicated in the detailed pump specification sheets.

.2 Provide motors that comply with the provisions of Section 11205.

.3 VFDs are specified in Division 16. Certify compatibility between pump motor and drive manufacturers as specified in Section 11205.

2.16 Bases

.1 Provide bases with grouting holes, a minimum of one at the centre and one at each corner, of sufficient size to allow for the pouring of grout into the annular space.

.2 Ensure bases have square corners in all three directions, with parallel surfaces.

.3 Provide motor mounting blocks so that one size greater motor frame may be accommodated by replacing the mounting blocks.

2.17 Finishes

.1 Factory prime in accordance with Section 11900

2.18 Spare Parts

.1 In addition to the spare parts required in Section 11300, provide the following:

.1 One gland plate per pump

.2 One set of wearing elements for each size of pump.

3. EXECUTION

3.1 Manufacturer's Representative

.1 Arrange for a technically qualified manufacturer's representative to attend the installation work, certify correct installation, 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.

3.2 Installation

.1 Ensure that each pump is installed in accordance with Section 11020 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 as documented by Form 102, included in Section 01650.

3.3 Testing

.1 Ensure that each pump, including all component parts, operates as intended.

.2 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 Commissioning

.1 Attend during commissioning of the process system that includes the pump specified in this Section to ensure that each pump functions as intended in the process system.

END OF SECTION

DETAILED PUMP SPECIFICATION

Description: Sludge Vault Recirculation Pump

Tag Number: TXXX-P, TXXX-P

Design Conditions (See Attached System Curves):

Liquid:	Fermented and Thickened WAS Sludges
Liquid temperature:	10°C - 20°C
Solids content:	up to 10%
NPSHA:	m
Atmospheric pressure:	98.7 kPa

Rating Point:

Rating Point Design Flow	100 L/s
Rating Point TDH	16.5 m

Each pump shall be capable of operating at the above mentioned design flow and total dynamic head defined by the system head curves.

Construction:

Suction Connection:	200 mm
Discharge Connection:	150 mm
Flange Rating:	Class 150
Seals:	Double Mechanical
Impeller Type:	Semi-open cutter
Impeller Upper Cutter Material:	Cast steel minimum Rockwell C60
Impeller Cutter Bar Material	Plate Steel minimum Rockwell C 60
Casing Material:	Ductile Cast Iron
Wear Plate:	Ni-hard
Solids Handling Capability	75 mm

Driver:

Drive Type:	Fixed Speed V-Belt Drive
Motor Type:	TEFC
Voltage/Phase/Frequency:	575/3/60
Motor Size:	37.5 kW
Maximum Motor Speed:	1750 RPM

DETAILED PUMP SPECIFICATION

Accessories:

Seal Water Connection
Annular pressure sensor and pressure gauge (0 kPa to 350 kPa)

Acceptable Manufacturers:

Vaughan

System Curve:

END OF SECTION

HORIZONTAL, RECESSED IMPELLER PUMPS SEVERE DUTY

1. GENERAL

1.1 Description

.1 This Section specifies the supply and supervision of the installation, testing, and commissioning of horizontally mounted, recessed impeller centrifugal pumps.

2. PRODUCTS

2.1 Description

.1 Use these pumps for pumping wastewater or wastewater sludge with solids content up to 80,000 mg/L or with a high fraction of debris.

2.2 Acceptable Manufacturers

.1 Hayward Gordon

.2 Wemco

2.3 Capacities and Performance

.1 Specific pumps are listed in the detailed specification sheets. Required performance data and system curves are presented.

2.4 Materials

.1 Fabricate the impeller of Ni-hard or hardened high chrome iron, ASTM A352, with minimum Brinnell hardness of 600

.2 Fabricate the casing of Ni-hard or hardened high chrome iron, ASTM A532, with minimum Brinnell hardness of 600

.3 Fabricate the suction cover and wear plate of Ni-hard or hardened high chrome iron, ASTM A532, with minimum Brinnell hardness of 600

.4 Fabricate the shaft of steel, ASTM A108, Grade 1141 or 1045

.5 Fabricate the shaft sleeve of Stainless steel, ASTM A276, Type 416 or 420, Brinnell Hardness of 450, minimum

.6 Manufacture pump bases of cast iron or fabricated steel

2.5 Impellers

.1 Use heavy duty recessed impellers of either the radial or cup type design, mounted completely out of the flow path so that solids pumped are not required to pass through the impeller while traversing from the inlet to the outlet.

.2 Key the impeller to shaft and secure by a shrouded bolt and lockwasher or connect by babbiting to a tapered shaft and secure by an impeller bolt.

.3 Statically and dynamically balance impellers.

2.6 Wear Elements

.1 For pumps with radial vane impeller, provide a rear casing wear plant and integral tapered radial wear element. Minimum thickness of the radial wear element at the base: 30 mm.

.2 For pumps with cupped impeller, the suction cover is the primary wear element. Minimum thickness of the suction cover is 19 mm, thickened to at least 30 mm at critical wear areas.

2.7 Casings

.1 Provide casings with an end suction and vertical discharges.

.2 Use either three-piece construction with separate rear liner and suction pipe to allow front or back pull-out, or one-piece casing with integral suction and discharge nozzles plus a back plate with integral wear element.

.3 Make all internal clearances equal to or greater than the discharge diameter so that all material that can pass through the discharge can pass through the pump.

.4 Design the casing so that it is capable of passing a solid sphere as large as the discharge diameter.

.5 Ensure that minimum casing thickness is 19 mm. Pressure test casings at 1.5 times the pressure developed by the pump at shut-off head.

.6 Solidly foot-mount casings to allow each access to pump interior.

.7 Provide suction and discharge connections that are flanged, faced, and drilled to conform to ASTM B16.5, Class 125.

2.8 Cleanouts

.1 Supply each pump with a hand-sized cleanout either integral with the casing or on a suction spool piece attached to the casing.

2.9 Shafts

.1 Make the shaft of sufficient diameter to assure rigid support of the impeller and to transmit loads without slip, vibration, or undue deflection at operating loads. Maintain L^3/D^4 less than 60, where L is impeller overhang and D is shaft diameter.

2.10 Motors

.1 Motor types, voltages, service conditions, and power ratings are indicated in the detailed pump specification sheets.

.2 Provide motors that comply with the provisions of Section 11205.

.3 VFDs are specified in Division 16. Certify compatibility between pump motor and drive manufacturers as specified in Section 11205.

2.11 Bases

.1 Provide bases with grouting holes, a minimum of one at the centre and one at each corner, of sufficient size to allow for the pouring of grout into the annular space.

.2 Ensure bases have square corners in all three directions, with parallel surfaces.

.3 Provide motor mounting blocks so that one size greater motor frame may be accommodated by replacing the mounting blocks.

2.12 Finishes

.1 Factory prime in accordance with Section 11900

2.13 Spare Parts

.1 In addition to the spare parts required in Section 11300, provide the following:

.1 One gland plate per pump

.2 One set of wearing elements for each size of pump.

3. EXECUTION

3.1 Manufacturer’s Representative

.1 Arrange for a technically qualified manufacturer's representative to attend the installation work, certify correct installation, 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.

3.2 Installation

.1 Ensure that each pump is installed in accordance with Section 11020 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 as documented by Form 102, included in Section 01650.

3.3 Testing

.1 Ensure that each pump, including all component parts, operates as intended.

.2 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 Commissioning

.1 Attend during commissioning of the process system that includes the pump specified in this Section to ensure that each pump functions as intended in the process system.

END OF SECTION

DETAILED PUMP SPECIFICATION

Description: Fermenter Supernatant Pump

Tag Number: F556-P; F557-P; F558-P

Design Conditions (See Attached System Curves):

Liquid:	Fermenter Supernatant
Liquid temperature:	10°C - 20°C
Solids content:	< 1%
NPSHA:	m
Atmospheric pressure:	98.7 kPa

Rating Point:

Rating Point Design Flow	10 to 20 L/s
Rating Point TDH	0.9 to 3.7 m

Each pump shall be capable of operating at the above mentioned design flow and total dynamic head defined by the system head curves.

Construction:

Suction Connection:	150 mm
Discharge Connection:	100 mm
Flange Rating:	Class 125
Seals:	Double Mechanical
Impeller Type:	Recessed Impeller
Impeller Material:	Ni-hard (Brinnell 600)
Casing Material:	Ni-hard
Wear Plate:	Ni-hard
Solids Handling Capability	75 mm

Driver:

Drive Type:	Variable Speed Direct Drive
Motor Type:	TEFC
Phases/Voltage/Frequency:	3-phase/575V/60 Hz
Motor Size:	5.6 kW
Maximum Motor Speed:	1,200 RPM

DETAILED PUMP SPECIFICATION

Accessories:

Seal Water Connection
Annular pressure sensor and pressure gauge (0 kPa to 350 kPa)

Acceptable Manufacturers:

Hayward Gordon
Wemco

System Curve:

END OF SECTION

DETAILED PUMP SPECIFICATION

Description: Primary Sludge Pump

Tag Number: F551-P; F552-P

Design Conditions (See Attached System Curves):

Liquid:	Primary Sludge
Liquid temperature:	10°C - 20°C
Solids content:	< 1%
NPSHA:	m
Atmospheric pressure:	98.7 kPa

Rating Point:

Rating Point Design Flow	10 to 20 L/s
Rating Point TDH	2.2 to 4.3 m

Each pump shall be capable of operating at the above mentioned design flow and total dynamic head defined by the system head curves.

Construction:

Suction Connection:	150 mm
Discharge Connection:	100 mm
Flange Rating:	Class 125
Seals:	Double Mechanical
Impeller Type:	Recessed Impeller
Impeller Material:	Ni-hard (Brinnell 600)
Casing Material:	Ni-hard
Wear Plate:	Ni-hard
Solids Handling Capability	75 mm

Driver:

Drive Type:	Variable Speed V-belt Drive
Motor Type:	TEFC
Phases/Voltage/Frequency:	3-phase/575V/60 Hz
Motor Size:	2.24 kW
Maximum Motor Speed:	1200 RPM

Accessories:

Seal water connection
Annular pressure sensor and pressure gauge (0 kPa to 350 kPa)

DETAILED PUMP SPECIFICATION

Acceptable Manufacturers:

Hayward Gordon
Wemco

System Curve:

END OF SECTION

DETAILED PUMP SPECIFICATION

Description: Waste Activated Sludge Pump

Tag Number: S810-WAP; S820-WAP

Design Conditions (See Attached System Curves):

Liquid:	Waste Activated Sludge
Liquid temperature:	10°C - 20°C
Solids content:	2,000 to 10,000 mg/'L
NPSHA:	m
Atmospheric pressure:	98.7 kPa

Rating Point:

Rating Point Design Flow	15 L/s
Rating Point TDH	5 m

Each pump shall be capable of operating at the above mentioned design flow and total dynamic head defined by the system head curves.

Construction:

Suction Connection:	150 mm
Discharge Connection:	100 mm
Flange Rating:	Class 125
Seals:	Double Mechanical
Impeller Type:	Recessed Impeller
Impeller Material:	Ni-hard (Brinnell 600)
Casing Material:	Ni-hard
Wear Plate:	Ni-hard
Solids Handling Capability	75 mm

Driver:

Drive Type:	Variable Speed Direct Drive
Motor Type:	TEFC
Phases/Voltage/Frequency:	3-phase/575V/60 Hz
Motor Size:	5 kW
Maximum Motor Speed:	1200 RPM

Accessories:

Seal water connection
Annular pressure sensor and pressure gauge (0 kPa to 350 kPa)

DETAILED PUMP SPECIFICATION

Acceptable Manufacturers:

Hayward Gordon
Wemco

System Curve:

END OF SECTION

DETAILED PUMP SPECIFICATION

Description: Waste Activated Sludge Pump

Tag Number: T125-P; T126-P

Design Conditions (See Attached System Curves):

Liquid:	DAF Subnatant
Liquid temperature:	10°C - 20°C
Solids content:	1,000 mg/L max
NPSHA:	m
Atmospheric pressure:	98.7 kPa

Rating Point:

Rating Point Design Flow	12-18 L/s
Rating Point TDH	9 m

Each pump shall be capable of operating at the above mentioned design flow and total dynamic head defined by the system head curves.

Construction:

Suction Connection:	150 mm
Discharge Connection:	100 mm
Flange Rating:	Class 125
Seals:	Double Mechanical
Impeller Type:	Recessed Impeller
Impeller Material:	Ni-hard (Brinnell 600)
Casing Material:	Ni-hard
Wear Plate:	Ni-hard
Solids Handling Capability	75 mm

Driver:

Drive Type:	Variable Speed Direct Drive
Motor Type:	TEFC
Phases/Voltage/Frequency:	3-phase/575V/60 Hz
Motor Size:	5 kW
Maximum Motor Speed:	1200 RPM

Accessories:

Seal water connection
Annular pressure sensor and pressure gauge (0 kPa to 350 kPa)

Acceptable Manufacturers:

Hayward Gordon
Wemco

System Curve:

END OF SECTION

SELF-PRIMING CENTRIFUGAL SOLIDS-HANDLING PUMP

1. GENERAL

1.1 Work Included

.1 Supply and supervision of the installation, testing, and commissioning of self-priming solids-handling centrifugal emergnecy flood control pump in the Primary Clarifier Pump Room.

2. PRODUCTS

2.1 Detailed Pump Specification Sheets

.1 Specific pumps are listed in the detailed specification sheets.

2.2 Design

.1 Horizontally-mounted, end suction, centrifugal self-priming pump. Design the pump to retain adequate liquid in the pump casing to ensure unattended automatic repriming, in a completely open system without suction or discharge check valves and a dry suction leg.

.2 Provide openings and passages large enough to permit the passage of a 75 mm diameter sphere.

.3 Equip the pump with a removable cover plate to allow complete access to the pump's interior, permitting clearance of stoppages and access for simple service and repairs without the need to disturb suctionor discharge piping.

.4 Fit the pump with a replaceable wear plate.

.5 Provide 125# flanged connections on the inlet and discharge ports.

2.3 Impellers

.1 Construct impeller cast ductile iron.

.2 Provide semi-open nonclog impellers with integral pump out vanes on the back shroud.

.3 Balance the impellers both statically and dynamically.

2.4 Casings

.1 Construct casings of gray iron.

.2 Casings shall have an end suction and shall discharge vertically upwards.

.3 Suction and discharge nozzles shall be flanged, faced, and drilled to conform to ANSI 16.1, or be 125# rating.

2.5 Shafts

.1 Fabricate shaft of 4140 alloy steel.

.2 Provide a shaft of sufficient diameter to assure rigid support of the impeller and to transmit loads without slip, vibration, or undue deflection at operating loads.

2.6 Bearings

.1 Duplex thrust (angular contact), anti-friction type.

.2 ABFMA B-10 bearing life: 40,000 hours.

.3 Oil lubricated.

2.7 Seals

.1 Double mechanical seals, stationary design, bellows type.

.2 Materials of construction:

.1 Metal parts - 316L stainless steel

.2 "O" Rings - Viton

.3 Spring - 316L stainless steel or Hastelloy C.

.4 Faces - Sintered silicon carbide or carbon

.3 Acceptable Manufacturers:

.1 Durametallic

.2 John Crane

.3 Five Star

.4 Chesterton

2.8 Motors

.1 Motor types, voltages, service conditions and power ratings are indicated in the detailed pump specification sheets.

.2 Motors shall comply with the provisions of Section 11200.

2.9 Bases

.1 Manufacture pump bases of cast iron or fabricated steel.

.2 Provide bases with square corners in all three directions, with parallel surfaces.

2.10 Balancing

.1 Dynamically balance the pumps.

2.11 Spare Parts

.1 Provide all spare parts, except lubricants, which would normally be required for one year's operation.

.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 Manufacturer's Representative

.1 Manufacturer's representative shall be required to attend the site to train installation personnel and to witness installation and testing to ensure the equipment is installed and operated as intended.

3.2 Installation Training

.1 Instruct the installer in the methods and precautions to be followed in the installation of the pumps.

.2 The manufacturer's representative shall verify the installer's understanding by completing Form 101, included in Section 01650.

3.3 Installation

.1 Ensure that each pump is installed and aligned in accordance with Section 13020 as required to provide satisfactory service.

.2 Cooperate with the installer to fulfill the requirements for satisfactory installation as documented by Form 102, included in Section 01650.

3.4 Testing

.1 Ensure that each pump, including all component parts, operates as intended.

.2 Cooperate with the installer to fulfill the requirements for satisfactory performance of the equipment as documented by Form 103, included in Section 01650.

3.5 Commissioning

.1 Attend during commissioning of the process system which includes the pump specified in this section to ensure that each pump functions as intended in the process system.

END OF SECTION

DETAILED PUMP SPECIFICATION SHEET

Description: Primary Clarifer Pump Room Flood Pump

Tag Number: PXXX-P

Design Conditions:

Liquid	
Liquid Temperature	4°C to 20°C
Solids Content	10000 mg/L
NPSHA	m
Atmospheric Pressure	97.3 kPa

Rating Point:

Rating Point Design Flow	40 L/s
Rating Point TDH	11 m

Each pump shall be capable of operating at the rated design flow and be non-overloading when operated against the shown system curves detailed on Page 2 of this specification.

Construction:

Suction Connection	150 mm
Discharge Connection	150 mm
Flange Rating	Class 125
Seals	Double Mechanical
Impeller Type	Open, two vane
Impeller Material	Ductile Iron
Impeller Shaft	4140 Alloy steel
Casing Material	Cast Iron

Driver:

Motor Type	Fixed Speed V-belt
Exposure Rating	TEFC
Voltage/Phases/Frequency	575/3/60
Motor Size	11.2 kW
Maximum Motor Speed	1800 rpm

Design Standard:

Gorman Rupp T6A3-B/F

END OF SECTION

AIR OPERATED, SINGLE DIAPHRAGM PUMPS

1. GENERAL

1.1 Work Included

.1 This Section specifies the supply and supervision of the installation, testing, and commissioning of air operated, single diaphragm pumps, complete with inlet and outlet check valves, surge suppressors, and controls.

1.2 Submittals

.1 Submit in accordance with Section 11300

2. PRODUCTS

2.1 Description

.1 Use these pumps for fermenter sludge that have total suspended solids concentrations of up to 120,000 mg/L.

2.2 Acceptable Manufacturers

.1 Dorr Oliver

.2 Gorman Rupp

2.3 Capacities and Performance

.1 Number of pumps: 2

.2 Condition 1:

.1 Capacity: 2.5 L/s

.2 Discharge Pressure: 10 m

.3 Solids Content: 12 percent

.3 Condition 1:

.1 Capacity: 7.5 L/s

.2 Discharge Pressure: 3.5 m

.3 Solids Content: 4 percent

2.4 Materials

.1 Pump body, cover, and base: cast iron, Class 40

.2 Diaphragm: hypalon reinforced with nylon

.3 Ball check valve body: cast iron, Class 40

.4 Ball check valve ball: nitrile covered

.5 Pulsation dampener: steel body, Buna-N element

2.5 Diaphragm

.1 The diaphragm serves as the gasket between the pump body and cover.

.2 Use a diaphragm design to have a minimum life of not less than 2,000,000 strokes.

2.6 Pump Body and Cover

.1 Make the pump body capable of sustaining the vacuum and pressure loads imposed by the operating conditions described. Reinforce the cover with radial ribs.

.2 Drill and tap the cover to provide for air connection.

.3 Provide lifting lugs to facilitate installation.

.4 Design the cover in accordance with ASME Section VIII.

2.7 Air Cylinder Assembly

.1 Construct pumps to allow complete maintenance to be performed on the air cylinder mechanism.

.2 Provide air cylinder piston and rod seals which are air pressure activated.

.3 Make air cylinder a single sealed unit with air inlet port and exhaust port connections, vented; a minimum of 150 mm in diameter in accordance with NFPA standards and CSA standards.

2.8 Check Valves

.1 Supply each pump with suction and discharge ball type check valves.

.2 Provide each valve with a replaceable valve seat and a quick-opening cover, allowing operator easy access to the ball for cleaning, unclogging and replacement.

.3 Provide inlet and outlet valve chambers with ANSI Class 125 flanges.

2.9 Pulsation Dampeners

.1 Provide an elastomer type pulsation dampener capable of being installed "in-line" at the discharge of each pump.

.2 Make the damping action a result of the compression of an elastomeric membrane encompassed by a pressurized carbon steel shell.

.3 Construct dampers in accordance with ASME Section VIII and capable of being pressurized with nitrogen or service air.

.4 Equip each dampener with a pressure gauge and quick disconnect air hose coupling to allow pressure monitoring and manual charging.

.5 Make inlet and outlet flanges ANSI Class 150 raised face.

2.10 Cleanouts

.1 Supply each pump with a hand sized cleanout either integral with the casing or on a suction spool piece attached to the casing.

2.11 Air Control and Assembly

.1 Furnish each pump with an air control assembly comprised of the following components:

.1 One 4-way solenoid valve to control the intake and exhaust of air from the air cylinder. Make 30 mm, 120 VAC, 60 Hz to draw no more than 1 A continuous and 5 A maximum.

.2 Pressure gauge: 0 to 1050 kPa

.3 One 30 mm air pressure regulator

.4 One 30 mm air filter immediately upstream from the air pressure regulator.

.5 One muffler with replaceable cartridge to limit air discharge noise.

.6 Interconnecting piping as required a complete unit assembly.

.2 Design the air header assembly to minimize the formation of ice from water droplets in the air supply.

2.12 Pump Controls

.1 Provide pump with a locally-mounted pump controller for manual and automatic flow rate adjustment.

.2 Make controller so that it accepts 4-20 mA signal to control stroke rate (when remote-local switch in remote) or so the stroke rate can be manually adjusted by control knobs at the controller (when remote-local switch in local) up to a maximum of 30 strokes per minute.

2.13 Positive Stroke Indicator

.1 Provide a positive diaphragm stroke indicator, which is physically measurable, to show adjustment of line velocities and provide visual evidence of diaphragm operating condition, pump displacement performance, and change in consistency as a function of variation in pump fill time.

2.14 Seals and Bearings

.1 Not used

2.15 Motors

.1 Not used

2.16 Finishes

.1 Factory prime in accordance with Section 11900

2.17 Spare Parts

.1 In addition to the spare parts required in Section 11300, provide the following:

.1 One (1) diaphragm per pump

.2 One (1) 4-way solenoid valves per pump

.3 One (1) replacement muffler cartridge per pump

.4 One (1) set of special disassembly and maintenance tools.

.5 For each size of pump, provide

.1 one (1) air cylinder assist assembly including cover and upper and lower clamps, completely assembled

.2 Two (2) check valve balls

.3 Two (2) check valve seats

3. EXECUTION

3.1 Manufacturer's Representative

.1 Arrange for a technically qualified manufacturer's representative to attend the installation work, certify correct installation, 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.

3.2 Installation

.1 Ensure that each pump is installed in accordance with Section 11020 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 as documented by Form 102, included in Section 01650.

3.3 Testing

.1 Ensure that each pump, including all component parts, operates as intended.

.2 Cooperate with the installer to fulfill the requirements for successful testing of the equipment as documented by Form 103, included in Section 01650.

.3 Refer to Section 11300 for testing requirements.

3.4 Commissioning

.1 Attend during commissioning of the process system that includes the pump specified in this Section to ensure that each pump functions as intended in the process system.

END OF SECTION

PROGRESSIVE CAVITY PUMPS – POLYMER FEED

1. GENERAL

1.1 Work Included

.1 This Section specifies the supply installation, testing and commissioning of positive displacement progressive cavity pumps, complete with electric motors, variable speed drives, pressure switches and indicators and all specified appurtenances, including discharge static mixer when applicable, skid-mounted.

.2 Pumps are positive displacement, progressive cavity type specifically designed for pumping chemical solutions.

.3 Pumps are designed for variable speed operation.

1.2 Submittals

.1 Submit in accordance with Section 11300

1.3 Coordination

.1 For pumps requiring VFDs, coordinate design, supply and installation of pumps and motors with VFD manufacturer.

1.4 Shipment, Protection, and Storage

.1 Ship pre-assembled to the degree that is practical.

.2 Identify special storage requirements. Store on site until ready for incorporation into the work using methods recommended by the manufacturer to prevent damage, undue stress or weathering.

2. PRODUCTS

2.1 Description

.1 DAF Polymer System

.1 Tag Numbers

.1 T131-POF

.2 T132-POF

.2 The two identical DAF Polymer Feed Pumps meter 0.5 percent polymer solution from the polymer aging tank of the DAF polymer makedown system (T130-POL) to the DAF thickeners (T111-DAF and T121-DAF). Both pumps are design to work as duty pumps and operate at 50 percent of its maximum capacity under maximum design condition. T131-POF is dedicated to DAF thickener 1(T111-DAF); T132-POF is dedicated to DAF thickener 2 (T121-DAF). A cross-connection on the discharge allows each pump to service either DAF or both if required. The two pumps are designed to have 100 percent standby capacity under designed operation.

.3 The polymer solution for the DAF unit will be post-diluted by the addition of flushing water to 0.1 percent through manual flow adjustment on valves (T131-HV8 and T132-HV9).

.2 CEPT Polymer System

.1 Tag Numbers

.1 T136-POF

.2 T137-POF

.2 The two identical CEPT Polymer Feed Pumps meter 0.5 percent polymer solution from the common polymer aging tank of the CEPT polymer makedown system (T135-POL) to the primary clarifier influent channel. Both pumps are design to work as duty pumps and operate at 100 percent of its maximum capacity under maximum design condition. No standby capacity is considered due to their low operation frequency.

.3 The polymer solution for the primary treatment will be post-diluted by the addition of flushing water to 0.1 percent through manual flow adjustment on valve (T136-HV7).

2.2 Acceptable Manufacturers

.1 Bornemann

.2 Seepex Inc.

.3 Moyno

.4 Netzsch Inc

.5 Mono Pumps Ltd.

2.3 Capacities and Performance

.1 Refer to detail pump specifications

2.4 Materials

.1 Fabricate rotor of stainless steel, type 316

.2 Fabricate stator of Viton or Buna-N

.3 Fabricate pump body of stainless steel, type 316 or of HDPE

.4 Fabricate shaft sleeve of stainless steel, type 316

2.5 Rotor and Stator

.1 Single-stage design employing a convoluted rotor operating in a similarly convoluted stator.

.2 Configure convolutions to form a cavity between the rotor and stator progressing from the pump's inlet to discharge port with the operation of the rotor.

.3 Fit the rotor and stator so that at the point of contact the stator material is sufficiently compressed to form a good seal and to prevent leakage from the discharge back to the inlet end of the pumping chamber.

2.6 Connecting Rod to Rotor and Input Shaft Joint

.1 Provide pumps with Type 1, Type 2, or Type 3 Joints as follows:

.2 Type 1: Gear Joint Rotor Drive Train

.1 Drive the pump rotor through a connecting rod coupled to an input shaft.

.2 Joint shall be designed to transmit the maximum expected torque at the maximum speed at the maximum pressure rating of the pump.

.3 Couple the connecting rod to the rotor and input shaft through machined crowned gear type joints.

.4 Machine balls and sockets from chrome alloy tool steel, designed to withstand shock and thrust reversal.

.5 Protect each gear joint against the entrance of dirt, sludge, and other foreign objects by a sealed steel shell.

.6 Positively secure the gear joint to the connecting rod to ensure against failure when the pump is in operation.

.7 Provide input shaft with bearings and housing.

.3 Type 2: Pin Joint Rotor Drive Train

.1 Drive pump rotor through a solid connecting rod coupled to an input shaft.

.2 Joint shall be designed to transmit the maximum expected torque at the maximum speed at the maximum pressure rating of the pump.

.3 Couple the connecting rod to the rotor and the input shaft using universal joints of the type that use an oversized pin and companion bushing assembly. These parts are to be hardened stainless steel. The joint shall be so designed that only replacement of the pins and bushings are required and not the drive shaft and connecting rod.

.4 Pin joints are to be packed with synthetic grease protected with an elastomeric sleeve which is positively sealed with two (2) stainless steel retaining bands. This positive seal shall prevent the ingress of the pumped liquid into the joint assembly.

.5 The input shaft shall be manufactured of solid stainless steel hardened with a metalized surface coating. Chrome plating and hollow shafts are not acceptable.

.6 Provide input shaft with bearings and housing.

.4 Type 3: Flexible Joint Rotor Drive Train

.1 Drive pump rotor through a flexible torsion bar drive which is connected to the input shaft with a Morse taper and to the rotor via a Morse taper or a forged flange.

.2 Provide flexible shaft of forged stainless steel with SAE radii to ensure no stress buildup at the connection points.

.3 Machined shafts are not acceptable

.4 Coat shaft with Olefin coating at least 3 mm thick

.5 If the detailed pump specification sheet indicates only one or two of these types, then provide only the types so indicated.

2.7 Casing

.1 Fabricate pump casing of three piece construction to allow front pull out of rotor provided with a cleanout opening on each side of the inlet fitting.

.2 Place cleanout opening immediately opposite the rotor/connecting rod joint to provide access for maintenance.

.3 Suction provided with a 12 mm tap to permit installation of a water lubrication system.

2.8 Bearings

.1 Provide grease lubricated thrust and radial bearings designed for all loads imposed by the specified service and rated per Section 11005.

2.9 Shaft Sealing

.1 Provide seals as specified in detailed specification sheets.

.2 Where necessary, provide for seal or flush water connection from an external source.

2.10 Motor and Drive Unit

.1 Pumps are gear driven.

.2 Provide gear motors or gear reducers, designed in accordance with AGMA 6019-E (Class II) or AGMA 6010-E (Service Factor 1.50).

.3 Design gear reducer drive equipment to transmit 150 percent of the maximum torque under the full range of operating conditions.

.4 Provide variable speed drives and controllers in accordance with Division 16.

.5 For VFD-driven units, pump manufacturer is responsible for the provision of the gear reducer between the motor and pump.

.6 Provide reduction ratio as required to operate the pump at its maximum operating speed when the motor is operating at its nominal rated full speed in accordance with specifications.

.7 Mount pump and motor along with associated drive appurtenances on a one-piece, fabricated steel baseplate in an inline configuration with full drip lip, grout holes, drains, etc.

2.11 Finishes

.1 Factory prime in accordance with Section 11900

2.12 Spare Parts

.1 Provide the following spare parts for each size progressive cavity pump in addition to those parts specified in Section 11300:

.1 One (1) stator assembly for each size of pump

.2 One (1) rotor assembly for each size of pump

.3 One (1) connecting rod

.4 One (1) set connecting rod joint assemblies

.5 Two (2) sets of mechanical seals

.6 Two (2) sets of drive pins, washers, and retention screws

.7 One (1) screw wrench

.8 One (1) bearing assembly

.9 One (1) shelf spare for each size of pump.

3. EXECUTION

3.1 Manufacturer’s Representative

.1 Arrange for a technically qualified manufacturer's representative to attend the installation work, certify correct installation, 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.

3.2 Installation

.1 Ensure that each pump is installed in accordance with Section 11020 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 as documented by Form 102, included in Section 01650.

3.3 Testing

.1 Ensure that each pump, including all component parts, operates as intended.

.2 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 Commissioning

.1 Attend during commissioning of the process system that includes the pump specified in this Section to ensure that each pump functions as intended in the process system.

.2 Cooperate with the Contractor to fulfill the requirements for successful testing of the equipment as documented by Form 103, included in Section 01650.

.3 Refer to Section 11300 for testing requirements.

.4 Attend during commissioning of the process system that includes the equipment specified in this section to ensure the equipment functions as intended in the process system as documented by Form 104. Provide assistance as required for system programming, startup and troubleshooting. Conform to the requirements of Section 01670.

3.5 Training

.1 Provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Forms T1 and T2. Conform to the requirements of Section 01664.

END OF SECTION

DETAILED PUMP SPECIFICATION

Description: CEPT Polymer Feed Pump

Tag Number: T136-POF, T137-POF

Design Conditions:

Liquid:	Polymer
Liquid temperature:	10°C - 20°C
Solids content:	0.25 - 0.50%
Atmospheric pressure:	96.4 kPa

Rating Point:

Rating Point Maximum Design Flow (0.5% polymer)	120 L/hr
Rating Point TDH @ Maximum	15 m

Construction:

Suction Connection:	25 mm NPT
Discharge Connection:	13 mm NPT
Seals:	Double Mechanical
Rotor Material:	316 stainless steel
Stator Material:	Viton or Buna-N
Casing Material:	316 stainless steel or HDPE

Driver:

Drive Type:	Direct Coupled Variable Speed Motor
Motor Type:	TEFC
Voltage/Phase/Frequency:	575 V/3-phase/60 Hz
Motor Size:	0.37 kW
Motor Synchronous Speed:	1800 RPM

Accessories:

Seal water connection, rotameter
Discharge annular pressure sensor and gauge

Acceptable Manufacturers:

Bornemann
Moyno
Monoflo
Seepex
Netzsch

END OF SECTION

DETAILED PUMP SPECIFICATION

Description:	DAF Polymer Feed Pump
Tag Number:	T131-POF, T132-POF

Design Conditions:

Liquid:	Polymer
Liquid temperature:	10°C - 20°C
Solids content:	0.25 - 0.50%
Atmospheric pressure:	96.4 kPa

Rating Point:

Rating Point Maximum Design Flow (0.5% polymer)	120 L/hr
Rating Point TDH @ Maximum	10 m

Construction:

Suction Connection:	25 mm NPT
Discharge Connection:	13 mm NPT
Seals:	Double Mechanical
Rotor Material:	316 stainless steel
Stator Material:	Viton or Buna-N
Casing Material:	316 stainless steel or HDPE

Driver:

Drive Type:	Direct Coupled Variable Speed Motor
Motor Type:	TEFC
Voltage/Phase/Frequency:	575 V/3-phase/60 Hz
Motor Size:	0.37 kW
Motor Synchronous Speed:	1800 RPM

Accessories:

Seal water connection, rotameter
Discharge annular pressure sensor and gauge

Acceptable Manufacturers:

Bornemann
Moyno
Monoflo
Seepex
Netzsch

END OF SECTION

SUBMERSIBLE HORIZONTAL PROPELLER MIXERS

1. GENERAL

1.1 Work Included

.1 This Section specifies the supply and supervision of the installation, testing, and commissioning of eight (8) horizontally mounted submersible propeller mixers and all associated appurtenances in two bioreactors.

1.2 Submittals

.1 Shop Drawings: submit in accordance with Sections 01300 and 11005, and include:

.1 Performance evaluation for the mixing units including characteristics of induced flow, calculations of energy gradient through the tank, and other pertinent details which illustrate the ability of the mixing system to maintain homogeneity or the desired level of turbulence within the process system.

.2 Motor operating data, including motor and insulation 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 mixer(s), their materials of construction, and reference specifications for those materials.

.4 Required ancillary equipment including but not limited to electrical and lifting appliances and anchor bolts. Provide the sizes, ratings, and any other information related to this equipment.

.5 Installation instructions indicating assembly and mounting requirements, alignment and assembly tolerances, and points of connection for ancillary equipment.

.6 Start-up instructions including lubricant requirements, electrical requirements.

.7 Provide supporting data (either hydraulic testing or computer modeling) to support the proposed mixing energy levels, and location/orientation of the mixers to meet the requirements set out in Clause 3.3.

.2 Operating and Maintenance Data: provide for incorporation in O&M Manual as specified in Section 01300. Include complete description of operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, parts catalogues with complete list of repair and replacement parts with section drawings, illustrating the connections and the part manufacturer's identifying numbers.

1.3 Shipment, Protection, and Storage

.1 Ship the equipment pre-assembled to the degree possible; identify any site assembly requirements.

.2 Identify special storage requirements. Store on-site until ready for incorporation in the Work using methods recommended by the manufacturer to prevent damage, undue stress or weathering.

2. PRODUCTS

2.1 Description

.1 This Specification covers low speed, large diameter propeller mixers and medium speed, medium diameter propeller mixers.

.2 Low speed, large diameter propeller mixers rotate at between 15 RPM and 80 RPM.

.3 Medium speed, medium diameter propeller mixers rotate at between 200 RPM and 1200 RPM.

.4 Mixers are submersible, horizontally mounted, and include a motor and propeller in a close coupled configuration.

.5 Provide materials suitable for use in anoxic and anaerobic activated sludge.

.6 Provide mixers able to be raised and lowered and easily removable for inspection without the need for personnel to enter mixing tank.

.7 Guide the entire weight of the mixer unit by a single bracket or double bracket, as specified in the data sheets, designed to handle all thrust created by the mixer.

.8 The mixer, appurtenances, and cable, are to be capable of continuous underwater operation.

2.2 Acceptable Manufacturers

.1 Flygt

.2 KSB

.3 ABS

2.3 Capacities and Performance

.1 Specific mixers are listed in the detailed specification sheets

2.4 Propeller

.1 For low speed mixers:

.1 Provide two-blade, non-clogging propellers, with back curved leading edges that shed stringy material.

.2 Fabricate propeller of FRP

.2 For medium speed mixers:

.1 Provide two- to four-blade, non-clogging propellers, with back curved leading edges that shed stringy material.

.2 Fabricate propeller of type 316 stainless steel.

.3 Secure propeller to the propeller shaft by polygon friction fitting and nut.

.4 Dynamically balance propeller.

2.5 Propeller Shaft

.1 Fabricate shafts of type 329 or 431 stainless steel conforming to ASTM A276.

.2 Provide shafts of sufficient size to limit whip or deflection.

.3 Design mixers such that shafts operate at less than 80 percent of their critical speed.

2.6 Bearings

.1 Support propeller shafts by two (2) permanently lubricated bearings. The outer bearing a double row angular contact ball bearing and the inner bearing a single row, cylindrical roller bearing or ball bearing.

.2 ABMA B10 bearing life: 100,000 hours

2.7 Motor

.1 Provide submersible motors in compliance with Section 11205 and 11207.

.2 Motor types, voltages, service conditions and power ratings are indicated in the detailed mixer data sheets.

2.8 Gear Drives for Slow Speed Mixers

.1 For designs that employ gear drives to achieve the appropriate propeller speed, design to AGMA standards for continuous heavy duty service.

.2 Seal gear drives in watertight enclosures and provide permanent oil lubrication.

.3 Use bearings with ABMA B10 bearing life of 100,000 hours.

2.9 Seals

.1 Fit the propeller shaft with a mechanical seal and two lip seals where it exits the moisture protection oil reservoir.

.2 Provide single mechanical seals with type 316 stainless steel metal parts, Viton O-rings, and tungsten carbide faces.

.3 Provide lip seals made of Viton (inner) and nitrile rubber (outer).

2.10 Accessories

.1 Guide Brackets and Guidebars:

.1 Provide each unit with an integral sliding bracket and single or double guidebar, as specified in the data sheets.

.2 Configure single mast guidebar arrangements as hollow square sections; 100 x 100 mm square by 4.0 mm thick. Mast to pivot to provide adjustable angle of rotation.

.3 Configure double mast guidebar arrangement of two cylindrical sections; 114.3 mm diameter, 6.0 mm thick. Provide brackets to ensure angle of mixer installation from the horizontal will be the angle recommended by the supplier.

.4 Provide upper and lower mounting brackets for the guidebars and mast-mounted socket.

.5 All material and accessories to be stainless steel, as detailed in the data sheets.

.6 All stainless steel components must be pickled and passivated.

.2 Provide a power cable.

.3 Provide a stainless steel lifting cable, shackle and hook.

.4 Portable Lifting Davit:

.1 Supply lifting davits capable of lifting all submerged mixers. Make the lifting davit portable and include mast, adjustable boom, winch assembly suitable for manual or electrically powered operation and associated chains, cables, sheaves, hooks, handles and fasteners.

.2 Provide 100 mm x 100 mm square tube mast, a minimum 2100 mm long.

.3 Design the boom to adjust from a minimum extension of 1200 mm to a maximum extension of 1800 mm and capable of vertical adjustment from horizontal to 45 degrees from horizontal. Design the boom to rotate horizontally through a sweep of 270 degrees of arc. Provide boom handles to assist in horizontal rotation.

.4 Design the lifting davit to support the weight of the mixer or pump at all angles from horizontal up to 45 degrees, between minimum and maximum extension of the boom.

.5 Each winch assembly should have the capability of being powered by an electric powered device. Provide winch complete with 6.35 mm diameter by 12 m long lifting cable.

.6 Make the combination of winch and electrical driving device so that they can raise and lower the load at approximately 3 m/min. Also supply a ratchet for manual operation.

.5 Power Lifting Device:

.1 Provide as the powered lifting device, a reversible electric right angle drill complete with adaptor for connection to the winch assembly. Supply a drill rated at 0.75 kW, minimum, suitable for 120 V/single-phase/60 Hz power supply. Include 9 m of extension cord.

.6 Platform Mounting Base Floor Socket

.1 Provide type 304 stainless steel floor socket matched to the lifting davit, complete with mounting hardware for anchoring to concrete platforms.

.2 Provide and install one floor socket per mixer.

.7 Anchor Bolts

.1 All anchor bolts to be stainless steel.

2.11 Painting

.1 Equipment, excluding stainless steel or aluminum components, shall be provided with protective coatings suitable for submerged or splash zone service conditions.

.2 Shop prime and paint metals in accordance with manufacturer’s written recommendations.

2.12 Welding

.1 All stainless steel welds for the guide rails shall be pickled and passivated.

2.13 Spare Parts

.1 For each mixer, provide one spare mechanical seal, one spare lip seal of each type, and one set of bearings.

.2 For each mixer type and size, provide a single propeller, and one propeller shaft and end fitting.

.3 Provide a list of spare parts which might be required during the initial five years of operation. Provide prices for each part.

3. EXECUTION

3.1 Manufacturer's Representative

.1 The manufacturer's representative shall be required to attend the Site to train installation personnel, train operating and maintenance staff, to witness installation and testing to ensure the equipment is installed and operated as intended.

3.2 Installation

.1 Verify satisfactory delivery of the equipment by completing Form 100, included in Section 01650.

.2 Ensure that each mixer is installed and aligned, as required to provide satisfactory service. Mixers to be installed sufficiently high above the floor to accommodate the fine bubble aeration system (top of diffuser at 300 mm above floor) in Aerobic Cell 4.

.3 Instruct the 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.

.4 Cooperate with the Contractor to fulfill the requirements for a successful installation as documented by Form 102, included in Section 01650.

.5 Conform to the requirements of Section 01664.

3.3 Equipment Performance Testing

.1 Ensure that each mixer, including all components parts, operates as intended.

.2 Demonstrate satisfaction of requirements specified herein.

.3 Cooperate with the Contractor to fulfill the requirements for successful testing of the equipment as documented by Form 103, included in Section 01650.

.4 Conduct testing to confirm satisfactory mixing. Conduct these tests using mixed liquor similar to that expected under normal operating conditions. Fill the tank with this liquid, ensuring the solids are close to the maximum concentration listed. Start and continue mixing for one half hour. At that time, withdraw samples from at least three points in the tank, at various depths, one per 200 m^3.

.5 Sample locations shall be confirmed with Contract Administrator.

.6 Analyze each sample to determine the suspended solids content. The test will be deemed successful if all suspended solids concentrations are within 10 percent of the average. Repeat the test at a concentration about 50 percent of the initial test. The same conditions apply.

.7 Cooperate with the installer to fulfill the requirements for successful testing of the equipment as documented by Form 104, included in Section 01670.

3.4 Training

.1 Conform to the requirements of Section 01664.

END OF SECTION

DETAILED MIXER SPECIFICATION

Description: Bioreactor Mixers

Tag Number:

Pre-anoxic Cell Mixers:	S-760-MXR; S-765-MXR
Anaerobic Cell Mixers:	S-761-MXR; S-766-MXR
Anoxic Cell Mixers:	S-762-MXR; S-763-MXR; S-767-MXR; S-768-MXR

Propeller:

Type:	Medium speed, medium diameter
Number of blades:	two or three
Maximum propeller speed:	900 RPM

Construction:

Blade material:	316 stainless steel
Propeller housing:	316 stainless steel
Jet ring:	316 stainless steel
Stator housing:	316 stainless steel
Shaft:	431 or 329 stainless steel

Driver:

Drive Type:	Constant speed
Motor Type:	Submersible, totally enclosed
Voltage/Phase/Frequency:	575 V/3-phase/60 Hz
Motor Size:	3.0 kW
Motor Speed:	900 RPM

Testing:

Test the mixing intensity to ensure agitation is sufficient.

Accessories:

Single mast, stainless steel guide bars complete with all mounting brackets.
12m lifting cable (stainless steel) per mixer
15m power/control cable per mixer
one pedestal per mixer
one power assisted crane, total

Acceptable Manufacturers:

ITT Flygt, KSB, ABS

END OF SECTION

RECIPROCATING AIR COMPRESSORS

1. GENERAL

1.1 Work Included

.1 This Section specifies the supply, delivery and the supervision of installation, testing and commissioning of reciprocating compressors for compressing air, complete with electric motors and air receivers with accessories.

1.2 Quality Assurance

.1 Ensure compressors operate at the design air volume without oil creep, are non-overloading and operate within 10 percent of peak efficiency.

.2 Air receivers to meet requirements of ASME Code for Unfired Pressure Vessels and carry ASME approval stamp.

1.3 Submittals

.1 In addition to the submittals specified in Section 11005, provide the following information:

.1 Detailed Drawings of all equipment and accessories as a complete system, providing dimensions, assembly, and installation requirements.

.2 Tubing arrangement for pneumatic controls

.3 Vibration isolation system

.4 List of which components will be shipped pre-assembled and parts list for other components and materials. Indicate weights and physical dimensions for each assembly and package to be shipped.

.5 Provide descriptive information for the following ancillary items

.1 Inlet filter

.2 Inlet valve

.3 Oil reservoir, filter, and valves

.4 Oil separator

.5 Oil cooler

.6 Relief/blowoff valve

.6 Submit U1A form and provincial inspector's certificate for air receiver for inclusion in O&M Manuals.

.2 Operation and Maintenance Data: provide for incorporation in O&M Manual, as specified in Section 01300. Include complete description of operation together with general arrangement and detailed Drawings; wiring diagrams for power and control schematics, parts catalogues, with complete list of repair and replacement parts with section drawings, illustrating the connections and identifying numbers.

1.4 Shipment, Protection and Storage

.1 Ship the equipment pre-assembled to the degree that is practicable.

.2 Provide storage instructions indicating specific requirements to ensure there is no uneven wear, distortion or weathering of components.

.3 Identify all special storage requirements as specified in Section 01650.

2. PRODUCTS

2.1 Description

.1 The compressed air system provides compressed air for the DAF saturation vessels (T112-SAT and T122-SAT) where air is dissolved under pressure.

.2 The pressured flows from the saturation vessels (T112-SAT and T122-SAT) mix with WAS influent at DAF (T111-DAF and T121-DAF) entrance zones and releases fine air bubbles due to reduced pressure.

.3 The released fine bubbles attach to the solids and causes the WAS particles to rise to the surface of DAF tanks

2.2 Tag Numbers

.1 Air Compressor 1: T112-AC.

.2 Air Compressor 2: T122-AC.

2.3 Acceptable Manufacturers

.1 Atlas Copco

.2 Gardner Denver

.3 Ingersoll Rand

.4 Quincy

2.4 Capacities and Performance

.1 Design the compressor to produce the design airflow at the design pressure, and to operate within the design pressure range.

.2 Working pressure of the system is 552 kPa.

2.5 Compressor Type

.1 Provide two-stage simplex or duplex compressor unit, as appropriate, consisting of air-cooled, motor-compressor, air receiver, particle filter and aerosol filter on the discharge line, and operating controls.

2.6 Compressor Construction

.1 Construct compressor unit with cast iron housing and head, heat-treated forged steel or ductile iron shaft, aluminum alloy connecting rods, aluminum pistons with non-lubricated carbon rings, high strength alloy suction and discharge valves. Statically and dynamically balance rotating parts.

.2 For splash-lubricated system, equip compressor with low oil level switch to automatically shut down compressor in event of low oil level.

.3 For pressure lubricated systems, equip compressor with low oil pressure switch to automatically shut down compressor in event of low oil pressure.

.4 Fabricate pressure relief/control valves of forged steel with Viton or EPDM diaphragms suitable for hot air service.

.5 Provide intercooler.

.6 Provide for unloaded compressor start.

.7 Mount motor with provision for V-belt adjustment and compressor on one piece ribbed cast iron or welded steel base.

.8 Provide three-sided belt guards on all compressors in accordance with Section 11005.

.9 Provide inlet filter silencer.

2.7 Aftercooler

.1 Provide air aftercooler suitable for operation under the design working pressure.

.2 Construct with removable tube nests of non-ferrous metal tubes and corrosion resistant tube plates, safety valves, pressure gauge, moisture separator, moisture drain valve, water inlet piping with automatic water valve, automatic condensate trap, and overflow piping with open funnel.

.3 Design to have capacity to cool discharge air to a level required by the downstream equipment.

2.8 Air Receiver

.1 Provide horizontal or vertical receiver built to CSA B51 for the design working pressure. Flange or screw inlet and outlet connections.

.2 Fittings to include adjustable pressure regulator, safety valve, pressure gauge, drain cock and automatic condensate trap.

.3 The size of assembled air receiver and compressor is limited to extent that it can move through an 865 mm wide door.

2.9 Instrumentation

.1 Provide a direct reading air/fluid temperature gauge and system air pressure gauge.

.2 Provide other instrumentation necessary to ensure safe, reliable and efficient operation of the compressor.

2.10 Compressor Controls

.1 Provide a control system capable of starting/stopping, capacity control, operating control and safety control of the compressor unit.

.2 Provide motors that comply with the provisions of Section 11205.

.3 Provide all required motor protection and control interfaces in accordance with this specification and Divisions 16 and 17.

.4 Provide electrical equipment which meets the general requirements detailed in Division 16.

.5 Provide a PANEL/REMOTE switch for each compressor.

.6 Set the compressor to regulate line pressure to the design level.

.7 Provide emergency interlocks to shut down the compressor and indicate compressor failure under the following conditions:

.1 High discharge air temperature

.2 Motor overload

.3 High discharge pressure

.8 Provide dry contacts for connection to the plant control system for remote monitoring of, as a minimum, individual compressor failure, and run statuses, compressor Panel/Remote status and low air pressure.

.9 Provide controls for the automatic start-up of a compressor after a power outage condition.

.10 Provide pressure switch to cut out at the design pressure and design differential. Compressor regulation to be through lead-lag switch with time delay relay.

.11 Provide electrical duty compressor alternation set to alternate compressor after each start or after 12 hours, as appropriate. In the event one compressor fails, another compressor automatically maintains air pressure. Incorporate run time indication for each compressor.

.12 Provide a discharge header pressure transmitter for interface to the plant control system, as per the requirements of Division 17.

2.11 Air Dryer and Filters

.1 The air dryer and filters condition the compressed air so that it is suitable for use in the DAF tank system.

.2 Air Dryer

.1 Provide fully automatic dual tower heatless regenerative desiccant air dryer with -40°C dewpoint

.2 Provide a purge line from the dried air discharge to each tower to regenerate the saturated tower

.3 Air is dried by downflow through the first tower. Regeneration of the saturated tower will be by upflow of air from the purge line.

.4 Provide desiccant towers which are 1000 kPa (150 psig) ASME code stamped with a stainless steel desiccant support.

.5 Acceptable Manufacturers

.1 Atlas Copco

.2 Ingersoll Rand

.3 Pure Aire

.4 Xebec

.3 Filters, Air Inlet

.1 Provide coalescing type filters with automatic drain traps and pressure drop indication.

.2 Provide vertical in-line type filters.

.3 Acceptable Manufacturers

.1 Atlas Copco

.2 Ingersoll Rand

.3 Pure Aire

.4 Filters, Aerosol

.1 Provide cartridge type filters with pressure drop indication.

.2 Provide vertical in-line type filters.

.3 Acceptable Manufacturers

.1 Atlas Copco

.2 Ingersoll Rand

.3 Pure Aire

.5 Filters, Particulate

.1 Provide cartridge type filters with pressure drop indication.

.2 Provide vertical in-line type filters.

.3 Acceptable Manufacturers

.1 Atlas Copco

.2 Ingersoll Rand

.3 Pure Aire

2.12 Spare Parts

.1 Provide spare parts for each compressor in accordance with Section 01750. Specifically supply the following for each compressor:

.1 Three (3) aerosol filter cartridges

.2 Three (3) particulate filter cartridges

.3 One (1) set of any specialty tools

2.13 Finishes

.1 Factory prime and paint in accordance with Section 11900.

3. EXECUTION

3.1 Manufacturer's Representative

.1 Arrange for a technically qualified manufacturer's representative to attend the installation Work, certify correct installation, 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.

3.2 Installation

.1 Ensure that each device is installed in accordance with Section 11020 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 as documented by Form 102, included in Section 01650.

3.3 Testing

.1 Ensure that each device, including all component parts, operates as intended.

.2 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 Commissioning

.1 Attend during commissioning of the process system specified in this Section to ensure that each device functions as intended in the process system.

3.5 Training

.1 Provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Forms T1 and T2. Conform to the requirements of Section 01664.

END OF SECTION

PRIMARY SLUDGE FERMENTER

1. GENERAL

1.1 Work Included

.1 This Section specifies design, fabrication, delivery, installation, and commissioning of the components and mechanisms and all other associated equipment, appurtenances, controls and aluminum covers required for two fermenter tanks.

.2 The fermenter tanks will be covered for odour control Coordinate with the cover fabricator so that the center platform, center drive mechanism motor, primary and intermediate gear reducers remain above the cover and that minimum clearances from fermenter equipment are met. Provide gasketing in the centre platform to prevent leakage of foul air from fermenters at the center platform. Support the cover underneath the bottom chord of the walk-on bridge mechanism allowing complete access to the drive mechanism. The aluminum covers shall have a minimum 2 percent slope to the north and south about the bridge section.

.3 Provide site services for the components and mechanisms and all other associated equipment, appurtenances and controls required for two fermenters, as listed below:

.1 Installation training

.2 Witnessing of equipment installation

.3 Assistance in equipment performance testing

.4 Operations and maintenance training

.4 The equipment provided for each fermenter includes, but is not necessarily limited to:

.1 Bridge support structure

.2 Walkway supports

.3 Walkway surface

.4 Centre platform

.5 Platform surface

.6 Handrail

.7 Side feed pipe

.8 Energy dissipating feedwell

.9 Sludge thickener drive assembly with rakes and pickets

.10 Sludge thickening and collection arms

.11 Torque shaft

.12 Cone scraper

.13 Sludge thickener drive on/off pushbuttons and an alarm in a control panel

.14 Effluent weirs

.15 Aluminum covers

.16 All necessary assembly and anchor bolts

.17 Include remote signals not specifically listed but which are required to enhance or optimize the process performance of each fermenter. These signals shall be listed and provided and will be used in the DCS for advanced process control

1.2 Reference Standards

.1 AFBMA Bearing Life Specifications

.2 British Std 721:1963 British Standards - Governing Worm and Worm Gear Design

.3 RP0178-2003 Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to Be Lined for Immersion Service

.4 ABMA, American Bearing Manufacturer's Association

.5 AGMA, American Gear Manufacturer's Association

.6 AISI, Pocketbook of AISI Standard Steels

.7 ANSI B16.5, Pipe Flanges and Flanged Fittings

.8 ANSI/ASME B36.19M, Stainless Steel Pipe

.9 ANSI/AWWA F102, Matched-Die-Molded, Fiberglass-Reinforced Plastic Weir Plates, Scum Baffles, and Mounting Brackets (includes addendum F102a-97)

.10 ASME IX, Boiler and Pressure Vessel Code, Welding and Brazing Requirements

.11 ASTM A36/A36M, Standard Specification for Carbon Structural Steel

.12 ASTM A48 Class 40A Standard Specification for Gray Iron Castings

.13 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

.14 ASTM A167/A167M, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

.15 ASTM A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping

.16 ASTM A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

.17 ASTM A242/A242M, Standard Specification for High-Strength Low-Alloy Structural Steel

.18 ASTM A269/A269M, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

.19 ASTM A276, Standard Specification for Stainless Steel Bars and Shapes

.20 ASTM A283C, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

.21 ASTM 304 - Standard Specification for Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements

.22 ASTM A311/A311M, Standard Specification for Cold-Drawn, Stress-Relieved Carbon Steel Bars Subject to Mechanical Property Requirements

.23 ASTM A312/A312M, Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes

.24 ASTM A320/A320M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service

.25 ASTM A322, Standard Specification for Steel Bars, Alloy, Standard Grades

.26 ASTM A325/A325M, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

.27 ASTM A333/A333M, Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service

.28 ASTM A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings

.29 ASTM A484/A484M, Standard Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings

.30 ASTM A529/A529M, Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality

.31 ASTM A633/A633M, Standard Specification for Normalized High-Strength Low-Alloy Structural Steel Plates

.32 ASTM A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

.33 ASTM A733/A733M, Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples

.34 ASTM A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures

.35 ASTM A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products

.36 ASTM A790/A790M, Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe

.37 ASTM A813/A813M, Standard Specification for Single-or Double-Welded Austenitic Stainless Steel Pipe

.38 ASTM A814/A814M, Standard Specification for Cold-Worked Welded Austenitic Stainless Steel Pipe

.39 ASTM A815/A815M, Standard Specification for Wrought Ferritic, Ferritic/Austenitic, and Martensitic Stainless Steel Piping Fittings

.40 ASTM A928/A928M, Standard Specification for Ferritic/Austenitic (Duplex) Stainless Steel Pipe Electric Fusion Welded with Addition of Filler Metal

.41 ASTM A999/A999M, Standard Specification for General Requirements for Alloy and Stainless Steel Pipe

.42 ASTM D256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

.43 ASTM D570, Standard Test Method for Water Absorption of Plastics

.44 ASTM D618, Standard Practice for Conditioning Plastics for Testing

.45 ASTM D638, Standard Test Method for Tensile Properties of Plastics

.46 ASTM D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

.47 ASTM D2583, Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor

.48 ASTM E831, Standard Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis

.49 ASTM F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

.50 ASTM F738M, Standard Specification for Stainless Steel Metric Bolts, Screws, and Studs

.51 AWS B2.1, Welding Specifications

.52 AWS D1.1, Structural Welding Code – Steel

.53 CAN/CSA-G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steels

.54 CAN/CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures

.55 CAN/CSA W48.1, Carbon Steel Covered Electrodes for Shielded Metal Arc Welding

.56 CISC Handbook of Steel Construction CSA W47.1 Certification of Companies for Fusion Welding of Steel Structures

.57 CSA 22.2 No. 100, Motors and Generators

.58 CSA W59.1, Welded Steel Construction (Metal Arc Welding)

.59 CAN/CSA-G164, Hot Dip Galvanizing of Irregularly Shaped Articles

.60 CSA W178.1, Certification of Welding Inspection Organizations

.61 CSA W178.2, Certification of Welding Inspectors

.62 CSA Z662, Stainless Steel Fabrication

.63 CSA/CAN 3-S157 Strength Design in Aluminum

.64 CSA W59.2, Welded Aluminum Construction

.65 CSA S244, Welded Aluminum Design and Workmanship

.66 CSA W47.2 Certification of Companies for Fusion Welding of Aluminum

.67 NBC 1995: Structural Commentaires Part 4.

.68 Aluminum Association Standard SSA-46

.69 NEMA M61, Motors and Generators

1.3 Definitions

.1 Continuous Operating Torque: calculated using specified sludge load described in this Section plus the additional load created by the manufacturer's fermenter mechanism. This is the torque the centre drive is required to deliver, operating continuously, 24 hours per day, 7 days per week, 365 days per year.

.2 Cover Fabricator: fabricator of the aluminum covers for the fermenter tanks as per the Drawings and Specifications.

1.4 Submittals

.1 In addition to the submittals specified in Section 11005, provide the following in one complete submittal in accordance with Section 01300:

.1 A copy of this Section with checks marks to indicate conformance or acceptance of each clause. Non-conformance shall be indicated by a cross "X".

.2 Fabrication drawings for the fermenter mechanisms, trusses and aluminum covers etc. The Drawings shall be signed and sealed by a Professional Engineer registered in Canada or the United States.

.3 Shop Drawings showing general arrangements and layouts, overall dimensions, connection and mounting details, cross-sections and weights, make and model numbers, and a complete materials list. Include specifications, catalogue cuts, descriptive literature. Include electrical schematics and control schematics. Provide information for all components including, but not necessarily limited to, those listed in 1.1.4

.4 Motor operating data, including motor and insulation ratings, start-up and operating current ratings, operating voltage and amperage tolerances, and description of construction. Electrical equipment and material to be CSA certified.

.5 Gearbox and drive data including AGMA/ABMA ratings for components, materials of construction, tolerances and description of construction.

.6 Installation instructions indicating assembly and mounting requirements, alignment and assembly tolerances, and points of connection for ancillary services.

.7 Assembly Drawings showing details of connections and termination of equipment for connection by others.

.8 Start-up instructions including lubricant requirements, electrical requirements, etc.

.9 List of which components and materials will be shipped pre-assembled and a parts list for other components and materials. Weights and physical dimensions shall be indicated for each part, assembly and package to be shipped.

.10 Details of surface preparation and coating systems for all components.

.2 Fabrication and Welding Submittals

.1 In addition to the submittals specified in Section 11005, provide the following in one complete submittal in accordance with Section 01300:

.1 Current and complete documentation of all welder's qualifications prior to commencement of welding.

.2 A written description of welding procedures including, but not limited to materials, methods, and quality control. Written procedures to be sealed and signed by a registered Professional Engineer who is qualified in welding design. All welding to conforming to CSA W59.

.3 Design Submittals

.1 Submit structural calculations for the design of the bridge, distribution center well, centre column, rake and picket assembly, aluminum cover and all supports and connections to new structures. Structural calculations to be sealed, signed and dated by a Professional Engineer registered in Canada or the United States.

.2 Submit hydraulic calculations and a hydraulic profile that extends from the center column to the effluent launder. The hydraulic calculations and profile shall demonstrate that the center column ports and distribution center well elevations (as shown on the Shop Drawings) are suitable for the flow conditions specified below. The design calculations shall be sealed, signed and dated by a Professional Engineer registered in Manitoba. The flow conditions stated in 2.4.1 are to be used for hydraulic calculations.

.3 Complete all other submissions as required by other regulatory authorities.

.4 Provide all operating and maintenance data required for incorporation into the O&M Manual specified in Section 01300. Include complete operation description together with general arrangement and 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.

.5 Provide a list of recommended spare parts for the first year of operation and for the first five years of operation, including a price list and the location of the nearest facility from which all spare parts can be obtained.

1.5 Coordination

.1 Coordinate supply and installation of anchors.

.2 Coordinate with other Divisions to ensure there are no conflicts in the Work.

.3 Coordinate requirements of fermenter mechanism with those of the cover (refer to structural drawings and specifications). Consider all clearances required. The center platform which allows access to the drive unit, primary and intermediate gear reducers, is to remain above the cover. Coordinate with the cover fabricator to ensure that maintenance access to fermenter mechanism is not restricted by the cover design.

1.6 Quality Assurance

.1 The manufacturer of the sludge thickener mechanism will modify his standard equipment to meet the values specified for dimensions, design, and the intent of this specification.

1.7 Shipment, Protection, and Storage

.1 Ship equipment and mechanisms pre-assembled to the degree possible.

.2 Provide storage instructions indicating specific requirements to ensure there is no weathering, corrosion, contamination, mechanical damage, distortion, or any other deterioration of the components.

.3 Identify all other special storage requirements.

2. PRODUCTS

2.1 Description

.1 The fermenter tank mechanism dewaters primary sludge by gravity separation, producing a sludge of higher concentration for further stabilization. The feed sludge is discharged into the central distribution well, which dissipates the flow radially across the tank. The flow becomes quiescent allowing solids to settle. The pickets move through the settling solids to further assist dewatering. The settled solids are raked by rotating plough arms to a central pit. The clarified liquid flows into the effluent launder over a weir.

.2 The sludge thickener mechanism will be of the bridge-supported type resting upon the basin walls.

.3 The completed sludge thickener mechanism shall be of sufficient strength to sweep in a 2 inch layer of grout over the tank bottom under its own power. Grouting, if required, shall be done in strict accordance with the sludge thickener manufacturer's instructions.

.4 Equipment supplied for the fermenter mechanism is to include those listed in 1.1.4

.5 Centre platform with checker plate to be gasketed to seal around holes where cabling, drive mechanism, bolts, etc protrude through the checker plate. Provide gaskets between sections of checker plates. Provide airtight details of center platform sealed to prevent escape of fermenter gases.

2.2 Tag Numbers

.1 Fermenter 1: F-550-FM

.2 Fermenter 2: F-560-FM

2.3 Acceptable Manufacturers

.1 Supply products, modified as necessary by the manufacturer to provide the specified features and to meet the specified operating conditions. Refer to Section 11005.

.2 Design Standard:

.1 Dorr-Oliver Eimco

.3 Acceptable Manufacturers:

.1 Envirex/US Filter

.2 WesTech Engineering

2.4 Design Parameters

Number of fermenters	2
Diameter	16 m
Sidewater depth	4.6 m
Sludge depth	3 m
Clear water depth	1.6 m
Freeboard	1 m
Volume each	925 m^3
Sludge volume, each	585 m^3
Sludge retention time	7 days
Primary sludge flow to each fermenter	11 L/s
Primary sludge solids concentration	0.5%
Elutriation water flow to each fermenter	11 L/s
Fermenter sludge solids concentration	
Average	3 percent
At top of blanket	2 percent
At bottom of blanket	12 percent
Distribution well depth, m	1.5 m
Distribution well diameter, m	3 m
Design life, years	20
Headspace H_2S concentration	200 ppm
Bottom slope	1:6
Maximum headspace temperature	40°C

2.5 Materials

.1 The entire mechanism shall be fabricated of 316L Stainless Steel except where noted.

.2 Materials are to conform to ASTM specifications where possible. State all deviations.

.3 Design structural steel components so that stresses developed do not exceed allowable stresses as defined by current CSA Standards when designed for the AGMA rated design peak.

.4 Provide dielectric insulator fittings between all dissimilar metals and isolation of bolting materials or other connectors.

.5 Unless otherwise noted, minimum thickness of all plates and structural members designated for submerged or partially submerged service is 6 mm.

.6 The submerged rotating trusses for the support of scrapers, sludge collection devices, skimmers, etc., shall be all-welded construction designed for assembly by bolting in the field. Field welding is to be minimized.

.7 Shop welding shall conform to CSA W59.1 and ASTM E109.

.8 Sludge removal arms of steel truss construction with steel raking blades and spring brass squeegees. Secure squeegees with stainless steel fasteners and dielectric insulator fittings.

.9 Unless otherwise specified, all bolts, nuts, washers and other fasteners and similar fittings shall be 316 stainless steel dipped in "moly" or other similar lubricant to prevent galling.

.10 Provide neoprene seals between the stationary and rotating elements.

.11 Enclose gear reduction and turntable units in ductile iron housing.

.12 Provide aluminum plate of minimum 9.5 mm thickness for the platform at the centre of the fermenter. Provide air-tight details of platform sealed to prevent escape of fermenter gases.

2.6 Drive Mechanism

.1 The drive assembly shall be a regularly manufactured in-house product of the sludge thickener manufacturer. Complete drive assemblies purchased from third party vendors are not acceptable.

.2 Provide a primary gear reduction unit, an intermediate gear reduction unit (if required), and a final reduction unit enclosed in a turntable base.

.3 Design gears to meet current AGMA Standards for standard duty.

.4 Run all gears and bearings in an oil bath. Provide readily accessible lubricant fill and drain pipes with necessary fittings and oil indicators. Enclose gear reduction and turntable units in ductile iron housings. Oil pumps for lubrication will not be allowed. Provision shall be made for condensate collection below the main bearing and gear to positively prevent the bearings and gears from running in water. Sight glasses and condensate drains for the drive shall be easily accessible without removing plates or structures. Inspection of the completed drive unit shall be accomplished at the sludge thickener manufacturer's shop, with reports of all tests and certifications of material hardness being made available for review at the Contract Administrator's request prior to shipment to the jobsite.

.5 In no case will units using lower bearings, feedwell bearings, chains, sprockets or any part of the drive unit below the top of walkway beams be allowed.

.6 Drive components will be located via a machined, registered fit or pilot to insure proper alignment. In order to preserve the alignment of key drive components, no welding on the drive will be permitted following final machining operations.

.7 Design the sludge rake arms, scrapers and drive unit for a continuous imposed sludge load of 1200 N per metre of arm length.

.1 Tank radius (arm length), R = 8 m

.2 Rake Arm Loading, W = 1200 N/m

.3 Continuous Operating Torque at 100 percent of rake arm loading, WR^2 = 76,800 N-m

.4 Alarm Torque: 120 percent of continuous operating torque

.5 Cutout Torque: 130 percent of continuous operating torque

.6 Backup Cutout Torque: 140 percent of continuous operating torque

.7 Momentary Peak Torque: 300 percent of continuous operating torque

.8 Maximum tip speed 92 mm/sec

.8 Provide as backup cutout torque protection a mechanical disconnect consisting of a shear pin that disconnects the motor at 140 percent of the continuous operating torque.

.9 Design the drive main bearing for the total rotating weight with a minimum ABMA B10 bearing life of 200,000 hours continuous operation.

.10 Design all main drive components to provide a minimum wear life of 20 years

.11 Design all bearings other than the drive main bearing for a minimum ABMA B10 bearing life of 100,000 hours continuous operation.

.12 Design the entire drive mechanism, including turntable, to be serviced without removal of the fermenter tank cover.

2.7 Drive Motor

.1 Motors shall comply with provisions specified in Section 11205 and Division 16.

.2 All drive motors, controls, wiring, switches etc shall be located above the cover, outside of the fermenter headspace.

.3 Further to 2.7.2 being met, Electrical Area Classification is unclassified.

.4 Electric motors shall be sealed for operation in a moisture-laden atmosphere and suitable for washdown and outdoor severe duty. Conduit boxes shall be gasketed with neoprene or an equivalent material to prevent moisture from entering the stator through the conduit box. Moisture drains will be placed in suitable positions to prevent accumulation of moisture in the motor housing. Sealed, grease-lubricated ball bearings or roller bearings shall be provided. Nameplates shall be stainless steel. All windings shall be copper with a grounding lug, the stator bores and rotor cores shall be coated with lacquer, and the entire enclosure shall be sealed with a corrosion-resistant paint to provide additional protection against moisture and contaminants.

.5 The sludge thickener drive motor shall be minimum 3.73 kW.

2.8 Motor Protection and Alarm

.1 Equip each drive motor and mechanism with a weatherproof NEMA 4X torque indicator and electro-mechanical overload contacts. Include a torque switch and analogue torque signal.

.2 Display torque in “percent of continuous operating torque”.

.3 Provide and arrange micro-switches to provide an alarm signal when torque overload starts to develop (alarm torque) and to stop the motor when the torque becomes excessive (cutout

torque and backup cutout torque). Mount the switches in a weatherproof enclosure and pre-wire the switches to the weatherproof NEMA 4X enclosure.

.4 Pre-wire the micro-switches to a numbered terminal strip. Provide the following dry contacts for each drive unit:

.1 Alarm Torque: 120 percent of continuous operating torque

.2 Cutout Torque: 130 percent of continuous operating torque

.3 Backup Cutout Torque: 140 percent of continuous operating torque

.4 Rate contacts 5 A, 120 VAC. Configure as Normally Open, to close on alarm condition.

.5 Amperage sensing devices are not acceptable for torque overload protection due to their inability to react quickly enough to prevent damage to the drive.

2.9 Sludge Removal Arms with Blades

.1 Provide a two full radius sludge thickening and collection arms of truss construction with raking blades, sludge thickening pickets, and adjustable squeegees.

.2 Sludge thickening and collection arms will be attached to the sludge thickener drive mechanism by means of a steel torque shaft. Support tie rods in the sludge thickening and collection arm design will not be allowed.

.3 The minimum angle size used in construction of the sludge thickening and collection arms shall be 50 mm by 50 mm by 6 mm.

.4 The blades supported from the arms should be 125 mm high, and 375 mm in length. The bottom of the blades shall clear the tank floor by between 5 to 10 mm, this variation to account for local differences in level of the tank floor. Rake blades shall be properly spaced to insure complete raking of the tank bottom twice per revolution.

.5 Set the blades at 45° in plan to the sludge removal arms, angled to direct the sludge towards the tank centre during rotation of the drive mechanism in the normal direction

.6 Attach squeegees to the bottom blades with stainless steel fasteners and dielectric insulator fittings.

.7 At the bottom of the torque shaft will be a cone scraper constructed of 316L stainless steel angles for agitating solids collected in the sludge thickening cone at the center of the sludge thickener.

.8 Design to hold the sludge scraper devices in a horizontal and vertical plane when subjected to momentary peak torque.

.9 Each sludge thickening and collection arm shall be designed to withstand the mechanism design strength (200 percent of continuous torque) while maintaining structural steel stresses within the AISC allowable stress.

2.10 Picket Assembly

.1 Sludge thickening pickets will be attached to the sludge thickening and collection arms on 600 mm centres to promote proper sludge thickening. Pickets will extend from an elevation even with the tops of the rake blades to an elevation allowing 600 mm of clearance between the top of each picket and any non-rotating components within the tank.

.2 The mechanism to support the pickets at higher level shall include two radius arms flanged from the centre shaft. The sludge removal arms shall support the pickets at lower level. The top arms shall be approximately 1.5 m below high water level.

.3 Fix 50 mm diameter or v-shaped steel pickets to the top and bottom arms. Space these pickets on 610 mm centres and offset to each side such that the first (left hand) is set at 300 mm from the centre drive shaft line. Set the first (right hand) picket at 450 mm from the centre shaft line. The end pickets or top support arm are not to be closer than 300 mm to the tank wall and are not to conflict with any other rotating or non-rotating device.

.4 Mount the pickets to the forward edge of each arm in the normal direction of rotation.

.5 Terminate the pickets 500 mm below high water level, except those used to support the skimming blade or where interference would occur.

2.11 Torque Shaft

.1 The torque shaft shall be constructed of 316L Stainless Steel Pipe, and be designed to handle the 200 percent of continuous torque of 153,600 N-m.

.2 The torque shaft shall be attached to the output shaft of the drive and shall have provisions for connections to support two sludge thickening and collection arms and a cone scraper.

2.12 Distribution Centre Well

.1 Design the distribution center well to dissipate the influent primary sludge flow radially across the fermenter tank.

.2 The feedwell shall be 3000 mm in diameter with a 1500 mm side depth. Extend the distribution center well to 1.35 m below the water level in the sludge fermenter. Distribution center well shall extend 0.15 m above the water level in the sludge fermenter.

.3 The steel plate from which the feedwell is fabricated will have a minimum 5 mm thickness. Support will be provided by brackets suspended from the truss. All necessary reinforcing rim angles, stiffeners, and supporting brackets shall have a minimum thickness of 6 mm. All components of the feedwell including supports and stiffeners shall be 316L SS.

.4 The distribution centre well is open at the bottom

2.13 Influent Pipe

.1 A 150 mm diameter schedule 40 steel influent pipe shall be provided to extend from a point 450 mm inside the basin wall to the feedwell. Influent pipe shall be 316L SS

.2 At the termination of a wall spool 450 mm inside the basin wall supplied by the Contractor will be a flexible coupling supplied by the Contractor to connect the influent pipe to a pipe stub.

2.14 Mechanism Support, Cover, and Walkway Access

.1 Provide isolation between dissimilar metals and concrete at the connection points to prevent corrosion.

.2 The mechanism shall be supported by a "walk-on" bridge mechanism which spans the diameter of the tank. The bridge shall be steel construction with hot dipped galvanized finish conforming to CAN/CSA-G164; minimum 610 g/m^2, or 6061-T6 or 6351-T6 aluminum alloy. Touch-up damaged galvanizing with minimum two (2) coats of zinc rich primer.

.3 Access to the center operating platform surrounding the drive assembly shall be provided by means of a walkway with a clear width of 900 mm and a minimum of 600 mm working space around the equipment mounted above the operating platform. The walkway shall extend from the tank wall at the Fermenter Supernatant Wet Well to the drive assembly platform. The walkway shall be constructed using slip resistant aluminum checker plate.

.4 Provide double row horizontal pipe guardrails, 1070 mm high constructed from 6061-T6 aluminum alloy connected to the Supernatant Wet Well guardrails. Provide 150 high 6061-T6 aluminum kick plate along the bottom. Design the handrails for all applied loads in accordance with the 1995 National Building Code of Canada.

.5 The walkway design live load shall be 4.8 kN/m^2. The maximum deflection of the walkway and truss assembly shall not be more than 1/360 of the span when all relevant loads are included. The dead load shall be defined as the weight of the structure and all materials and equipment attached to and supported by the structure.

.6 The aluminum sloped cover shall be designed as follows:

.1 The dead load shall be defined as the weight of the structure and all materials and equipment attached to and supported by the structure.

.2 The uniform load shall be assumed to act vertically upon the area of the cover projected upon a horizontal plane. The value of the live load shall be based on a ground snow load (Ss) of 1.7 kPa (unfactored) in accordance with the 1995 National Building Code of Canada.

.3 The design shall ensure that no ponding water will occur which may discolour the Architectural Concrete Masonry Units below. The cover shall be constructed from corrosion resistant aluminum alloy.

.7 Provide one safety davit and a minimum 1200 wide removable section of guardrail for man access along the walkway portion of the bridge mechanism. Provide additional removable section of guardrail for ease of man hoist installation into davit. Minimum design davit live load 18.0 kN applied in any direction. Confirm location of removable sections of guardrail with Contract Administrator prior to construction.

.8 Safety davit: model number PNUS101-SS complete with sleeve cap model number PNUS106-SS as manufactured by Pelsue. Use stainless steel 304 or 316 bolts, nuts, plates and washers for mounted sleeves in accordance with manufacturer's instructions. Provide stainless steel cable to secure sleeve cap to bridge.

2.15 Weirs

.1 Effluent weirs shall consist of 230 mm deep, 6 mm thick fiberglass reinforced plastic sections.

.2 Weirs shall be slotted and fastened to the tank wall using fiberglass reinforced plastic washers, stainless steel anchor bolts, and hex nuts to allow vertical adjustment.

.3 All joints between walls and weirs shall be sealed using a suitable water-resistant, non-leaching mastic provided by the Contractor.

2.16 Welding

.1 General

.1 Members shall be fully welded, and welds and sharp edges ground to a smooth contour.

.2 All welded connections shall develop the full strength of the connected elements and all joined or lapped surfaces shall be completely seal welded with a minimum 4.8 mm (3/16 inch) fillet weld. Intermittent welding is not allowed. All welding shall be done in accordance with the latest edition of NACE RP0178.

.3 All edges of ferrous metals shall be ground to a radius by multiple passes of a power grinder as required to ensure satisfactory coating adherence. Fillets and corners must be accessible for grinding. All rough welds shall be ground to remove sharp edges, undercuts, pinholes, weld spatter and other such surface flaws and irregularities. Provide a minimum radius of 6 mm on all edges and corners.

.4 Butt-welded joints shall be used whenever possible. The use of internal bolted connections shall be avoided. Continuous lap-welded joints are permissible, but not preferred.

.5 Where possible, all connections shall be shop welded or field bolted. Field welds are not permitted unless authorized by the Contract Administrator.

.6 Provide continuous seal welds on both sides of all welded joints.

.7 Provide minimum clearance between members in accordance with NACE RP0178.

.8 Continuously weld all welded connections to seal the mating surfaces completely.

.2 Steel

.1 Welding shall be done to written procedures tested and qualified in accordance with AWS D1.1, CSA W47.1 or ASME IX.

.2 Welders and welding operators shall be qualified in accordance with AWS D1.1, CSA W47.1 or ASME IX.

.3 Welding workmanship shall conform to CSA W59.1

.4 For pipe less than 75 mm in diameter, butt-weld to develop full strength, full penetration joints.

.5 For pipe equal to or greater than 75 mm in diameter, where not specified or shown otherwise, butt-weld to develop full strength, full penetration joints or furnish flanges, conforming to ANSI B16.5, Class 150. Where disassembly is required, flanges are sufficient.

.6 Use manual shielded metallic arc welding, submerged arc welding, inert gas shield arc welding, or gas tungsten arc welding.

.7 Bevel plain pipe ends prior to welding.

.8 Joints to be welded shall be clean and dry for a distance of at least 50 mm on each side of the joint.

.9 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.

.10 Make tack welds material equal to the root pass. Tack welds which have not cracked may be incorporated in the root pass.

.11 Ensure the first bead obtains full root penetration with a minimum of weld material projecting within the pipe.

.12 Use welding materials conforming to CSA or AWS specifications.

.13 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 Stainless Steel

.1 Conform to stainless steel welding procedures tested and qualified in accordance with ASME IX, which have been signed and sealed by a Professional Engineer registered in the Manitoba.

.2 Welders and welding operators shall be qualified in accordance with either AWS D1.1, CSA W47.1 or ASME IX.

.3 For all stainless steel pipe intended to convey liquids, use inert gas backing for field and shop welds. For these services, Solar Flux or similar granular backing will not be allowed.

.4 Pickle and wash all stainless steel to remove discolouration and iron particles. Following assembly, treat all welds with pickling paste, scrub with stainless steel brushes and wash until clean. Wash the completed assembly with clean water to remove all dirt and other foreign matter.

.5 Swab all welds with a passivation solution of 6 percent nitric acid

.6 Neutralize and/or rinse as appropriate the joint after passivation.

.7 Maintain a welding record which identifies all welds related to the welder or the welding operator.

.8 The chemical analysis of the material used, as supplied by the stainless steel manufacturer, shall be available to the Contract Administrator upon request.

.9 All equipment used in welding preparation shall be covered or faced with material that will prevent mild steel particles from contaminating the surfaces and joints of the stainless steel material.

.10 Equipment used to prepare joints such as ground clamps, wire brushes, steel wool, chisels, files and peen hammers shall be made from stainless steel. Mark these items "Stainless Steel".

.11 Grinding wheels shall be correctly selected for use on stainless steel and grinders shall be identified by a distinguishable colour to prevent accidental contamination.

.12 All metal that is to be fused during welding shall be clean of lubricants, grease, paint, fillings, and cuttings. Cleaning may be done only with alcohol or acetone. Chlorinated solvents shall not be used for cleaning purposes.

.13 Joint alignment shall be done with mechanical devices and shall be free of depressions and bumps. Under no circumstances shall heat be used in the alignment of joints.

.14 Tack welds shall be made of the same quality as the final weld. It shall be made small enough to allow them to be absorbed into the following beads, and they shall have oxides removed in advance of making the finishing weld.

.15 All scale, oxides, and discoloration shall be removed from the pipe and welds.

.16 Provide electrodes compatible with the material welded and which deposit metal with strength and corrosion resistance properties at least equivalent to the base metal.

2.17 Local Control Panel

.1 A local control panel with the capacity to control all functions described in this section shall be provided for the sludge fermenter mechanism.

.2 The control panel shall be of anodized aluminum construction conforming to NEMA 4 requirements and suitable for wall- or stand-mounting by the Contractor.

.3 A hinged front door shall be provided on the control panel adequately sized to contain all of the required controls with access for repairs.

.4 The control panel shall have a 600 V, 60 Hz, 1 phase power supply.

.5 The control panel shall be factory wired and tested with clearly identified, industrial-type terminal strips for all external field connections.

.6 An industrial-type alarm horn shall be supplied to indicate a high torque situation.

.7 The following indicators and control devices shall be mounted on the front of the panel:

.1 Sludge thickener drive "ON-OFF" selector switches

.2 An alarm silence button

.3 Mechanism "RUN" indicating light, alarm light, cut-out light.

.8 Motor starters are provided under Division 16.

2.18 Coatings

.1 Coatings are required on all process and mechanical equipment, vessels and pipes unless specifically deleted.

.2 Shop-prime and paint all ferrous components of the equipment with high build epoxy in accordance with Section 11900.

.3 Coordinate and cooperate with any independent testing and inspection agencies that may be retained by the City (refer to Section 01400).

2.19 Spare Parts

.1 The intent of this specification is to provide uninterrupted operation for a minimum period of two years. To meet this objective, supply all spare parts that are required to meet this requirement. As a minimum, the following spare parts will be furnished:

.1 One (1) set of seals for the sludge thickener drive

.2 One (1) set of overload control device switches

.3 One (1) set of squeegees

.4 If bearings supplied with center column, provide spare bearings.

.5 With the exception of anchor bolts, a quantity of fasteners equal to 10 percent of each type of fastener used

.6 One (1) oil sight glass

.7 All spare parts recommended by the manufacturer, for the first two years of operation.

3. EXECUTION

3.1 Fabrication

.1 Prevent electrolytic action between dissimilar metals and materials.

.2 Where dissimilar metals are mated, isolate all mating surfaces and bolts, nuts and washers to prevent galvanic corrosion.

.1 Clean and coat surfaces that are to be assembled or bolted together for shipment.

.2 Provide match markings on sections for ease of field erection.

.3 Ensure ease of field erection by test assembly in the shop where field assembly may be awkward or difficult.

3.2 Testing and Inspection

.1 Welders

.1 As a minimum, welders will hold a Journeyman Welder's Certificate or shall have qualifications and certifications in accordance with AWS D1.1, CSA W47.1 or ASME IX.

.2 Welder shall be qualified for the processes and filler metals they are using.

.2 Weld Tests

.1 Provide 14 days advanced, written notice to the Contract Administrator to confirm the timing for commencing and completing shop welding on each fermenter component.

.2 The Contract Administrator will arrange for shop weld tests to be conducted by an independent inspection and testing agency retained by the City, in accordance with Section 01400.

.3 The independent inspection and testing agency may use radiography or ultrasound to test the quality of a weld. For each defective weld, additional radiography will be conducted by the independent inspection and testing agency, at three additional locations to be identified by the Contract Administrator, in addition to a radiograph of the repaired weld. The cost of all additional inspections due to failed test results will be borne by the Contractor.

.4 The independent inspection and testing agency may use magnetic particle or liquid penetrant techniques to test the quality of a weld. All defects shall be removed and the area re-welded.

.5 In case of dispute one or more rejected welds will be cut out to verify by visual examination. Costs for additional testing will be borne by the Contractor if the weld(s) are defective, and by the City if the weld(s) are not defective.

.6 All repairs of defective welds will be at the Contractor's expense.

.3 Hold Point

.1 After all weld fabrication and clean-up, the fermenter mechanism shall be inspected and tested.

3.3 Manufacturer's Representative

.1 The manufacturer's representative shall be required to attend the site to train installation personnel, train operating and maintenance staff, to witness installation and testing to ensure the equipment is installed and operated as intended.

.2 The minimum periods of site attendance are identified in the following Table along with the Form to be completed on each of these trips. A "day" is defined as eight working hours on site. Forms are illustrated in Section 01650

.3 The total number of trips will depend on the Contractor's schedule. The cost of additional trips required by the Contract Administrator will be born by the Contractor.

	Description	Trips / Fermenter	Total of Trips*	Days	Form
1	Equipment Delivery	1	2	1	100
2	Installation Assistance (combined with first Equipment Delivery Trip)	---		1	101
3	Witnessing of Equipment Installation	1	2	1	102
4	Assistance in Equipment Performance Testing (combined with Item 3)	1		3	103
5	Process Performance Testing (combined with Items 3 and 4)	1		2	104
6	Operator and Maintenance Training (combined with first Equipment Performance Testing Trip)	---		2	T1

3.4 Installation Training

.1 Conform to the requirements of Section 01650.

.2 Certify the installer's understanding of installation procedures by completing Form 101.

3.5 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb and true, free of warp or twist, within tolerances specified by the manufacturer and as indicated in the Contract Documents. The fermenter mechanism shall be level to minimize wear on the bearings.

.2 The Contractor shall check and set equipment for proper alignment and elevation before and after each fermenter is filled. Make adjustments as required.

.3 The Contractor shall ensure the equipment is installed as required to provide satisfactory service. Successful installation shall be documented by Form 102.

.4 Conform to the requirements of Section 01650.

3.6 Equipment Performance Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.2 Test level of fermenter to ensure clearance from floor does not vary by more than ±5 mm.

.3 Demonstrate satisfaction of requirements specified herein.

.4 Load test fermenter to 150 percent of continuous operating torque. Verify torque settings of protective devices. Provide written summary of test protocols, one month prior to proceeding.

.5 Ensure the fermenter mechanism reversal procedure is as per specified herein. Provide written summary of test protocols, one month prior to proceeding.

.6 Document satisfactory performance of the equipment in Form 103.

3.7 Process Performance Testing

.1 Attend during commissioning of the process system specified in this section to ensure that they function as intended. Cooperate with the City, Contract Administrator, and manufacturer's representative in developing the commissioning plan for the equipment and in conducting the commissioning process. Conform to the requirements of Section 01670.

3.8 Operator Training

.1 Provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment. Conform to the requirements of Section 01664.

END OF SECTION

SECONDARY CLARIFIER MECHANISMS

1. GENERAL

1.1 Work Included

.1 This Section specifies the supply and supervision of installation, testing, and commissioning of three (3) circular secondary clarifier mechanisms.

1.2 Submittals

.1 Shop Drawings: submit in accordance with Section 01300 and Section 11005.

.1 Fabrication Drawings for the clarifier mechanism including truss arms, centre torque cage, etc. The Drawings shall be signed and sealed by a Professional Engineer registered in Canada or the United States.

.2 Provide data for incorporation in the O&M Manual as specified in Section 01735. Include complete operation description 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 Divisions to ensure there are no conflicts in the Work.

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 Design the secondary clarifier mechanism to remove settleable biological floc from mixed liquor from the bioreactor. Mixed liquor enters through pipe installed below the tank floor and flows up the centre column through inlet ports into the centre energy dissipating compartment. Ports in this compartment direct mixed liquor to the outer flocculating well. Settled solids are collected hydraulically through a rotating conduit with variable-sized orifices which collect the sludge.

.2 The secondary clarifiers will each have dedicated RAS pumps to return RAS to the bioreactor’s pre-anoxic zones.

.3 Clarified effluent overflows the V-notch weir plate, located along the perimeter of the clarifier, and discharges into the effluent launder.

.4 Effluent from the secondary clarifiers discharges via channels to a common central collector pipe

.5 Provide clarifier mechanisms capable of continuous operation.

.6 The complete package shall be of sufficient strength to sweep in the 50mm grout on the tank bottom under its own power.

.7 Equipment supplied for the clarifier mechanism is to include the walkway with handrails, centre drive unit, top bearings, inlet feed pipework and fittings, energy dissipating compartment, flocculation well, centre cage, centre drive support assembly, sludge removal arms, and weir plates.

2.2 Design Criteria

.1 Number: 3 (two existing, refitted; one new)

.2 Total Area: 2100 m^2

.3 Area, one out of service: 1400 m^2

.4 Overflow rates, one out of service

.1 Average: 23 $m^3/m^2/d$

.2 Peak: 38 $m^3/m^2/d$

.5 Tank Dimensions

.1 Secondary Clarifier 1 (new mechanism in existing tank)

.1 30 m inside diameter

.2 4.87 m sidewater depth

.3 Tank floor slope 1:50

.2 Secondary Clarifier 2 (new mechanism in existing tank)

.1 30 m inside diameter

.2 4.87 m sidewater depth

.3 Tank floor slope 1:50

.3 Secondary Clarifier 3 (new mechanism in new tank)

.1 30 m inside diameter

.2 5.00 m sidewater depth

.3 Tank floor slope 1:200

.6 Sludge Suction Header:

.1 Maximum headloss: 0.41 m

.2 Minimum flow velocity: 0.15 m/s

.7 Dimensions:

.1 Minimum suction header orifice diameter: 40 mm

.2 Influent energy dissipation well: 5.0 m diameter x 1.80 m depth

.3 Influent flocculation well: 10.0 m diameter x 2.5 m depth

.1 Retention time at average flow: 27 minutes

.2 Retention time at peak: 16 minutes

.8 Structural Requirements:

.1 NBC 1995: Structural Commentaires Part 4.

2.3 Acceptable Manufacturers

.1 Dorr-Oliver Eimco

.2 Envirex

.3 WesTech

2.4 Materials

.1 All fabricated structural steel is to conform to ASTM A-36.

.2 All fabrication of aluminum is to conform to

.1 CSA/CAN 3-S157 Strength Design in Aluminum

.2 CSA W59.2, Welded Aluminum Construction

.3 CSA S244, Welded Aluminum Design and Workmanship

.4 CSA W47.2 Certification of Companies for Fusion Welding of Aluminum

.3 Unless otherwise noted, minimum thickness of all plates and structural members designated for submerged or partially submerged service is 6 mm.

.4 The centre cage and submerged rotating trusses for the support of scrapers, sludge collection devices, skimmers, etc., shall be all-welded steel construction designed for assembly by bolting in the field.

.5 Welding shall conform to CSA W59.1 and ASTM E109.

.6 304 stainless steel or aluminum effluent weirs, minimum thickness of 5 mm.

.7 Enclose gear reduction and turntable units in cast iron housings.

.8 Fabricate energy dissipating compartment of steel plate to ASTM A36.

.9 Fabricate flocculating well frame of hollow structural steel sections. Use 6 mm steel plate or corrugated fibreglass for panels between framing members.

.10 Sludge removal arms of steel truss construction with steel raking blades and spring brass squeegees. Secure squeegees with brass bolts and nuts.

.11 Sludge suction header of hollow 304 stainless steel construction.

.12 Other bolts and nuts shall be 316 stainless steel dipped in “moly” to prevent galling.

.13 Structural steel centre cage

.14 Anodized aluminum handrails

.15 Provide aluminum open grating platform and aluminum structural members for the access stairways.

.16 Provide neoprene seals between the stationary centre column and any rotating elements.

2.5 Centre Column

.1 Use standard weight steel pipe, mounted over mixed liquor inlet so centre column acts as influent pipe.

.2 Flange base of column for bolting to clarifier floor and top of column for bolting to base of drive.

.3 Design column to withstand torque and vertical loads as well as any unbalanced loads.

.4 Provide a minimum of 4 ports to allow exit of mixed liquor, that remove no more than 50 percent of column material. Design for exit velocity no greater than 3 m/s. Extend openings a minimum of 150 mm above water surface to allow escape of floatables and scum.

2.6 Drive Mechanism

.1 A primary gear reduction unit, an intermediate gear reduction unit (if required), and a final reduction unit enclosed in a turntable base.

.2 Design gears to meet AGMA Standards for standard duty.

.3 Run all gears and bearings in an oil bath. Provide readily accessible lubricant fill and drain pipes with necessary fittings and oil indicators.

.4 Design the mechanism and drive unit for a continuous operating load of 80 N per metre of width. Supply calculations to show that these torque conditions are met:

.1 Alarm Torque: 120 percent of continuous operating torque

.2 Cut-out Torque: 130 percent of continuous operating torque

.3 Design Torque: 300 percent of continuous operating torque

.4 Maximum tip speed: 100 mm/s

.5 As a backup mechanical disconnect, provide a shear pin to disconnect the motor at 140 percent of the continuous operating torque

.6 Design the drive main bearing for the total rotating weight with a minimum ABFMA B10 bearing life of 200,000 hours, suitable for 24 hour continuous operation.

.7 Design all main drive components to provide a minimum wear life of 20 years.

.8 Design all bearings other than the drive main bearing for a minimum ABFMA B10 bearing life of 100,000 hours, suitable for 24-hour continuous operation.

.9 Design the entire drive mechanism, including turntable, to be serviced without removal of the walkway.

2.7 Drive Motor

.1 Provide a motor adequately sized to continuously carry all loads which may be imposed.

.2 TEFC, designed for a maximum ambient temperature of 40°C

.3 Mount the motor on top of the drive mechanism unit

.4 Comply with requirements of Section 11205

2.8 Protection and Alarm

.1 Equip the drive mechanism with a weatherproof torque indicator and electro-mechanical overload contacts.

.2 Provide and arrange micro-switches to provide an alarm signal when torque overload starts to develop and to stop the motor when the torque becomes excessive. Mount the switches in weatherproof enclosures and pre-wire the switches to a weatherproof enclosure.

.3 Pre-wire the micro-switches to a numbered terminal strip. Provide the following dry contacts for each drive unit:

.1 Excessive torque

.2 Torque overload

.4 Contacts shall be rated 5 A, 220 VAC, and shall be normally open to close on alarm condition.

2.9 Bridge Mechanism

.1 The bridge mechanism shall be constructed using CSA/CAN 3-S157-M83, 6061-T6 or 6351-T6 aluminum alloy.

2.10 Walkway

.1 Provide isolation between dissimilar metals and concrete at the connection points to prevent corrosion.

.2 Support the walkway at the centre column and by the clarifier wall. The walkway design live load shall be 4.8 kN/m^2. The maximum deflection of the walkway shall not be more than 1/360 of the span when all relevant loads are included.

.3 Provide a walkway clear width of 900 mm and a minimum of 600 mm working space around the equipment mounted above the operating platform. The walkway shall be constructed using slip resistant aluminum checker plate.

.4 Provide double row horizontal pipe guardrails, 1070 mm high. Provide 150 high kick plate along the bottom. Design the handrails for all applied loads in accordance with the 1995 National Building Code of Canada.

.5 Provide one safety davit and a minimum 1200 wide removable section of guardrail for man access along the walkway portion of the bridge mechanism. Provide additional removable section of guardrail for ease of man hoist installation into davit. Minimum design davit live load 18.0 kN applied in any direction.

.6 Safety davit: model number PNUS101-SS complete with sleeve cap model number PNUS106-SS as manufactured by Pelsue. Use stainless steel 304 or 316 bolts, nuts, plates and washers for mounted sleeves in accordance with manufacturer’s instructions. Provide stainless steel cable to secure sleeve cap to bridge.

2.11 Centre Cage

.1 Suspend the centre cage from the turntable, adequately braced and sufficiently strong and stiff to support and rotate the rake arm and suction header.

.2 Bolt the cage to the main gear and include connections for the sludge rake arm and suction header.

2.12 Energy Dissipating Well

.1 For dimensions, see 2.2

.2 Extend the distribution well to 50 mm below the water level in the clarifier.

.3 Provide centre well with a closed bottom. Size the well to provide a minimum 20 second retention time at maximum flow.

.4 Provide the center well with a minimum of eight adjustable diffuser gates. Size gates to provide an exit velocity no greater then 0.6 m/s when gates full open.

.5 Hinge the gates on one side and provide adjusting arm that can be locked in position when an appropriate gate setting is found.

.6 Extend gate opening above water level to allow scum and floatables to exit the energy dissipation compartment.

.7 Provide neoprene seal between energy dissipation compartment and centre column.

2.13 Flocculation Well

.1 For dimensions, see 2.2

.2 Make the flocculation well structure extend from 50 mm below the clarifier water surface to halfway down the clarifier's sidewater depth.

.3 Support from truss arms and/or centre cage.

.4 Fabricate flocculation well as a circle or as a polygon with a minimum of eight equal sides.

.5 Use hollow steel shapes to frame the well.

.6 For panels, use steel plate or corrugated fibreglass. Connect adjacent pieces and the frame with neoprene gaskets between to minimize leakage.

.7 Mount the well level with the top edge of the frame at the normal water surface, ±3 mm. Mounting at this elevation allows the passage of scum and foam without compromising the flow pattern.

2.14 Truss Arms

.1 Support rotating truss arms from centre stage.

.2 Fabricate truss arms using steel rods, structural steel sections, turnbuckles, clevises, and locknuts.

.3 Design to hold the sludge collection devices in a horizontal and vertical plane when subjected to momentary peak torque.

2.15 Sludge Suction Header

.1 Include a full-diameter suction header of a minimum of 6 mm stainless steel plate construction flanged from a central rotating collection chamber.

.2 Taper the header with rectangular cross-section, decreasing from the centre of the tank to the outer tip to impart a uniform sludge withdrawal velocity that is less than 600 mm/s, to reduce the probability of sludge build-up in the header or orifice clogging.

.3 At regular intervals, not to exceed 0.75 m, inlet orifices varying in size from a minimum diameter near the tank centre to a maximum at the outer end, shall be accurately located in the header. The design of each orifice shall be proportional to the volume of sludge withdrawn and the design of the orifices and header shall be such as to insure hydraulic balance in the tank and uniform sludge withdrawal from the entire tank bottom at all flows.

.4 Mount the header with the face on which the orifices have been placed on an angle of 45 degrees to physically and hydraulically trap the sludge for maximum solids concentration.

.5 Provide a bottom vane to fluidize the sludge into the area of influences of the orifices. Provide a neoprene squeegee with a steel backing plate attached to this vane. On the squeegee, provide slotted holes allowing for 25 mm vertical adjustment.

.6 At the inner end of the header, a flange shall be provided for bolting to the centre outlet manifold. The header shall have a centre scraper of 6 mm steel plate with a neoprene blade to clean the tank bottom around the manifold directing the sludge to the first orifice.

.7 Sludge Suction Header Supports

.1 The header supports shall consist of steel tie-bars with turnbuckles and locknuts which shall hold the header in alignment in both a horizontal and vertical plane. A structural steel tie-bar arm shall be provided for the attachment of the steel tie-bars.

2.16 Rotating Collection Chamber

.1 Fabricate rotating collection chamber of steel plate. Provide flanged connection to sludge suction header and connect to centre cage.

.2 The return secondary sludge enters from the suction header and exits through a hole in the floor within the chamber.

.3 Design to preclude leakage when subjected to 1000 mm head. Make seal between centre column and collection chamber using neoprene.

.4 Provide a steel plate to cast into the floor and provide a seal between the floor and the bottom of the collection chamber.

.5 Design for a maximum headloss of 100 mm.

2.17 Effluent Weir

.1 Provide an effluent weir with 75 mm deep V-notch weirs located on 150 mm centers. Locate this weir on the inboard side of the peripheral effluent launder. Slot the weir to allow up to 100 mm vertical adjustment.

.2 Provide the weir for each tank complete with angle and butt plate supports.

2.18 Painting

.1 Shop prime and paint all ferrous components of the equipment with high-build epoxy in accordance with Section 11900, except the suction header. Galvanize the suction header.

2.19 Spare Parts and Maintenance Materials

.1 Provide a spare secondary bearing for each mechanism.

.2 Provide 10 m of neoprene seal material.

.3 Provide a spare seal for centre sludge collection chamber.

3. EXECUTION

3.1 Manufacturer's Representative

.1 Manufacturer's representative shall be required to attend the Site to train installation personnel; to train operating personnel; and to witness installation and testing to ensure the equipment is installed and operated as intended.

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 installers understanding by completing Form 101 as included in Section 01650.

.3 Cooperate with the installer to fulfill the requirements for a successful installation, as documented by Form 102, included in Section 01650.

3.3 Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.2 Test level of clarifier to ensure clearance from floor does not very by more than ±5 mm.

.3 Load test clarifier to 150 percent of continuous torque. Verify torque settings of protective devices.

.4 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 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

INSTALLATION OF AERATION EQUIPMENT

1. GENERAL

1.1 Work Included

.1 This Section specifies the installation, testing, and commissioning of the fine bubble aeration equipment for the biological nutrient removal reactors.

.2 The aeration equipment will be supplied by the City via a separate Contract - Contract No. 602-2005 Supply and Delivery of Bioreactor Aeration Equipment for the West End Water Pollution Control Centre BNR Upgrade Project.

.3 The Aeration Equipment Supply Contract includes the following:

.1 Fabrication and factory testing of the aeration equipment;

.2 Supply of aeration equipment including diffusers and related equipment;

.3 Delivery of aeration equipment to the WEWPCC;

.4 Inspection of delivered aeration equipment;

.5 Installation training for the aeration equipment;

.6 Installation witnessing of the aeration equipment;

.7 Testing assistance of the installed aeration equipment;

.8 Operations and maintenance training for the aeration equipment;

.9 Operating and maintenance manuals for the aeration equipment;

.10 As-Constructed drawings for the aeration equipment;

.11 Technical support and remedying defects in the aeration equipment during the warranty period for the Aeration Equipment Supply Contract.

.4 Responsibilities of the Contractor include, but are not limited to:

.1 Receipt of the aeration equipment upon delivery;

.2 Off-loading and storage of the aeration equipment;

.3 Installation of the aeration equipment;

.4 Equipment testing;

.5 Coordinate installation training for the aeration equipment;

.6 Install all equipment and materials provided under the Aeration Equipment Supply Contract;

.7 Conduct equipment testing and commissioning of the aeration equipment;

.8 Coordinate operation and maintenance training for the aeration equipment.

1.2 Coordination

.1 Coordinate with other Divisions to ensure that there is no conflict with the Work.

2. EXECUTION

2.1 Manufacturer's Representative

.1 The Supply Contractor will provide a technically qualified Manufacturer's Representative. Arrange for the Manufacturer's Representative to:

.1 Attend and certify equipment delivery;

.2 Attend and certify installation training;

.3 Attend and certify equipment installation;

.4 Attend and certify equipment performance testing;

.5 Provide operation and maintenance training.

2.2 Delivery, Protection, and Storage

.1 The aeration equipment will be delivered by the Supply Contractor to the WEWPCC. Off-load the aeration equipment, take custody and store the equipment. Execute Form 100, Certificate of Equipment Delivery, in the Aeration Equipment Supply Contract (copy appended to this Section for information).

.2 Store the equipment in accordance with the requirements specified by the Supply Contractor.

2.3 Installation

.1 Receive installation training from the Supply Contractor. Execute Form 101, Certificate of Equipment Installation Instruction, in the Aeration Equipment Supply Contract (copy appended to this Section for information).

.2 Follow the written installation instructions and drawings provided by the Supply Contractor

.3 The aeration equipment shall be installed prior to the completion of the building, specifically prior to installation of the pre-cast double tees.

.4 Ensure the equipment is installed as required to provide satisfactory service.

.5 Cooperate with the Supply Contractor to fulfill the requirements for a successful installation, as documented by Form 102, included in Section 01650.

2.4 Commissioning

.1 The Contractor is responsible for Commissioning of the process systems which includes the equipment specified in this Section and to ensure the equipment functions as intended in the process systems.

2.5 Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.2 For the aeration equipment testing requirements, refer to instructions provided by the Supply Contractor and to the requirements outlined in the Aeration Equipment Supply Contract.

.3 Cooperate with the Supply Contractor to fulfill the requirements for successful testing of the equipment. Execute Form 105, Certificate of Satisfactory Equipment Testing (copy appended to this Section for information).

2.6 Training

.1 Arrange and coordinate the operation and maintenance training included in the scope of services specified in the Aeration Equipment Supply Contract.

CERTIFICATE OF EQUIPMENT DELIVERY
FORM 100

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

PROJECT: _____

ITEM OF EQUIPMENT: Aeration Equipment

_____

TAG NO: _____

REFERENCE SPECIFICATION: _____

_____ _____
(Authorized Signing Representative of the Installation Contractor) Date

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

CERTIFICATE OF EQUIPMENT INSTALLATION INSTRUCTION FORM 101

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

PROJECT: _____

ITEM OF EQUIPMENT: Aeration Equipment

_____

TAG NO: _____

REFERENCE SPECIFICATION: _____

_____ _____
(Authorized Signing Representative of the Contractor) Date

I certify that I have received satisfactory installation instructions from the equipment supplier.

_____ _____
(Authorized Signing Representative of the Installation Contractor) Date

CERTIFICATE OF SATISFACTORY EQUIPMENT TESTING
FORM 105

We certify that the equipment listed below has been tested and meets the Equipment Testing Requirements as set out in the Contract.

PROJECT: _____

ITEM OF EQUIPMENT: Aeration Equipment _____

_____

TAG NO: _____

REFERENCE SPECIFICATION: _____

_____ _____
(Authorized Signing Representative of the Contractor) Date

_____ _____
(Authorized Signing Representative of the Installation Contractor) Date

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

END OF SECTION

DISSOLVED AIR FLOTATION THICKENERS – RECTANGULAR

1. GENERAL

1.1 Work Included

.1 This Section specifies the supply, delivery and supervision of the installation, testing and commissioning of two rectangular DAF thickeners (T111-DAF and T121-DAF), each complete with tank, recirculation pump, saturation vessel, air compressor with associated control panel and air receiver, air control panel and accessories, pressurized flow piping and fittings including back pressure control device, flow control, flow monitoring, sludge skimming system, drive, float trough, cover, and other necessary accessories as specified.

1.2 Definitions

.1 Saturation efficiency is the ratio of the actual amount of air dissolved in the full pressurization flow to the theoretical amount that could be dissolved in the pressurization flow at the design pressure and test temperature based on one pressurization pump in operation per air saturation system at given loading.

.2 Hydraulic loading rate is the sum of the feed and recycle rates divided by the net effective flotation area.

.3 Solids loading rate is the total suspended solids load to the DAF tank (excluding recirculation) divided by the effective flotation area.

.4 Solids capture is the solids load in the influent less the solids load in the subnatant, all divided by the influent solids load.

.5 Air to solids ratio is the weight ratio of air available for flotation to the solids to be floated in the feed stream.

1.3 Submittals

.1 Shop Drawings: submit in accordance with Section 01300 and Section 11005, including the following:

.1 Design details for pressurization vessels, signed and sealed by a Professional Engineer registered in Manitoba.

.2 Provide process design calculations indicating the basic design assumptions; influent flow and load conditions considered; and predicted requirements for compressed air system, recirculation pump, saturation reset, and polymer system.

.3 Performance data for the back-pressure control device over the specified range of flows.

.4 Pressurized flow pipe support details.

.5 Provide hydraulic calculations indicating the assumptions; influent flow conditions considered; predicted water levels through a range of operating conditions including minimum, normal, and maximum flows; and sizing requirements for the various hydraulic elements including valves, pipes, and channels.

.6 Provide description of reciprocating compressors, complete with performance characteristics. Include all information required in Section 11005 and Section 11471.

.7 Provide description of pumps, complete with performance characteristics. Include all information required in Section 11005, Section 11300 and Section 11301.

.8 Provide layout drawings in plan and section indicating general arrangement of the various equipment components, major and minor piping, valving, major structural requirements, control stations, and all other ancillary devices and systems.

.9 Provide description of system operation under normal and adverse operating conditions. Adverse conditions are defined as periods of high flow, loading, or as periods when an equipment component has been removed from service for maintenance. Include startup requirements for initial placement into service and any subsequent return to service. Also include shutdown requirements. Provide description of system operation under all potential failure modes (equipment failure, control loss, power loss, etc.). Illustrate how system responds to failures to ensure that safety requirements are met, process equipment is protected from damage, and process performance is maintained to the degree possible.

.2 Operation and Maintenance Data: Provide for incorporation in O&M Manual as specified in Section 01300. Include complete description of operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, parts catalogues with complete list of repair and replacement parts with section drawings illustrating the connections and identifying numbers. Also provide:

.1 Detailed descriptions of initial start up, normal start up and shutdown procedures for the whole system

.2 Recommended maintenance schedules for each component of the system.

.3 Trouble-shooting procedures describing normal faults, possible causes and corrective actions. Emergency stop and its corrective actions shall be provided with this section.

1.4 Coordination

.1 Coordinate with other Divisions to ensure that there are no conflicts in the Work.

1.5 Shipment, Protection, and Storage

.1 Ship the equipment pre-assembled to the degree possible.

.2 Provide storage instructions indicating specific requirements to ensure there is no uneven wear, damage, distortion, or weathering of components.

.3 Provide any site assembly instructions and supervision as required.

.4 Identify all special storage requirements as specified in Section 01650.

1.6 Quality Assurance

.1 Structural steel and welds: use all structural steel used for equipment fabrication which conforms to the requirements of the Standard Specifications for Steel for Bridges and Buildings and ASTM A36. Conform to the latest standards of the American Welding Society.

.2 Structural design: design all steel structural components so that the stresses developed under the specified conditions will not exceed the allowable stresses defined by the latest AISC Standards and the aforementioned standards.

.3 Gear design: design all drive unit components in accordance with AGMA 2001-B, 6010-E, and 6034-A as applicable.

.4 Bearing design: design main bearing in accordance with AFBMA

2. PRODUCTS

2.1 Description

.1 Design the DAF thickening equipment for thickening WAS from an activated sludge biological nitrogen removal (BNR) municipal wastewater treatment plant. The wastewater tributary to this treatment plant, although mostly of domestic origin, can be expected to contain some industrial waste. The DAF Thickener System increases the solids concentration in WAS, resulting in a TWAS concentration of 3 percent without polymer and 4 to 6 percent with polymer flotation aids. The system skims the TWAS float from the DAF thickener tank to a TWAS hopper, where TWAS flows to existing sludge storage vaults through a discharge pipe inclined at 45 degrees.

.2 Design DAF thickener float collection equipment to be installed in a rectangular steel tank.

.3 WAS is conveyed to the thickener at a flow rate which will vary in response to desired sludge retention time (SRT) to satisfy operational requirements.

.4 Include the surface skimmer and associated chains, sprockets, shafts, flights, rails and guards, dewatering beach, flight wiper, retention baffle, effluent weir, drives, variable speed drive, and control panel.

.5 Include a pressurization system including compressor, inlet distribution system, pressure regulating valve, saturation tank with level control systems, air control panels and back pressure control valves, recycle flow control and monitoring devices. Design the systems to achieve the specified air saturation efficiency under all specified operating conditions.

.6 The DAF thickener pressurization system uses the DAF subnatant. Supply a non-clog centrifugal recirculation pump to supply DAF subnatant to the saturation tank.

.7 Remove floating thickened sludge from the surface of the tank with float collectors which sweep the float into a TWAS hopper which is equipped with a manual isolation valve installed on its glass-lined discharge pipe. The pipe is inclined at 45 degrees in order to allow a constant gravity flow to the existing sludge holding tank. The manual isolation valve is designed to isolate the odour from the existing sludge storage vaults when the DAF tank is out of service for maintenance.

.8 Design the collector components to operate in both a dry (short time for commissioning) and a wet tank condition, construct to meet or exceed working loads created when removing thickened sludge of a concentration of 10 percent solids.

.9 Service conditions will be corrosive for equipment located inside the DAF tanks.

.10 Design the system to permit the use of polymers as a flocculating aid, while achieving the required solids concentration under all conditions

.1 Two DAF thickeners in service without polymer addition

.2 One DAF thickener in service with polymer addition

.11 Bottom sludge will be removed from the DAF tank periodically controlled by a motorized valve-equipped drain line to the existing sludge holding tank.

.12 The bottom sludge pipe and subnatant pump suction pipe are connected such that the DAF can be drained to the plant headworks through the subnatant pumps when a DAF tank is required to be emptied or out of service.

.13 Provide overflow connection for each DAF tank from the subnatant hopper.

2.2 Acceptable Manufacturers

.1 Komline Sanderson

.2 US Filter Envirex

.3 Westech

2.3 Design Loadings Rates

.1 Design the DAF system to achieve the specified requirements while subjected to the following flows and loads.

	Minimum	Average	Maximum
WAS Flow m3/d	684	760	1285
TSS Loading kg/d	1490	3530	5850

.1 Governing design condition: design the system to operate under the more stringent of:

.1 Two thickeners in operation accommodating 100 percent of the solids and hydraulic load without polymer

.2 One thickener in operation accommodating 100 percent of the solids and hydraulic load with polymer

.2 Average flow: 760 m^3/d

.3 Maximum flow: 1285 m^3/d

.4 Average solids load: 3530 kg/d

.5 Maximum solids load: 5850 kg/d

.2 Design the DAF system to meet the following criteria.

.1 Solids loading rate at maximum flow, without polymer addition, is to be no greater than 4.4 kg/m^2/hr.

.2 Active polymer dose rate at average flow and load to be no greater than 1.5 kg/T.

.3 Active polymer dose rate at maximum flow and load to be no greater than 2.5 kg/T.

.3 Minimum air saturation efficiency 80 percent

.4 Minimum Air to Solids ratio of 0.03, based on one pressurization pump in operation per air saturation system at given loading.

.5 Number of Units: 2

.6 Operation: 24 hr/day

.7 Effective flotation area of 27.9 m^2 each

.8 Minimum air saturation efficiency: 80 percent

.9 Designed pressurized recirculation flow pressure: 450 kPa with a variation range of 380 to 520 kPag.

.10 Minimum Air to Solids ratio of 0.03, based on one pressurization pump in operation per air saturation system at given loading.

.11 Minimum solids capture

.1 95 percent with polymer

.2 90 percent without polymer

.12 TWAS concentration

.1 40,000 to 60,000 mg/L TSS with polymer

.2 30,000 mg/L TSS without polymer

2.4 General Arrangement

.1 Each tank is no longer than 10.5 m and no wider than 3.8 m.

.2 WAS feed inlet and distribution system at end of DAF tank.

.3 TWAS (float) removal system and its outlet may be located at either the same end, or the opposite end of DAF Tank from WAS feed inlet.

.4 Subnatant removal system and outlet at opposite end of DAF tank from WAS feed inlet.

.5 Recirculation pump, saturation vessel and air compressor located adjacent to long side of DAF tank.

2.5 Materials

.1 Design all stainless steel structural components so that the stresses developed under the specified conditions will not exceed the allowable stresses defined by the latest AISC Standards and the aforementioned standards.

.2 Design all drive unit components in accordance with AGMA 2001-B, 6010-E, and 6034-A as applicable.

.3 Design main bearing in accordance with ABFMA.

.4 Fabricate structural and water retaining components of AISI Type 304L stainless steel plate, a minimum of 6 mm thick, to ASTM A240/A666.

.5 Fabricate submerged hardware of AISI Type 316 stainless steel.

.6 Fabricate air saturation vessel of 304L SS designed per ASME code, Section VIII, Division 1, for a minimum design pressure of 950 kPa.

.7 Fabricate saturation vessel nozzle impingement plate and fastening hardware of AISI Type 316 stainless steel.

.8 For submerged back pressure control valves, fabricate the valves and fastening hardware of AISI Type 316 stainless steel. For non-submerged back pressure control valves, fabricate the valve from cast iron.

.9 Fabricate weir plates of aluminum or AISI Type 304 stainless steel.

.10 Fabricate skimmer-carrying and drive chains of reinforced polymer.

.11 Fabricate float skimmers of AISI Type 304 stainless steel or fiberglass.

2.6 DAF Tanks

.1 Identify the proposed arrangement and dimensions of the DAF tanks.

.2 Provide details to enable structural design of concrete structures.

2.7 Influent Structure

.1 Design the influent structure to distribute the flow evenly across the width of the tanks.

2.8 Float Removal System

.1 Float to be removed from the surface of the tank by a skimmer system. The skimmer consists of two strands of chain running above the liquid surface by two sets of sprockets with runners provided for attachment to the steel tank to maintain a vertical position. Flights connect to the chains and convey the sludge towards the end same as or opposite to the effluent discharge and scrape the sludge over the dewatering beach and into the sludge hopper.

.2 Support the skimmer on its carrying and return runs by tracks constructed of 6 mm minimum structural angles.

.3 Design the skimmer chain system for operation without the use of chain lubrication or oilers, and fabricate of only non-corrodable materials.

.4 Provide driven and idler sprockets with hardened tooth bearing surfaces of not less than 360 Brinell and a depth of at least 5 mm, or high strength non-metallic polyethylene sprockets.

.5 Design the flights to provide a horizontal movement and with a full width neoprene wiper. Fabricate the flights of 3 mm thick 304L stainless steel and minimum 200 mm high; designed to have the full weight of the flight resist the thickened sludge blanket, or be fitted with a non-corroding spring, to prevent the flight wiper from traveling beyond the horizontal position and provide effective removal of the thickened sludge. Design the flight to allow the wiper to be parallel to the beach. Space the flights to provide for the efficient removal of the sludge volumes required but no greater than 1000 mm apart.

.6 Skimmers transfer the float up a dewatering beach. Extend beach plate the full width of the basin. Ensure one surface is smooth to prevent skimmer blade erosion.

.7 Provide a 1:4 beach slope, with the highest point sufficiently above the normal water surface to prevent liquid from entering the sludge trough when the skimmer is not operating.

.8 Ensure the beach provides an adequate horizontal surface for the entrapment of the sludge by the skimmer flight.

.9 Provide an effective wiper system for cleaning the skimmer flights.

2.9 Bottom Sludge Collection

.1 A dedicated scraper system and drive is not required.

.2 Design the DAF tank to include a bottom sludge collection system that drains to the existing sludge holding tank by controlling a motorized valve.

2.10 Float Trough

.1 For integral troughs, provide all equipment including supports.

.2 Design trough to allow for the thickened sludge to flow freely. Systems which use water jets and other similar devices to move the sludge along the trough are not permitted.

2.11 Subnatant Removal

.1 Subnatant will pass under a retention baffle and discharge over a weir.

.2 Place the retention baffle a minimum of 300 mm from the subnatant overflow weir. The quiescent zone between the weir and the overflow baffle is not considered in tank sizing. Extend the baffle from above the high water level plus 100 mm to mid depth of the tank.

.3 For the retention baffle, use minimum 5 mm thick stainless steel or 10 mm thick high strength FRP.

.4 Provide a minimum 6 mm stainless steel or aluminum weir plate at the weir wall to permit adjustment of the float level, with a vertical travel equal to the rise of the inclined portion of the dewatering beach, or a minimum of 75 mm.

.5 A portion of the subnatant will be recirculated through the pressurization system.

2.12 Drive Mechanism

.1 Use a directly mounted hollow shaft gear motor with manual speed control for the skimmer drive. The manual speed control shall be capable of driving the skimmer at speeds between 10 to 40 mm/s.

.2 Fit the drive with a zero speed switch for full protection of equipment in case of stalling due to excessive loading or mechanical failure.

.3 Make the driven sprocket on the skimmer headshaft not less than 630 mm pitch diameter.

.4 The drive chain is to be reinforced polymer.

.5 Make driven sprockets of split dished construction. Use cast iron sprocket body bored, with keyway and set screw, to suit the head shaft. Use driven sprockets that are at least 535 mm pitch diameter and that have not less than 40 teeth for NM 78 chain.

.6 Fit drive sprockets with bronze bushings and shear pins. Select driving sprockets on speed reducers that have no fewer than 11 teeth and that are not less than 235 mm diameter.

.7 Furnish sprockets on all shafts. Traction wheels, idler wheels, or other substitutes are not acceptable. Key sprockets firmly to the headshafts. The skimmer take-up shaft to have one sprocket set-screwed and one sprocket to run loose on the shaft. Protect all drives by shear pin hubs on either the driving or driven sprocket.

.8 Make all shafting of type 304 stainless steel, extending the full width of the tank. Fabricate the shafts to contain keyways with fitted keys where necessary and to be of sufficient size to transmit the power required and to prevent deflection greater than 4 mm/m and to permit the smooth travel of the carrying chain and flights. Ship skimmer shafting as complete subassemblies with sprockets, bearings and set collars in place.

.9 Design the shafts to be supported by and rotated in babbitted bearings. Use bearings that are grease lubricated in and above water service. Provide the surface skimmer with take-up bearings, providing not less than 250 mm of horizontal movement and of cantilever design with fabricated steel support base and stainless steel take-up screws.

.10 Provide double reduction right angle worm gear reducer, fully housed, running in oil with anti-friction bearings throughout. Design to AGMA standards for 24 hour continuous operation, moderate shock loads, and 20-year design year life. Design gear drive bearings for an ABFMS L-10 design life of 100,000 hours.

.11 Include a locally-mounted, manual handwheel adjustable variable speed gear for drive.

.12 Provide LO and HI torque switches for drive.

.13 Provide motor conforming to EEMAC standards, in compliance with Section 11205.

.14 Drive units pre-assembled as a complete assembly.

2.13 Pressurization System

.1 DAF thickener pressurization system consists of air compressor, recirculation pump, saturation vessel with associated air control panel and accessories, pressurized flow piping and fittings only where provided by this Contract, including back pressure control devices, recycle flow control and monitoring devices.

.2 Inlet Distribution System

.1 Provide a fabricated stainless steel manifold inlet mixing and distribution system inside the flotation tank, to allow for intimate mixing of the wastewater influent and the flow of recirculated pressurization water from the air saturation vessel and to distribute the mixed flow evenly across the width of the tank. A distribution system employing valves or other mechanical means is unacceptable.

.3 Air Saturation vessel

.1 Provide one air saturation vessel for each DAF tank.

.2 Design the air control system is such that it supplies sufficient air for the flotation process.

.3 Provide cylindrical welded stainless steel tank, sized for efficient saturation of the pressurized flow with air and separation of large bubbles required to achieve the design performance. Design the tank in accordance with ASME Code, Section VIII, Division 1, for the design working pressure.

.4 Design the internal arrangement of the saturation vessel and size the recirculation pump to achieve the specified air saturation efficiency. Internal packing, secondary recirculation pumps and mixers are not allowed. Minimum discharge velocity of the pressurized flow nozzle(s), if required, is 6 m/sec. Nozzle(s), if required, discharge on a replaceable stainless steel target baffle(s) without impinging directly on the pressure vessel.

.5 Water enters the retention tank vessel through the spray nozzle and leaves through the return piping to the DAF tank. The liquid level rises as air is dissolved in the recycle stream. The high level switch makes contact and the air solenoid energizes to open. Air is supplied until the water in the tank has been displaced to the point where the low level switch breaks contact and the air solenoid valve closes. The air blanket pressurizes and works to empty the vessel. This starts the cycle again. The water fill cycle repeats.

.6 Fit the saturation vessel with the following:

.1 Pressure access hatch, 300 x 400 mm minimum

.2 Flanged support skirt suitable for anchor bolting with 150 mm diameter holes at 90° quadrants to permit access to the drain connection.

.3 A bottom 50 mm diameter drain and valve

.4 A 19 mm safety relief valve

.5 A 600 mm long armoured sight gauge visible from the air control panel and fitted with gauge valves in addition to top and bottom cleanouts with ball valves.

.6 Mechanically activated level control device with a monel float-actuated mercury switch, which controls the operation of the solenoid control valve located in the air control panel. The solenoid control valve enables and disables the flow of air from the compressed air receiver to the air saturation vessel. Mount the float in a cast iron chamber, external to the saturation vessel, with type 316 stainless steel internal trim, type 400 stainless steel magnetic sleeve, and brass inner liner. Attach the chamber to the saturation vessel with two 25 mm ball valved connections and a 25 mm ball valved drain.

.7 High and low water level switches, DPDT in an EEMAC 4X enclosure. Upon high level close a High Level alarm contact; upon low level close a Low Level alarm contact. Attach the switches to the saturation vessel with two 19 mm ball valve connections.

.8 A pressure gauge in accordance with Section 11005. The range of the pressure gauge to be from zero to a level appropriate for the system.

.9 Flanged inlet and outlet connections

.10 19 mm air inlet connection

.11 Internal piping and nozzle(s)

.12 Internal dissolution nozzles, if required, with replaceable stainless steel target baffles.

.13 Fit the tank with plate baffles, size and locate the entrance to the pressurized flow outlet pipe to prevent the formation of vortices and the entrainment of bubbles from the tank gas space.

.14 Provide fittings which comply with code requirements so that the sight glass, the level control valve float chamber, and instrumentation connections can be purged with high-pressure plant water without draining the saturation vessel.

.4 Air Control Panel

.1 Provide an air control panel mounted in an open faced 12 gauge type 304 stainless steel enclosure that is designed to control the volume and pressure of air delivered to the saturation vessel from the compressed air receiver. Make provisions for remote monitoring from the plant Distributed Control System (DCS).

.2 Mount the air control panel on the DAF tank adjacent to the saturation vessel. Provide components with a 19 mm nominal line size.

.3 Provide a manually adjustable combined air pressure regulator/filter/pressure gauge with drip trap, air flow control valve and check valve.

.4 The solenoid control valve shall be wired such that it is normally closed except when the recirculation pump is operating. Solenoid valve shall be rated for 120V, 60Hz, 1 phase. Provide a valved bypass.

.5 Provide an air flow rotameter with a valved bypass and drain.

.6 Provide isolation valves as required to permit proper isolation of various system components.

.5 Back Pressure Control Valve

.1 Provide a manual back pressure control valve to control the back pressure and injection rate of pressurized recirculation back into the tank near the feedwell inlet. Provide a handwheel operator.

.2 Design the back pressure valve for the required pressure. Identify the design pressure.

.6 Recirculation Pressurization Pump

.1 Provide a minimum of one recirculation pressurization pump. Pumps to be of the single stage, horizontal, base-mounted, end suction, top centerline discharge, centrifugal type with Class 125 flanged connections.

.2 Provide pumps with cast iron casings and impellers, polished steel shaft, hardened 12 percent chrome shaft sleeve, and fabricated steel base plate.

.3 Design the pump to recirculate the required flow at a total dynamic head appropriate to a saturation vessel.

.4 Select a pump that operates at a flow that is 80 to 100 percent of the flow at its Best Efficiency Point.

.5 Provide pump with a maximum speed of 1800 rpm.

.6 Couple pump to a single speed motor, in accordance with Section 11205.

.7 Air Compressor

.1 Provide an air compressor in accordance Section 11471.

.2 Provide an air receiver in accordance with Section 11471. Design the air receiver with sufficient capacity to permit the air blanket in the saturation vessel to be replenished between solenoid control valve open and close liquid levels without over-cycling the air compressor.

.3 If necessary, provide an acoustic enclosure such that noise measurements at 3 m from any point on the equipment in free field does not exceed 85 dBA.

.4 If the particular DAF equipment requires further conditioning of the compressed air, provide the conditioning equipment.

2.14 Controls

.1 The various parts of the DAF system shall be operated in one of two modes, Panel or Remote, as selected at the local control panel Panel/Remote switch. In Remote mode the DAF and its ancillary components will be operated by the distributed control system (DCS). In Panel mode the individual DAF components shall be operated manually by the operator.

.2 The DAF manufacturer is to provide all necessary instrumentation for normal operation of the DAF and its ancillary components. The DAF manufacturer is to provide a single common control panel for location next to the DAF equipment. Wire all instrumentation and control signals to terminals in the common panel for connection to the DCS. Signals made available to the DCS shall include but not be limited to process values, instrumentation or equipment fault status, process control switch points, process and equipment alarms.

.3 The DAF manufacturer is to provide at the common panel all local controls, indicators and annunciators as required to permit operation of individual DAF components in Panel mode. Local Panel controls shall include momentary contact Start and Stop push buttons for each motor or pump and a single momentary contact push button to operate the air solenoid valve.

.4 The DCS will provide the necessary system remote monitoring, control and alarms as well as the archiving of significant process of performance data. The DCS will interface to the DAF system via the local interface points provided under this Contract. Provide all necessary items to facilitate this interface consistent with the functional operation of the DAF and the intent of these specifications.

.5 Provide an emergency shutdown, initiated either by the emergency stop push-button or by system alarms. The emergency shutdown will shut down the equipment simultaneously. After the condition is cleared and the emergency stop push-button de-energized, the system shall require a safety check and restarting by the operator.

2.15 Protective Coatings

.1 Equipment, excluding stainless steel or aluminum components, shall be provided with protective coatings suitable for indoor industrial service.

.2 Shop prime and paint metals in accordance with manufacturer's written recommendations.

.3 Provide coating system equivalent to Amercoat 385 prime coat and Amercoat 450 HS Urethane finish coat.

2.16 Spare Parts

.1 Provide spare parts in accordance with Section 11005. Specifically, provide the following:

.1 One (1) spare valve of each type and size used

.2 One (1) spare recirculation pump

.3 One (1) set of nozzles and target baffles for saturation vessel

.4 One (1) set of any special tools required to assemble, disassemble, or maintain the equipment

.5 3 m of skimmer chain

.6 Two (2) skimmer guide blocks

.7 Two (2) skimmer rubber inserts

.8 One (1) spare gear drive for the mechanism

.2 Provide a list of all spare parts which would be expected to be required under normal conditions (for all parts of the equipment package) for a period of five years. At the Contract Administrator's request, provide a price for these parts.

3. EXECUTION

3.1 Manufacturer's Representative

.1 The manufacturer shall arrange for a technically qualified manufacturer's representative to attend the installation work, train City 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 requirements and specifications.

.2 The minimum periods of site attendance are identified in the following table along with the Form to be completed on each of these trips. A "day" is defined as eight working hours on site.

Item	Description	No. of Days per Trip	Form
1	Equipment Delivery	0.5	100
2	Installation Assistance (combined with Item 1)	0.5	101
3	Witnessing of Equipment Installation	1	102
4	Operator and Maintenance Training (combined with Item 3)	1	T1
5	Equipment Performance Testing	3	103
6	Process Performance Testing	1	104
7	Operator and Maintenance Training (combined with Item 6)	1	T2

.3 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor.

3.2 Installation Assistance

.1 The manufacturer's representative shall verify satisfactory delivery of the equipment by completing Form 100, included in Section 01650.

.2 The manufacturer's representative shall instruct the Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractors' understanding by completing Form 101, included in Section 01650.

3.3 Installation Witnessing

.1 The Contractor shall ensure that the equipment is installed plumb, square and true within tolerances specified by the manufacturer and as indicated in the Contract Documents.

.2 The Contractor shall ensure that the equipment is installed as required to provide satisfactory service.

.3 The manufacturer's representative shall cooperate with the Contractor to deliver a successful installation as documented by Form 102, included in Section 01650.

3.4 Equipment Performance Testing

.1 The manufacturer's representative shall ensure the equipment, including all component parts, operates as intended.

.2 The manufacturer's representative shall demonstrate conformance to the requirements specified herein.

.3 The manufacturer's representative shall cooperate with the Contractor to test the equipment as documented by Form 103, included in Section 01650.

.4 Tests to include, but not to be limited to the following:

.1 Pump field tests as required by Section 11300.

.2 Compressor field tests as required by Section 11471.

.3 Valve operation tests, as required by Section 15100, in conjunction with pipe pressure tests.

.4 Local control devices and assemblies in conjunction with the equipment controlled.

.5 Clean water running test on the DAF system, as follows.

.1 The DAF tank will be filled with the plant secondary effluent.

.2 The recirculation pump, compressor and skimmer will be started. Operate for periods specified in Section 01650. Record air and water pressures.

.3 Undertake series of tests to confirm the efficiency of the air saturation system. Provide written summary of test protocol, one month prior to proceeding.

.6 Performance tests, as follows:

.1 Conduct performance tests on the DAF unit for periods specified in Section 01650.

.2 Use the plant secondary effluent for first stage of performance tests.

.3 Use WAS for the second stage of performance tests.

.4 Introduce WAS in a manner that does not damage equipment.

.5 Run second stage of performance test for the periods specified in Section 01650.

.5 At the successful conclusion of operational and performance tests, verify successful performance of the DAF system by completing Form 103, included in Section 01650.

3.5 Process Performance Testing

.1 The manufacturer's representative shall attend the commissioning of the process system that includes the equipment specified in this section to ensure the equipment functions as intended. The manufacturer's representative shall cooperate in the development of the commissioning plan for this equipment and cooperate with the Contractor in the commissioning of the equipment as documented by Form 104, illustrated in Section 01670.

.2 The manufacturer's representative shall demonstrate conformance to the requirements specified herein.

.3 Instruct the Contractor and City as to the proper procedures for introducing WAS to the unit. In addition to testing, establish all other conditions necessary for proper commissioning.

.4 Provide guidance regarding operation parameter setpoints during commissioning.

.5 Forewarn the Contractor of any potential problems related to the introduction of WAS to the system and provide contingency plans for handling the problems.

.6 At the end of the commissioning period, verify successful commissioning by certifying Form 104.

3.6 Training

.1 The manufacturer's representative shall provide training to the City's staff in the proper operation and maintenance of the equipment as documented by Forms T1 and T2, illustrated in Section 01665.

END OF SECTION

DRY POLYMER MAKEUP SYSTEM

1. GENERAL

1.1 Work Included

.1 This Section describes the requirements for the design, supply, delivery, installation, supervision of the start-up, field testing and commissioning of a volumetric or gravimetric dry chemical system. The system shall be capable of handling dry powder polymer material, feeding it into the makeup system, preparing a solution of the polymer in water, and aging the polymer solution for feeding to the WWTP process.

1.2 Submittals

.1 Submit Shop Drawings in accordance with Sections 01300 and 11005.

.2 Manufacturer's catalogue data describing capacities of each component of the package, power requirements, control signals provided, completed parts list noting materials of construction and gross and net weights of the complete package, including frames.

.3 Operation and Maintenance Data: provide for incorporation in an O&M Manual as specified in Section 01300. Include a complete description of the system's operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, status information to the DCS, parts catalogues with complete list of repair and replacement parts, with section drawings, illustrating the connections and identifying numbers. Also provide:

.1 Detailed description of initial start up, normal start up and shut down procedures for the whole system

.2 Recommended maintenance schedules for each component of the system.

.3 Trouble-shooting procedures describing normal faults, their possible causes, and corrective actions. Emergency stop and its corrective actions shall be provided with this section.

1.3 Shipment, Protection, and Storage

.1 Ship all equipment pre-assembled, pre-piped, pre-wired, and skid-mounted. Test the system prior to shipment.

.2 Provide complete storage instructions, indicating specific requirements necessary to prevent any weathering, corrosion, contamination, mechanical damage, freezing, or any other deterioration of components.

2. PRODUCTS

2.1 Description

.1 Provide two (2) identical fully automatic polymer makeup systems to prepare polymer solution of exact concentration (0.5 percent) on a batch basis. One system (T130-POL) system will be dedicated to the DAF units and the other system (T135-POL) will be dedicated to periodic primary treatment enhancement as required (CEPT).

.2 Supply products modified as necessary by the manufacturer to provide the specified features and to meet specified operating conditions.

2.2 Acceptable Manufacturers

.1 Ciba Specialty Chemicals

.2 Chem Systems Inc

.3 Performance Fluid Equipment

.4 Semblex

.5 Teknofanghi

.6 USF/Stranco

2.3 Capacities and Performance

.1 DAF Polymer System (T130-POL)

.1 The design polymer dosage rate is based on 25 kg polymer per 1000 kg dry WAS solids and maximum day polymer consumption is 14.6 kg/d

.2 Design Criteria

	Dry Polymer Consumption		Polymer Solution Demand	
Polymer Dosage Rate (maximum)	2.5	kg/T solids		
Polymer Solution concentration	0.5	%		
Polymer Consumption Maximum	14.6	kg/d	122	L/hr
Polymer Consumption Average	8.8	kg/d	74	L/hr
Polymer Consumption Minimum	3.7	kg/d	31	L/hr

.3 Polymer solution concentration: 0.5 percent

.2 CEPT Polymer System (T135-POL)

.1 The design polymer dosage rate is based on 0.25 mg/L of plant influent, the design maximum and average polymer kg polymer consumptions are 28.0 kg/d and 8.8 kg/d respectively in response to the maximum and average plant design flow rates of the primary tanks.

.2 Design Criteria

	Dry Polymer Consumption		Polymer Solution Demand	
Polymer Dosage Rate (maximum)	0.25	mg/L		
Polymer Solution concentration	0.5	%		
Polymer Consumption Maximum	28.0	kg/d	233	L/hr
Polymer Consumption Average	8.8	kg/d	74	L/hr

.3 Polymer solution concentration: 0.5 percent

.3 Dry polymer: microbead or powder type with cationic charge.

.4 The system shall produce a clean polymer solution with no evidence of partially-wetted particulate agglomerations or turbidity at the end of the mixing period.

.5 At the end of the process performance testing period, the following shall be verified:

.1 No evidence of polymer dust depositions on equipment surfaces, the floor, or other surfaces within reasonable distance from the equipment.

.2 No evidence of leaks of polymer solution through piping joints, valves, or any other component.

.3 No evidence of accumulation of agglomerated or partially wetted semi-liquid polymer in the receiving hopper outlet, screw feeder interior, blower interior, wetting system, or instruments in the tanks.

2.4 Materials

.1 Fabricate the components in contact with the polymer (dry or wet) of Type 304 stainless steel.

.2 Fabricate the mixing and aging tanks of stainless steel, polyalyphatic plastic (HDPE or PP), or fiberglass (FRP).

.3 All electrical, instrumentation, and controls components in the dry polymer handling system to be rated for Class II Division 2.

.4 All parts in contact with dry polymer to be electrically connected to one common ground to prevent electrostatic charges.

2.5 Bulk Bag Discharger

.1 Provide a pallet to accommodate 36 25-kg bags or total 900 kg polymer.

.2 Polymer bags will be delivered to and positioned on the pallet by hand.

.3 Provide a hand pallet truck to move the pallet from outside to the polymer makedown room.

2.6 Receiving Hopper

.1 The 25 kg bags of polymer will be delivered to the receiving hopper from their storage pallet by operators

.2 Provide a receiving hopper having a storage volume of dry polymer of 75 kg, equivalent to three 25-kg bags

.3 The hopper is equipped with a low level sensor to activate an alarm to indicate refilling is required.

2.7 Screw Feeder

.1 Provide a screw feeder to transport dry polymer from the receiving hopper.

.2 For volumetric feeders, the auger shall be driven by a variable speed motor to allow for calibration of the feeder. For gravimetric feeders the motor will be constant speed.

.3 The feeder shall feature a heated powder dryer at the discharge and a positive closure device to prevent after-run during shutdown.

.4 Provide a 120 V, 1 phase (less than 0.375 kW) or 575 V, 3 phase (greater than 0.375 kW), 60 Hz motor, TEFC.

.5 Polymer feed shall be operator-adjustable to produce polymer solutions with concentrations anywhere in the range of 0.1 to 0.5 percent without varying the volume of water in each batch.

2.8 Blower

.1 If blower is required in dry polymer makeup system:

.1 Provide with 120 V, 1 phase (less than 0.375 kW) or 575 V, 3 phase (greater than 0.375 kW), 60 Hz TEFC motor.

.2 Steel casing or impeller are not acceptable, even if coated.

2.9 Wetting System

.1 Provide a non-mechanical wetting chamber for makeup of the polymer solution.

.2 Fabricate the feed spout of Type 316 stainless steel.

.3 Provide a connection for the potable water line.

.4 Provide a bronze electrically actuated valve for controlling flow of potable water to the dispenser and manual isolation valve.

.5 Provide pressure regulating valve with integral pressure gauge, flow switch low with audible alarm on loss of flow before reaching desired level in mixing.

.6 Ensure no restrictions are present downstream from the point of water/polymer contact.

.7 Provide high level overflow for the wetting system and a high level switch to provide an audible alarm upon malfunction of the wetting chamber.

2.10 Tanks

.1 A mixing tank shall be provided for mixing of the polymer solution after discharge from the disperser and before transfer to the aging tank. The mixing tank shall contain a stainless steel mixer.

.2 An aging tank shall be provided to receive solution from the mixing tank and store the solutions for the purposes of feeding via the polymer feed pumps.

.3 The tanks must be separated such that the flow from the upstream tank flows in a manner to ensure that the fresh polymer cannot short circuit into aged polymer.

2.11 Mixer

.1 Provide one (1) mixer for the mixing tank.

.2 All wetted parts of the mixer shall be Type 316 stainless steel.

.3 Drive the mixer for the mixing tank with a 120 V, 1 phase (less than 0.375 kW) or 575 V, 3 phase (greater than 0.375 kW), 60 Hz electric motor with a service factor of 1.15.

.4 Gear reduced to 350 rpm maximum output. Output torque designed for corresponding tank size and to ensure gentle mixing of polymer solution without fracturing the polymer chains.

.5 For mixers with motors less than 3.7 kW, the mixer may be supported from a structure on the side of the tank, with the mixer shaft installed at an angle. For motors greater than 3.7 kW, the mixer should be mounted on a dedicated bridge frame structure on top of the mixing tank.

2.12 Liquid Level Control

.1 In addition to any level sensors or switches required for process control, provide one (1) LSLL and one (1) LSHH in each tank for safety and loss prevention interlocks.

2.13 Control and Instrumentation

.1 All instrumentation, control equipment, and enclosures shall be provided in accordance with Division 17.

.2 Provide a control panel for automatic operation of the entire polymer makeup system.

.3 Provide a completely pre-wired control panel complete with EEMAC 4X enclosure.

.4 Wire the panel to accommodate 120 V, 1 phase, or 575 V, 3 phase, 60 Hz power supply. Separate electrical panel enclosures shall be provided for low voltage (up to 120 V, 1 phase) and high voltage (over 120 V, 1 phase and including 575 V, 3 phase) applications.

.5 Include all pushbuttons, running lights, motor starters, relays, timers, transformers, and appurtenances, designed for automatic operation.

.6 Provide an emergency shutdown, initiated either by the emergency stop push-button or by system alarms. The emergency shutdown will shut down the equipment simultaneously. After the condition is cleared and the emergency stop push-button de-energized, the system shall require a safety check and restarting by the operator.

.7 Provide programmable logic controller. The controller shall allow proportional dosing of the powder to the water flow rate, and shall allow programming of the polymer concentration during operation. Programmable parameters shall include dry feeder speed, dry feeder temperature control, and mixer on/off times.

.8 Allow for a controlled shutdown. The shutdown sequence shall be specific to system provided by manufacturer.

.9 Level switches in the mixing tank control the feeding of the dry polymer. Mixing continues for a period determined by the operator.

.10 Mixing time to be operator adjustable.

.11 Polymer feed to be operator adjustable.

.12 Provide to the DCS via ethernet communications the following signals and status information:

.1 Aging tank level information, i.e. level value if analogous, individual level signals for Low-Low, Low, High, and High-High if from level switches.

.2 Polymer package makeup operation status, i.e. mixing, idle, etc.

.3 All alarm values for high and low limits, equipment faults, makeup system failure, etc.

.13 Polymer solution consumption shall be continuous.

2.14 Protective Coatings

.1 Equipment, excluding stainless steel, aluminum or plastic components, shall be provided with protective coatings suitable for indoor service.

.2 Shop prime and paint metals in accordance with manufacturer's written recommendations.

.3 System thickness to be 75 to 125 microns total dry film thickness of epoxy and 50 to 100 microns total dry film thickness of urethane.

.4 Provide a urethane finish coating, comparable to high gloss safety blue for the structural steel for the bulk bag frame system and lifting crucifix and all motors.

2.15 Piping, Valves and Actuators

.1 All piping shall be Type 304L or Type 316L stainless steel, schedule 10, rated for 150 lbs. at saturated steam temperature per ANSI/ASME B31.3. For nipples, use schedule 40. Threaded connections should be minimized. Threaded joints are not allowed for piping with diameter of 50 mm and above.

.2 Flanges may be C.S. ASTM A-105, ANSI/ASME Class 150 lb lap-joint, but with butt-welded, forged SS stub ends similar to piping. Purchaser will not accept stamped stub ends. Steel flanges to be corrosion protected. Flange bolt holes shall straddle natural centrelines.

.3 Acid pickle and passivate SS piping before testing and flush with clean water.

.4 Direct tapping on piping walls for instrument insertion will not be accepted.

.5 Only welders who have qualified according to the applicable code or standard shall be used for pressure welds.

.6 Equipment, pumps, valves, flow switches, and other in-line equipment shall be installed in such a manner that they are accessible and can be replaced or repaired without placing a strain on the piping. Breakout flanges or unions shall be provided between equipment and block valves, if any, to allow easy removal.

.7 Provide actuator electrical enclosures rated for the area classification. Electrical actuators must be CSA approved. Provide each actuator with a built-in motor overload protection and fit each actuator with a manual override control of the valve.

.8 All piping, valves, and equipment shall be supported and anchored to avoid undue stresses and vibrations during shipment as well as during normal operation.

.9 Provide valved drain connections at low points on tanks and lines, and on suction and discharge piping on pumps. Valved vent connections shall be installed on high points of lines.

.10 Valves: for stainless steel pipe 50 mm and less, use stainless steel ball valves with filled Teflon seats. For stainless steel pipe 75 mm and greater, use stainless steel ball valves with filled Teflon seats or butterfly valves with stainless steel disc.

.11 Care shall be taken to ensure that globe, check and control valves, are installed correctly in regard to flow direction.

.12 Piping, equipment, tubing, conduit, supports, etc. shall be installed plumb to natural centrelines and visual surfaces.

.13 All pipe, fittings, flanges, and other piping elements shall meet ANSI and ASTM standards.

2.16 Spare Parts

.1 Provide one (1) set of bearings and seals for each piece of equipment.

.2 Provide replacement variable speed drive for screw feeder.

3. EXECUTION

3.1 Manufacturer's Representative

.1 Arrange for a technically qualified manufacturer's representative to attend the installation work, certify correct installation, 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.

3.2 Delivery and Installation Assistance

.1 Verify satisfactory delivery of the equipment by completing Form 100, included in Section 01650.

.2 Instruct the Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor’s understanding by completing Form 101, included in Section 01650.

3.3 Installation Witnessing

.1 The Contractor shall ensure that the equipment is installed plumb, square and true within tolerances specified by the manufacturer and as indicated in the Contract Documents.

.2 The Contractor shall ensure that the equipment is installed as required to provide satisfactory service.

.3 Cooperate with the Contractor to deliver a successful installation as documented by Form 102, included in Section 01650.

3.4 Equipment Performance Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.2 Demonstrate conformance to the requirements specified herein.

.3 Cooperate with the Contractor to test the equipment as documented by Form 103, included in Section 01650.

.4 Assist the Contractor with a clean water running test on the polymer system, as follows.

.1 The polymer mixing tank will be filled with domestic cold water.

.2 The domestic cold water will be transferred from the mixing tank to the aging tank.

.5 Assist the Contractor with performance tests, as follows:

.1 Conduct performance tests on the polymer system for periods specified in Section 01650.

.2 Use domestic cold water for first stage of performance tests.

.3 Introduce the dry polymer and use polymer solution for the second stage of performance tests.

.4 Run second stage of performance tests for the periods specified in Section 01650.

.6 At the successful conclusion of operational and performance tests, verify successful performance of the polymer makeup system by certifying Form 103.

3.5 Process Performance Testing

.1 Attend the commissioning of the process system that includes the equipment specified in this Section to ensure the equipment functions as intended. Cooperate with the development of the commissioning plan for this equipment and cooperate with the Contractor in the commissioning of the equipment as documented by Form 104, included in Section 01670.

.2 Demonstrate conformance to the requirements specified herein. Performance criteria that must be met are defined in Clause 2.3 Capacities and Performance.

.3 Instruct the Contractor and City as to the proper procedures for introducing the dry polymer to the receiving hopper. In addition to testing, establish all other conditions necessary for proper commissioning.

.4 Provide guidance regarding operation parameter setpoints during commissioning.

.5 At the end of the commissioning period, verify successful commissioning by certifying Form 104.

3.6 Training

.1 Provide training to the City in the proper operation and maintenance of the equipment as documented by Forms T1 and T2, included in Section 01665.

END OF SECTION

THERMAL OXIDIZER

1. GENERAL

1.1 Work Included

.1 This Section specifies the design, fabrication of pre-assembled package, factory testing, supply, installation, on-site testing, commissioning, training, and coordinated design responsibility of a thermal oxidizer system.

.2 The scope of Work includes:

.1 Supply and install one (1) thermal oxidizer to effectively remove odour from the foul air exhausted from the primary sludge fermenters, the dissolved air flotation thickeners, the sludge storage tanks, and the truck loading area.

.2 Provide appurtenances, fittings, and materials not specified herein or elsewhere specifically mentioned or included, but necessary for the complete operation of the equipment. This includes all works associated with natural gas supply, combustion air supply, exhaust gas systems, and all associated controls, control valves, blowers, and safety interlocks recommended by the thermal oxidizer supplier and to comply with Natural Gas Installation Code B149.1.

.3 Provide on-site testing and commissioning services required to place the thermal oxidizer system in operation.

.4 Provided on-site training for the City staff.

.5 Provide a complete set of documentation including As-Constructed Drawings and O&M Manuals.

1.2 Reference Corfdes, Standards, and Specifications

.1 Natural Gas Installation Code CSA B149.1.

.2 Comply with the applicable reference codes, standards, and specifications as applicable in the Province of Manitoba.

.3 Materials: conform to ASTM and CSA standards unless specified otherwise.

.4 Equipment: conform to ASME standards unless specified otherwise.

.5 Welding: conform to CSA W59 M (metal arc welding) and W47.1 (welding certification).

.6 Screw fastenings: conform to ANSI.

.7 Painting: conform to SSPC standards unless specified otherwise.

.8 Structural design: conform to CSA Standard S16.1 for steel and the Manitoba Building Code.

.9 Stainless steel pipe used for structural members shall conform to the requirements of ASTM A312.

.10 Manitoba Building Code, National Building Code, OSHA, NFPA, IEEE, NEMA, ULC, Canadian Electrical Codes, ISA etc. and other standards as may be applicable and as part of good engineering, design, fabrication practice.

.11 Natural gas fuel train: conform to CSA 149.3.

1.3 Submittals

.1 Shop Drawings: submit six (6) copies of Shop Drawings, include the following:

.1 Catalogue cuts or equipment data sheets showing manufacturer's complete descriptive information which shall include, but not limited to, product literature, equipment make and model, material of construction, weight of product, mechanical components.

.2 Process mechanical drawing with general arrangement showing principal dimensions and weights of the thermal oxidizer, piping connections sizes for foul air and natural gas, anchor bolt location, and other information required for the installation of the equipment and accessories as a complete system.

.3 Design brief with the Shop Drawings outlining the adequacy of the proposed design. To include technical data for air and gas flow rates, velocities, chamber sizing, exhaust temperature, anchor bolt sizing, noise conditions, weight etc.

.4 Sample print-out copies (single pages) of the temperature data logging in graph and numerical forms. Each form is to record the date and time for each temperature reading. The Contract Administrator reserves the right to request temperature programming changes at any time.

.5 Product data sheets and dimension drawings for all accessories.

.6 Electrical single line diagram showing all power requirements.

.7 Drawings of control panel including door layout, interior layout, electrical ladder diagram, and interconnects to all components outside of panel.

.8 Operating description for the equipment and control panel covering all logic and sequence of operation.

.9 Sample equipment nameplates.

.2 O&M Data: two (2) draft copies of the O&M Manuals, covering each item of equipment, a minimum of two (2) weeks prior to the scheduled start-up of the equipment. A maximum of three (3) weeks after review, five (5) copies of the final manuals shall be supplied. Include the following in the O&M Manual:

.1 Submit certified shop performance test results for materials requiring testing, quote standard.

.2 Submit certified field performance test results, quote method standard.

.3 Submit a certificate, which confirms that the thermal oxidizer received the specified insulation, finishings, etc.

.4 Submit a commissioning certificate regarding installation and performance requirements.

1.4 Coordination

.1 Coordinate with the other Divisions to ensure there are no conflicts in the Work.

1.5 Performance Data and Factory Test

.1 Provide non-witnessed certified shop tests on the thermal oxidizer. Ensure satisfactory performance to the manufacturer's or various recognized standards.

1.6 Shipment, Protection, and Storage

.1 Ship pre-assembled to the degree possible. Site assembly as per manufacturer’s recommendations.

.2 Identify special storage requirements. Store on-site, until ready for incorporation in the Work, using methods recommended by the manufacturer to prevent damage, undue stress, or weathering.

1.7 Warranty

.1 Provide warranty in accordance with the General Specifications but for a period of five years on both the thermal oxidizer and the exhaust stack.

2. PRODUCTS

2.1 Description

.1 The thermal oxidizer is to be located indoors in the fermenter pump room.

.2 The thermal oxidizer is to be used for foul air treatment. Foul air will be utilized as combustion air for the thermal oxidizer. Provisions are available to add ambient air as well. The high temperature in the thermal oxidizer shall oxidize odorous compounds in the foul air.

.3 The fuel for the thermal oxidizer is natural gas and the natural gas supply is at approximately 34 kPa (5 psi).

.4 Operating temperature range: 600°C to 800°C

.5 Maximum outside skin temperature of the thermal oxidizer and exhaust stack: 50°C

.6 Maximum total mass of thermal oxidizer and stack: 4,500 kg

.7 Expected foul air conditions are as follows:

.1 Air flowrate varies from 14.2 m^3/min to 39.6 m^3/min (500 scfm ~ 1400 scfm)

.2 High concentration of hydrogen sulphide (maximum of 200 ppm)

.3 Volatile organic carbon <10% LEL

.4 Temperature of incoming air: Minimum 10°C; Maximum 30°C

.5 Fine particulate matter

.6 Trace quantities of methane

.7 Relative humidity of 100 percent

.8 Trace quantities of grease and oil

.9 Trace quantities of siloxane

.8 Minimum retention time to achieve 99.5 percent removal of hydrogen sulphide

2.2 Tag Number

.1 F661-TO

2.3 Combustion Chamber

.1 Chamber shall be oriented vertically. Length and diameter of the chamber to be designed such that it will fit in the allotted space.

.2 Fabricate the combustion chamber of 316 stainless steel. The external plate shall be braced with structural angles adequate for the temperatures and pressures.

.3 The combustion chamber shall be lined with a refractory insulating material capable of operation up to 800°C and designed to provide a skin temperature less than 50°C during normal operation.

.4 The combustion chamber shall be provided with one steel access door, fabricated of 316 stainless steel, lined with the same refractory insulating material specified in 2.3.3. The insulation shall be tapered to form a tight seal on closure without restricting access door operation. The door shall be hinged with quick opening, tight sealing hold-downs. A limit switch shall be provided on the door to prevent operation of the oxidizer while the door is open.

2.4 Forced Draft Burner Assembly Burner/Ignition Control Panel

.1 The burner assembly shall come complete with a high efficiency, TEFC, 120 V/1 phase/60 Hz, and a dynamically balanced reversed incline centrifugal blower wheel to provide combustion air.

.2 The burner assembly to be equipped with a factory-assembled natural gas train complete with required safeties. Gas train to be FM and Industrial Risk Insurers (IRI) approved as well as CSA B149.3 compliant. Equip the pilot natural gas supply line with a valve and regulator system. Provide an explosion-proof solenoid valve to fail close during system power failures to prevent the release of natural gas.

.3 Burner to be equipped with modulating controls to provide a variable heat input for higher efficiency. A Honeywell UDC 1000 series digital indicating temperature controller shall be provided to maintain and control the combustion chamber temperature. A thermocouple shall measure the mix gas temperature and provide the temperature signal to the temperature controller. If the temperature exceeds a preset value, the oxidizer shall shut down.

.4 Provide a control panel that shall include a burner safety system and local on/off push buttons with supervised safe burner operation at all times. The control panel shall be housed in a NEMA 4X control cabinet and shall be mounted to the structural steel base grid. The panel shall be completely pre-wired to terminal strips within the cabinet and ready for connection of main power supply and remote monitoring and control signals. The main power supply will be 120 VAC single phase. Control signals shall include remote burner start, burner stop, dry contact for burner on status, and dry contact for thermal oxidizer fault.

.5 Power failure: upon loss of utility power to the thermal oxidizer, the burner shall shut down and the main gas supply valve shall close automatically. When the utility power is restored, the flame control system shall automatically purge the combustion chamber and return to a ready state without manual intervention. In the event that the "remote start" contact is calling for the burner to run, the burner shall start automatically following the combustion chamber purge cycle.

2.5 Supports and Connections

.1 Provide independently driven 316 stainless steel process isolation and fresh air valves to provide positive isolation from the process and a source of fresh air during the purge and start-up cycles. The valves shall automatically switch when the “oxidizer run” permissive has been satisfied. The fresh air damper shall modulate to control the combustion chamber temperature during high load, and to provide a source of oxygen for combustion. Ball valves to be utilized for sizes smaller or equal to 51 mm. Valves larger that 51 mm to be butterfly valves.

.2 The combustion chamber shall be supported by a base grid, fabricated from 316 stainless steel in accordance with AISC specifications.

.3 Fabricate the flare tip of 316 stainless steel

.4 Provide a flame rod for continuous flame supervision. A burner sight glass will allow for the viewing of the oxidized flame during operation.

2.6 Exhaust Stack

.1 Provide an insulated exhaust stack on the discharge of the thermal oxidizer.

.2 The diameter of the stack shall be the same as the discharge of the thermal oxidizer.

.3 The outlet of the stack shall be at elevation of 255.0 m (approximately 12 m above the fermenter pump room roof elevation of 243.0).

.4 The stack shall be fabricated of 316 stainless steel and shall be lined with the same refractory insulating material as specified in 2.3.3.

.5 The stack shall comprise multiple flanged sections, a minimum of 1800 mm in length, will be bolted together. The stack shall attach to the discharge of the oxidizer. Design the discharge flange of the oxidizer outlet to accommodate the full weight of the assembled stack.

.6 The stack shall be supported at a maximum of 3 guy wire elevations with a maximum of 3 guy wires at each elevation. Guy wires to have a maximum slope of 4 vertical to 3 horizontal. Recommended guy wire tie down locations are provided on the drawings. Final placement of guy wire anchor points are subject to approval by the Contract Administrator.

2.7 Electrical and Controls

.1 All wiring shall be identified at both ends with designations corresponding to the diagrammatic wiring Drawings.

.2 Unless otherwise noted, all equipment and control devices must be CSA or ULC approved and of corrosion-resistant construction.

.3 Electrical equipment to comply with Canadian Electrical Code and Manitoba Electrical Code.

2.8 Spare Parts

.1 Furnish the following minimum spare parts, plus any additional parts required during the two year period of operation following Total Performance. Where specific special tools are required for the maintenance or operation of a specific item of equipment, but are not listed, the Contractor shall supply. Suitably mark and pack all parts in clearly identifiable and labeled containers.

.1 Gas regulator repair kit

.2 Thermocouple

.3 UV flame sensor

.4 Vent valve repair kit

.5 Gas shut off valve repair kit

.6 Burner replacement parts

.2 Provide spare parts that are identical and interchangeable with the original parts.

2.9 Acceptable Manufacturers

.1 A.H. Lundberg Systems Limited (telephone 604 273 5204)

.2 Inpro-heat (telephone 604 808 1974)

.3 Wisconsin Oven Corporation (telephone 262 642 3938)

3. EXECUTION

3.1 Manufacturer's Representative

.1 The manufacturer's representative shall be required to attend to train installation personnel; to train operating personnel; and to witness installation and testing to ensure the equipment is installed and operates as intended as per Section 01650 and Section 01670.

3.2 Installation

.1 Refer to Section 01650

.2 Equipment to be installed as required to provide satisfactory service.

.3 The manufacturer's representative to instruct the Contractor in the methods and precautions to be followed in the installation of the equipment. The Contractor's installation understanding to be certified by the completion of Form 101, included in Section 01650.

.4 Fulfill the requirements for a successful installation as documented by Form 102, included in Section 01650.

.5 Installer shall be certified to work on gas-fired equipment.

3.3 Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.2 Fulfill the requirements for successful testing of the equipment as documented by 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 to ensure the equipment functions as intended in the process system. Refer to Section 01670.

END OF SECTION

AUTOMATIC WASTEWATER MONITORING EQUIPMENT

1. GENERAL

1.1 Scope

.1 This Section specifies the supply, factory testing, delivery, installation, supervision of installation, testing and commissioning of On-line Nutrient Analysis Systems for detection of ammonia, nitrate, and ortho-phosphorus, pH and temperature.

.2 The single sample point Nutrient Analysis System consists of central process analyzer instruments and accessory items designed to operate as part of an integrated system including a sample pump, sample circulation chamber, cross flow ultra-filter system, sample line, and return line.

1.2 Shop Drawings

.1 Provide Shop Drawings in accordance with the requirements of Section 01300 and Section 11005. In addition, provide the following information:

.1 Manufacturer's data including name, type, model, capacity and equipment weight.

.2 Shop Drawings including dimensions and sectional view of equipment showing details of construction, arrangement and installation.

1.3 Other Submittals

.1 In addition to the submittals specified in Section 11005, provide the following for information only in accordance with Section 01300:

.1 Detection and analysis technique to be provided for each specified parameter.

.2 Calibration plan describing the complete calibration series including grab sample comparisons, spiked samples and standards for all parameters.

.2 In addition to the operating and maintenance data specified in Section 11005, provide the following for operating and maintenance data in accordance with requirements of Section 01750:

.1 Complete description of equipment and operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, parts catalogues with complete list of repair and replacement parts with section drawings, illustrating the connections and the part manufacturer's identifying numbers.

1.4 Coordination

.1 Coordinate with other Divisions to ensure there are no conflicts with the Work.

1.5 Shipment, Protection, and Storage

.1 Ship equipment and mechanisms pre-assembled to the degree possible.

.2 Provide storage instructions indicating specific requirements to ensure there is no weathering, corrosion, contamination, mechanical damage, distortion, or any other deterioration of the components.

.3 Identify all other special storage requirements.

2. PRODUCTS

2.1 Function

.1 A nutrient analysis system receives treated final effluent (FE) from the secondary clarifier effluent channel for analysis of ammonia, nitrate, total suspended solids (TSS) and ortho-phosphorus, pH, and temperature.

.2 Provide process analyzer instruments, sampling lines, and all required system accessories as a package system, including responsibility for correct operation, installation and interfacing of the equipment.

2.2 Design Standard and Acceptable Manufacturers

.1 Supply products modified as necessary by the manufacturer to provide the specified features and to meet the specified operating conditions.

.2 Design Standard

.1 ChemScan UV-4100, CL500

2.3 Performance

.1 The process analyzer instrument shall be capable of nutrient detection over the following concentrations:

.1 Ammonia-nitrogen: 0.1 to 20.0 mg/L

.2 Nitrate-nitrogen: 0.1 to 20.0 mg/L

.3 Ortho-phosphorus: 0.05 to 15.0 mg/L as P

.4 pH: 1-14

.5 Temperature: 0 to 30°C

.2 Provide a total package process analyzer system capable of analyzing all required parameters from the sample location. The system may be an all-in-one system or a fully coordinated package of individual analyzers and instruments.

.3 Provide nutrient analysis system capable of measuring all designated parameters within 8 minutes or less, not including sample accumulation time.

.4 The total time required to measure all designated parameters at the sample point, including flushing, is to be 90 minutes or less.

.5 Provide system capable of enabling or disabling parameter selections individually on the local controls, without the need for external software modifications.

.6 Provide an externally mounted, back illuminated, LCD display with keypad for entry of operator-selected variables and menu options.

.7 Nutrient analysis system to be located in the Final Plant Effluent Tunnel in a designated location shown on the Drawings.

.8 Provide a discharge line (50 mm) from the analyzer system to discharge in the effluent discharge channel.

2.4 Materials

.1 Analyzer electronics modules: NEMA 4 enclosure of coated metal or fabricated using stainless steel.

.2 Flow Cell Modules: NEMA 3R enclosure of coated metal or fabricated using stainless steel.

.3 Optical window: quartz

2.5 Detection Techniques

.1 Ion-selective electrodes or any method that employs reagents for nitrate analysis are not acceptable.

.2 Submit detection and analysis techniques for each specified parameter.

.3 Provide for the elimination of interferences due to background substances present during analyses using multiple wavelength ultraviolet absorbance spectrometry of a minimum 30 wavelengths.

.4 Provide analyzer with a dedicated sample port for the introduction of calibration and test samples.

.5 Provide automatic zeroing capability using deionized water as the standard.

2.6 Filter System

.1 Provide a sample circulation chamber and in-line filter as an integral part of the nutrient analysis system.

.2 Provide a filter which can easily be removed for maintenance and cleaning.

2.7 Sample Pump

.1 Quantity required: One (1)

.2 Function: pumps sample water to the automatic wastewater monitoring equipment. Sample pump is for sampling final effluent and pumping to the on-line wastewater monitoring equipment sample circulation chamber.

.3 Provide one (1) pump with rating 0.3 L/s (5gpm) at 1 m TDH.

.4 Pump to be CSA approved

.5 Provide NEMA-B design motors with shell type design and housed in an air filled, water tight chamber in accordance with Section 11062.

.6 Centrifugal pump, cast iron casing, bronze or cast iron impeller, stainless steel shaft.

.7 Provide a pump with a casing and impeller design suitable for handling solids and stringy material.

.8 Motor attached to bracket on pump frame, flexible shaft coupling, and mechanical shaft seal.

.9 Provide bracket for mounting pumps on a concrete wall, with simple disconnect for service and maintenance.

.10 Provide sample pumps suitable for 120V/60Hz/1 phase service.

.11 The pump shall be located at the sampling location shown on the Drawings.

2.8 Sample Circulation Chamber

.1 The system shall include a sample circulation chamber, consisting of a sample chamber with sample line connection to a mesh strainer plus sample flow inlet and outlet connections. Sample line piping from the effluent channel to the chamber and from the chamber to drain shall be provided by the installation Contractor.

.2 The system shall include a sample circulation chamber, consisting of a sample chamber with sample line connection to a mesh strainer plus sample flow inlet and outlet connections. A 5 gallon per minute continuous duty transfer pump shall also be provided (see 2.7 above) to extract sample from the final effluent channel and deliver the sample to the sample circulation chamber. Sample line piping from the effluent basin to the chamber and from the chamber to drain or back to the effluent basin shall be provided by the installation Contractor.

2.9 Controls – General Requirements

.1 The controls section is specific to the Nutrient Analysis System only.

.2 It is intended by the City to monitor the parameters determined by the Nutrient Analysis Sampling System via a plant DCS.

.3 Provide a system to transmit all analysis results for each parameter and output control command signals in Ethernet format for transmission to the plant DCS

.4 Equip the control system with an operator interface unit and display screen to display operating status, analysis results, operational commands, and other information required to operate and control the system.

.5 Provide a NEMA 4X control panel.

.6 In addition to MODBUS provide PLC with an Ethernet port and a memory map of all process control and monitoring data for incorporation the packaged unit into the DCS.

2.10 Protective Coatings

.1 Preparation, primer and coatings: in accordance with Section 11901.

2.11 Spare Parts

.1 Provide the following spare parts:

.1 Reagent injector pump (1)

.2 Tubing for analyzer internal pump (set of 3)

.3 Reagent containers (3)

.4 Zero solution container (1)

.5 Cleaning solution container (1)

.6 Manifold valve (1)

.2 Tag and store spare parts in accordance with Section 01750.

2.12 Special Tools

.1 Provide any special tools required for the maintenance of the equipment supplied. Special tools are defined as tools which are not normally available in mechanic's or millwright's tool kit and which are peculiar to the equipment supplied.

3. EXECUTION

3.1 Manufacturer's Representative

.1 Provide the services of a qualified technical representative for installation, testing and commissioning.

.2 Provide the services of a qualified technical representative for personnel training.

3.2 Installation

.1 Ensure the equipment is installed and aligned in accordance with Section 11005, 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 Have the manufacturer's representative supervise and cooperate with the installer as necessary.

.4 Have the manufacturer's representative verify successful installation, as documented by Form 102, included in Section 01650.

3.3 Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.2 Performance Testing

.1 Prior to testing, provide procedure and sketches to demonstrate method of system testing to Contract Administrator for approval.

.2 Test run the sample pump to assure correct flow conditions are present in the sample circulation chamber. With adequate flow, set the correct sequence and timing for sample flush and sample analysis.

.3 Perform a complete calibration series including grab sample comparisons, spiked samples and standards for all parameters. Provide a complete description of the "Calibration Plan" as a submittal document to Contract Administrator for review.

3.4 Training

.1 Provide the services of a qualified technical representative for personnel training as specified below and in accordance with Section 01664.

.2 During equipment operational testing provide as a minimum:

.1 Operator and Maintenance Training: two (2) sessions, 2 hours each

.3 6 months after the operational testing provide as a minimum:

.1 Operator training: one session, 1 hour

.2 Maintenance training: one session, 2 hour

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

FIELD-APPLIED MAINTENANCE AND CORROSION PROTECTION 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 deleted.

.2 Refer to Drawings and schedules for the type, location and extent of coatings required and include for all field coating necessary to complete all the Work shown, specified or scheduled.

1.2 Reference Standards

.1 Reference to the SSPC Good Painting Practice and the National Association of Corrosion Engineers specifications refers to the latest edition of these specifications.

.2 Apply all coating in accordance with manufacturers' recommendations, and to SSPC Standard. Specifications contained therein take precedence over manufacturers' recommendations.

.3 Strictly observe all safety rules and regulations of the City, applicable governing bodies, and insurance underwriters in the storage, handling, use and application of coating system material, solvents, and cleaning agents.

.4 Employ qualified and competent personnel to perform the Work in a neat and workmanlike manner, conforming to all City and Government Safety Standards and Regulations.

1.3 Shipment, Protection, and Storage

.1 Deliver all materials to the site in sealed containers properly labeled as to the manufacturer's name, type, and colour of contents, date of manufacture, batch number, storage requirements, and shelf-life.

.2 Provide adequately ventilated storage for all materials and ensure compliance with fire prevention regulations.

1.4 Guarantee

.1 Furnish to the City a two-year guarantee in an approved format, or alternatively a 100 percent two-year maintenance bond, on completion of the work. The Work performed by the Contractor shall be inspected by an independent inspector acceptable to the Contract Administrator. Include the cost of this inspection and the guarantee or maintenance bond in the Bid Price.

1.5 Restrictions

.1 Regardless of whatever else is specified in this Section, no paint containing a chromate based additive can be used. Substitute products of equal or greater quality.

2. PRODUCTS

2.1 Manufacturers

.1 All constituents of each coating system are to be provided by the same manufacturer.

2.2 Coating Application

.1 Use application methods in accordance with the coating manufacturer's recommendation for the particular coating being applied, and the requirements of SSPC Good Painting Practice.

.2 Provide traps or separators to remove oil and water from the air, so that the air from the spray gun impinging onto the steel substrata shows no condensed water or oil.

.3 Hand brush all welded and hard-to-spray areas prior to the first spray coat application, with coating mixed to manufacturer's recommended procedures.

.4 Coat by brush, roller, sheepskin dauber, or other suitable method, all areas inaccessible to the spray gun.

.5 Do not apply coatings to a surface at a temperature that will cause blistering, separation or otherwise be detrimental to the life of the coating.

.6 Only thinners specified by the manufacturer are acceptable.

.7 Materials that exceed manufacturer's published shelf life are not be acceptable.

.8 Immediately brush out all runs, sags, blisters, etc, or remove and repair the area prior to the next application.

.9 Apply the coating using a 3-coat, 2-colour system.

.10 Apply coating by conventional or airless spray as power coating manufacturer's data sheet.

.11 Follow manufacturer's application procedures as closely as possible as to recommended pressures, atomization, etc.

.12 Provide final dry film coating thickness in accordance with the coating manufacturer's specification.

.13 Apply the coating 100 percent holiday free.

2.3 Drying and Curing

.1 Accommodate all drying and re-coat times in accordance with the manufacturer's specifications.

.2 Cure in accordance with the manufacturer's recommended specifications. Force curing specifications are available from manufacturer if required.

.3 Supply indirect fired heaters and ducting as required to maintain drying and curing temperatures during coating operations.

2.4 Quality Control and Acceptance

.1 Apply, cure, and handle coatings using procedures which produce a final product that complies to the manufacturer's published literature and performance testing conducted by the City.

.2 Ensure the finished coating is free of obvious defects such as runs, sags, blisters or pinholes, air entrapment, fish-eyes and foreign matter.

.3 Provide film thickness, as determined by a calibrated Mikrotest gauge or equivalent, in accordance with SSPC Good Painting Practice.

.4 Apply all immersion coating 100 percent holiday free.

.5 Conduct wet sponge holiday testing in accordance with proposed NACE Standard, "Holiday Detection of Internal Tubular Coatings" (less than 0.254 mm (10 mil) thickness).

.6 A "holiday" is an area of applied coating with electrical resistance less than 80,000 ohms as identified by a detection instrument connected to a clean sponge wetted with a solution of one teaspoon of detergent per 3.78 L of tap water.

.7 No immersion coating will be accepted or released from coating applicators until fully cured. Cure test will be performed using the M.E.K. rub test in conjunction with a time and temperature relationship for the coatings being used.

.8 Repair or replace at the Contractor's expense any coating not meeting the requirements of this Specification.

2.5 Surface Treatment

.1 Remove all organic substances such as oil, grease, paraffin, etc. in accordance with SSPC-1, "Solvent Cleaning", prior to commencement of sandblast cleaning operations.

.2 Provide proper traps or separators to remove all oil and water from the air supply. The air from the blast nozzle is to be free of condensed water or oil that will impinge onto steel substrata. In high humidity areas, the use of air dryers may be required.

.3 Do not blast surfaces when surface temperatures are less than 10°C, when substrata is less than 3°C above the dew point, when the relative humidity is greater than 80 percent, or when there is a possibility that the blasted surface will be subject to wetting prior to the primer coat being applied.

.4 Blow down all surfaces with clean, dry air; brush and vacuum free of dust before the surface is primed.

.5 Do not blast more surface than can be prime coated before visible or detrimental re-rusting occurs.

.6 Use siliceous sand, free of dirt, clay or other foreign material, graded 16/30 or 20/40 mesh to give an anchor pattern 0.038 mm to .076 mm (1.5 to 3.0 mil).

2.6 Schedule of Surface Treatments

.1 The schedule of Surface Treatments defines the components of the protective coating systems.

Reference	Description	Surface Treatment
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	The surface shall be lightly abraded using steel wool or abrasive cloth to provide a key for the next coat, to remove runs or excessive brushmarks
H	Vinyl Wash Primer	DFT 13 micron To be overcoated within 24 hr
I	Water-borne Acrylic Primer	Nominal DFT 40 micron
J	Inorganic Zinc Primer	Zinc in ethyl silicate vehicle Minimum DFT 40 micron
K	Industrial Enamel (to 100°C)	To CGSB 1-GP-61M Alkyd Enamel Minimum DFT 40 micron
L	High Build Epoxy	Black Polyamine cured Minimum DFT 200 micron
M	Bituminous Paint	To AWWA C230 MIL-P-151470
N	Silicone Alkyd (100°C to 150°C)	Minimum 60% Solids by Wt Nominal DFT 25 micron
O	Silicone Enamel (150°C to 400°C)	To CGSB 1-GP-143M Nominal DFT 40 micron
P	Fast Drying Aluminum Sealer	To CGSB 1-GP-69M Nominal DFT 25 micron
Q	Canvas Insulation Sealer	Acrylic or PVA Latex
R	Epoxy Gloss Enamel	To CGSB 1-GP-146 Nominal DFT 50 micron
SSPC: Steel Structures Painting Council Pittsburgh PA 15213 Surface Preparation Specifications 1985		

2.7 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 there categories as follows:

.2 Category A: Immersed Service - equipment or material fully, partially or intermittently immersed in sewage during routine plant operation.

.3 Category B: Exposed Service - equipment or material exposed to the normal range of atmospheric conditions and conditions common to sewage treatment facilities (high humidity, H_2S, etc.)

.4 Category C: Indoor Service - equipment or material inside buildings or other ventilated spaces.

2.8 Category A

.1 Category A: all category A systems will be tested by the Contract Administrator using a wet sponge holiday detector set at 67.5 volts. Touch up will be required at points where the detector is grounded.

Reference	Surface Treatments	Typical Applications
A1	A, D, I, L	Equipment or piping delivered with inorganic zinc primer, e.g., clarifier mechanisms, mixers, etc.
A2	A, F, J, L ,L	Equipment or piping delivered uncoated or with coatings not compatible with high build epoxy, e.g., ductile iron, cast iron or steel pipe and pipe sleeves inside treatment units. External surfaces at valves, ferrous weir plates, weirs, penstocks, fabricated pipe supports, brackets, etc.
A3	A, G, M	Aluminum surfaces in contact with concrete, e.g. stop log guides, access cover frames.
A4	A, E	Ferrous metal surface cast concrete, e.g., penstocks, sluice gates
A5	A	Stainless steels, plastics, and fiberglass products.
A6	A, E, J, M, M	Ferrous metal immersed in abrasive environment, listed below: - grit tanks

2.9 Category B

.1 Schedule

Reference	Surface Treatments	Typical Applications
B1	A, B, R, R	Equipment or piping delivered with inorganic zinc primer, e.g. clarifier motor, gearbox and motor, valve headstocks, piping above ground and outside treatment units, hydrants, etc.
B2	A, B, J, R ,R	Equipment or piping delivered not supplied with an inorganic zinc prime coat or with a prime coat not compatible with an inorganic zinc overcoat
B3	A, G, R, R	Equipment delivered with factory applied paint which is to be painted for identification only
B4	A	Stainless steel or aluminum products, e.g. insulation recovering.

2.10 Category C

.1 Schedule

Reference	Surface Treatments	Typical Applications
C1	A, B, K, K	Equipment or piping delivered comes with factory finished coatings. Coated for system identification and maintenance. Surface temperature during operation not exceeding 100°C, e.g., pumps, air handling units, valves, etc.
C2	A, G, K, K	Equipment or accessories fully primed. Surface temperatures not exceeding 100°C, e.g. pumps, steel piping
C3	A, C, I, N, N	Equipment or accessories as C1 or C2 but with operating surface temperatures between 100°C and 150°C, e.g. air compressors, blowers
C4	E, J, O	Equipment or accessories as C1 or C2 but with operating surface temperatures between 150°C and 400°C, e.g. boiler fittings
C5	B, P, K, K	Piping or valves with bituminous or tar coatings. Surface temperatures not exceeding 100°C, e.g., cast iron and 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 hangar 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		

2.11 Colour Coding

.1 Refer to Section 11910 for pipe and equipment identification colour coding.

2.12 Acceptable Products

.1 Amercoat Ltd.

.2 Carboline

.3 General Paints Ltd.

.4 ICI Paints Ltd.

.5 Plasite

.6 Rust Oleum

.7 Valspar

3. EXECUTION

3.1 Quality Assurance

.1 Apply and cure 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 treatment and coatings. Be responsible for the compatibility of all surface treatments and coatings.

3.2 Environmental Conditions

.1 Apply no coating when the ambient or surface temperature is below 10°C or less than 3°C above the dew point.

.2 Provide a minimum of 300 lux illumination on surface to be treated.

.3 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 Work. Make good within seven days any damage to coatings.

.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 Adequately mask, or remove and replace after painting, 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 Prior to starting Work, thoroughly examine all surfaces to be treated or coated. Report, in writing, to the Contract Administrator any condition or defect that may affect the integrity or quality of the finished coating. Do not start 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.

3.5 Inspection

.1 The Contract Administrator has the right to request tests, to witness the performance of tests, or to perform tests.

.2 Such inspection does not relieve any responsibility for guarantee of the coating application from the Applicator.

3.6 Clean-Up

.1 After acceptance of coating, remove all masking, grease, etc, from all equipment which was not intended to be coated.

.2 Remove all unused material, containers, etc, from the Site upon completion of Work.

END OF SECTION

FACTORY-APPLIED MAINTENANCE AND CORROSION PROTECTION 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 reference standard. The Contractor may submit for review alternative coating systems 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: after degreasing, dry blast all ferrous components to a white metal finish in accordance with SSPC-SP5 to a degree of cleanliness in accordance with NACE #1 and obtain a 50 micron blast profile.

.2 Non-immersion Service: after degreasing, dry blast all ferrous components to a near white finish in accordance with SSPC-SP10 to a degree of cleanness in accordance with NACE #3 and obtain a 50 micron blast profile.

2.2 Prime Coating

.1 Prime coat all ferrous surfaces before the blasted surfaces deteriorate.

.2 Coat ferrous surfaces with inorganic zinc primer, containing a minimum of 50 percent solids by volume, applied 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 For items which are to be bolted together before shipment, clean surfaces and coat before the parts are assembled.

.2 Continuous weld all welded connections, sealing the mating surface completely. On completion of the welding and fettling, treat all weld seams with phosphoric acid solution. Rinse and thoroughly dry before the prime is applied.

.3 Where dissimilar metals are mated insulate the mating surfaces from one another to provide protection against corrosion. Insulate bolts, nuts, washers and rivets in a similar manner.

.4 Use 304 stainless steel or better for all nuts, bolts, washers and similar fittings for immersion service. For non-immersion service, use 304 stainless or zinc or cadmium plated nuts, bolts, washers, and similar fittings. Clean and coat the inner face of non-threaded bolt holes as required for other surfaces.

3. EXECUTION

3.1 Inspection

.1 Notify the Contract Administrator two weeks before commencing the protective coating to permit the inspection by the Contract Administrator of the surface preparation and protective coating application.

3.2 Protection

.1 Protect all coated equipment adequately 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 and re-coat the equipment at the Contractor's cost.

.2 Make good damage to coatings occurring at any time prior to the application of any further coatings.

3.3 Application Conditions

.1 Apply all factory applied coatings under controlled conditions, in a dust-free atmosphere at a temperature of between 10°C and 20°C, and a relative humidity should not exceed 80 percent.

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

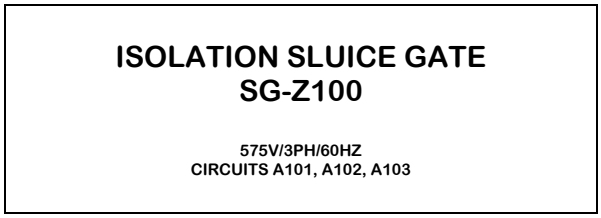
.1 Provide metal nameplate on each piece of equipment, mechanically fastened with raised or recessed letters.

.2 Provide UL 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 the Drawings or identified in Section 11059.

.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

.3 All motors: paint all motors grey

.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 colour scheme as outlined in the following table:

Item	Colour	Colour Code
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
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
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
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/Pumps	Match conduit	
Valve Hand/Chainwheels	Red	SW 3065
Boilers	Heat Resistant Aluminum	B 59S3
Concrete/Blockwork	Platinum Grey	SW 4012

Note: SW is 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

END OF SECTION

TABLE OF CONTENTS

DIVISION 13

1. GENERAL

1.1 Description

.1 This Section specifies the requirements for FRP fabrications and equipment including items fabricated with resins but employing glass and other fibre filaments for structural reinforcement.

.2 This Section does not apply to architectural and structural FRP components specified in Division 6.

.3 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 five years of experience

.2 Installer qualifications: minimum five 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 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 ±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 ±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 ±2 mm. Variations in all other flanges are within ±1 mm.

.8 Tolerance in bolt hole locations and in bolt circle diameter is within ±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 fibreglass 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 two 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 ±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 fibres 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/m^2 of chopped strand mat and resin in two plies of 0.05 kg/m^2 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 5 by 4 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/m^2, 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° helix angle of winding as measured from the centerline of revolution of the component shell. Tolerance on helix angle is +2°, 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/m^2 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 jobsite. 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 Section 01600, 01650 and 01670.

3.2 Preparation

.1 Verify dimensions and conditions in field

.2 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 four 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 four 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 eight 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 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 01300, Section 11005, and Section 13200.

.1 Detailed fabrication drawings showing connections and termination of equipment.

.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 01300 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 01300:

.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 01700:

.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 five years of experience in the fabrication of fibreglass structures.

.2 Designer: Professional Engineer registered in the Province of Manitoba.

.3 Independent FRP Quality Assurance Inspector:

.1 Minimum five 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 five years of experience in acoustic emission testing of fibreglass structures.

1.9 Coordination

.1 Refer to Section 11005 for general coordination requirements of the equipment supplied with piping, structures, structural supports, drainage, ventilation/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 11005.

.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 Acceptable Manufacturers

.1 Structural Glass (Design Standard)

.2 Plas-tanks Industries Inc.

2.3 Design Parameters

.1 Design tanks suitable for the storage of 38 percent ferric chloride ($FeCl_3$) solution, density of 1.26 kg/m^3 to 1.48 kg/m^3 at 20°C

.2 Number of tanks: 1

.3 Total volume, each: 40,000 L

.4 Minimum working volume, each: 34,000 L

.5 Internal diameter: 3500 mm

.6 Overall height: 4000 mm

.7 Design maximum liquid specific gravity: 1.6

.8 Lifting lugs, each: 4

.9 Sight glass with protective FRP cage, each: 1

.10 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 200 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 Viewing hatch: one 300 mm hinged

.11 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.

.12 Provide 6 mm thick neoprene blanket pad for each tank suitable for tank bottom.

2.4 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

2.5 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.

2.6 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.

2.7 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.

2.8 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.

2.9 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 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 ±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.

2.10 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 11020.

2.11 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 Section 01600, Section 01650, and Section 01670.

3.2 Installation

.1 Ensure the equipment is installed in accordance with Section 11020, 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 Installer's understanding by completing Form 101 as included in Section 01650.

.3 Accurately place anchor bolts using templates furnished by the fabricator and as specified in Section 05500, Metal Fabrications.

.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 Not used

3.5 Commissioning

.1 Not used

END OF SECTION

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DIVISION 14

HOISTS AND CRANES

1. GENERAL

1.1 Work Included

.1 Supply and installation of single girder under running crane and appurtenances required for a fully operational crane.

.2 Supply and install of steel girder and appurtenances required for a fully operational under running crane.

.3 Supply and installation of trolley equipment and appurtenances.

.4 Testing and start-up reports.

1.2 Qualification

.1 Installation is to be done by an established firm having at least five years of proven, satisfactory experience in this trade and employing skilled personnel. The firm is to be authorized by the equipment manufacturer to install the equipment specified.

.2 Submit proof of qualifications and certification in writing to the Contract Administrator four weeks prior to commencement of Work.

1.3 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01300.

.2 Indicate size and description of components, materials, attachment devices, finish and construction details and safe loading.

.3 Shop Drawings and design briefs shall be signed and sealed by a Professional Engineer registered in the Province of Manitoba.

1.4 Maintenance Data

.1 Provide maintenance data for hardware complete with pertinent details, spare parts lists, and warnings against harmful maintenance materials and practices for incorporation into maintenance manual.

1.5 Warranty

.1 Contractor hereby warrants that the monorail and hoist system will remain operative in accordance with General Conditions, but for five years.

2. PRODUCTS

2.1 Trolley

.1 Trolley: Columbus McKinnon (CM) Series 632, Close Radius Trolley.

.2 Provide one trolley for each monorail beam.

.3 Each trolley to be rated for individual rated capacities as indicated on the Drawings.

.4 Manufactures identification sticker to indicated rated trolley capacity.

2.2 Single Girder Under Running Crane

.1 Hoist Description:

.1 Model: EK DR 3 – 1 Ton Demag Low Head Room Rope Hoist, one required.

.2 Safe Working Load: 907 kg (1 Ton)

.3 Reeving: 4/1

.4 Hook path in metres: 6.0

.5 Motor Type: Z - Cylindrical rotor

.6 Lifting Speed in metres/minute: 6/1

.7 Operating Voltage and frequency: 600V AC/ 3 phase, 60 Hz

.8 Maximum cross–travel speed in metres/minute: 13/1

.9 Controls: Demag DRC-10 Radio Control, for operator multilevel applications.

.2 End Truck Description:

.1 Model: KTD-DK 125/1524 Demag End Truck, two required.

.2 Speed: 100 VPC FPM

3. EXECUTION

3.1 Examination

.1 Before starting erection, take field measurements and examine other Work 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.

.4 Store crane and trolley equipment as required by the manufacturer.

3.2 Damaged Members

.1 Repair or replace members damaged during transit or erection, before securing in position.

.2 Upon completion, touch up and restore to new condition, damaged or defaced factory finished surfaces.

.3 Touch up shop primer bolts, welds, and burned or scratched surfaces at completion of installation.

.4 Remove protective coverings and clean exposed surfaces after completion. Leave equipment and appurtenances in a first class condition.

3.3 Erection

.1 Install crane and trolley equipment in accordance with manufacturer's instructions.

.2 Install and hook up all equipment remote control, relays, and other electrical equipment required for operation.

.3 Adjust crane operating components to ensure smooth operation.

.4 Coordinate and cooperate with the structural steel supplier and erector to ensure that the crane and trolley supporting steel are erected to the required tolerances.

END OF SECTION

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DIVISION 15

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 maximise 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 the Contractor.

.8 Furnish a written guarantee stating that all Work executed in this Contract will be free from defective workmanship and materials for a period of one year from the date of Substantial Performance. 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.

.10 'Provide' shall mean; 'supply and install'.

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 resolve all conflicts on-site before fabricating or installing any materials or equipment.

.3 Where dimensional details are required, coordinate 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 All Work shall comply with provincial, municipal, bylaws and authorities having jurisdiction.

.2 Obtain all permits and pay all fees applicable to the Work.

.3 Contractor shall arrange for inspections of the Work by the authorities having jurisdiction and shall provide certificates indicating Final Approval.

1.4 Examination of Site

.1 Before submitting Bid, visit and examine the Site and note all characteristics and features affecting the Work. No allowances will be made for any difficulties encountered or any expenses incurred because of any conditions of the Site or item existing thereon, which is visible or known to exist at the time of Bid.

1.5 Quality of Work

.1 All Work shall be by qualified tradesmen with valid Provincial Trade Qualification Certificates. Spot checks will be made by the Contract Administrator.

.2 Work which does not conform to standards accepted by the Contract Administrator and the trade may be rejected by the Contract Administrator. The Contractor shall redo rejected Work to the accepted standard at no cost to the City.

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 (0.125)	50 (2)	300 (12)
6 (0.25)	65 (2.5)	375 (15)
10 (0.375)	75 (3)	450 (18)
15 (0.5)	100 (4)	500 (20)
20 (0.75)	125 (5)	600 (24)
25 (1)	150 (6)	750 (30)
30 (1.25)	200 (8)	
40 (1.5)	250 (10)	

.5 Metric Duct Sizes:

.1 The metric duct sizes are expressed as 25 mm = 1 inch.

.6 Not applicable.

1.7 Alternate Materials and Equipment

.1 The price submitted for this Contract shall be based on the use of materials and equipment as specified or as contained within the Acceptable Manufacturers List.

.2 The Contractor shall be fully responsible for any additional Work or materials required by the trades or other Contractors to accommodate use of other than specified materials or equipment. Extras will not be approved to cover such Work.

1.8 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 Bid. 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.

1.9 Shop Drawings

.1 Refer to Section 01300.

1.10 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.

1.11 Cutting, Patching and Coring

.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 Provide openings and holes required in precast members for mechanical Work. Cast holes 100 mm (4 inch) or larger in diameter. Field-cut smaller than 100 mm (4 inch).

.5 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective section.

1.12 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 (6 inch) compacted sand bedding under and first 300 mm (12 inch) of compacted sand over piping and ducting.

1.13 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.

1.14 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.

1.15 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.

1.16 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 days prior to the Bid 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 Bid price.

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 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.

1.18 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, Canadian Electrical Code 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 shall be inverter duty 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 0.5 hp shall be 120 V, 60 Hz, 1 phase. Motors 0.5 hp and larger shall be 3 phase at the indicated voltage.

.6 All motors shall be 1800 rpm unless otherwise 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 the following table, or premium efficiency, whichever is higher.

	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

1.19 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 (8 inch x 8 inch) for cleanout, 300 mm x 300 mm (12 inch x 12 inch) for hand 600 mm x 600 mm (24 inch x 24 inch) for body access minimum.

.5 Provide ULC listed fire rated access doors installed in rated wall and ceilings.

1.20 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

.3 Access platforms and catwalks

1.21 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.

1.22 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 (0.75 inch) high black lettering equal to Brady System B-500, vinyl cloth labels for non-insulated surfaces; and Brady B 946 for insulated surfaces.

.4 Identify piping with labels, colour bands, and flow arrows. Provide identification at 15 m (50 ft) maximum intervals, before and after pipes pass through walls, at all sides of tees, behind access doors and in equipment rooms as required.

.5 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.

.6 Provide 20 mm (0.75 inch) diameter brass, with metal photo black numbers, or white lamacoid with black engraved numbers, secured to valve stem with key chain.

.7 Provide neat, typewritten directories, giving valve number, services and location. Frame one copy under glass for wall mounting as directed, second copy to be forwarded to City. Include copies in O&M Manuals.

.8 Tag automatic controls, instruments and relays and match/key to control Shop Drawing identification numbers. Tag all equipment and control panels.

.9 Identify electric starting switches, thermostats controlling motors, remote push button stations, and controls equipment supplied under this Division with lamicoid plates having 6 mm (1/4 inch) minimum letter size. Identification to state equipment controlled.

.10 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	C.A.
Controls, including heat sensors	black	C.
Dampers (backdraft, balance & control)	blue	D.
Fire dampers	red	F.D.
Smoke dampers and detectors	red	S.D.

Note: Provide black lettering for yellow or white background, white for all other colours.

.11 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.

1.23 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

SECONDARY COLOURS FOR BANDS

1. Red - 509-102
2. Orange - 508-102
3. Blue - 502-106

BANDING

1. Red - to indicate extremely hazardous material
2. Orange - to indicate mildly hazardous material
3. Blue - to indicate non-hazardous material

.2 Identification Symbols and Colour for Piping

	Pipe Colour	Stripe Colour	Symbol
Compressed Air	White	None	kPa Air
Domestic Cold Water	Light Blue	None	Dom Cold Wat
Domestic Hot Water	Green	Orange	Dom Hot Wat
Domestic Hot Water	Green	Blue	Dom Hot Wat R
Drains	Aluminum	Red/Orange	Drain
Effluent Return	Green	Orange	Effluent R
Effluent Return	Green	Orange	Effluent S
Glycol Heating Return	Green	Orange	Glycol Heat R
Glycol Heating Supply	Green	Orange	Glycol Heat S
Vent	Aluminum	Red/Orange	Vent

.3 Identification Symbols and Colours for Equipment:

	Pipe Colour	Stripe Colour	Symbol
Fan Guards - Motor Guards	Red Machinery Enamel		
Hangers, Brackets, Hanger Rods	Black Machinery Enamel		
Heat Exchangers	Green	Orange	None
Pumps - Regular	Aluminum	None	None
Supports	Black	None	None
Tanks – Hot Water (Insulated)	Green	Orange	None
Valves Uninsulated	High Heat Aluminum		
Boiler	Green	Orange	GH

.4 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.

.5 Ductwork

All ductwork in mechanical rooms to be identified as follows, complete with directional arrows:

Return Air	R.A.
Supply Air	S.A.
Outside Air	O.A.
Mixed Air	M.A.
Combustion Air	Comb.Air
Relief Air	Relief Air
Exhaust Air	Exh.Air.

1.24 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. Connect alarm to independent alarm company system.

.7 Where pumps are used for temporary heating, replace mechanical seals, regardless of condition, with new mechanical seals.

1.25 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.

1.26 Substantial and Total Performance Inspection

.1 Prior to requesting an inspection for Substantial Performance, provide a complete list of items which are deficient.

.2 The Contractor shall ensure that all mechanical systems are ready for testing a minimum of eight weeks in advance of the projected completion date to allow for completion of DCS programming by City and all commissioning activities.

.3 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 O&M 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 As-Constructed 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.

.4 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.

Inspection:

- ☐ Complete commissioning checklists
- ☐ Final plumbing inspection certificate from local plumbing inspector
- ☐ Final backflow prevention test reports for all backflow devices
- ☐ Controls commissioning, checklist and 15 day trend logs for all major equipment (AHU's, Chiller/Boiler Plants, etc.)
- ☐ Fire alarm test certificate (via Division.16)
- ☐ Fire stopping and fire damper test letter
- ☐ Vibration isolation supplier's inspection report
- ☐ Chemical treatment supplies final inspection and test certificate
- ☐ Potable water main's flushing and chlorination test certificate
- ☐ Sound level tests reports (as required)
- ☐ Major equipment – suppliers start-up test sheets and letters certifying start-up. (boilers, chillers, packaged equipment)
- ☐ Final As-Constructed Drawings ready for review
- ☐ O&M Manuals, ready for review

.5 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 O&M Manuals

.3 Complete final calibration

.6 The Contract Administrator shall provide one (1) visitation for the purpose of Total Performance inspection. Subsequent visitations if required shall be at the expense of the Contractor.

.7 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until Substantial Performance is declared.

1.27 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 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 manufacturers' 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.

.5 List of acceptable Manufacturers:

.1	Access Doors	Maxam, Acudor, Milcor, Can.Aqua, Mifab
.2	Actuators – Dampers	Belimo, Johnson, Honeywell, Siemens *(*All actuators supplied for control components must be by same Manufacturer).
.3	Air Handling Units – Electrical Room	Circulaire
.4	Make Up Air Units	Haakon, Scott Springfield, Racan, Circulaire
.5	Air Separators, Relief Valves	Armstrong, Bell & Gossett, Taco

.6	Air Terminals - Grilles Registers, Diffusers	E.H. Price, Titus, Nailor
.7	Air Vents	Hoffman, Maid-O-Mist, Taco
.8	Backdraft Dampers	Airolite, Vent-Aire, Penn, T.A. Morrison
.9	Backflow Preventers	Febco, Watts, Hersey, Singer, Ames
.10	Boilers – Electric	Super Hot, CCI Thermal
.11	Coils – Heating and Cooling	Trane, Aerofin, Engineered Air, McQuay
.12	Dampers - Control, Backdraft	Ruskin, Tamco
.13	Domestic Water Heaters - Electric	Jetglas, Aerco, AO Smith, Ruud-Rheem, State
.14	Drains – Floor, Roof, Cleanouts Trap Primers, Water Hammer Arrestors	Zurn, Ancon, PPP, J.R. Smith
.15	Expansion Compensators	Flexonics, Tube Turn, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
.16	Expansion Joints	Flexonics, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
.17	Eye Wash Fountains	Western, Haws
.18	Fan Coil Units (low profile)	McQuay, Trane, Engineered Air
.19	Fans – Centrifugal Roof Exhausters	Penn, Greenheck, Cook
.20	Fans – Direct Drive Inline Centrifugal	Penn, Greenheck, Cook
.21	Fans – Centrifugal	Buffalo, Twin City, Trane, Chicago, Barry Blower, Northern
.22	Filters	Cambridge, AAF, Pacific, FARR
.23	Fire Dampers	Controlled Air, Ruskin, Canadian Advanced Air, Maxam, Nailor
.24	Flexible Connectors – Ducting	Thermaflex, G.I. Industries Type IHP
.25	Flexible Connectors – Piping	Flexonics, Tube Turn, Atlantic, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
.26	Gauges – Air	Dwyer, Magnehelic
.27	Gauges - OWG Pressure	Trerice, Marsh, Ashcroft, Weiss

.28	Grooved Mechanical Pipe Joints	Victaulic, Shurjoint, Groove-lok (only where permitted)
.29	Heat Exchangers – Plate and Frame	Armstrong, ITT, Bell & Gossett
.30	DX Condensing Units	Lennox, AAON, Carrier
.31	Hose Bibbs	Jenkins, Dahl, Crane, Toyo, Mifab
.32	Insulation – Piping and Duct	Fibreglass Canada, Manson, Knauf Fibreglass, Plasti-Fab, Manville
.33	Louvres	Airolite, Penn, Airstream, West Vent, Nailor, Ruskin, Ventex
.34	Piping Hangers and Saddles	Grinnell, Myatt
.35	Plumbing Brass	Crane, American Standard, Cambridge Brass, Waltec, Kohler, Symmons
.36	Plumbing Fixtures	Crane, American Standard, Kohler
.37	Pumps – Vertical In-Line and Base Mounted	Armstrong, Aurora, B & G, Taco, Grundfos
.38	Sinks – Mop	Fiat, Crane, American Standard
.39	Strainers	Armstrong, Sarco, Mueller, Toyo, Anderson, Metraflex, Yarway
.40	Tank – Diaphragm Type Expansion	Amtrol, Hamlet and Garneau Inc., B & G
.41	Thermometers	Trerice, Marsh, Ashcroft, Winters
.42	Valves – Butterfly	Jenkins, Keystone, DeZurik, Centreline, Dresser, Crane, Bray, Toyo, Grinnell
.43	Valves – Circuit Balancing	Armstrong, B & G, Tour & Anderson
.44	Valves – Ball (Flushing water and Heat Exchanger Effluent)	American Valve
.45	Valves – Control Valves	Belimo, Honeywell, Johnson *(Valve actuators to be supplied by same manufacture of damper actuators)*
.46	Valves – Drain, Radiator	Jenkins,Dahl, Crane, Toyo
.47	Valves, Bronze – Check, Ball	Jenkins, Toyo, Crane, Milwaukee
.48	Valves – Pressure Reducing	Armstrong, Bell & Gossett, Taco
.49	Valves – Relief	Armstrong, Bell & Gossett, Taco

.50 Valves – Silent Check	Val-matic, APCO, StreamFlo
.51 Valves – Suction Diffusers	Armstrong, B&G, Taco
.52 Valves – Thermostatic Mixing	Symmons, Powers, Leonard
.53 Vent Caps	Jenn-Air, Penn Ventilator
.54 Vent Sets	Greenheck, Trane, Sheldons, Buffalo, New York, Brundage, Loren Cook, Lau
.55 Vibration Isolation	Mason, Vibro Acoustic
.56 Water Closet Seats	Olsonite, Moldex, Beneke

1.28 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 Contract Administrator.

.4 Arrange piping connections to allow for equipment removal.

2. PRODUCTS

2.1 Counter Flashing Materials

.1 Counterflashings: galvanized sheet steel of 0.85 mm (22 gauge) minimum thickness.

.2 Counterflashings are attached to mechanical equipment and lap the base flashings on the roof curbs.

.3 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.

.4 Vertical flange section of roof jacks shall be screwed to face of curb.

3. EXECUTION

.1 Not Applicable

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 compressed air piping

.5 Test low velocity ducts

.6 Test medium and high velocity ducts

.7 Test glycol piping

.8 Test refrigeration piping

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 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.

.7 The Contract Administrator shall be allowed to witness any testing, adjusting, starting, balancing and cleaning procedures.

.8 Assume all costs associated with testing, including the supply of testing or cleaning medium.

.9 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.

.10 Assume all liabilities associated with testing.

1.3 Submittals

.1 Obtain certificates of approval, acceptance, and comply with current rules and regulations from authorities having jurisdiction and include in O&M Manuals.

.2 Perform tests as specified and upon completion of mechanical installation. Provide certification of tests with detailed data as required. Itemize each test as to time performed and personnel responsible. Include in O&M 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 (5 psi) minimum and 62 kPa (10 psi) maximum.

.4 Water/Glycol Piping: test to 1-1/2 times maximum working pressure or 1033 kPa (150 psi), whichever is greater, water pressure measured at system low point.

.5 Ducts: test ducts as per current edition of SMACNA Manual.

.6 Check systems during application of test pressure including visual check for leakage of water test medium, soap bubble test for air.

.7 During heating and cooling piping system tests, check linear expansion at elbows, U bends, expansion joints and offsets for proper clearance.

.8 When using water as test medium for system not using water, evacuate and dehydrate the piping and certify the lines are dry. Use agency specializing in this type of Work.

.9 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.

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 (12 inch) long flex connection on all ductwork 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 (0.25 inch) thick neoprene sound pads and zinc chromate plated hardware.

.3 Sound pads shall be sized for a minimum deflection of 1.2 mm (1/16 inch) 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 (0.25 inch) thick sound pad sized for a minimum static deflection of 1.2 mm (1/16 inch) meeting the requirements for neoprene isolators.

.4 Floor mount units shall incorporate neoprene side stabilizers with a minimum 6 mm (0.25 inch) 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 Spring Hangers

.1 Hangers capable of a 10° 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 (1 inch) clearance between housekeeping pad and base. Set concrete inertia bases for 50 mm (2 inch) clearance. Adjust equipment level.

.3 Deflections 12 mm (0.5 inch) and over shall use steel spring isolators.

.4 Deflections 5 mm (0.2 inch) and under shall use neoprene isolators.

.5 Horizontal limit springs shall be provided on fans in excess of 1.5 kPa (6 in wg) static pressure except vertical discharge fans and on hanger supported, horizontally mounted axial fans where thrust due to static pressure exceeds 300 N (68 lbs).

.6 All equipment mounted on vibration isolators shall have a minimum clearance of 50 mm (2 inch) 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 mm (inch)	Distance, m (ft)
15 - 40 mm (0.5 - 1.5 inch)	3.0 m (10) ft
50 - 65 mm (2 - 2.5 inch)	4.5 m (15) ft
75 - 100 mm (3 - 4 inch)	7.0 m (25) ft
125 - 200 mm (5 - 8 inch)	9.0 m (30) ft
225 - 275 mm (9 - 11 inch)	13.5 m (45) ft
300 - 350 mm (12 - 14 inch)	15.0 m (50) ft

The three closest hangers to the vibration source shall be selected for the lesser of a 25 mm (1 inch) static deflection or the static deflection of the isolated equipment. The remaining isolators shall be selected for the lesser of the 25 mm (1 inch) static deflection or 0.5 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 (0.25 inch) 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.

.15 Steam pressure reducing valve stations and associated piping shall be supported resiliently for the following distances unless otherwise indicated on the drawings:

Pipe Size mm (inch)	High Pressure Side m (ft)	Low Pressure Side m (ft)
15 - 40 mm (0.5 - 1.5 inch)	3.0 m (10) ft	9.0 m (30) ft
50 - 65 mm (2 - 2.5 inch)	4.5 m (15) ft	13.5 m (45) ft
75 - 100 mm (3 - 4 inch)	7.0 m (25) ft	21.0 m (75) ft
125 - 200 mm (5 - 8 inch)	9.0 m (30) ft	27.0 m (90) ft
225 - 275 mm (9 - 11 inch)	13.5 m (45) ft	40.5 m (135) ft
300 - 350 mm (12 - 14 inch)	15.0 m (50) ft	45.0 m (150) ft

3.2 Performance

.1 Install isolators of type and deflection as indicated on the following table.

The required static deflection of isolators for equipment exceeding 0.35 kW (0.5 Hp) is indicated below. Spring isolators shall be "open spring". Closed spring isolators shall only be used where specified.

Machine Speed r/min	Main Floor		Mezzanine Mechanical Room	
	Under 15 kW (20 Hp)	Over 15 kW (20 Hp)	Normal	Critical
Under 400	Special*	Special*	Special*	Special*
400 - 600	25 mm (1 inch)	50 mm (2 inch)	90 mm (3.5 inch)	Special*
600 - 800	12 mm (0.5 inch)	25 mm (1 inch)	50 mm (2 inch)	90 mm (3.5 inch)
800 - 1100	5 mm (3/16 inch)	12 mm (0.5 inch)	25 mm (1 inch)	50 mm (2 inch)
1100 - 1500	3 mm (1/8 inch)	4 mm (5/32 inch)	5 mm (3/16 inch)	12 mm (0.5 inch)

* "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 and/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 (3 inch) diameter dial in drawn steel case, bimetallic helix actuated, brass separable socket of flange and bushing, glass cover, adjustable pointer, dual °C/°F scales.

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 (4 inch) 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 dual psi/kPa scales. Provide gauge cock and syphon for steam service, pulsation danper and ball valve for water service.

2.4 Pressure Gauge Taps

.1 Brass ball valve

2.5 Static Pressure Gauges

.1 Dial Gauge: 100 mm (4 inch) dial, diaphragm actuated, suitable for positive, negative or differential pressure measurement with dual inches w.c./Pa scales. Accuracy within +2 percent of full scale, complete with static pressure tips and mounting accessories.

.2 Inclined Vertical Manometer: molded 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 with dual inches w.c./Pa scales.

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 (1.5 inch) 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 And 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 Heat pumps, inlet and outlet

.6 And where shown on Drawings

.3 Thermometers:

.1 Heat pumps, inlet and outlet

.2 Boiler, inlet and outlet

.3 Supply and return headers of central equipment

.4 Heat exchangers, inlet and outlet tube and shell side

.5 Heating and cooling coils, inlet and outlet

.6 And where shown on Drawings

.4 Thermometer Wells Only:

.1 All lines to three-way control valves

.2 And 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 And where shown on Drawings

.6 Static Pressure Taps:

.1 Across all major dampers

.2 Across heating and cooling coils

.3 And 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.

.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 Contractor Administrator the Contractor shall, at his own cost, employ a structural engineer to design equipment supports and/or pipe anchors.

2. PRODUCTS

2.1 Inserts

.1 Inserts shall be malleable iron case or galvanized 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 (0.5 inch) to 40 mm (1.5 inch): adjustable wrought steel ring

.2 Hangers: Pipe Sizes 50 mm (2 inch) to 100 mm (4 inch) and Cold Pipe Sizes 150 mm (6 inch) Over: adjustable wrought steel clevis

.3 Hangers: Hot Pipe Sizes 150 mm (6 inch) 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 (6 inch) and over

.5 Wall Support: Pipe Sizes to 80 mm (3 inch): cast iron hook

.6 Wall Support: Pipe Sizes 100 mm (4 inch) and Over: welded steel bracket and wrought steel clamp, adjustable steel yoke and cast iron roll for hot pipe sizes 150 mm (6 inch) and over

.7 Vertical Support: steel riser clamp

.8 Floor Support: Pipe Sizes to 100 mm (4 inch) and All Cold Pipe Sizes: steel adjustable pipe saddle, locknut nipple, floor flange and concrete pier to steel support

.9 Floor Support: Hot Pipe Sizes 125 mm (5 inch) and over: adjustable steel 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 galvanized hangers and supports for galvanized piping.

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: 0.55 mm (26 gauge) galvanized steel.

.2 Lead Flashing: 25 kg/m² (5 lb/ft²) sheet lead for waterproofing, 5 kg/m² (1 lb/ft²) sheet lead for soundproofing.

.3 Safes: 25 kg/m² (5 lb/ft²) sheet lead or 0.5 mm (0.02 inch) neoprene.

.4 Caps: Steel, 0.7 mm (24 gauge) thickness minimum, 1.6 mm (16 gauge) thickness at fire resistance structures.

2.6 Sleeves

.1 Pipe sleeves shall be provided for piping passing through walls and floors. Minimum 0.61 mm (24 gauge) galvanized sheet metal. Sleeves shall extend 25 mm (1 inch) on either side of the wall.

.2 Schedule 40 steel pipe shall be used as floor pipe sleeves in wet areas with a 50 mm (2 inch) up-stand.

.3 Ducts: form sleeves with galvanized steel.

.4 Size large enough to allow for expansion with continuous insulation.

.5 Pipe sleeves are not required where pipes pass through cored concrete walls or floors.

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 (4 inch) or ducts over 1500 mm (60 inch) wide.

.3 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

.4 Where inserts are omitted, provide concrete clevis plate anchored to the 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 (0.5 inch)	1.8 m (6 ft)	1.5 m (5 ft)	10 mm (0.4 inch)
20 - 40 mm (0.75 - 1.5 inch)	2.1 m (7 ft)	1.8 m (6 ft)	10 mm (0.4 inch)
50 - 65 mm (2 - 2.5 inch)	3.0 m (10 ft)	2.4 m (8 ft)	10 mm (0.4 inch)
80 - 100 mm (3 - 4 inch)	3.6 m (12 ft)	3.0 m (10 ft)	16 mm (0.6 inch)
150 - 300 mm (6 - 12 inch)	4.2 m (14 ft)	4.0 m (13 ft)	22 mm (0.75 inch)
350 - 450 mm (14 - 18 inch)	6.0 m (20 ft)	--	25 mm (1 inch)

.2 Install hangers to provide minimum 12 mm (0.5 inch) clear space between finished covering and adjacent Work.

.3 Place a hanger within 300 mm (12 inch) of each horizontal elbow.

.4 Use hangers which are vertically adjustable 40 mm (1.5 inch) minimum after piping is erected.

.5 Support horizontal soil pipe near each hub with 1.5 m (5 ft) 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 (2 inch) use high density rigid pipe insulation at hanger location, with an insulation protection shield. For pipes 65 mm (2.5 inch) and over, use insulation protection saddle.

3.3 Low Velocity Duct Hangers and Supports

.1 Hanger Minimum Sizes:

.1 Up to 750 mm (30 inch) wide: 25 x 1.6 mm (1 inch x 16 gauge) at 3 m (10 ft) spacing

.2 790 to 1200 mm (31 to 48 inch) wide: 40 x 1.6 mm (1.5 inch x 16 gauge) at 3 m (10 ft) spacing

.3 Over 1,200 mm (48 inch) wide: 40 x 1.6 mm (1.5 in x 16 gauge) at 2.4 m (8 ft) spacing

.2 Horizontal Duct on Wall Supports Minimum Sizes:

.1 Up to 450 mm (18 inch) wide: 40 x 1.6 mm (1.5 inch x 16 gauge) or 25 x 25 x 3 mm (1 x 1 inch x 11 gauge) at 2.4 m (8 ft) spacing

.2 480 to 1,000 m (19 to 40 inch) wide: 40 x 40 x 3 mm (1.5 x 1.5 x 11 gauge) at 1.2 m (4 ft) spacing

.3 Vertical Duct on Wall Supports Minimum Sizes at 3.65 m (12 ft) spacing:

.1 Up to 610 mm (24 inch) wide: 40 x 1.6 mm. (1.5 inch x 16 gauge)

.2 640 to 900 mm (25 to 36 inch) wide: 25 x 25 x 3 mm (1 x 1 inch x 11 gauge)

.3 940 to 1,200 mm (37 to 48 inch) wide: 30 x 30 x 3 mm. (1.2 x 1.2 inch x 11 gauge)

.4 Over 1,200 mm (48 inch) wide: 50 x 50 x 3 mm (2 x 2 inch x 11 gauge)

.4 Vertical Duct Floor Supports Minimum Sizes, riveted or screwed to ducts:

.1 Up to 1,520 mm (60 inch) wide: 40 x 40 x 3 mm (1.5 x 1.5 inch x 11 gauge)

.2 Over 1,520 mm (60 inch) wide: 50 x 50 x 3 mm (2 x 2 inch x 11 gauge)

3.4 Medium and High Velocity Duct Hangers and Supports

.1 Hanger Minimum Sizes:

.1 Up to 900 mm (36 inch) wide: 2 at 25 x 1.6 mm (1 inch x 16 gauge) at 3 m (10 ft) spacing

.2 940 to 1,520 mm (37 to 60 inch) wide: 2 at 25 x 1.6 mm (1 inch x 16 gauge) at 2.4 m (8 ft) spacing and 50 x 50 x 6 mm (2 x 2 inch x 0.25 inch) trapeze

.3 1,550 to 3,050 mm (61 to 120 inch) wide: 2 at 38 x 2.6 mm (1.5 inch x 12 gauge) at 2.4 m (8 ft) spacing and 50 x 50 x 7 mm (2 x 2 inch x 0.3 inch) trapeze

.4 2,070 to 6,700 mm (121 to 264 inch) wide: 3 at 10 mm (0.5 inch) diameter at 1.2 m (4 ft) spacing and 65 x 65 x 5 mm (2.5 x 2.5 x 0.2 inch) trapeze

.2 Round Duct Hangers Minimum Sizes at 3 m (10 ft) spacings:

.1 Up to 460 mm (18 inch) diameter: 25 x 1.6 mm (1 inch x 16 gauge)

.2 480 to 900 mm (19 to 36 inch) diameter: 25 x 2.6 mm (1 in x 12 gauge)

.3 940 to 1,270 mm (37 to 50 inch) diameter: 40 x 2.6 mm (1½ in x 12 gauge)

.4 1,300 to 2,130 mm (51 to 84 inch) diameter: 2 at 40 x 2.6 mm (1.5 x 12 gauge) from girth reinforcing angle

.3 Vertical Duct Floor Supports Minimum Sizes:

.1 Up to 1,220 mm (48 inch) wide: 40 x 40 x 3 mm (1½ x 1½ inch x 11 gauge)

.2 Over 1,220 mm (48 inch) wide: 50 x 50 x 3 mm (2 x 2 inch x 11 gauge)

.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 (4 inch) thick minimum, extended 100 mm (4 inch) 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 (3 inch) minimum above roof membrane with lead worked 25 mm (1 inch) minimum into hub, 200 mm (8 inch) minimum clear on sides with minimum 600 x 600 mm (24 x 24 inch) 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 (10 inch) clear on sides with minimum 920 x 920 mm (36 x 36 inch) sheet size. Fasten flashing to drain clamp device.

.4 Provide curbs for mechanical roof installations minimum 200 mm (8 inch) high. Flash and counterflash with steel; solder and make waterproof.

.5 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 (6 inch) into walls or to top of curbs and caulk into joints.

.6 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 (1 inch) above finished floor level. Caulk sleeves full depth and provide floor plate.

.3 Piping and ductwork 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 (1 inch) "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

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 Domestic Water, Drainage and Vent Piping: current Provincial and Municipal Codes.

.4 All below grade steel piping shall be yellow jacketed with taped and sealed joints.

.5 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	PVC-DWV, CAN3B182
.3	Storm drainage, inside building, above ground	Cast iron, CSA B70 DWV Copper, ASTM B306
.4	Storm drainage, inside building, below ground	PVC-DWV, CAN3B182.1
.5	Domestic water, above ground (inside building)	Type `K' hard copper for sizes up to 100 mm (4 inch), ASTM B88M Ductile Iron centrifugally cast for cold water main sizes 100 mm (4 inch) and larger, ANSI/AWWA C151/A21.51. No steel piping allowed for domestic hot water.
.6	Domestic Water (buried inside building)	Type `K' soft copper, ASTM B88M
.7	Flushing Water	Sch. 40, 304 SS, ASTM A312, Seamless ERW.

	Service	Material
.8	Glycol Piping and Natural Gas	Steel, Sch.40, ASTM A53, Grade B
.9	Compressed air, above ground	Steel, Sch. 40, ASTM A53, Grade B, seamless, plain ends, galvanized
.10	Compressed air, below ground	Type ‘K’ soft copper, ASTM B88M
.11	Equipment drains and overflows	Sch.40, galvanized steel, ASTM A120
		Type `L' hard copper ASTM B88M

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	PVC-DWV	Solvent weld
.3	Storm drainage, inside building, above ground	Cast iron	Gasket & clamp
		Wrought or cast copper	50-50 solder
.4	Storm drainage, inside building, below ground	PVC-DWV	Solvent weld
.5	Domestic water, above ground	Wrought copper, bronze	Lead free solder, brazed for pipes over 50 mm
		Cast bronze	Screwed
		Ductile Iron pipe	Grooved mechanical
.6	Domestic water, buried	PVC	Hub & spigot, with "O" ring
		Copper pipe	No joints permitted underground
.7	Flushing and Heat Exchanger Effluent Water	Stainless steel mechanical	Grooved Victaulic, Shurjoint or Gruv-Lok only

	Service	Material	Joint
.8	Glycol Piping and Natural Gas	Banded malleable iron, 1033 kPa (150 psi), up to 40 mm (1.5 inch)	Screwed
		Steel, same schedule as pipe, for sizes 50 mm (2 inch) and larger	Welded
.9	Compressed air, above ground	3000 # carbon steel, galvanized, sizes up to 40 mm (1.5 inch)	Screwed
.10	Compressed air, below ground	Copper tube	No joints permitted underground
.11	Equipment drains and overflows	Galvanized banded malleable iron	Screwed
		Wrought copper, bronze	50-50 solder
		Cast brass	Screwed

.12 Use factory fabricated butt welded fittings for welded steel pipes.

.13 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 (2 inch) and under: 1033 kPa (150 psi) 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 (2.5 inch) and over: 1033 kPa (150 psi) forged steel welding neck flanges for ferrous piping, 1033 kPa (150 psi) bronze slip-on flanges for copper piping. Gaskets shall be 1.5 mm (1/16 inch) thick performed synthetic rubber bonded asbestos. Gaskets for gas service shall be synthetic rubber.

.3 Flange bolting: for systems up to 120°C (250°F), use carbon steel stud bolts, semi-flushed and heavy hex nuts, ASTM A307-GrB. For systems up to 215°C (420°F), 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 galvanized couplings for galvanized 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 pipes when stored on-site from external conditions and ensure protective coating remains intact.

3.2 Connection

.1 Screw joint steel piping up to and including 40 mm (1.5 inch). Weld piping 50 mm (2 inch) and larger, including branch connections.

.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 (0.75 inch) rods and properly anchor and support.

.5 Use grooved mechanical couplings and mechanical fasteners, only where permitted by the Contract Administrator.

.6 Use galvanized couplings with galvanized pipe.

.7 Make connections to equipment, specialty components, and branch mains with unions or flanges.

.8 Provide dielectric type connections wherever joining dissimilar metals. 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 (0.75 inch) 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 (1 inch) diameter or line size whichever is greater and 150 mm (6 inch) high minimum. Square tees may only be used to assist with complete venting and draining.

.5 Make reductions in water and steam pipes with eccentric reducing fittings installed to provide drainage and venting. Top flat for water, bottom flat for steam.

.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 1500 mm (5 ft) 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: Forged tee or reducing tee

S: Socolet

W: Weldolet

Branch Connections (90 degree only)

Header Diameter, mm (inch)

Branch Diameter, mm (inch)	200 (8)	150 (6)	100 (4)	75 (3)	65 (2.5)	50 (2)	40 (1.5)	30 (1.25)	25 (1)	20 (0.75	15 (0.5)
15 (0.5)	S	S	S	S	S	W	W	W	T	T	T
20 (0.75)	S	S	S	S	S	W	T	T	T	T	
25 (1)	S	S	S	S	S	T	T	T	T		
30 (1.25)	S	S	S	S	S	T	T	T			
40 (1.5)	S	S	S	S	T	T	T				
50 (2)	S	S	S	T	T	T					
65 (2.5)	T	T	T	T	T						
75 (3)	T	T	T	T							
100 (4)	T	T	T								
150 (6)	T	T									
200 (8)	T										

Connection Symbols

T: Forged tee or reducing tee

S: Socolet

W: Weldolet

END OF SECTION

VALVES AND STRAINERS

1. GENERAL

1.1 Scope

.1 Ball valves

.2 Check valves

.3 Butterfly valves

.4 Drain valves

.5 Hose bibbs

.6 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 valve "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 (2 inch): brass body, chrome plated brass ball, threaded or solder ends, TFE seat and packing. 4134 kPa (600 psi) 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 (4 inch), heavy duty gear handwheel operator with position indicator for valve sizes 150 mm (6 inch) and over. Minimum rating 1200 kPa (175 psi), 121°C (250°F). Keystone AR2.

.3 Swing Check Valves:

.1 Up to 50 mm (2 inch): bronze body, screw-in cap, replaceable disc, 860 kPa (125 psi) steam rating. Threaded, Red-White Fig. 236. Solder ends, Red-White Fig. 237.

.2 65 mm (2.5 inch) and over: cast iron body, regrind-renew swing check, bolted cover, flanged ends, bronze disc and seat ring, rating 860 kPa (125 psi) steam. Red-White Fig. 435.

.4 Silent Check Valves for Pump Discharge:

.1 Up to 50 mm (2 inch): bronze body, SS stem, 316 SS spring, Teflon disc and seat ring, 430 SS seat screw, threaded ends. 1380 kPa (200 psi) water. Val Matic VM-S1400.

.2 65 mm (2.5 inch) and over: wafer style, cast iron body, 316 SS seat, plug, spring and bushing. ANSI Class 125. Val Matic, Series 1400.

2.2 Flushing Water Systems

.1 Foot Valves up to 50 mm (2 inch): cast iron body, stainless steel spring, delrin and stainless steel poppet, nitrile seat and polypropylene strainer. Silent operating and normally closed. Threaded connection. Crispin FV Series.

.2 Foot Valves 65 mm (2.5 inch) and over: cast iron body, bronze disc, bushing and seating ring with Buna-N seal, stainless steel screen. Silent operating and normally closed. ANSI Class 125 flange connection. Crispin FV Series.

.3 Ball Valves up to 100 mm (4 inch):

.1 Floating ball design capable of providing bi-directional, tight shutoff in accordance with MSS SP-72.

.2 Rating: 200 WOG

.3 Body: cast iron per ASTM A126 class B, with ANSI class 125 flat-face flanges, interior and exterior epoxy coated

.4 Ball: PFTE infused cast iron with 304 stainless steel blow-out proof stem

.5 Seats and seals: PTFE

.6 Stem seal: PTFE, externally adjustable chevron type

.7 Body bolts and nuts: carbon steel

.8 Operator: lever handle

.9 Standard of acceptance: American Valve model 4000, or as approved by the Contract Administrator.

2.3 Hydronic Systems

.1 Ball Valves up to 50 mm (2 inch): brass body, chrome plated brass ball, threaded or solder ends, TFE seat and packing. 4134 kPa (600 psi) 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 (4 inch), heavy duty gear handwheel operator with position indicator for valve sizes 150 mm (6 inch) and over. Minimum rating 1200 kPa (175 psi), 121°C (250°F). Keystone AR2.

.3 Swing Check Valves:

.1 Up to 50 mm (2 inch): bronze body, screw-in cap, replaceable disc, 860 kPa (125 psi) steam rating. Threaded, Red-White Fig. 236. Solder ends, Red-White Fig. 237.

.2 65 mm (2.5 inch) and over: cast iron body, regrind-renew swing check, bolted cover, flanged ends, bronze disc and seat ring, rating 860 kPa (125 psi) steam. Red-White Fig. 435.

.4 Silent Check Valves for Pump Discharge:

.1 Up to 50 mm (2 inch): bronze body, SS stem, 316 SS spring, Teflon disc and seat ring, 430 SS seat screw, threaded ends. 1380 kPa (200 psi) water. Val Matic VM-S1400.

.2 65 mm (2.5 inch) and over: wafer style, cast iron body, 316 SS seat, plug, spring and bushing. ANSI Class 125. Val Matic, Series 1400.

.5 Drain Valves up to 50 mm (2 inch): brass 2 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 (600 psi) WOG rating, Red-White Fig. 5046.

.6 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 & Gosset circuit setter.

.7 Control Valves

.1 Two-way valves: two-way valves shall have equal percentage characteristics. Size two-way valve operators to close against maximum pump shut-off head.

.2 Size control valves as per following criteria:

.1 Select control valves in equipment room to supply varying water temperature to the system at 24 kPa (3.5 psi) or less pressure drop.

.2 Select two-way control valves for coils, heat exchangers, terminal units, etc., with a minimum pressure drop of 35 kPa (5 psi) and a maximum pressure drop of 70 kPa (10 psi).

.3 Valves shall "fail-safe", spring return to normal position.

.4 Provide valves complete with electronic operators. Standard of acceptance: Belimo.

.5 Two-way Valves 15 mm to 50 mm (0.5 inch to 2 inch):

.1 Ball valve with flow-characterizing disc installed in the inlet of the valve.

.2 Trim: a stainless steel ball and stem.

.3 Body: nickel-plated, forged brass with female NPT threads. Bodies to 30 mm (1.25 inch) shall be rated at 4.1 MPa (600 psi) and sizes 40 mm to 50 mm (1.5 inch to 2 inch) at 2.8 MPa (400 psi). Valves shall have a self-aligning, blowout proof stem with a dual EPDM O-ring packing design.

.4 Seats: fibreglass reinforced PTFE.

.5 Coupling: non-metallic, constructed of high temperature, continual use material shall provide a direct, mechanical connection between the valve body and actuator. The coupling shall be designed to provide thermal isolation and eliminate lateral and rotational stem forces. Vent hole shall be provided to reduce condensation build-up.

.6 Valves shall have a four bolt mounting flange to provide a four position, field changeable, electronic actuator mounting arrangement.

.6 Actuators:

.1 Valve mounting: direct couple and mount to a stem, shaft or ISO style-mounting pad.

.2 Actuators shall be fully modulating/proportional or on/off as required by Specification Section 15940 and Division 17. Actuators shall have visual position indicators and shall operate in sequence with other devices as required.

.3 Operating temperature range: -30°C to 50°C (-22°F to 122°F).

.4 Proportional actuators shall accept a 0-10 VDC or 0-20 mA input signal and provide a 4-20 mA operating range.

.5 Operating Voltage: 24 VDC with a power consumption not exceeding 8 watts per actuator.

.6 Housing: NEMA 2 rated with a 1 m pre-wired electrical cable.

.7 Spring Return Mechanism: capable of CW or CCW mounting orientation. Spring return actuators with more than 6.8 N-m (60 in-lb) of torque shall have a metal, manual override crank. Upon loss of signal, a proportional actuator shall fail open or closed based on the minimum control signal.

.8 Actuators shall be capable of being mechanically or electrically paralleled to increase torque if required. Valves requiring greater torque or higher close off may be assembled with multiple low torque actuators.

.9 Running time: 70 seconds

.10 Fail-position: open for heating, closed for cooling

.8 Backpressure Valve:

.1 General: direct operated backpressure regulating valve

.2 Body: steel body, NPT screwed connections

.3 Seat: Buna-N

.4 Seat: stainless steel

.5 Diaphragm: Neoprene or Buna-N

.6 Standard of acceptance: Fisher series 98L, Cash FR Series

2.4 Natural Gas

.1 Ball valves up to 50 mm (2 inch): Class 125 non-lubricated, brass body, CGA approved. Kitz Figure No. 68 (AKTAF).

.2 Pressure Regulators; cast iron body. Sized for full gas load to reduce pressure down to requirement by appliance (boiler). Body rating 1030 kPa (150 psi). Fisher.

2.5 Compressed Air System

.1 Ball Valves up to 40 mm (1.5 inch): carbon steel ASTM A-105 three piece bolted body, 316 SS ball and stem, screwed ends, TFE seat and packing, lever operator. 1,000 WOG rating. Standard of acceptance: Milwaukee 30 Series, 30CS OF.

.2 Check Valves up to 40 mm (1.5 inch): forged steel ASTM A-105 piston check valve, bolted bonnet, screwed ends, class 800. Standard of acceptance: Vogt Series 710.

2.6 Valve Operators

.1 Provide valves larger than 100 mm (4 inch) located more than 2.1 m (7 ft) from floor in equipment rooms with chain operated sheaves. Extend chains to 1.5 m (5 ft) above floor and hook to clips to arrange to clear walking aisles.

2.7 Strainers

.1 Size 50 mm (2 inch) and under: screwed brass or iron body, Y pattern with 0.75 mm (24 gauge) stainless steel perforated screen.

.2 Size 65 mm to 100 mm (2.5 inch to 4 inch): flanged iron body, Y pattern with 1 mm (20 gauge) stainless steel perforated screen.

.3 Size 125 mm (5 inch) and larger: flanged iron body, Y pattern with 3 mm (11 gauge) stainless steel perforated screen.

.4 Screen free area shall be minimum three times area of inlet pipe.

2.8 Suction Diffuser

.1 For base mounted or floor mounted vertical inline pumps.

.1 Cast iron construction; NPT connections up to 50 mm (2 inch): flanged connections.

.2 Over 65 mm (2.5 inch): cast iron straightening fitting, stainless steel combination diffuser - strainer - orifice cylinder with 4.8 mm (3/16 inch) 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 Provide drain valves at main shut-off valves, low points of piping and apparatus and terminal units.

.4 Size drain lines and drain valves equal to size of apparatus drain connection.

.5 For pipe sizes 20 mm (0.75 inch) and over, minimum drain size to be 20 mm (0.75 inch).

.6 Provide hose thread connection with cap and chain for 20 mm (0.75 inch) drain valves located in ceiling and public areas.

.7 Provide male NPT nipples with threaded pipe cap for drain sizes over 20 mm (0.75 inch) where not piped directly to floor drains.

.8 Provide valved drain and hose connections off the bottom of all strainers.

.9 Install circuit balancing valves on the discharge of pumps where indicated.

END OF SECTION

GLYCOL SPECIALTIES

1. GENERAL

1.1 Scope

.1 Glycol mixing/charging tank, fill pump

.2 Propylene glycol solution

.3 Manual and automatic air vents

.4 Air separators

.5 Relief valves and fittings

.6 By-pass filter

.7 Quantity meters

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 Glycol Feed Package

.1 Glycol feed package shall include 180 L (48 US gallon) storage/mixing tank with cover; pump suction hose with inlet strainer; pressure pump with thermal cut-out; integral pressure switch; integral check valve; cord and plug; pre-charged accumulator tank with EPDM diaphragm, manual diverter valve for purging air and agitating contents of storage tank; pressure regulating valve adjustable 35 to 380 kPa (5 to 55 psi) complete with pressure gauge; integral replaceable strainer; built-in check valve; union connection; 15mm (0.5 inch) x 900mm (36 inch) long flexible hose with check valve; low level pump cut-out; low level alarm panel with remote monitoring dry contacts. Power supply 115/1 phase/60 0.7 A. Pump performance 0.09 L/s (1.4 usgpm) at free flow, 0.06 L/s (1.0 usgpm) at 345 kPA (50 psi), self-priming to 2.1 m (7 feet).

.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 SF100.

2.2 High Capacity Automatic Air Vents

.1 A float actuated high capacity air vent designed to purge free air from the system and provide shutoff at pressures up to 1035 kPag (150 psig) at a maximum temperature of 120°C (250°F). The design of the high capacity air vent shall prevent air from entering the system if system pressure should drop below atmospheric pressure. The high capacity air vent shall purge free at pressures up to 1035 kPag (150 psig) during normal operation. The high capacity air shall be constructed of cast iron and fitted with components of stainless steel, brass and EPDM.

.2 Standard of Acceptance: Bell & Gossett model 107A.

2.3 Automatic Air Vents

.1 Provide automatic air vents where shown on Drawings. Vents shall be non-ferrous construction, rated for 1000 kPag (145 psig) and 116°C (240°F) operating temperature.

.2 Standard of Acceptance: Bell & Gossett model 7 or 87.

2.4 Manual Air Vents

.1 Provide manual air vents with 25 mm (1 inch) or line diameter pipe which ever is greater to form air collection chamber. Collection chamber to be 150 mm (6 inch) high.

2.5 Air Separators

.1 Provide, as shown on plans, centrifugal type air separator. The unit shall have flanged inlet and outlet connections tangential to the vessel shell. The unit shall have an internal stainless steel air collector tube with 4 mm (5/32 inch) diameter perforations and 63 percent open area designed to direct accumulated air to the high capacity air vent on an air elimination system via an NPT vent connection at the top of unit.

.2 A blowdown connection shall be provided to facilitate routine cleaning of the separator.

.3 Manufacture to furnish data sheet specifying air collection efficiency and pressure drop at rated flow.

.4 Vessel shell diameter is to be three times the nominal inlet/outlet pipe diameter, with a minimum vessel volume for sufficient velocity reduction. The air separator must be designed, constructed and stamped for 861 kPag (125 psig) at 177°C (350°F) in accordance with Section VIII, Division I of the ASME Boiler and Pressure Vessel Code, and registered with the National Board of Boiler and Pressure Vessel Inseptors.

.5 The air separator(s) shall be painted with one shop coat of light gray air dry enamel.

.6 A manufacturer's data report for pressure vessels, Form U-1 as required by the provisions of the ASME Boiler and Pressure Vessel Code, shall be furnished for each air separator upon request.

.7 Refer to schedule for size and performance

.8 Standard of Acceptance: Bell & Gossett

2.6 Relief Valves

.1 Provide ASME rated direct spring loaded type, lever operated non-adjustable factory set discharge pressure as indicated.

2.7 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 (1 inch) Female NPT Thread.

Filter cartridges: 10 each of 10 micron retention, and 20 micron retention.

Manufacturer: Guthrie Hydroniclean System.

2.8 Chemical Pot Feeder

.1 150 mm (6 inch) diameter x 550 mm (22 inch) long feeder, suitable for 861 kPa (125 psi) operating pressure complete with isolation valves on 20 mm (0.75 inch) inlet and outlet lines. 20 mm (0.75 inch) drain valve 40 mm (1.5 inch) fill complete with filling funnel.

2.9 Expansion Tank

.1 Pre-charged horizontal steel expansion tank with integral heavy duty Butyl rubber diaphragm. The tank shall have 13 mm (0.5 inch NPT) system connections and a 0.302"-32 charging valve connection to facilitate the on-site charging of the tank to meet system requirements. The tank must be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code and stamped 861 kPa (125 psi) working pressure.

.2 Refer to Section 15999 – Schedules for selections and sizes

.3 Standard of acceptance: Bell & Gossett Series D

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 Chemical Pot Feeder

.1 Install one chemical pot feeder for each glycol system.

END OF SECTION

INHIBITED GLYCOL FLUID

1. GENERAL

1.1 Scope

.1 The Work under this Section shall include labour, materials, equipment, appliances, instruments, services and transportation in connection with the aqueous based heat transfer fluid. Work shall be as indicated in the Specification and as noted on the Drawings.

.2 Clean, degrease and thoroughly flush the systems.

.3 Mix and charge the inhibited glycol solution.

.4 Test and certify the concentration of glycol, corrosion inhibitors, pH, reserve alkalinity and trace chemicals.

.5 Provide identification materials and system nameplates.

1.2 Quality Assurance

.1 All applicable codes shall be adhered to in the transportation, use, storage and disposal of the heat transfer fluid.

.2 All system components in contact with the inhibited glycol based heat transfer fluid in normal use, testing repair or servicing, including but not limited to pumps, valves, gaskets, seals, o-rings, etc. shall be fully compatible with the solution of heat transfer fluid at the temperatures and pressures used in the systems. Fully compatible means free from corrosion within the limits of the ASTM D1384, free from erosion and scaling, free from fluid leaks, capable of performing the stated or implied function without binding, sticking or plugging, free from degradation of system materials, leaching of the system materials or degradation of the glycol solution and the inhibitors.

.3 Commercially available automotive antifreeze solutions are not acceptable.

.4 After installation and circulation of the glycol mixture, a representative sample shall be sent to the manufacturer for analysis. The analysis results will be returned to the Contract Administrator.

.5 Annual analysis of the fluid will be provided by the manufacturer, free of charge, to insure fluid quality. Recommendations for adjustment, if necessary, will be made at that time.

1.3 Submittals

.1 Product data to include the percentage of volume of glycol and the following fluid properties: thermal conductivity, density, viscosity and specific heat.

.2 The manufacturer of the fluid must supply written documentation in the submittal package for compliance to the corrosion standards of ASTM D1384 (less than 0.5 mil penetration per year for all system metals).

.3 A manufacturer's certificate of analysis that guarantees the content of the delivered product shall be furnished with the inhibited glycol and presented to the Contractor at the time of delivery. A copy shall be forwarded to the Contract Administrator.

2. PRODUCTS

2.1 Fluid Material

.1 Provide a 45 percent by volume solution of industrial grade inhibited ethylene glycol based heat transfer fluid. The concentration shall not be less than 40 percent glycol by volume, with the balance being good quality water.

.2 The fluid must be easily analyzed for glycol concentration and inhibitor level, and easily reinhibited using replacement inhibitor available from the fluid manufacturer.

.3 An annual analysis must be provided free of charge by the fluid manufacturer. The analysis shall report glycol concentration, freeze point temperature, inhibitor level, pH, reserve alkalinity, contaminants such as: chlorine, sulphate, nitrate and total hardness. Recommendations on additions of glycol or inhibitors shall also be given as needed.

.4 The fluid must pass ASTM D1384 (less than 0.5 mil penetration per year for all system metals).

2.2 Dilution Water

.1 The water used to dilute the concentrated inhibited glycol based heat transfer fluid must be either distilled, de-ionized or contain less than 25 ppm each of chloride or sulphate and less than 50 ppm each of hard water ions (calcium and magnesium as calcium carbonate) with a total hardness not to exceed 100 ppm. If good quality water is unavailable, the manufacturer of the product will provide the heat transfer fluid and water to meet the specifications of the systems.

3. EXECUTION

3.1 System Preparation

.1 The system shall be cleaned and flushed prior to the installation of the industrially inhibited glycol based heat transfer fluid to remove dirt, weld slag, filings, solder flux, oil, etc. A new or mildly corroded system shall be cleaned with a 1 percent to 2 percent solution of trisodium phosphate in water, or another approved cleaning solution. This cleaning solution shall be circulated for 8 to 12 hours and then flushed from the systems.

.2 The system shall be flushed with clean water and circulated for a minimum of 72 hours, at which time a sample shall be taken to verify that the system is free of particulates, mil scale, weld scale, solder flux, rust, metal filings, oil, grease, chlorides, sulphates, silicates and other foreign matter that could degrade the inhibited glycol based heat transfer fluid.

.3 If water in the system is not acceptable, the water in the system shall be drained and the systems filled with water meeting the water quality requirements of this section. If the manufacturer is supplying both fluid and water, the systems may be filled with the fluids upon removal of the flush water.

3.2 Fluid Installation

.1 The system is to be hydrostatically tested to insure that there are no leaks. The flush water may be used for the testing. Refer to Section 15030 – Testing.

.2 The Contractor shall provide a water meter to measure the volume of flush water put into the system. The total volume of the system is needed to determine the amount of inhibited heat transfer fluid required to meet the specified glycol concentration for the system. The Contractor is responsible disposal of glycol or water overages.

.3 A refractometer shall be provided by the Contractor and left with the City. The refractometer shall be used to measure the freezing point in degrees Fahrenheit of the inhibited glycol/water solution in the system. Standard of acceptance: Misco.

.4 The Contractor shall take a fluid sample with the manufacturer's supplied test kit after the system has been circulating for a minimum of 24 hours. The manufacturer shall provide a thermal fluid analysis report to the Contract Administrator in writing. The Contractor shall be responsible to complete any changes in the heat transfer solution if it does not meet with these Specifications.

3.3 Identification Materials

.1 The Contractor will provide a system nameplate permanently encased in clear plastic with, but not limited to, the following information:

.1 Date

.2 Description of heat transfer fluid

.3 Manufacturer's name, address, telephone number and fax number for normal and emergency contact

.4 Percent glycol by volume

.5 Freeze point

.6 Total system volume in litres

.7 Reference of the MSDS

.8 Instruction for sampling

.9 The address to which the sample can be sent

.2 Include a notation that proper inhibitor monitoring and maintenance must be performed (via annual analysis by the manufacturer) in order to prevent corrosion of the piping system components, degradation of piping system materials, degradation of the glycol, sludge formation in the system, or freezing of the solution.

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 "Expansion Joint Manufacturers Association" 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 (12 inch) 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 (150 psi) at 120°C (250°F). Union end connections for sizes 50 mm (2 inch) and under; floating galvanised ductile iron flanges for sizes over 50 mm (2 inch).

.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 (150 psi) at 120°C (250°F).

.4 Braided Spools for Steel Piping: stainless steel inner core and braid welded to steel pipe nipples, threaded for pipe up to 50 mm (2 inch) diameter, flanged for 65 mm (2.5 inch) diameter pipe and over. Suitable for service at 1035 kPa (150 psi) at 120°C (250°F).

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 (150 psi) at 260°C (500°F).

.2 Steel Piping up to 100 mm (4 inch): laminated stainless steel bellows welded to steel pipe nipples. Anti-torque device and threaded ends for sizes to 50 mm (2 inch), flanged ends for sizes 65 mm (2.5 inch) and over. Internal guide and carbon steel shroud suitable for 1035 kPa (150 psi) at 260°C (500°F).

.3 Steel Piping 100 mm (4 inch) 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 (150 psi) at 260°C (500°F).

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 (12 inch).

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 structural consultant 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.

EXPANSION COMPENSATION

.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 Saddles and structural supports

.3 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 Provide Shop Drawings for all tanks specified.

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 sheet separating air chamber from water.

.3 Provide with air side charge connection, and water side inlet connection precharged as scheduled.

3. EXECUTION

3.1 Installation

.1 Support tanks inside building from building structure as indicated on Drawings. Provide 100 mm (4 inch) high housekeeping bases on floor mounted tanks.

3.2 Performance

.1 Provide tanks of dimensions and capacities as indicated on tank schedules.

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 jobsite 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 (75°F) maximum 0.035 W/m.°C (0.25 Btu-in/hr-ft^2-°F). Service temperature -14°C (7°F) to 100°C (212°F).

.2 Roof Drain Piping and Plumbing Vents: 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 (75°F) maximum 0.035 W/m.°C (0.25 Btu-in/hr-ft^2-°F). Service temperature -14°C (7°F) to 100°C (212°F).

.3 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 (0.25 Btu-in/hr-ft^2-°F) at 24°C (75°F). Service temperature up to 150°C (300°F).

.4 Recovery Jackets:

.1 PVC:

.1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.

.2 Colours: white

.3 Service temperatures: minimum -4°F, maximum 150°F

.4 Moisture vapour transmission: 0.02 perm

.5 Thickness: 20 mils

.6 Fastenings: use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Aluminum:

.1 To ASTM B 209

.2 Thickness: 30 gauge for piping

.3 Finish: stucco embossed

.4 Joining: longitudinal and circumferential slip joints with 2 inch laps

.5 Fittings: die-shaped fitting covers with factory-attached protective liner

.6 Metal jacket banding and mechanical seals: stainless steel, 0.75 inches wide, at 12 inch spacing.

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 complete system including fittings, valves, unions, flanges, strainers. Do not insulate flexible connections and expansion joints. Terminate insulation neatly with plastic material travelled on a bevel.

.3 Insulate piping, fittings and valves. Do not insulate unions, flanges (except on flanged valves), "victaulic" couplings, strainers, (except on chilled water lines), flexible connections and expansion joints. Terminate insulation neatly with plastic material trowelled on a bevel.

.4 Finish insulation neatly on hangers, supports and other protrusions.

.5 Locate insulation or cover seams in least visible locations. Locate seams on piping in ceiling spaces on the underside of the pipe.

.6 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.

.7 Cold Piping: seal lap joints with 100 percent coverage of vapour barrier adhesive. Seal butt joints with 50 mm (2 inch) 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 (4 inch) centres.

.9 Hot Piping: for fittings and valves, apply hydraulic insulating cement; or apply factory fabricated insulation half shells.

3.3 Insulation Installation Thickness Schedule

	Piping or Equipment	Pipe Sizes mm (inch)	Insulation Thickness mm (inch)	Recovery Jacket
.1	Domestic Cold Water Piping	15 to 20 (0.5 to 0.75) 25 (1) & over	15 (0.5) 25 (1)	PVC
.2	Domestic Hot Water Supply and Recirculation Piping	15 (0.5) to 50 (2) Over 50 (2)	25 (1) 40 (1.5)	PVC
.3	Glycol Heating Piping	All sizes	40 (1.5)	Aluminum
.4	Roof Drains and complete storm drainage piping within building	All sizes	25 (1)	PVC
.5	Vents within 3 m (10 ft) of Roof Outlet, as measured along pipe	All sizes	25 (1)	PVC
.6	Air Separators		25 (1)	Aluminum

Note: Pipe insulation for piping installed in 38 mm x 92 mm (2 inch x 4 inch) wall cavity can be reduced 15 mm (0.5 inch), for pipe sizes 40 mm (1.5 inch) to (65 mm 2.5 inch). 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 Duct acoustic 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 jobsite 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 for 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 Aluminum:

.1 To ASTM B 209

.2 Thickness: 30 gauge for piping

.3 Finish: stucco embossed

.4 Joining: longitudinal and circumferential slip joints with 50 mm (2 inch) laps

.5 Fittings: die-shaped fitting covers with factory-attached protective liner

.4 Metal jacket banding and mechanical seals: stainless steel, 19 mm (0.75 inch) wide, at 300 mm (12 inch) spacing. 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 (0.25 BTU-in/hr.ft^2.°F) at 24°C (75°F). Factory applied reinforced aluminum foil vapour barrier for cold ducts. Hot duct service temperature 20°C (68°F) to 65°C (150°F). Cold ducts service temperature -40°C (-40°F) to 65°C (150°F).

.2 Round Ducts and Concealed Rectangular Ducts: flexible fibrous glass or mineral fibre insulation, "K" value maximum 0.035 W/m.°C (0.25 BTU-in/hr.ft^2.°F) at 24°C (75°F). Factory applied reinforced aluminum foil vapour barrier for cold ducts. Hot duct service temperature 20°C (68°F) to 65°C (150°F). Cold duct service temperature -40° (-40°F) to 65°C (150°F).

.3 Acoustic Lining: fibrous glass or mineral fibreboard insulation with "K" value maximum 0.035 W/m.°C (0.25 BTU-in/hr ft^2°F) at 24°C (75°F). Absolute roughness of exposed surface not to exceed 0.58 mm (0.02 inch), coated to prevent fibre erosion at air velocities up to 25.4 m/s (5,000 fpm), 24 kg/m^3 (1.5 lb/ft^3) minimum density for ductwork and 75 kg/m³ (4.7 lb/ft^3) for plenums. Substrate must not be dark in colour. Service temperature -40°C (-40°F) to 65°C (150°F).

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 (8 inch) centres or screws on 150 mm (6 inch) centres. Lap joints 75 mm (3 inch) minimum and seal with compatible waterproof lap cement.

.7 Exposed Rectangular Ducts: Secure rigid insulation with galvanised anchors or welded pins on 400 mm (16 inch) centres. Secure in place with retaining pins. Seal all insulation joints and breaks with joint tape. Seal adhesive; cover joints with 100 mm (4 inch) 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 (6 inch) wide strips on 400 mm (16 inch) centres. Provide annealed tie wire tied at 400 mm (16 inch) 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 Acoustic Lining: apply to interior of ducts where shown. Secure to ductwork with adhesive using 50 percent coverage and anchors or weld pins on 400 mm (16 inch) centres. Secure in place with retaining clips. Cut off excess fastener length and cover with brush coat of mastic over protrusions and all raw edges. Use 25 mm (1 inch) thick insulation unless otherwise noted. Provide vapour barrier located on the warm side for outside air intakes. Bevel corners at joints and butt together. Install acoustic gauze over all cut corners and joints and brush coat with lap seal adhesive.

.10 Where duct velocities exceed 15 m/s (3,000 fpm), cover internal duct insulation with 0.8 mm (22 gauge) perforated galvanised steel with 24 percent free area.

.11 Fasten aluminum recovery jacket in place with aluminum banding on 200 mm (8 inch) centres or screws or rivets on 150 mm (6 inch) centres.

3.3 Insulation Installation Thickness Schedule

Ducts and Equipment		Insulation Thickness mm (inch)	Recovery Jacket
.1	Relief Duct	50 (2)	Aluminum
.2	Exhaust Ducts within 3000 mm (10 ft) of Exterior Walls or after heat exchanger	50 (1)	Aluminum
.3	Outside Air Intake Ducts	50 (2)	Aluminum
.4	Plenums (Heating Systems)	50 (2)	Aluminum
.5	Plenums (Systems with Cooling Coils)	50 (2)	Aluminum
.6	Supply Ducts Heating/Cooling System	25 (1)	Aluminum
.7	Ducts Exposed to Outdoors	50 (2)	Aluminum
.8	Acoustic Lining (where indicated)	25 (1)	--

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 Shop Drawings and product data in accordance with Section 01300 – Submittals and Section 15010 – Mechanical General Requirements.

.2 Shop Drawings shall be clear and legible, facsimiles will not be accepted. Provide a cover page for each air handling unit, showing the project name, consulting engineer, mechanical contractor, tagging information, revision if applicable and submission date, leaving adequate space for approval stamps.

.3 Provide all technical information relevant to the product being provided, including but not limited to all the information shown in the schedules of the Specification. It is the responsibility of the vendor to highlight any variances the equipment has with the requirements of this Specification.

.4 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 and/or inverter only as specified in Section 15010 – Mechanical General Requirements.

1.4 Related Work and Documents

.1 Division 1

.2 Division 16

.3 Division 17

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 1800 rpm unless specified otherwise.

.4 Pump connections shall be flanged.

2.2 Close Couple Pump

.1 Type: centrifugal, close couple, single stage, vertical split case design

.2 Casing: Class 30 cast iron volute, end suction rated for 1.2 MPa (175 psi) working pressure. The casing shall have gauge ports, vent and drain ports.

.3 Impeller: cast bronze, fully enclosed, statically and dynamically balanced, keyed to shaft and secured by a locking screw.

.4 Shaft: steel

.5 Seals: internal self-flushing mechanical seal with ceramic seal seat of at least 98 percent alumina oxide content and carbon seal ring, suitable for continuous operation at 107°C (225°F). A replaceable shaft sleeve of bronze alloy shall completely cover the wetted area under the seal.

.6 Motors: open drip proof, unless noted otherwise in pump schedule

.7 Finish: high grade machinery enamel

2.3 Self-Priming Centrifugal Pump

.1 Type: horizontal, self-priming centrifugal type; Standard of Acceptance ‘Gorman-Rupp’.

.2 Casing: cast iron, back pullout design. Casing shall incorporate following features:

.1 Mounting feet sized to prevent tipping or binding when pump is completely disassembled for maintenance.

.2 Integral steel-weighted, rubber moulded check valve

.3 Casing drain plug

.4 Taps for pressure and vacuum gauges on the suction inlet, discharge outlet and the volute casing.

.5 The suction and discharge connections shall be threaded (NPT).

.3 Rotating Assembly: a rotating assembly, which includes impeller, shaft, mechanical shaft seal, lip seals, bearings, seal plate and bearing housing must be removable as a single unit without disturbing the pump casing or piping. Design shall incorporate following features:

.1 Seal plate and bearing housing shall be cast iron. Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings. Cavities must be cooled by the liquid pumped and lip seals will prevent leakage of oil. The bearing cavity to have an oil level sight gauge and fill plug check valve. The check valve shall vent the cavity but prevent introduction of moist air to the bearings.

.2 Impeller shall be ductile iron, two-vane, semi-open, non-clog, with integral pump out vanes on the back shroud. Impeller shall thread onto the pump shaft and be secured with a lockscrew and conical washer.

.3 Diffuser: cast iron

.4 Shaft: steel

.5 Bearings shall be anti-friction ball or tapered roller type of proper size and design to withstand all radial and thrust loads expected during normal operation. Bearings shall be oil lubricated from a dedicated reservoir.

.6 Shaft seal shall be oil lubricated mechanical type.

.4 Motors:

.1 Refer to Specification Section 15010 – Mechanical General Requirements.

.2 Pump motors shall be horizontal, open drip proof, 1,750 RPM, EEMAC design B with cast iron frame with copper windings, induction type, with class F insulation and 1.15 Service Factor for normal starting torque and low starting current characteristics, suitable for continuous service. The motors shall not overload at the design condition or at any head in the operating range as specified.

.5 Drive Transmission:

.1 Flexible coupling with coupling guard

.6 Baseplate: high grade heat treated cast iron or reinforced heavy steel

2.4 In-Line Circulator

.1 Materials of construction:

.1 Inlet cone, bearing plate and retainers, rotor can, rotor cladding, shaft retainer, and impeller: stainless steel

.2 Stator housing: aluminium

.3 Shaft and upper and lower radial bearings: aluminium oxide ceramic

.4 Thrust bearing: metal impregnated carbon

.5 Volute: cast iron

.6 O-ring and gaskets: ethylene propylene rubber

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 (4 inch) and over.

.5 Check and align pumps prior to start-up

3.2 Performance

.1 Refer to the Pump Schedule in Section 15999

END OF SECTION

PLUMBING GENERAL

1. GENERAL

1.1 Scope

.1 Cleanouts

.2 Air chambers or water hammer arresters

.3 Roof and floor drains

.4 Cooling equipment condensate drains

.5 Domestic water heaters

.6 Sanitary sewer service connections

.7 Water service connections

.8 Backflow preventers

.9 Vacuum breakers

.10 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.

.3 Provide an approved water meter and bypass installation conforming to Local Codes and Standards.

.4 Provide and include charges for connections to utilities.

1.3 Submittals

.1 Submit Shop Drawings for review by the Contract Administrator, in accordance with the General Conditions. Provide Shop Drawings for the following items:

.1 Roof drains

.2 Floor drains

.3 Domestic water heaters

.4 Backflow preventers

.5 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 (0.75 inch) minimum and minimum 450 mm (18 inch) long.

.2 Install stainless steel bellows type water hammer arresters on water lines connected to solenoid valves and to fixture or group of fixtures complete with accessible isolation valve.

2.3 Roof Drains

.1 Flow Characteristics: full open flow

.2 Material: all major components including body, flashing clamping flange, under deck clamping ring and dome strainer shall be cast iron or cast aluminum, lacquered. Bolts shall be galvanised or prime painted steel.

.3 Body:

.1 Sump: minimum 180 mm (7 inch) internal diameter, minimum 75 mm (3 inch) deep

.2 Discharge: nominal 100 mm (4 inch) non-threaded MJ

.3 Bosses: solid, integrally cast, for under deck clamping ring and flashing flange bolts

.4 Deck flange: nominal 300 mm (12 inch) outside diameter, minimum 50 mm (2 inch) width

.4 Flashing Clamping Flange: outside diameter same as outside diameter of deck flange; V-notched positive draining gravel stop lip, 15 mm (0.5 inch) high.

.5 Dome Strainer: minimum 150 mm (6 inch) high; 8 mm (0.3 inch) to 15 mm (0.5 inch) slotted openings, sides, and top.

.6 Standard of acceptance: ‘Zurn’ model Z-121-C.

2.4 Floor Drains

.1 FD-1: floor drain with heavy duty round strainer and clamping collar. Floor drain shall have lacquered cast iron body with bottom outlet, combination invertible membrane clamp, trap primer connection, sediment bucket and adjustable collar heavy-duty five-inch polished nickel bronze strainer. Extension adaptors provided as required. Washroom floor drains shall have a removable perforated sediment bucket. Standard of acceptance: 'Zurn' model ZX-415-A5-AR-P-Y.

.2 FD-2: floor drains in equipment rooms shall be similar to FD-1, with 100 mm (4 inch) cast iron funnel type strainer.

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 25 mm (1 inch) complete with 100 mm (4 inch) 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 (24 inch) must also meet the requirements of Boiler and Pressure Vessel Safety Act.

.2 Refer to equipment schedules in Section 15999 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 double check valve type assembly consisting of two (2) positive sealing replaceable check valves with stainless steel or bronze seats. Provide check valve on units 50 mm (2 inch) and smaller. Watts No. 709.

.3 Provide complete atmospheric vent backflow preventer assembly, consisting of two (2) positive sealing replaceable check valves with bronze seats, integral stainer and threaded vent connection. Watts No. 9D.

2.8 Vacuum Breaker Assemblies

.1 Provide pressure type vacuum breaker assembly complete with shut-off valves before and after check valves and test cocks. Assembly shall consist of one (1) positive sealing check valve and one (1) atmospheric vent disk with stainless steel or bronze seats complete with shut-off valves before and after check valves and test cocks. Assembly shall meet AWWA requirements and CSA B64 standards. Watts No. 800.

.2 Provide atmospheric type vacuum breaker assembly complete with shut-off valve before assembly. Assembly shall consist of one (1) free floating poppet to seal the atmospheric vent under flow conditions. Watts No. 288A. For bottom inlet and outlet, Watts No. 388 ASC.

.3 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 Trap Seal Primers

.1 Bronze automatic trap primer complete with sediment strainer, union and access door for concealed installations with 13 mm (0.5 inch) copper tubing connections between primer valve and floor drain.

3. EXECUTION

3.1 Installation

.1 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 leak proof joint.

.2 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 bibbs and flush valves.

.3 Where floor drains are located over occupied areas, provide waterproof installation.

.4 Install trap primers on all floor drains.

.5 Drainage lines shall grade 2 mm per 100 mm (2 in per 100 inch) unless otherwise indicated on Drawings.

.6 Locate plumbing vents minimum 4.9m (16 ft.) from air intakes.

.7 Provide a heat trap loop in domestic hot water supply piping at domestic hot water storage tank.

END OF SECTION

PLUMBING FIXTURES AND TRIM

1. GENERAL

1.1 Scope

.1 Plumbing fixtures and trim

.2 Emergency eye/face wash and thermostatic mixing valve

.3 Hose reel

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 Check millwork Shop Drawings. Confirm location and size of fixtures and openings before rough-in and installation.

1.4 Submittals

.1 Submit Shop Drawings for review

2. PRODUCTS

.1 Refer to Fixture Schedule on Drawings

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.

.2 Provide chrome plated rigid or flexible supplies to fixtures with screwdriver stops, reducers and escutcheons.

.3 Install wall mounted lavatories with approved wall carriers.

.4 Caulk gap between mop sink and wall with silicone sealant.

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
Lavatories	15 mm (0.5 inch)	15 mm (0.5 inch)	40 mm (1.5 inch)	30 mm (1.25 inch)
Service Sink	15 mm (0.5 inch)	15 mm (0.5 inch)	50 mm (2 inch)	40 mm (1.5 inch)
Floor Drains	--	--	100 mm (4 inch)	40 mm (1.5 inch)
Water Closet (Tank Type)	--	15 mm (0.5 inch)	100 mm (4 inch)	50 mm (2 inch)

END OF SECTION

FIRE EXTINGUISHERS

1. GENERAL

1.1 Scope

.1 Fire extinguishers

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 – latest edition.

1.4 Submittals

.1 Submit Shop Drawings for review. Submit with Shop Drawings 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 (10 lb.) capacity rating 4A:60BC.

.2 Carbon Dioxide (Type 3): hose and horn discharge, self-closing lever or squeeze grip operated, insulated handle fully charge and complete with mounting brackets, 2.25 kg (5 lb.) capacity. Rating 5BC.

3. EXECUTION

3.1 Installation

.1 Install extinguishers so that the bottom of extinguisher is no more than 1200 mm (4 ft.) above floor.

3.2 Schedules

	Location	Fire Extinguisher	Cabinet Type	Size	Rating
.1	Corridor	Type 1	None	4.5 kg	4A:60BC
.2	Electrical	Type 3	None	2.25 kg	5BC
.3	Mech.	Type 1	None	4.5 kg	4A:60BC

END OF SECTION

MEDIUM EFFICIENCY GAS BOILERS

1. GENERAL

1.1 Scope

.1 Provide medium efficiency (85.1 percent AFUE or better).

.2 Boilers, control and trim, comes with hot water connections, fuel connections, electrical connections, controls and power.

.3 Provide flues, draft dampers and flue stack connections as required and shown on Drawings.

1.2 Quality Assurance

.1 Boilers to comply with Provincial Regulations and bear the CSA Approval Stamp/Seal.

.2 Boilers shall have Canadian CRN numbers and shall be approved and labelled by the UL.

1.3 Start-up

.1 Provide the services of a factory trained representative to start up the boiler(s), test the efficiency and train the operators.

1.4 Submittals

.1 Submit Shop Drawings indicating capacity rating, physical dimensions, wiring diagrams, materials of construction, code compliance, etc.

.2 Provide four (4) sets of O&M Manuals with complete description of installation and operation of boilers.

2. PRODUCTS

2.1 Type

.1 Standard of acceptance for medium efficiency boilers is RBI Dominator Series.

.1 The Boiler shall be Model DB 1350 having and input of 1350 MBH and rated output of 1134 MBH. The Boiler shall be operated on Natural Gas. Boiler thermal efficiency shall be a minimum of 84 percent. The boiler shall be design certified and tested by International Approval Services. The boiler shall meet the requirements of ANSI Standard Z21.13 and the Canadian Gas Association Standard CGA3.1. The boiler shall operate on negative stack pressure and Category I according to ANSI Standards or Class I according to CGA Standards. The boiler shall be approved for indoor or outdoor installation. The boiler shall be approved for sidewall, direct vent vertical, direct vent horizontal sealed combustion with the use of RBI provided Draft Inducer Kit. Flue outlet shall be convertible to allow venting from top or rear outlet of the boiler.

.2 Boilers shall be suitable for vertical stacking and be supplied comes with stacking frame.

.2 Heat Exchanger:

.1 The heat exchanger shall be inspected and bear the ASME Section IV seal of approval. The ASME seal of approval shall not be provided as standard for jurisdictions not requiring the ASME Section IV seal of approval. The heat exchanger shall a two-pass design with a maximum working pressure of 160 psi. The water tube shall be of straight 7/8 inch I.D., .065 minimum wall thickness, integral finned copper tube, 7 fins per inch, with a fin height of 3/8 inch. The water tubes shall be set horizontally with heavy galvanized steel "V" baffles tightly secured above the tubes throughout the length of the tubes. Each end of the water tubes shall be rolled into a steel tube sheet. The headers shall be secured to the tube sheet by properly spaced stud bolts, flange nuts and the use of "O" rings. The headers shall be solid cast iron construction only. "O" rings must be constructed of EPDM and Silicone, capable of withstanding temperatures of 540°F. The use of red "O"-rings constructed of Neoprene and Silicone with temperature ratings of 250°F will not be permitted. The boiler shall have a HEAT EXCHANGER DRAW GUIDE RAIL so that the heat exchanger may slide out for ease of service and maintenance.

.3 Combustion Chamber:

.1 The combustion chamber shall be sealed and completely enclosed with high temperature ceramic fiberboard insulation. The burners shall be constructed of "4059 Uginox" Stainless Steel Alloy and fired on a horizontal plane. The boiler shall have two, two-speed integral combustion air blowers to control the fuel/air mixture for maximum efficiency across the firing range. Standard firing for the boiler will be four stages, capable of 27 percent of total input in stage one, 54 percent of input in stage two, 77 percent of input in stage three, and 100 percent of input in the full fire mode.

2.2 Boiler Trim

.1 The boiler trim shall be complete with a combination pressure/temperature gauge, an ASME rated pressure relief valve set at 75 psig, a flow switch, low water cut off switch, and supply and return isolation values.

2.3 Boiler Controls

.1 The boiler staging will be controlled by a Tekmar "Tektra" model four-stage set point control, including circulating pump control, one per boiler. The control shall use PID Logic to calculate system differential, inter stage differential, and on/off time delays in response to system load changes. A Relay Logic Board will incorporate all relay functions and purge time delays. The pilot control shall be spark and proven prior to trial for main flame ignition. The control panel shall have a master switch with an indicating light and sequential and diagnostic indicator lights. Additional standard controls shall include manual reset high limit, and low airflow switches to monitor fan operation.

2.4 Gas Train

.1 The gas train shall include a manual gas shut-off valve, Honeywell VR8205Q Pilot Valve, and two Honeywell V8944B two-stage firing valves.

2.5 NOx Emissions

.1 The boiler shall conform to SCAQMD 1146.2 for NOx emissions of 30ppm or less.

2.6 Paint Finish

.1 The paint finish shall be RBI Gray Hammer Toned Finish.

3. EXECUTION

3.1 Housekeeping Pads

.1 Mount boilers on 100 mm (4 inch) housekeeping pads.

3.2 Performance

.1 Refer to Equipment Schedules in Section 15999

END OF SECTION

INDOOR CUSTOM MANUFACTURED MAKE-UP AIR UNITS

1. GENERAL

1.1 Scope

.1 Supply and install indoor air handling units as described here in and indicated on Drawings. Units provide ventilation, heating, and exhaust air heat recovery.

.2 This Specification is applicable to MUA units T600, T605, F600 ad S750.

.3 Refer to Section 15999 MUA Schedule for performance specifications.

1.2 References

.1 AFBMA 9, Load Ratings and Fatigue Life for Ball Bearings

.2 AMCA 99, Standards Handbook

.3 AMCA 210, Laboratory Methods of Testing Fans for Rating Purposes

.4 AMCA 300, Test Code for Sound Rating Air Moving Devices

.5 AMCA 500, Test Methods for Louvers, Dampers and Shutters

.6 ARI 410, Forced-Circulation Air-Cooling and Air-Heating Coils

.7 NEC

.8 NEMA MG1, Motors and Generators

.9 NFPA 70, National Fire Protection Code

.10 SMACNA, HVAC Duct Construction Standards – Metal and Flexible

.11 ULC 900, Test Performance of Air Filter Units

.12 ASHRAE 62-2001, Ventilation for Acceptable Indoor Air Quality

1.3 Quality Assurance

.1 Local service shall be available either directly from the factory or through the local certified factory representatives.

.2 Major components shall be products of recognized manufacturers regularly engaged in production of such equipment and whose products are in compliance with industry standards.

.3 The following parameters shall establish the selection criteria and shall be as specified: airflow rates, external static pressures, and water flow rates. The following are to be as specified or improved: coil and filter face velocities, cabinet air leakage rate, inlet/discharge/radiated sound power levels, and internal static pressure/brake horsepower.

.4 Unit casing leak rate shall not exceed 0.1 cfm per square foot of cabinet area at 5 inch static pressure in order to meet efficiency and indoor air quality standards.

.5 Units shall be factory built and shipped in a single piece, multiple sections or as a knock-down package depending on the project Specification and/or field restrictions.

.6 Fans shall conform to AMCA standards regarding testing and construction. Fans shall bear the AMCA certified rating seal for sound and airflow. Fan wheels and housings shall be epoxy coat for corrosion resistance and be phenolic coated.

.7 Heating coils shall be ARI certified.

.8 Filter media shall be ULC listed.

.9 Units with factory wiring shall be CSA or ETL approved for electrical safety.

.10 Provide all motors with thermal overload protection. Provide thermisters in motor windings. General motor data shall be in accordance with Section 15010 – Mechanical General Requirements.

.11 Start-up of unit shall be executed by manufacturer's personnel.

.12 All components, paints and lining shall have a flame spread rating of not over 25 without evidence of continued progressive combustion and a smoke developed rating no higher than 50.

1.4 Operation and Maintenance Data

.1 Include instructions for lubrication, filter replacement, motor and drive adjustment and replacement, spare parts lists and wiring diagrams.

1.5 Delivery, Storage and Handling

.1 Accept products on-site in factory applied protective wrapping, and factory installed lifting lugs. Inspect for damage. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.

1.6 Environmental Requirements

.1 Do not operate units for any purpose, temporary or permanent, until vendor installation certification has been completed, ductwork is clean, filters are in place, bearings lubricated and fan has been test run under observation.

1.7 Submittals

.1 Submit Shop Drawings and product data in accordance with Section 01300 – Submittals and Section 15010 – Mechanical General Requirements.

.2 Shop Drawings shall be clear and legible, facsimiles will not be accepted. Provide a cover page for each air handling unit, showing the project name, consulting engineer, mechanical Contractor, tagging information, revision if applicable and submission date, leaving adequate space for approval stamps.

.3 Provide all technical information relevant to the product being provided, including but not limited to all the information shown in the schedules of the Specification. It is the responsibility of the vendor to highlight any variances the equipment has with the requirements of this Specification.

.4 Product data shall include dimensions, weights, capacities, component performances, electronic characteristics, construction details, required clearances, field connection details (indicating size and location), proposed test descriptions and sample reports, pressure drops, vibration isolation, gauges and finishes of materials.

.5 Provide fan performance curves depicting the operating point described on the schedule for each individual fan.

.6 Provide coil selection data sheets, clearly showing input data with proper consideration for altitude, air density, glycol correction, as well as clearly indicating the selected coils' output data.

.7 Provide details showing condensate drain connection height and required P-trap height.

.8 Provide filter information, including initial APD, final APD, dust spot efficiency, filter dust holding capacity, filter media description, filter frame details, filter replacement details and filter gauge details if applicable.

.9 Provide damper Shop Drawings indicating materials of construction, leak ratings, air pressure drops.

.10 Submit air handling unit inlet, discharge and radiated sound power levels at nominal capacity.

.11 Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring; clearly indicating factory installed and field installed wiring and accessories.

.12 Submit manufacturer's recommended installation instructions.

.13 Omission of any of the above information will cause submittal package to be immediately returned without review.

1.8 Related Work and Documents

.1 Division 1

.2 Division 16

.3 Division 17

2. PRODUCTS

2.1 Components

.1 Air handling units shall consist of, but not be limited to, the following components sections:

.1 Supply fan

.2 Plate type heat exchanger

.3 Access

.4 Glycol heating coil

.5 Filter

.6 Motorized dampers

.7 Exhaust/Return fan

.2 All components exposed to the air streams shall be corrosion resistant.

.1 Interior walls shall be type 316 SS.

.2 Heating coils shall have a baked phenolic coatings.

.3 Fan wheels and housings shall be either epoxy coated of fabricated from 316 SS.

.4 Motorized dampers shall be fabricated from 316 SS.

2.2 Casing

.1 Post and Panel Construction including:

.1 Walls and ceilings shall be constructed with acoustic panels. The panels shall have a 50 mm (2 inch) cross section that includes 50 mm (2 inch) thick injected foam insulation.

.2 The panel's exterior skin shall be 18 gauge G90 galvanized steel and the interior skin shall be 18 gauge 316 SS liner to permit washdown of the interior surface.

.3 Insulation shall have long resilient inorganic glass fibres bonded with a thermo-setting resin. The media shall have a density of 48 kg/m^3 (3.0 lb/ft^3) and be compressed by a minimum of 10 percent. The average thermal conductance of the panels shall not exceed 0.12 $BTU/ft^2/hr/°F$.

.4 The channel posts shall be fabricated from 16 gauge G90 galvanized steel.

.5 The panels and channel posts shall be assembled with stainless steel screws and gasketed to ensure air tightness.

.6 Sections shall be assembled with bulb type gaskets and bolts.

.7 The acoustic performance shall be in accordance with the following:

Octave Band	125	250	500	1000	2000	4000
Absorption Coefficient	0.33	0.72	1.11	1.05	1.10	1.01
Transmission Loss (dB)	20	23	35	46	54	59

.2 Base:

.1 Construct from heavy gauge galvanized steel structural frame. The perimeter shall consist of a double galvanized steel formed channel. Intermediate channels and structural supports shall be heavy gauge galvanized steel. The base shall be of continuous construction and adjacent perimeter sections shall be joined by heavy-duty bolted assemblies. The structural perimeter shall include removable lifting lugs. The minimum base height shall be 100mm (4 inch).

.3 Floor:

.1 Construct the floor from 16 gauge 316 stainless steel. 50 mm (2 inch) thick injected foam insulation shall be installed within the floor and protected from underneath by a galvanized steel liner.

2.3 Access Doors

.1 Access doors shall be manufactured from 18 gauge G90 galvanized steel. The doors shall be double wall construction with 18 gauge 316 SS solid metal liner on the inside. 50 mm (2 inch) of injected foam insulation shall be sandwiched between the inner and outer layer.

.2 Door frames shall be made of 16 gauge G90 galvanized steel with the outside of the door flush with the unit. Doors to be sealed with automotive type 50 mm (0.5 inch) closed cell hollow round black gasket with a metal encapsulated reinforced backing that mechanically fastens to the door frame. (Neoprene or foam gaskets are not acceptable).

.3 Provide minimum two ventlock latches per door openable from both sides. **Camlock latches are not acceptable**. Door hinge to be continuous stainless steel piano hinge with brass pin.

.4 Provide access doors for the following Sections.

.1 Fan Sections

.2 Filter Section

.3 Heat Exchange Section

.4 Access Sections

2.4 Marine Lights

.1 Provide marine type lights on all units with sections having an access door. Lights shall be factory installed and wired to a single lighted switch located outside the supply fan access door.

2.5 Drain Pans

.1 Provide a 316 SS drain pan to drain the fresh air intake fan section, and heat exchanger. Pipe all drains to the exterior side of unit.

2.6 Fan Sections

.1 Fans shall be either backward inclined or airfoil type.

.2 Fans performance shall be based on tests conducted in accordance with AMCA standard test code for air moving devices. All fans shall be certified to bear the AMCA certified rating seal. The fans shall have quiet and stable operation under all conditions. The fan Manufacturer shall provide sound power ratings in the eight octave bands which shall be based on AMCA standards. Sound power ratings shall be in decibels referenced to 10^{-12} watts.

.3 Fans shall be dynamically balanced. An IRD or PMC analyser shall be used to measure velocity, and the final reading shall not exceed 2.5 mm/s (0.1 in/s). The vibration level shall be recorded on the fans as proof of the final dynamic balance at the factory.

.4 Fans and motors shall be mounted on all welded galvanized steel integral base with 50 mm (2 inch) deflection spring isolators and supplied with flexible connection between the fan and the cabinet. Spring thrust restraints shall be supplied for stable operation and to protect the flexible connections from tearing. Less efficient 1 inch deflection isolators and rubber-in-shear isolators are not acceptable.

.5 Plenum fans shall be centred within the cabinet for best aerodynamics and the wheel tips shall be at least half a wheel diameter away from the cabinet to minimize air induced vibrations and enhanced airflow profiles.

.6 Housed centrifugal fans shall be double width and double inlet arrangement type 3. Air inlets shall be at least 0.7 of a wheel diameter away from the cabinet wall to minimize airflow resistance. Fans shall be centred within the cabinet for best aerodynamics.

.7 Wheel diameters and discharge areas shall be in accordance with the standard sizes adopted by AMCA. Inlets shall be fully streamlined and housings shall be suitably braced to prevent vibration and pulsation. Housings shall be constructed of epoxy coated heavy-gauge steel and shall be continuously welded throughout.

.8 Fan wheels shall be sandblasted and then epoxy coated for corrosion resistance. Fan shafts shall be TG &P solid and keyed to fan wheels. They shall also be keyed to the sheaves for positive wheel and shaft interlock.

.9 The first critical shaft speeds shall be at least 125 percent (Class I and II) and 142 percent (Class III) of the fan's maximum operating speed.

.10 Bearings shall be designed for heavy-duty service with a minimum L-50 life of 200,000 hours. Bearing ratings are to be based on the fans' maximum catalogued operating speed and horsepower. Pillow block bearings shall be either single row ball or double row spherical roller type. Bearing bars shall be rigidly fixed to the base (bearing supports mounted to the inlet funnel are unacceptable). Bearing supports shall consist of two or more full-length structural uprights. Provide copper lubrication lines extended to the access side of unit. Grease fittings attached to fan base assembly near access door.

.11 Acceptable fan Manufacturers: Northern Blower, Chicago, Lau, Twin City, Barry Blower, Greenheck.

.12 Provide variable pitch sheaves for motors 11.2 kW (15 hp) and under and fixed sheaves for motors 20 hp and over.

2.7 Motors and Drives

.1 Motors shall be supplied in accordance with Section 15010 – Mechanical General Requirements and schedules. Motors shall be mounted on slide bases for proper alignment and belt tension adjustment.

.2 Provide v-belt, cast-iron sheaves, and reinforced rubber belts (minimum of two belts per drive). The belts and drives shall be selected for minimum 150 percent of the motor nameplate horsepower. Provide adjustable motor sheaves on motors of 11.2 kW (15 hp) and less.

.3 Provide a metal belt guard having sides and face of galvanized steel with openings for fan tachometer readings. Belt guard shall be sized to allow either sheave to be increased by two sizes.

.4 Provide and install pulleys and sheaves for rotating equipment, as required to properly balance the systems to design flows, without additional cost to the City.

2.8 Coils

.1 Coils shall be fully enclosed within the section and shall have double wall stainless steel floor construction consistent with stainless steel coil casing construction.

.2 Piping connections shall extend to the outside through rubber grommets.

.3 Coils shall include stainless steel blankout sheets to hold coils rigid and prevent air from bypassing the coils.

.4 Removable two inch thick access panels shall be provided on both sides to remove coils through casing wall. Coils shall be mounted on independent racks and shall be individually removable.

.5 Drains for drain pans shall be fully recessed in the drain pans to ensure complete drainage.

.6 Coils shall be tested in accordance with ARI standard 410.

.7 The complete coil core shall be tested with 2170 kPag (315 psig) of air pressure under warm water and be suitable for operation at 1725 kPag (250 psig) working pressure. Water coils shall be circuited for drainability without removing individual plugs from each tube.

.8 Limit heating coil face velocity to 3.0 m/s (600 fpm).

.9 Glycol coils:

.1 Fins have a minimum thickness of 0.20 mm (.0075 inch) with full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes mechanically expanded into the fins to provide a continuous primary and secondary compression bond over the entire finned length for maximum heat transfer rates. Bared copper tube shall not be visible between fins.

.2 Coils shall be phenolic coated, dipped and baked for extra protection in corrosive conditions.

.10 Water coils provided with headers of seamless copper tubing intruded tube holes to permit expansion and contraction without creating undue stress or strain. Carbon steel coil connections with connection size to be determined by manufacturer based upon the most efficient coil circuiting or as indicated in schedules. Vent connections provided at the highest point to assure proper venting. Drain connections provided at the lowest point to insure complete drainage and freeze-up.

2.9 Filters

.1 Filter types, efficiencies and face areas shall be in accordance with the Make-up Air Unit schedule.

.2 Filter section shall be front loading where access is available upstream of the filter section or slide out through the side when access is not available. Front loading filters shall be mounted on factory fabricated 16 gauge galvanized steel holding frames. Side access filters shall slide out through factory fabricated galvanized steel racks and shall have previously described access doors.

.3 Limit filter velocity based on face area to less than 2.54 m/s (500 fpm).

2.10 Filter Gauges

.1 Provide and flush mount Dwyer 2000 magnehelic air filter gauges.

.2 Static pressure tips, shut off valves and tubing shall be provided and installed by the AHU manufacturer.

.3 One Magnehelic gauge shall be provided for each filter bank.

2.11 Heat Exchanger Section

.1 Construction

.1 Provide a factory assembled Air-to-Air plate type heat exchanger as shown on the Drawings with performance as indicated in the equipment schedule. The unit shall consist of, but no limited to: insulated casing and aluminum Air-to-Air plate type heat exchanger, defrost system, dampers, drain pans, and air filter. The exchanger shall be a cross-flow, aluminum plate type.

.2 The manufacturer shall clearly identify the supply air efficiency, both with and without latent heat transfer. The heat exchanger shall comply with the performance requirements listed in the equipment schedule for: supply and exhaust air volume flow rates, temperatures, humidity, air pressure drops, and mounting arrangements as shown on the Drawings.

.3 Heat exchanger module shall house a diagonally mounted Air-to-Air plate exchanger in a factory fabricated case. Heat exchanger plates shall be die formed from 99.9 percent pure aluminum and protected from corrosion by a PVC or phenolic mill applied coating. The extrusions and endplates shall be epoxy sealed to provide corrosion protection. Module casing shall be single package type and shall provide complete protection for all components and controls. Casing shall be G90 galvanized steel with 16-gauge structural 'C' channel base for support. Casing walls, roof and base shall be double wall construction insulated with 2 inch thick injected foam insulation covered with 18 gauge G90 galvanized steel with the interior walls 16 gauge 316 SS. The casing shall be airtight, waterproof and comes with sloped stainless steel condensate drain pans having NPT external drain connections. Drain pans shall have a depth of 3 inch and be pitched towards the threaded drain connections.

.4 The casing roof shall be one-piece or standing seam construction for maximum protection from water intrusion. The module case shall utilize unibody and stressed skin construction for light weight and maximum strength. Access panels shall be double walled insulated and gasketed. The unit shall be equipped with lifting lugs. The manufacturer shall provide flat metal surfaces for ductwork connections at each point where air streams enter or leave the module casing. Entering and leaving airflow configurations shall be as indicated on the Drawings.

.2 Heat Exchanger Defrost System

.1 The heat exchanger shall be supplied and equipped with a defrost system such that the leaving air temperature (as indicated in the schedule) is maintained, while operating at the specified conditions and while operating the defrost system. The heat exchanger shall provide continuous output temperatures while operating in defrost mode. The defrost system shall be backed up by a pressure-sensing switch that opens a normally closed set of contacts. The pressure-sensing switch shall monitor ice buildup in the exhaust, and activate when ice adds 0.5 inch wc of static pressure to the system.

.3 Filter Box

.1 The heat exchanger module shall be supplied with a factory assembled filter fox with filter rails and access door. The access door shall be hinged, double walled, insulated, bubble gasketed and have an industrial 'T' handle latch. Hinges shall be stainless steel.

.2 The filter box shall be provided before the exchanger in the outside air intake stream. Supply air filters shall be 2 inch thick 'Farr" 30/30 or equivalent. Filter face velocity shall not exceed 500 fpm. Filter bank shall be equipped with a differential pressure type dirty filter switch with indicator light.

2.12 Aluminum Airfoil Dampers

.1 Thermally insulated dampers shall have the following features:

.1 Damper frame to be insulated with polystyrene on all sides. The hollow blades shall be filled with non-CFC, expanded polyurethane insulation for an insulation factor of R2.29 and a temperature index of 55. The entire frame shall be thermally broken by means of polyurethane resin pockets complete with thermal cuts.

.2 Air leakage through a 1.2 m by 1.2 m (48 inch by 48 inch) damper shall not exceed 21 l/s per m^2 (4.12 cfm/ft^2) against a 1.0 kPa (4 inch wg) differential static pressure at standard air, based on tests and procedures performed in accordance with AMCA Publication 511.

.3 Pressure drop through a fully opened 1.2 m by 1.2 m (48 inch by 48 inch) damper shall not exceed 7.5 Pa (0.03 in wg) at 5 m/s (1000 fpm).

.4 Standard of acceptance: Tamco 9000 series.

.2 Provide isolation/shut-off damper on outside air inlet and exhaust air discharge of each MUA unit.

2.13 Electricity, Power Package and Controls

.1 Wire power connection for all lights to one point for connection by Division 16.

.2 Light to be fed from a separate source so that the lights are operative even when the unit is off.

.3 Motors shall be wired to individual disconnects located outside their respective fan sections.

.4 All components shall be CSA and UL approved.

.5 Units shall be CSA or ETL factory approved for electrical safety. Approval includes a dielectric factory test. Approved air handling units shall a CSA or ETL label.

.6 Variable frequency drives are to be provided for motors as indicated. Refer to Specification Section 16815 – Variable Frequency Drives.

3. EXECUTION

3.1 Installation

.1 Use all factory provided lifting lugs to rig the units or modules. Ensure that spreader bars are used to prevent damaging the cabinets.

.2 Lift modules in an upright position.

.3 Ensure housekeeping pads or mounting bases are level and in accordance with approved dimensions. Air handling units or modules shall be level, shim if necessary.

.4 Mechanical Contractor shall provide and install adequately sized P-traps for all condensate pipe connections. Disposal of condensate (cooling coil, steam or floor drains) shall be in accordance with local codes.

.5 Remove gussets, hold-down bolts and shipping fasteners.

.6 Assemble modules together according to the installation manual.

3.2 Pre-Operation Start-Up

.1 Remove fans' shipping restraints and level spring isolators. Adjust thrust restraints.

.2 Belt drives shall be adjusted for tension and alignment.

.3 Lubricate all bearings.

.4 Check fan motors for rotation and amp draw for each phase. Record information on the start-up data sheets.

3.3 MUA Unit Schedule

.1 Refer to Equipment Schedules in Section 15999

END OF SECTION

FANS

1. GENERAL

1.1 Scope

.1 Centrifugal roof mounted fans

.2 Bathroom exhaust fans

.3 Inline FRP fans

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 premium efficiency as specified in Section 15010 – Mechanical General Requirements.

1.3 Submittals

.1 Submit Shop Drawings and product data in accordance with Section 01300 – Submittals and Section 15010 – Mechanical General Requirements.

.2 Shop Drawings shall be clear and legible, facsimiles will not be accepted. Provide a cover page for each air handling unit, showing the project name, consulting engineer, mechanical contractor, tagging information, revision if applicable and submission date, leaving adequate space for approval stamps.

.3 Provide all technical information relevant to the product being provided, including but not limited to all the information shown in the schedules of the Specification. It is the responsibility of the vendor to highlight any variances the equipment has with the requirements of this Specification.

.4 Product data shall include dimensions, weights, capacities, component performances, electrical characteristics, construction details, required clearances, field connection details (indicating size and location), proposed test descriptions and sample reports, pressure drops, vibration isolation and finishes of materials.

.5 Provide fan performance curves depicting the operating point described on the schedule for each individual fan.

.6 Submit fan inlet, discharge and radiated sound power levels at nominal capacity.

.7 Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring; clearly indicating factory installed and field installed wiring and accessories.

.8 Submit manufacturer's recommended installation instructions.

.9 Omission of any of the above information will cause submittal package to be immediately returned without review.

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.

1.6 Related Work and Documents

.1 Division 1

.2 Division 16

.3 Division 17

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 Fans are to be capable of accommodating static pressure variations of ±10 percent with no objectionable operating characteristics.

.3 Fan suppliers to provide replacement sheaves for balancing purposes.

.4 Provide belt guards with tachometer holes.

.5 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.

.6 Variable speed applications: shall be inverter duty comes with variable speed drive matched to fan motor.

2.2 Centrifugal Roof Mounted Fans

.1 The housing shall be weatherproof, utilizing heavy gauge spun aluminium construction with a large rolled bead for strength, with galvanized base and rigid galvanized steel internal support structures. Housing shall not provide any internal structural support.

.2 Units shall be equipped with an oversized electrical conduit chase through the curb cap and into the motor compartment for ease of wiring. Unit shall be pre-wired to a junction box mounted in the motor compartment and equipped with an electrical disconnect device.

.3 Statically and dynamically balanced backward inclined, centrifugal wheels shall be aluminium, spark-resistant non-overloading and matched to deeply spun venturis.

.4 Motors shall be continuous duty, ball bearing design, permanently lubricated, mounted out of the main air stream and furnished at the specified voltage, phase and enclosure.

.5 Shafts shall be turned, ground, polished and rust protected.

.6 Heavy duty ball bearings are rated for a minimum L50 life exceeding 200,000 hours.

.7 Pulleys be adjustable, cast iron, machined, keyed, securely attached and sized for 150 percent of the horsepower at its rated maximum speed.

.8 Each fan shall bear the AMCA Listed Ratings Seal for Air and Sound Performance and shall be UL and CSA listed.

.9 Drip trays as noted.

2.3 Centrifugal Fans

.1 Fabricate with multi-blade wheels in heavy gauge steel on FRP 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 (17 inch) diameter shall have FRP on die formed air foil blades welded to side and back plate.

.7 Provide fan cabinets lined with minimum 25 mm (1 inch) acoustic insulation, unless noted otherwise elsewhere in the Specifications.

2.4 Axial Fans

.1 Provide die formed blades with belt drive and motor mounted outside air stream.

.2 The blades shall have fixed pitch.

.3 Extend lubrication fitting to outside of fan casing.

.4 Housing shall have flanges for connection of ductwork. When not connected to ducting, provide inlet cones.

.5 Provide easy access to fan wheel for varying blade angle setting during air balancing.

.6 Provide variable inlet vanes where indicated, complete with linkage and pneumatic actuators.

.7 Fans operating at over 374 Pa (1.5 inch wg) shall be of vane axial design for improved operating efficiency.

.8 Provide belt guards with tachometer hole and vibration isolators.

2.5 Corrosion Protection Coating, on Fan Wheel, Housing and Accessories

.1 Baked Polyester:

.1 Material: polyester

.2 Surface Preparation: sandblast surface to SSPC-SP 5

.3 Application: electrostatic spray

.4 Curing: oven baked at a metal temperature not to exceed 204°C

.5 Finished Thickness: 1.5-mil to 2.5-mil dry film thickness

.6 Performance: coating shall meet or exceed following criteria:

.1 Salt Spray Test: minimum 1,000-hour duration, ASTM B117 test method

.2 Humidity Resistance: minimum 1,000-hour duration, ASTM D2247 test method

.3 Impact Resistance: 1.15 kg meter, ASTM D2794 test method

.4 Pencil Hardness: 2H, ASTM D3363 test method

.5 UV Resistance: UV inhibited life of minimum ten years when exposed to sun in State of Florida

.6 Service Temperature: maximum 110°C, continuous

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.

3.2 Performance

.1 Fan performance indicated in schedules are based on sea level conditions.

.2 Refer to Equipment Schedule in Section 15999

END OF SECTION

DUCTWORK (STAINLESS STEEL AND FRP)

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 inch wg) and velocities less than 10 m/s (2,000 fpm).

.2 Medium Pressure: static pressure in duct less than 1,500 Pa (6 inch wg) and velocities greater than 10 m/s (2,000 fpm).

.3 High Pressure: static pressure over 1,500 Pa (6 inch wg) and less than 2,500 Pa (10 inch wg) and velocities greater than 10 m/s (2,000 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 and NFPA No. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

.2 Fabricate in accordance with SMACNA duct manuals and ASHRAE handbooks.

.3 Flexible air duct shall conform to NFPA 90A and UL 181 standard for factory made air duct materials and air duct connectors.

1.4 Submittals

.1 Submit Shop Drawings and samples of duct fittings for approval, 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 Stainless Steel Ductwork

.1 Ducts: all ductwork shall be Type 304L stainless steel. Galvanized metal is not acceptable.

.2 Stainless Steel Ductwork:

.1 Comply with ASTM A167, A176, A240/A240M, and ASTM A480.

.2 Stainless Steel Sheet: Type 304, unless indicated otherwise.

.3 Gauge shall comply with SMACNA manual, unless specified otherwise.

.4 Finish: No. 2 B (cold-rolled, bright) finish, except as otherwise noted.

.5 With No.4 finish on exposed surface for ducts exposed to view.

.3 Exposed Ductwork: where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains, discoloration, and other imperfections, including those which would impair painting.

.4 Reinforcement Shapes and Plates: unless otherwise indicated, provide reinforcements of same material as ductwork.

.5 Fasteners: use stainless steel rivets and bolts throughout; stainless steel sheet metal screws accepted on low pressure ducts.

.6 Sealant: water resistant, fire resistive, compatible with mating materials.

2.2 Fibreglass Ductwork, Where Indicated on Drawings

.1 Ductwork and fittings shall be constructed of filament wound fibreglass reinforced plastic, as manufactured by Perry Fiberglass Products, Inc. Manufactured per industry standards SMACNA, ASTM and PS 15-69 minimums. Ductwork and fittings shall be single wall (20S), low smoke Class 1 duct. Designed for a minimum of 10 inch wc pressure and 10 inch wc vacuum.

.2 The resin shall be ‘Perry’ 20S low smoke/Hetron FR992. Duct and fittings shall meet the Flame and Smoke requirements (25 and 50 respectively) of a Class 1 duct per UL 181 and UMC 10-1, and ASTM E-84. Liners and/or coatings are not acceptable.

.3 Field joints shall be butt-type wet lay-up method. Flanged joints shall be provided where indicated on the Drawings.

.4 Ductwork shall be round, rectangular or oval with complementary fittings constructed of the same material as the duct. Reducers shall be eccentric type installed so as to allow drainage of the duct system.

.5 Duct wall thickness:

.1 For diameters from 2 inch to 20 inch, 0.125 min.

.2 For diameters from 21 inch to 36 inch, 0.187 min.

.3 For diameters from 37 inch to 60 inch, 0.250 min.

2.3 Fasteners for Stainless Steel Ductwork System

.1 Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated Marutex® stainless steel with strength of Type 410 stainless steel and corrosion resistance of Type 304 stainless steel.

.2 Manufacturers:

.1 DB Building Fasteners Inc., Santa Fe Springs, CA

.2 Clark Craft Fasteners, Tonawanda, NY

.3 UCAN Fastening Products

3. EXECUTION

3.1 Installation

.1 Fabricate ductwork from field measurements and not from plans 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 (18 inch) 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. Where acoustical lining is provided, provide turning vanes of perforated metal type with fibreglass inside.

.5 Increase duct sizes gradually, not exceeding 15° divergence wherever possible. Maximum divergence upstream of equipment to be 30° and 45° 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 Provide drains in fresh air sections with deep seal traps.

.8 Set plenum doors 150 mm (6 inch) 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 gauge) thick material.

.3 Fabricate plenums between filters and upstream apparatus of 1.3 mm (18 gauge) 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 (0.06 inch) 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: 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 Coordinate the location of duct access doors. Refer to Section 15835 - Duct Accessories.

.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 15835 - 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.

END OF SECTION

DUCT ACCESSORIES

1. GENERAL

1.1 Scope

.1 Access doors

.2 Motorized dampers

.3 Fire dampers

.4 Balancing dampers

.5 Flexible connections

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 the City'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 Submit Shop Drawings and product data in accordance with Section 01300 - Submittals and Section 15010 - Mechanical General Requirements.

.3 Shop Drawings shall be clear and legible, facsimiles will not be accepted. Provide a cover page for each air handling unit, showing the project name, consulting engineer, mechanical contractor, tagging information, revision if applicable and submission date, leaving adequate space for approval stamps.

.4 Provide all technical information relevant to the product being provided, including but not limited to all the information shown in the schedules of the Specification. It is the responsibility of the vendor to highlight any variances the equipment has with the requirements of this Specification.

2. PRODUCTS

2.1 Duct Access Doors

.1 Fabricate rigid and close-fitting doors of 304L stainless steel with sealing gaskets and suitable quick fastening locking devices. Duct access panels with screws are not acceptable. Install minimum 25 mm (1 inch.) 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 (18 inch), two hinges and two compression latches with outside and inside handles for sizes up to 600 mm x 1200 mm (24 inch x 48 inch) and an additional hinge for larger sizes.

2.2 Motorized Dampers

.1 Rectangular

.1 Motorized dampers which are not supplied with MUA units or AHU's shall be 'Greenheck' severe environment dampers, corrosive resistant and constructed of 316 SS.

.2 Dampers shall be AMCA certified

.3 Dampers shall be rated for a minimum of 8"wg (1993 Pa)

.4 Dampers shall be rated for air velocities up to 4000 fpm (20.3 m/sec)

.5 Blade style for rectangular dampers shall be airfoil (SEVCD-33) constructed of double skin 316 stainless steel. To present a lower resistance to airflow.

.6 A stainless steel housing shall be provided for actuators, NEMA 4X watertight and dust tight.

.7 Where specifically indicated on the drawings or located outdoors, dampers shall be supplied complete with heat tape option -40°C/-40°F construction with heated actuators. The heat tape shall be wrapped around the frame of the damper to keep the linkage from freezing under cold moisture laden conditions.

.2 Round Dampers

.1 Industrial grade control dampers meeting the following specifications shall be furnished and installed where shown on plans and/or as described in schedules.

.2 Dampers shall consist of a round channel frame, single axle, and single circular blade fabricated from 316 stainless steel. Damper axle shall be continuous pivoting in externally mounted bronze sleeve bearings bolted to each side of the damper frame.

.3 Damper manufacturer's printed application and performance data including pressure, velocity and temperature limitations shall be submitted for approval showing damper

suitable for pressures to 13.5 inch wg (3400 Pa), velocities to 5150 fpm (26.5 m/s), and temperatures to 400°F (204°C). Testing and ratings to be in accordance with AMCA Standard 500-D.

.4 Dampers shall be equipped with blade seals for low EPDM synthetic rubber for 250°F (121°C) maximum temperature. Axles shall be equipped with Viton o-rings for clean air. Frame and blade gauges and axle diameters shall be at a minimum equal to those of the model which is the basis of design. Testing and ratings shall be per AMCA Standard 500-D.

.5 Basis of design is Greenheck model HCDR-250 316 stainless steel construction.

.3 Electronic Damper Operators:

.1 Proportional actuator, spring return:

.1 Electronic direct coupled type which require no crankarm and linkage.

.2 Power supply: 24 VDC

.3 Provide proportional damper control in response to 4 to 20 mA control input with the addition of a 500 ohms resistor.

.4 Designed so that may be used for either clockwise or counter-clockwise failsafe operation.

.5 Use a brushless DC motor and be protected from overload at all angles of rotation.

.6 Run time shall be constant and independent of torque.

.7 Two (2) SPDT, 6A, 250 VAC position switches, switching points fully adjustable over full actuator rotation.

.8 UL listed and CSA certified

.2 Provide sufficient damper motors to achieve unrestricted movement, with a minimum of one (1) damper operator per damper section.

.3 Standard of acceptance: Belimo

2.3 Backdraft Dampers

.1 Greenheck model HB-230

.2 316 stainless steel construction

.3 Pressures up to 13.5 inch wg (3363 Pa)

.4 Velocity up to 5150 fpm (26 m/sec)

.5 Temperature -40°F to 250°F (-40°C to 121°C)

2.4 Fire Dampers

.1 Duct Mounted Fire Dampers in Fire Walls with Rating of 2 Hours or Less:

.1 NFPA 90A rated for 1.5 hour service

.2 Blades, frame, and mounting angles same material as ductwork

.3 Accordion style folded blades

.4 74°C fusible link

.5 Approved for installation with 2-hour fire rating

.6 Rated, manufactured, tested, and approved in accordance with UL 555

.7 Blades out of airstream when open (Type B)

.8 Furnish with sleeved frame for duct connections

.9 Labeled for use in dynamic mode

.10 Furnish dynamic and horizontal mounted dampers with springs for proper closure

.11 Corrosive Service Dampers: Type 316 stainless steel

.12 Manufacturers and Products:

.1 Nailor-Hart; Model 0130, Type B

.2 Ruskin; IBD20, Type B

.2 Duct Mounted Fire Dampers in Walls with 3-Hour or Greater Fire Rating:

.1 NFPA 90A rated for 3-hour service

.2 Blades, frame, and mounting angles

.3 Accordion style folding blades

.4 74°C fusible link

.5 Approved for installation in 4-hour wall

.6 Rated, manufactured, tested, and approved in accordance with UL 555

.7 Blades out of airstream when open (Type B)

.8 Furnish with sleeved frame for duct connection

.9 Labeled for use in dynamic mode

.10 Furnish dynamic and horizontal mounted dampers with springs for proper closure

.11 Corrosive Service Dampers: Type 316 stainless steel

.12 Manufacturers and Products:

.1 Nailor-Hart; Model 0530, Type B

.2 Ruskin; IBD23, Type B

.3 Ceiling Grille and Diffuser Fire Dampers:

.1 UL Listed assembly with frame

.2 Butterfly type blades

.3 74°C fusible link

.4 Radiation type damper

.5 Manufacturers and Products:

.1 Nailor-Hart; Model 0722 or 0716

.2 Ruskin; Type CFD Series

2.5 Balancing Dampers

.1 Fabricate of 316L stainless 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 (16 inch) deep and on accessible round ducts.

.3 Wide pitch screw operating mechanism with crank operator and end bearings on accessible rectangular ducts 425 mm (17 inch) and over in depth and on all inaccessible rectangular and round ducts.

.4 On rectangular ducts up to 275 mm (11 inch) deep, construct of single blade (butterfly) type.

.5 On rectangular ducts 300 mm to 400 mm (12 inch to 16 inch) deep, construct of two opposed blades mechanically interlocked with pivots at quarter points.

.6 On rectangular ducts over 425 mm (17 inch) 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 (12 inch) 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.

2.6 Flexible Connections

.1 Fabricate of ULC approved neoprene coated flameproof glass fabric approximately 150 mm (6 inch) wide tightly crimped into metal edging strip and attached to ducting and equipment by screws or bolts at 150 mm (6 inch) intervals. Flexible connection airtight at 500 Pa (2 inch wg).

.2 Do not use flexible connections to connect kitchen ductwork to kitchen fans where the fan is mounted inside the building enclosure. Fan connections in these cases shall be governed by NFPA 96 (flanged connections).

3. EXECUTION

3.1 Application

.1 Provide access door minimum 450 mm x 350 mm (18 in x 14 inch) or 50 mm (2 inch) 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 fire separation duct shall be sealed with non-combustible material.

.4 Provide motorized dampers where indicated on Drawings comes with appropriately sized actuators.

.5 Provide balancing dampers at points on supply and exhaust systems where branches are taken from larger ducts as required for proper air balancing.

.6 Install ducts associated with fans and equipment subject to forced vibration with flexible connections, immediately adjacent to equipment and/or where indicated on Drawing.

.7 All fire dampers are to be left in the closed position for balancing Contractor to fix open.

END OF SECTION

AIR OUTLETS

1. GENERAL

1.1 Scope

.1 Diffusers

.2 Grilles and registers

.3 Outside louvers

.4 Gravity hoods

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 and product data in accordance with Section 01300 – Submittals and Section 15010 – Mechanical General Requirements.

.2 Shop Drawings shall be clear and legible, facsimiles will not be accepted. Provide a cover page for each air handling unit, showing the project name, consulting engineer, mechanical contractor, tagging information, revision if applicable and submission date, leaving adequate space for approval stamps.

.3 Provide all technical information relevant to the product being provided, including but not limited to all the information shown in the schedules of the Specification. It is the responsibility of the vendor to highlight any variances the equipment has with the requirements of this Specification.

.4 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.

.5 Submit AMCA laboratory test report on a 1200 mm x 1200 mm (4 ft x 4 ft) unit demonstrating that it provides a minimum of 0.740 m^2 (7.96 ft^2) of free area and shall intake 192 m/min (629 fpm) free area velocity at a static pressure drop not exceeding 20 Pa (0.08 inch wg) per square foot of free area at a velocity of 192 m/min (629 fpm) when tested for 15 minutes per AMCA Standard 500-L-99.

.6 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 Louvers

.1 Louvers 100 mm (4 inch) deep with stationary blades on 45° slope.

.2 Each louver shall be fitted with 13 mm (0.5 inch) x 1.60 mm (0.063 inch) aluminium bird screen in a non-rewirable U-frame.

.3 Fabricate of 2.0 mm (0.081 inch) extruded aluminum (6063T5) blades and frame. Provide welded assembly.

.4 Louvers shall be factory primed and finishes after assembly with a clear coat of Kynar 500 resin coating. Primer and Kynar resin coating shall be oven baked in accordance with the coating manufacturer's instructions.

.5 Louvers shall bear AMCA Certified Ratings Seals for air performance and water penetration ratings.

.6 Provide aluminium insect screen to the exterior frame of the louvre in a removable frame.

2.3 Gravity Hoods

.1 Air inlet or exhaust hoods shall have removable hood, curb flange and bird screen with 13 mm (0.5 inch) square mesh.

.2 Fabricate of galvanized steel minimum 1.6 mm (16 gauge) base and 1.0 mm (20 gauge) hood. Provide suitable reinforcing to hood.

.3 Mount unit on minimum 300 mm (12 inch) high curb base with insulation between duct and curb.

.4 Hood outlet area shall be minimum twice throat area.

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 in Section 15999

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 Provide manufactured chimneys for forced draft natural gas fired equipment.

1.2 Quality Assurance

.1 Vents and Chimneys: labelled by ULC

.2 The successful Bidder for the self-supporting stack shall provide to the General Contractor, All Relevant Moments And Loads That Result From Wind, Earthquake 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	Min. Thickness
Smaller than 125 mm (5 inch)	0.4 mm (30 gauge)
125 mm (5 inch) to 200 mm (8 inch)	0.5 mm (26 gauge)
Larger than 200 mm (8 inch)	0.6 mm (24 gauge)

.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	Min. Thickness
300 mm (12 inch) and smaller	1.3 mm (18 gauge)
325 mm (13 inch) and 600 mm (24 inch)	1.6 mm (16 gauge)
625 mm (25 inch) to 900 mm (36 inch)	2.0 mm (14 gauge)
925 mm (37 inch) and larger	3.0 mm (11 gauge)

.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: (single acting) (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 1-B149.1), (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, min. 2 percent.

.4 Suspend breeching using trapeze hangers at 1500 mm (5 ft) 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

CONTROL SEQUENCES

1. GENERAL

.1 The control sequences contain a general description of the intent of the operation of the systems to be controlled. The Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.

.2 The relationships between the points, systems and building are described in the control sequences.

.3 Review with the Contract Administrator during the Shop Drawing stage to finalise the control sequences for each system.

2. PRODUCTS

.1 Not applicable

3. EXECUTION

3.1 MUA (S750, F600, T600, T605) Unit Sequence of Operation

.1 Supply and Exhaust Fans, Speed Control

.1 The supply and exhaust fans operate continuously in either occupied or unoccupied mode. The supply and exhaust fans operate together. The DCS shall output a 4-20 mA proportional signal to each VFD to maintain a slight differential between supply and exhaust air volumes. The supply/exhaust fan speed differential shall be programmable through the DCS. If either fan fails the other fan shall shut down and the O/A and Ex/A dampers shall close.

.2 The DCS shall monitor the O/A temperature and reset downward the supply/exhaust fan speeds as O/A temperature drops. This is to prevent excess air flow when O/A temperatures are extremely low. Refer to MUA unit schedule for desired air flow rates.

.3 During occupied mode the supply and exhaust fans run to provide the desired maximum air change rate.

.4 During unoccupied mode the supply and exhaust fans run to provide the desired minimum air change rate

.5 A manually activated wind-up timer-switch shall cause the fans to toggle between occupied and unoccupied mode. Normal operation is unoccupied.

.6 Each fan’s VFD shall be provided with low and high current sensors to signal the DCS system of a fan failure. In this event the DCS shall shut the fans off through the VFD’s.

.2 Heating Coil

.1 A hydronic heating coil installed upstream of the supply fan shall modulate the supply air temperature to maintain space temperature at set point. An electrically operated fully modulating mixing valve shall modulate the flow to the heating coil in response to space temperature. Refer to Drawings for space temperature sensor location. Temperature sensor shall be suitable for operation in wet conditions, splash/spray proof, and accurate to ±1°F.

.3 Air-to-Air Heat Exchanger

.1 The Air-to-Air heat exchanger shall be supplied factory equipped with an automatic defrost system. The defrost system shall operate continuously and not reduce or by-pass air around the heat exchanger. The defrost system shall include a differential pressure switch that opens a normally closed set of contacts in response to ice build-up in the heat exchanger, causing excessive Ex/A static pressure (approximately 0.5 inch wc). This switch shall be wired to shut the supply and exhaust fans off and signal the DCS of the failure. The heat exchanger shall also be supplied equipped with dirty air filter sensing device for connection to the DCS.

.4 Motorized Supply and Exhaust Air Dampers

.1 When the supply and exhaust air fans are off the S/A and Ex/A dampers shall be closed. Upon system start-up, damper end-switches proving dampers are open shall make before fans start. End switches shall be wired in series to ensure both dampers are fully open prior to fans starting.

.5 Temperature Monitoring

.1 The DCS shall monitor the following temperatures: space, S/A downstream of heating coil, O/A, heat exchanger inlet and outlet on both outside air and exhaust air sides.

3.2 Boilers (S760-GH/S765-GH and T650-GH/T655-GH) and Circulating Pumps, Sequence of Operation

.1 The heating system boilers are supplied equipped with their own temperature controls. The DCS shall enable/disable the boilers in response to O/A temperature, enable boilers ON at O/A less than 5°C. The DCS shall monitor the GHS and GHR temperatures and alarm if outside the programmable high and low temperature ranges. When the boilers are enabled ON, the primary circulating pump shall run. Should the primary pump fail as detected by current sensing relay, the DCS shall start the back-up (secondary) pump and signal an alarm at the DCS. If both pumps fail the DCS shall sequentially shut the MUA units down and signal an alarm. The DCS shall alternate circulating pump operation so as to equalize pump run times, alternate pumps at least once per week.

3.3 T610-AHU and S780-AHU, Sequence of Operation and Other Electrical Room

.1 This unit runs continuously to maintain space temperature at set point. The unit is equipped with an economizer/mixing box section, filter section, DX cooling coil, electric heating coil, and supply fan. The DCS shall modulate the O/A and R/A dampers of the mixing box/economizer to maintain space temperature. In the event that O/A temperature is too high to maintain space temperature at set point the DCS shall energize the DX cooling and close the O/A damper to the minimum position. Upon a call for heating, the DCS shall modulate the O/A damper closed and modulate current via SCR to the electric heat coil. The DCS shall monitor: space temperature, fan status, and O/A temperature. A barometric relief damper is used to maintain space pressure slightly positive with respect to outside.

END OF SECTION

TESTING, ADJUSTING AND BALANCING

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

.1 The mechanical Contractor will Contract with a TAB agency to test, adjust, and balance the HVAC systems.

.2 The Work included in this Section consists of furnishing labour, instruments, and tools required in TAB 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 Air Handling Units

.2 Supply Fans

.3 Return Fans

.4 Exhaust Fans

.5 Zone branch and main ducts

.6 Diffusers, Registers and Grilles

.7 Coils (Air Temperatures)

.2 Hydronic Systems:

.1 Pumps (circulation pumps on all heat pumps and back-up electric boiler)

.2 System Mains and Branches

.3 Boilers (all heat pumps and back-up electrical boiler)

.4 Coils (air handling unit coils and reheat coils)

1.3 Definitions, References, Standards

.1 All Work shall be accordance with the latest edition of the AABC National Standards. If these Contract Documents set forth more stringent requirements than the AABC National Standards, these Contract Documents shall prevail.

.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 (latest edition), provides standards and operational criteria for HVAC systems.

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 TBE 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 TAB Preparation and Coordination

.1 Shop Drawings, submittal data, up-to-date revisions, 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 Building Control System 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 air 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 Refer to Division 1 for quantities of final report to submit.

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. PRODUCTS

2.1 Instruments

.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.

2.2 Acceptable Agencies

.1 AHS Testing & Balancing Ltd.

.2 Air Movement Services Ltd.

.3 DFC Mechanical Testing & Balancing

.4 Airdronics Ltd.

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 in accordance with AABC National Standards. Adjustment tolerances shall be ±10 percent unless otherwise stated.

.2 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.

.3 All information necessary to complete a proper TAB project and report shall be per AABC standards unless otherwise noted. The descriptions for Work required, 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 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 airflow.

.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 airflow

.4 Outside Air - Test and adjust the outside air on applicable equipment using a Pitot-tube traverse. If a traverse is not practical use the mixed-air temperature method if the inside and outside temperature difference is at least 20°F or use the difference between Pitot-tube traverses of the supply and return air ducts.

.5 Static Pressure - Test and record system static profile of each supply fan.

.2 For return fans:

.1 Fan speeds - Test and adjust fan RPM to achieve maximum or design airflow

.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 the main return ducts to obtain total airflow.

.4 Static Pressure - Test and record system static profile of each return fan.

.3 For exhaust fans:

.1 Fan speeds - Test and adjust fan RPM to achieve maximum or design airflow.

.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 the main exhaust ducts to obtain total airflow.

.4 Static Pressure - Test and record system static profile of each exhaust fan.

.4 For zone, branch and main ducts:

.1 Adjust ducts to within 5 percent of design airflow 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.

.5 For diffusers, registers and grilles:

.1 Tolerances - Test, adjust, and balance each diffuser, grille, and register to within 10 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.

.6 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 chilled water, hot water, and condenser water pumps to achieve maximum or design flowrate. Check pumps for proper operation. Pumps shall be free of vibration and cavitation. Record appropriate gauge readings for final total dynamic head (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.

.2 For system mains and branches:

.1 Adjust water flow in pipes to achieve maximum or design flowrate.

.3 For boilers and heat pumps:

.1 Verify that boilers have been filled and started and are in operation.

.2 Current and Voltage - As applicable, 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 Test and record temperature and pressure profiles of heat pumps and boilers.

.4 For coils:

.1 Tolerances - Test, adjust, and balance all chilled-water and hot-water coils within 10 percent of design requirements.

.2 Verification - Verify the type, location, final pressure drop and flowrate of each coil. This information shall be recorded on coil data sheets.

3.4 Additional 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 Jobsite 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 1.1°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 Fire and Smoke Testing:

.1 The TAB agency shall test fire/smoke dampers to assure operation. It shall verify that an access door has been installed for each fire and smoke damper. For fire dampers, the TAB agency shall open the access door, disconnect the fusible link, and allow the damper to close. Operation should be smooth and the damper must close completely. The TAB agency shall then reset the damper. For the smoke damper, the TAB agency shall open the access door, activate the damper, and observe operation. The damper must close quickly and completely. The TAB agency shall then reset the damper and observe its complete opening.

END OF SECTION

LIST OF SCHEDULES

1. LIST OF SCHEDULES

.1 Make-up Air Unit Schedule

.2 Air Handling Unit Schedule

.3 Air Fan Schedule

.4 Gas Heater (Boilers) Schedule

.5 Hot Water Unit Heater Schedule

.6 Pump Schedule

.7 Grilles, Registers and Diffusers

.8 Louvre Schedule

.9 Air Compressor Schedule

.10 Plumbing Fixtures

.11 Variable Frequency Drive Schedule

.12 Tank Schedule (Expansion, Glycol Fill, Pressure Tank)

.13 Gravity Hood Schedule

.14 Condensing Unit Schedule

.15 Coil Schedule

.16 Emergency Eyewash/Shower Schedule

LIST OF SCHEDULES

1.1 Make-up Air Unit Schedule

JOB NAME	WEWPCC BNR		
JOB DESCRIPTION	WEWPCC HEAT RECOVERY		
MODEL NUMBER	CAH012GHAC	**ENGINEER**	Earth Tech (Canada) Inc.
UNIT TAGGING	F600 MUA		

Unit configuration	Stacked with parallel air flows		
Drive (handing) location	Right		
	SUPPLY	**RETURN / EXHAUST**	
Air volume	5880	5880	s cfm
Altitude	0	0	ft
Turning loss	0.00	0.00	in WC.
External static	2.00	1.00	in WC.
Total static	3.50	2.44	in WC.
External H x W	42 x 66	42 x 66 (Not including base rails)	ins

CASING DETAILS	
Outer panel	Standard G90 galvanized steel, painted with Polyurethane enamel anticorrosive
Liner	316SS
Insulation	R-13 Injected Foam (Unless noted per section)
Frame	2 ins
Base	4" formed channel
Sound baffles	None (unless noted per section)
Tread Plate floor liner	None (unless noted per section)

Exhaust Airstream

1 PLENUM SECTION(22 ins)					SECTION **1**
Drain pan	None		Drain side	-	
Opening location	End upper		Opening size	18.00 x 62.00	ins
DOOR DATA					
Door location	Drive side		Window size	None	
Door width	18	ins	Light	None	
Door opening	Outward				

2 PANEL FILTER(12 ins)					SECTION **1**
Type	Pleated (MERV 6)		Clean air press. drop	0.15	ins WC
Efficiency	30	%	**Mean air press. drop**	**0.58**	**ins WC**
Face velocity	448	fpm	Dirty air press. drop	1.00	ins WC
Face area	13.1	ft2	Access	Side	
Air volume	5880	cfm			

BANK ARRANGEMENT		
No. of Filters	**Size H x W x D**	
2	24.00 x 24.00 x 2.00	Ins
1	24.00 x 12.00 x 2.00	
2	12.00 x 24.00 x 2.00	

DOOR DATA				
Door location	Drive side	Window size	None	
Door width	8	ins Light	None	
Door opening	Outward			

SPECIAL				
-				
Tread Plate floor liner	None			
Liner	(As casing details)			
Insulation	(As casing details)			
Sound baffles	None			
Special static pressure	-	ins WC	Filter Gauge	Minihelic II 0-2"

LIST OF SCHEDULES

3 ACCESS SECTION(24 ins)					SECTION	**1**
Drain pan	None		Drain side	-		
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	20	ins	Light	None		
Door opening	Outward					

4 Fixed Plate Heat Exchanger Section (68 ins)			SECTION	**3**
Drain pan	316 SS	Drain pan side	Drive side	
SPECIAL				
Plate Exchanger				
Tread Plate floor liner	None			
Liner	(As casing details)			
Insulation	(As casing details)			
Sound baffles	None			
Special static pressure	Return / Exhaust	0.83	ins WC	
	-			

5 ACCESS SECTION(36 ins)					SECTION	**4**
Drain pan	None		Drain side	-		
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	28	ins	Light	None		
Door opening	Outward					

6 RETURN/EXHAUST FAN SECTION(44 ins)					SECTION	**5**
Air volume	5880	cfm	Motor power	7.5		HP
External static pressure	1.00	ins WC	Motor type	TEFC		
Total static pressure	2.44	ins WC	Frame size	213 T frame		
			Electrical supply	575/60/3		
Type	-		Motor efficiency	Premium		
Blade type/Class	Airfoil / 2		Motor speed	1750		rpm
Fan wheel diameter	14.56	ins	Motor pole	4		
Brake horsepower	5.02	HP	Full load current	7.4		A
Operating/Max speed	2892 / 3918	rpm	Lock rotor current	52		A
Orientation	Up blast CW		Motor supplier	Generic		
Air modulation	None		Actual drive service fac.	1.12		
Drain pan	None		Bearing type	Standard - L50 (200K)		
Drain pan side	-		Outlet velocity	2042		ft/m
Wheel guard	None		Inlet screen	None		
Belt guard	None		Outlet screen	None		
Inspection port	None					
DRIVES						
Fan sheave	1B5V44		Motor sheave	BK77H		
Number of belts	1		Belt	BX40		
ANTI-VIBRATION MOUNTS / SPRINGS						
Type	Spring					
Seismic restraint	None					
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	30	ins	Light	None		
Door opening	Outward					

LIST OF SCHEDULES

Supply Airstream

1 PLENUM SECTION(22 ins)					SECTION	**2**
Drain pan	None		Drain side	-		
Opening location	Top		Opening size	18.00 x 62.00	ins	
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	18	ins	Light	None		
Door opening	Outward					

2 PANEL FILTER(12 ins)					SECTION	**2**
Type	Pleated (MERV 6)		Clean air press. drop	0.15	ins WC	
Efficiency	30	%	**Mean air press. drop**	**0.58**	**ins WC**	
Face velocity	448	fpm	Dirty air press. drop	1.00	ins WC	
Face area	13.1	ft2	Access	Side		
Air volume	5880	cfm				

BANK ARRANGEMENT	
No. of Filters	**Size H x W x D**
2	24.00 x 24.00 x 2.00 Ins
1	24.00 x 12.00 x 2.00
2	12.00 x 24.00 x 2.00

DOOR DATA					
Door location	Drive side		Window size	None	
Door width	8	ins	Light	None	
Door opening	Outward				

SPECIAL
-

Tread Plate floor liner	None			
Liner	(As casing details)			
Insulation	(As casing details)			
Sound baffles	None			
Special static pressure	-	ins WC	Filter Gauge	Minihelic II 0-2"

3 ACCESS SECTION(24 ins)					SECTION	**2**
Drain pan	None		Drain side	-		
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	20	ins	Light	None		
Door opening	Outward					

4 Fixed Plate Heat Exchanger Section (68 ins)					SECTION	**3**
Drain pan	316 SS		Drain pan side	Drive side		

SPECIAL
Plate Exchanger

Tread Plate floor liner	None			
Liner	(As casing details)			
Insulation	(As casing details)			
Sound baffles	None			
Special static pressure	Fresh / Supply	0.74	ins WC	
	-			

5 ACCESS SECTION(24 ins)					SECTION	**6**
Drain pan	None		Drain side	-		
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	20	ins	Light	None		
Door opening	Outward					

LIST OF SCHEDULES

6 HOT WATER COIL(12 ins)						SECTION	**6**
Coil model	5WQ0801C		Number of coils	1			
Capacity	247596	Btu/h	Number of rows	1			
			Fins per inch	8			
Air volume	5880	cfm					
Entering db	27.0	F	Entering water	180.0	F		
Leaving db	65.5	F	Leaving water	159.7	F		
Finned height x length	33 x 50	ins	Water flow rate	27.10	gpm		
Face area	11.46	ft2	Water pressure drop	9.90	ftHD		
Face velocity	513	ft/m	Water velocity	5.30	ft/s		
Coil air pressure drop	0.15	ins WC					
			Fluid volume	95.0	gal		
			Fluid weight	26.00	lb		
Connection type	Threaded		Fin material	Aluminum (.0075)			
Connection Qty x size	2 x 1.50	ins	Tube material	Copper (.020)			
Connection location	Drive side		Header material	Copper			
Glycol type (%)	Propylene (50 %)		Case material	Galvanized track			
Fouling Factor	0		Drain pan	None			
			Drain pan side	-			
			Turbospirals	None			
Coil code	5WQ0801C		Electro-fin coat	None			

7 SUPPLY FAN SECTION(44 ins)						SECTION	**7**
Air volume	5880	cfm	Motor power	7.5	HP		
External static pressure	2.00	ins WC	Motor type	TEFC			
Total static pressure	3.50	ins WC	Frame size	213 T frame			
			Electrical supply	575/60/3			
Type	-		Motor efficiency	High			
Blade type/Class	Airfoil / 2		Motor speed	1750	rpm		
Fan wheel diameter	14.56	ins	Motor pole	4			
Brake horsepower	6.19	HP	Full load current	8.2	A		
Operating/Max speed	3070 / 3918	rpm	Lock rotor current	49	A		
Orientation	Top horizontal		Motor supplier	Generic			
Air modulation	None		Actual drive service fac.	1.10			
Drain pan	None		Bearing type	Standard - L50 (200K)			
Drain pan side	-		Outlet velocity	2042	ft/m		
Wheel guard	None		Inlet screen	None			
Belt guard	None		Outlet screen	None			
Inspection port	None						
DRIVES							
Fan sheave	1B5V42		Motor sheave	BK80H			
Number of belts	1		Belt	BX40			
ANTI-VIBRATION MOUNTS / SPRINGS							
Type	Spring						
Seismic restraint	None						
DOOR DATA							
Door location	Drive side		Window size	None			
Door width	30	ins	Light	None			
Door opening	Outward						

NOTES

Important Notice

This unit may not meet ASHRAE Standard 90.1 - 1999 fan motor power limitations. If that code applies, alternate fan selections may be required.

The designer and installer must ensure compliance with applicable codes. A component supplier cannot determine the brake horsepower

LIST OF SCHEDULES

NOTES
("BHP") for other motors in the air handling system. Before approving this unit, determine whether ASHRAE Standard 90.1 - 1999 has been adopted in the specific jurisdiction or contract specifications in which the unit will be installed.

SHIPPING SECTION DETAILS			
	Length (inches)	**Weight (lb)**	
Section 1	58	494	
Section 2	58	411	
Section 3	68	633	
Section 4	36	228	
Section 5	44	691	
Section 6	36	434	
Section 7	44	736	
TOTALS	**206.00 (Lower level total)**	**3627 (Entire unit weight)**	

UNIT SOUND	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Radiated	75	74	69	67	59	47	40	32
Unit discharge	90	92	90	91	85	79	75	67
Unit return	90	92	90	91	85	79	75	67

LIST OF SCHEDULES

JOB NAME	WEWPCC BNR		
JOB DESCRIPTION	WEWPCC HEAT RECOVERY		
MODEL NUMBER	CAH050GHAC	**ENGINEER**	Earth Tech (Canada) Inc.
UNIT TAGGING	S750 MUA		

Unit configuration	Stacked with parallel air flows		
Drive (handing) location	Right		
	SUPPLY	**RETURN / EXHAUST**	
Air volume	22000	22000	s cfm
Altitude	0	0	ft
Turning loss	0.00	0.00	in WC.
External static	2.00	1.00	in WC.
Total static	3.36	2.36	in WC.
External H x W	80 x 120	80 x 120 (Not including base rails)	ins

CASING DETAILS	
Outer panel	Standard G90 galvanized steel
Liner	316 SS
Insulation	R-13 Injected Foam (Unless noted per section)
Frame	2 ins
Base	6" formed channel
Sound baffles	None (unless noted per section)
Tread Plate floor liner	None (unless noted per section)

Exhaust Airstream

1 PLENUM SECTION(38 ins)					SECTION	**1**
Drain pan	None		Drain side	-		
Opening location	End upper		Opening size	34.00 x 116.00		ins
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	30	ins	Light	None		
Door opening	Outward					

2 PANEL FILTER(12 ins)					SECTION	**1**
Type	Pleated (MERV 6)		Clean air press. drop	0.12		ins WC
Efficiency	30	%	**Mean air press. drop**	**0.56**		**ins WC**
Face velocity	389	fpm	Dirty air press. drop	1.00		ins WC
Face area	56.6	ft2	Access	Side		
Air volume	22000	cfm				
BANK ARRANGEMENT						
No. of Filters	**Size H x W x D**					
18	24.00 x 20.00 x 2.00	Ins				
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	8	ins	Light	None		
Door opening	Outward					
SPECIAL						
-						
Tread Plate floor liner	None					
Liner	(As casing details)					
Insulation	(As casing details)					
Sound baffles	None					
Special static pressure	-	ins WC	Filter Gauge	Minihelic II 0-2"		

LIST OF SCHEDULES

3 ACCESS SECTION(24 ins)					SECTION	**1**
Drain pan	None		Drain side	-		
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	20	ins	Light	None		
Door opening	Outward					

4 Fixed Plate Heat Exchanger Section (96 ins)					SECTION	**3**
Drain pan	316 SS		Drain pan side	Drive side		
SPECIAL						
Plate Heat Exchanger						
Tread Plate floor liner	None					
Liner	(As casing details)					
Insulation	(As casing details)					
Sound baffles	None					
Special static pressure	Return / Exhaust	0.76	ins WC			
	-					

5 ACCESS SECTION(36 ins)					SECTION	**4**
Drain pan	None		Drain side	-		
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	28	ins	Light	None		
Door opening	Outward					

6 RETURN/EXHAUST FAN SECTION(70 ins)					SECTION	**5**
Air volume	22000	cfm	Motor power	20.0		HP
External static pressure	1.00	ins WC	Motor type	TEFC		
Total static pressure	2.36	ins WC	Frame size	256 T frame		
			Electrical supply	575/60/3		
Type	-		Motor efficiency	Premium		
Blade type/Class	Airfoil / 2		Motor speed	1750		rpm
Fan wheel diameter	27.00	ins	Motor pole	4		
Brake horsepower	14.51	HP	Full load current	18.9		A
Operating/Max speed	1374 / 1928	rpm	Lock rotor current	130		A
Orientation	Up blast CW		Motor supplier	Generic		
Air modulation	None		Actual drive service fac.	1.37		
Drain pan	None		Bearing type	Standard - L50 (200K)		
Drain pan side	-		Outlet velocity	2887		ft/m
Wheel guard	None		Inlet screen	None		
Belt guard	None		Outlet screen	None		
Inspection port	None					
DRIVES						
Fan sheave	3B68Q		Motor sheave	3B5V54		
Number of belts	3		Belt	BX62		
ANTI-VIBRATION MOUNTS / SPRINGS						
Type	Spring					
Seismic restraint	None					
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	30	ins	Light	None		
Door opening	Outward					

LIST OF SCHEDULES

Supply Airstream

1 PLENUM SECTION(38 ins)					SECTION	**2**
Drain pan	None		Drain side	-		
Opening location	Top		Opening size	34.00 x 116.00	ins	
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	30	ins	Light	None		
Door opening	Outward					

2 PANEL FILTER(12 ins)					SECTION	**2**
Type	Pleated (MERV 6)		Clean air press. drop	0.12	ins WC	
Efficiency	30	%	**Mean air press. drop**	**0.56**	**ins WC**	
Face velocity	389	fpm	Dirty air press. drop	1.00	ins WC	
Face area	56.6	ft2	Access	Side		
Air volume	22000	cfm				
BANK ARRANGEMENT						
No. of Filters	**Size H x W x D**					
18	24.00 x 20.00 x 2.00	Ins				
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	8	ins	Light	None		
Door opening	Outward					
SPECIAL						
-						
Tread Plate floor liner	None					
Liner	(As casing details)					
Insulation	(As casing details)					
Sound baffles	None					
Special static pressure	-	ins WC	Filter Gauge	Minihelic II 0-2"		

3 ACCESS SECTION(24 ins)					SECTION	**2**
Drain pan	None		Drain side	-		
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	20	ins	Light	None		
Door opening	Outward					

4 Fixed Plate Heat Exchanger Section (96 ins)					SECTION	**3**
Drain pan	316 SS		Drain pan side	Drive side		
SPECIAL						
Plate Heat Exchanger						
Tread Plate floor liner	None					
Liner	(As casing details)					
Insulation	(As casing details)					
Sound baffles	None					
Special static pressure	Fresh / Supply	0.67	ins WC			
	-					

5 ACCESS SECTION(24 ins)					SECTION	**6**
Drain pan	None		Drain side	-		
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	20	ins	Light	None		
Door opening	Outward					

LIST OF SCHEDULES

6 HOT WATER COIL(12 ins)					SECTION	**6**
Coil model	5WH1001B		Number of coils	2		
Capacity	974259	Btu/h	Number of rows	1		
			Fins per inch	10		
Air volume	22000	cfm				
Entering db	26.0	F	Entering water	180.0	F	
Leaving db	66.5	F	Leaving water	159.2	F	
Finned height x length	33 x 104	ins	Water flow rate	104.20	gpm	
Face area	47.67	ft2	Water pressure drop	12.10	ftHD	
Face velocity	462	ft/m	Water velocity	5.00	ft/s	
Coil air pressure drop	0.09	ins WC				
			Fluid volume	95.0	gal	
			Fluid weight	77.00	lb	
Connection type	Threaded		Fin material	Aluminum (.0075)		
Connection Qty x size	2 x 1.50	ins	Tube material	Copper (.020)		
Connection location	Drive side		Header material	Copper		
Glycol type (%)	Propylene (50 %)		Case material	Galvanized track		
Fouling Factor	0		Drain pan	None		
			Drain pan side	-		
			Turbospirals	None		
Coil code	5WH1001B		Electro-fin coat	None		

7 SUPPLY FAN SECTION(70 ins)					SECTION	**7**
Air volume	22000	cfm	Motor power	20.0	HP	
External static pressure	2.00	ins WC	Motor type	TEFC		
Total static pressure	3.36	ins WC	Frame size	256 T frame		
			Electrical supply	575/60/3		
Type	-		Motor efficiency	High		
Blade type/Class	Airfoil / 2		Motor speed	1750	rpm	
Fan wheel diameter	27.00	ins	Motor pole	4		
Brake horsepower	18.22	HP	Full load current	20	A	
Operating/Max speed	1464 / 1928	rpm	Lock rotor current	135	A	
Orientation	Top horizontal		Motor supplier	Generic		
Air modulation	None		Actual drive service fac.	1.30		
Drain pan	None		Bearing type	Standard - L50 (200K)		
Drain pan side	-		Outlet velocity	2887	ft/m	
Wheel guard	None		Inlet screen	None		
Belt guard	None		Outlet screen	None		
Inspection port	None					
DRIVES						
Fan sheave	3B62Q		Motor sheave	3B5V52		
Number of belts	3		Belt	BX66		
ANTI-VIBRATION MOUNTS / SPRINGS						
Type	Spring					
Seismic restraint	None					
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	30	ins	Light	None		
Door opening	Outward					

NOTES

As a standalone component, unit meets or exceeds requirements of ASHRAE 90.1 - 1999. The approving authority is responsible for compliance of multi-component building systems.

LIST OF SCHEDULES

SHIPPING SECTION DETAILS			
	Length (inches)	**Weight (lb)**	
Section 1	74	1291	
Section 2	74	1017	
Section 3	96	1874	
Section 4	36	412	
Section 5	70	2293	
Section 6	36	1015	
Section 7	70	2555	
TOTALS	**276.00 (Lower level total)**	**10457 (Entire unit weight)**	

UNIT SOUND	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Radiated	80	79	77	69	64	52	45	37
Unit discharge	95	97	98	93	90	84	80	72
Unit return	95	97	98	93	90	84	80	72

LIST OF SCHEDULES

JOB NAME	WEWPCC BNR		
JOB DESCRIPTION	WEWPCC HEAT RECOVERY		
MODEL NUMBER	CAH012GHAC	**ENGINEER**	Earth Tech (Canada) Inc.
UNIT TAGGING	T600 MUA		

Unit configuration	Stacked with parallel air flows		
Drive (handing) location	Right		
	SUPPLY	**RETURN / EXHAUST**	
Air volume	6708	6708	s cfm
Altitude	0	0	ft
Turning loss	0.00	0.00	in WC.
External static	2.00	1.00	in WC.
Total static	4.00	2.70	in WC.
External H x W	42 x 66	42 x 66 (Not including base rails)	ins

CASING DETAILS	
Outer panel	Standard G90 galv steel
Liner	316 SS
Insulation	R-13 Injected Foam (Unless noted per section)
Frame	2 ins
Base	4" formed channel
Sound baffles	None (unless noted per section)
Tread Plate floor liner	None (unless noted per section)

Exhaust Airstream

1 PLENUM SECTION(22 ins)					SECTION **1**
Drain pan	None		Drain side	-	
Opening location	End upper		Opening size	18.00 x 62.00	ins
DOOR DATA					
Door location	Drive side		Window size	None	
Door width	18	ins	Light	None	
Door opening	Outward				

2 PANEL FILTER(12 ins)					SECTION **1**
Type	Pleated (MERV 6)		Clean air press. drop	0.20	ins WC
Efficiency	30	%	**Mean air press. drop**	**0.60**	**ins WC**
Face velocity	511	fpm	Dirty air press. drop	1.00	ins WC
Face area	13.1	ft2	Access	Side	
Air volume	6708	cfm			

BANK ARRANGEMENT

No. of Filters	**Size H x W x D**	
2	24.00 x 24.00 x 2.00	Ins
1	24.00 x 12.00 x 2.00	
2	12.00 x 24.00 x 2.00	

DOOR DATA				
Door location	Drive side	Window size	None	
Door width	8	ins Light	None	
Door opening	Outward			

SPECIAL

-

Tread Plate floor liner	None			
Liner	(As casing details)			
Insulation	(As casing details)			
Sound baffles	None			
Special static pressure	-	ins WC	Filter Gauge	Minihelic II 0-2"

LIST OF SCHEDULES

3 ACCESS SECTION(24 ins)					SECTION	**1**
Drain pan	None		Drain side	-		
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	20	ins	Light	None		
Door opening	Outward					

4 Fixed Plate Heat Exchanger Section (68 ins)					SECTION	**3**
Drain pan	316 SS		Drain pan side	Drive side		
SPECIAL						
Plate Heat Exchanger						
Tread Plate floor liner	None					
Liner	(As casing details)					
Insulation	(As casing details)					
Sound baffles	None					
Special static pressure	Return / Exhaust	1.06	ins WC			
	-					

5 ACCESS SECTION(36 ins)					SECTION	**4**
Drain pan	None		Drain side	-		
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	28	ins	Light	None		
Door opening	Outward					

6 RETURN/EXHAUST FAN SECTION(44 ins)					SECTION	**4**
Air volume	6708	cfm	Motor power	7.5		HP
External static pressure	1.00	ins WC	Motor type	TEFC		
Total static pressure	2.70	ins WC	Frame size	213 T frame		
			Electrical supply	575/60/3		
Type	-		Motor efficiency	Premium		
Blade type/Class	Airfoil / 2		Motor speed	1750		rpm
Fan wheel diameter	14.56	ins	Motor pole	4		
Brake horsepower	6.86	HP	Full load current	7.4		A
Operating/Max speed	3223 / 3918	rpm	Lock rotor current	52		A
Orientation	Up blast CW		Motor supplier	Generic		
Air modulation	None		Actual drive service fac.	1.13		
Drain pan	None		Bearing type	Standard - L50 (200K)		
Drain pan side	-		Outlet velocity	2329		ft/m
Wheel guard	None		Inlet screen	None		
Belt guard	None		Outlet screen	None		
Inspection port	None					
DRIVES						
Fan sheave	1B5V42		Motor sheave	BK85H		
Number of belts	1		Belt	BX41		
ANTI-VIBRATION MOUNTS / SPRINGS						
Type	Spring					
Seismic restraint	None					
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	30	ins	Light	None		
Door opening	Outward					

LIST OF SCHEDULES

Supply Airstream

1 PLENUM SECTION(22 ins)					SECTION	**2**
Drain pan	None		Drain side	-		
Opening location	Top		Opening size	18.00 x 62.00	ins	
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	18	ins	Light	None		
Door opening	Outward					

2 PANEL FILTER(12 ins)					SECTION	**2**
Type	Pleated (MERV 6)		Clean air press. drop	0.20	ins WC	
Efficiency	30	%	**Mean air press. drop**	**0.60**	**ins WC**	
Face velocity	511	fpm	Dirty air press. drop	1.00	ins WC	
Face area	13.1	ft2	Access	Side		
Air volume	6708	cfm				

BANK ARRANGEMENT	
No. of Filters	**Size H x W x D**
2	24.00 x 24.00 x 2.00 Ins
1	24.00 x 12.00 x 2.00
2	12.00 x 24.00 x 2.00

DOOR DATA					
Door location	Drive side		Window size	None	
Door width	8	ins	Light	None	
Door opening	Outward				

SPECIAL
-

Tread Plate floor liner	None			
Liner	(As casing details)			
Insulation	(As casing details)			
Sound baffles	None			
Special static pressure	-	ins WC	Filter Gauge	Minihelic II 0-2"

3 ACCESS SECTION(24 ins)					SECTION	**2**
Drain pan	None		Drain side	-		
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	20	ins	Light	None		
Door opening	Outward					

4 Fixed Plate Heat Exchanger Section (68 ins)					SECTION	**3**
Drain pan	316 SS		Drain pan side	Drive side		

SPECIAL
Plate Heat Exchanger

Tread Plate floor liner	None			
Liner	(As casing details)			
Insulation	(As casing details)			
Sound baffles	None			
Special static pressure	Fresh / Supply	0.95	ins WC	
	-			

5 ACCESS SECTION(24 ins)					SECTION	**5**
Drain pan	None		Drain side	-		
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	20	ins	Light	None		
Door opening	Outward					

LIST OF SCHEDULES

6 HOT WATER COIL(12 ins)					SECTION	**5**
Coil model	5WH1002C		Number of coils	1		
Capacity	541858	Btu/h	Number of rows	2		
			Fins per inch	10		
Air volume	6708	cfm				
Entering db	22.0	F	Entering water	180.0		F
Leaving db	95.9	F	Leaving water	159.2		F
Finned height x length	33 x 50	ins	Water flow rate	57.80		gpm
Face area	11.46	ft2	Water pressure drop	11.80		ftHD
Face velocity	585	ft/m	Water velocity	5.60		ft/s
Coil air pressure drop	0.41	ins WC				
			Fluid volume	25.0		gal
			Fluid weight	38.00		lb
Connection type	Threaded		Fin material	Aluminum (.0075)		
Connection Qty x size	2 x 2.50	ins	Tube material	Copper (.020)		
Connection location	Drive side		Header material	Copper		
Glycol type (%)	Propylene (50 %)		Case material	Galvanized track		
Fouling Factor	0		Drain pan	None		
			Drain pan side	-		
			Turbospirals	None		
Coil code	5WH1002C		Electro-fin coat	None		

7 SUPPLY FAN SECTION(44 ins)					SECTION	**5**
Air volume	6708	cfm	Motor power	10.0		HP
External static pressure	2.00	ins WC	Motor type	TEFC		
Total static pressure	4.00	ins WC	Frame size	215 T frame		
			Electrical supply	575/60/3		
Type	-		Motor efficiency	High		
Blade type/Class	Airfoil / 2		Motor speed	1750		rpm
Fan wheel diameter	14.56	ins	Motor pole	4		
Brake horsepower	8.49	HP	Full load current	11		A
Operating/Max speed	3424 / 3918	rpm	Lock rotor current	72		A
Orientation	Top horizontal		Motor supplier	Generic		
Air modulation	None		Actual drive service fac.	1.42		
Drain pan	None		Bearing type	Standard - L50 (200K)		
Drain pan side	-		Outlet velocity	2329		ft/m
Wheel guard	None		Inlet screen	None		
Belt guard	None		Outlet screen	None		
Inspection port	None					
DRIVES						
Fan sheave	2TB36		Motor sheave	2BK80H		
Number of belts	2		Belt	BX40		
ANTI-VIBRATION MOUNTS / SPRINGS						
Type	Spring					
Seismic restraint	None					
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	30	ins	Light	None		
Door opening	Outward					

NOTES

Important Notice

This unit may not meet ASHRAE Standard 90.1 - 1999 fan motor power limitations. If that code applies, alternate fan selections may be required.

The designer and installer must ensure compliance with applicable codes. A component supplier cannot determine the brake horsepower

LIST OF SCHEDULES

NOTES
("BHP") for other motors in the air handling system. Before approving this unit, determine whether ASHRAE Standard 90.1 - 1999 has been adopted in the specific jurisdiction or contract specifications in which the unit will be installed.

SHIPPING SECTION DETAILS			
	Length (inches)	**Weight (lb)**	
Section 1	58	494	
Section 2	58	411	
Section 3	68	633	
Section 4	80	869	
Section 5	80	1191	
TOTALS	**206.00 (Lower level total)**	**3598 (Entire unit weight)**	

UNIT SOUND	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Radiated	77	76	71	69	61	49	42	34
Unit discharge	92	94	92	93	87	81	77	69
Unit return	93	95	93	94	88	82	78	70

LIST OF SCHEDULES

JOB NAME	WEWPCC BNR		
JOB DESCRIPTION	WEWPCC HEAT RECOVERY		
MODEL NUMBER	CAH008GHAC	**ENGINEER**	Earth Tech (Canada) Inc.
UNIT TAGGING	T605 MUA		

Unit configuration	Stacked with parallel air flows		
Drive (handing) location	Right		
	SUPPLY	**RETURN / EXHAUST**	
Air volume	4182	4182	s cfm
Altitude	0	0	ft
Turning loss	0.00	0.00	in WC.
External static	2.00	1.00	in WC.
Total static	4.02	2.67	in WC.
External H x W	34 x 58	34 x 58 (Not including base rails)	ins

CASING DETAILS	
Outer panel	Standard G90 galv steel
Liner	316 SS
Insulation	R-13 Injected Foam (Unless noted per section)
Frame	2 ins
Base	4" formed channel
Sound baffles	None (unless noted per section)
Tread Plate floor liner	None (unless noted per section)

Exhaust Airstream

1 PLENUM SECTION(18 ins)					SECTION **1**
Drain pan	None		Drain side	-	
Opening location	End upper		Opening size	14.00 x 54.00	ins
DOOR DATA					
Door location	Drive side		Window size	None	
Door width	14	ins	Light	None	
Door opening	Outward				

2 PANEL FILTER(12 ins)					SECTION **1**
Type	Pleated (MERV 6)		Clean air press. drop	0.17	ins WC
Efficiency	30	%	**Mean air press. drop**	**0.59**	**ins WC**
Face velocity	476	fpm	Dirty air press. drop	1.00	ins WC
Face area	8.8	ft2	Access	Side	
Air volume	4182	cfm			

BANK ARRANGEMENT

No. of Filters	**Size H x W x D**	
1	24.00 x 24.00 x 2.00	Ins
1	24.00 x 20.00 x 2.00	
1	24.00 x 12.00 x 2.00	

DOOR DATA				
Door location	Drive side	Window size	None	
Door width	8	ins Light	None	
Door opening	Outward			

SPECIAL

-

Tread Plate floor liner	None			
Liner	(As casing details)			
Insulation	(As casing details)			
Sound baffles	None			
Special static pressure	-	ins WC	Filter Gauge	Minihelic II 0-2"

LIST OF SCHEDULES

3 ACCESS SECTION(24 ins)					SECTION	**1**
Drain pan	None		Drain side	-		
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	20	ins	Light	None		
Door opening	Outward					

4 Fixed Plate Heat Exchanger Section (68 ins)			SECTION	**3**
Drain pan	316 SS	Drain pan side	Drive side	

SPECIAL			
Plate Heat Exchanger			
Tread Plate floor liner	None		
Liner	(As casing details)		
Insulation	(As casing details)		
Sound baffles	None		
Special static pressure	Return / Exhaust	1.05	ins WC
	-		

5 ACCESS SECTION(36 ins)					SECTION	**4**
Drain pan	None		Drain side	-		
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	28	ins	Light	None		
Door opening	Outward					

6 RETURN/EXHAUST FAN SECTION(40 ins)					SECTION	**4**
Air volume	4182	cfm	Motor power	5.0		HP
External static pressure	1.00	ins WC	Motor type	TEFC		
Total static pressure	2.67	ins WC	Frame size	184 T frame		
			Electrical supply	575/60/3		
Type	Centrifugal		Motor efficiency	Premium		
Blade type/Class	Forward curved / 1		Motor speed	1750		rpm
Fan wheel diameter	12.62	ins	Motor pole	4		
Brake horsepower	3.43	HP	Full load current	5.2		A
Operating/Max speed	1394 / 1614	rpm	Lock rotor current	38.4		A
Orientation	Up blast CW		Motor supplier	Generic		
Air modulation	None		Actual drive service fac.	1.16		
Drain pan	None		Bearing type	Standard - L50 (200K)		
Drain pan side	-		Outlet velocity	2845		ft/m
Wheel guard	None		Inlet screen	None		
Belt guard	None		Outlet screen	None		
Inspection port	None					
DRIVES						
Fan sheave	AK71H		Motor sheave	AK59H		
Number of belts	1		Belt	A39		
ANTI-VIBRATION MOUNTS / SPRINGS						
Type	Spring					
Seismic restraint	None					
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	30	ins	Light	None		
Door opening	Outward					

LIST OF SCHEDULES

Supply Airstream

1 PLENUM SECTION(18 ins)					SECTION	**2**
Drain pan	None		Drain side	-		
Opening location	Top		Opening size	14.00 x 54.00	ins	
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	14	ins	Light	None		
Door opening	Outward					

2 PANEL FILTER(12 ins)					SECTION	**2**
Type	Pleated (MERV 6)		Clean air press. drop	0.17	ins WC	
Efficiency	30	%	**Mean air press. drop**	**0.59**	**ins WC**	
Face velocity	476	fpm	Dirty air press. drop	1.00	ins WC	
Face area	8.8	ft2	Access	Side		
Air volume	4182	cfm				

BANK ARRANGEMENT		
No. of Filters	**Size H x W x D**	
1	24.00 x 24.00 x 2.00	Ins
1	24.00 x 20.00 x 2.00	
1	24.00 x 12.00 x 2.00	

DOOR DATA				
Door location	Drive side	Window size	None	
Door width	8	ins	Light	None
Door opening	Outward			

SPECIAL				
-				
Tread Plate floor liner	None			
Liner	(As casing details)			
Insulation	(As casing details)			
Sound baffles	None			
Special static pressure	-	ins WC	Filter Gauge	Minihelic II 0-2"

3 ACCESS SECTION(24 ins)					SECTION	**2**
Drain pan	None		Drain side	-		
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	20	ins	Light	None		
Door opening	Outward					

4 Fixed Plate Heat Exchanger Section (68 ins)					SECTION	**3**
Drain pan	316 SS		Drain pan side	Drive side		

SPECIAL				
Plate Heat Exchanger				
Tread Plate floor liner	None			
Liner	(As casing details)			
Insulation	(As casing details)			
Sound baffles	None			
Special static pressure	Fresh / Supply	0.95	ins WC	
	-			

5 ACCESS SECTION(24 ins)					SECTION	**5**
Drain pan	None		Drain side	-		
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	20	ins	Light	None		
Door opening	Outward					

LIST OF SCHEDULES

6 HOT WATER COIL(12 ins)					SECTION	**5**
Coil model	5WH1102C		Number of coils	1		
Capacity	351335	Btu/h	Number of rows	2		
			Fins per inch	11		
Air volume	4182	cfm				
Entering db	20.0	F	Entering water	180.0		F
Leaving db	96.8	F	Leaving water	159.2		F
Finned height x length	24 x 42	ins	Water flow rate	37.60		gpm
Face area	7.00	ft2	Water pressure drop	7.00		ftHD
Face velocity	597	ft/m	Water velocity	5.00		ft/s
Coil air pressure drop	0.45	ins WC				
			Fluid volume	55.0		gal
			Fluid weight	25.00		lb
Connection type	Threaded		Fin material	Aluminum (.0075)		
Connection Qty x size	2 x 2.50	ins	Tube material	Copper (.020)		
Connection location	Drive side		Header material	Copper		
Glycol type (%)	Propylene (50 %)		Case material	Galvanized track		
Fouling Factor	0		Drain pan	None		
			Drain pan side	-		
			Turbospirals	None		
Coil code	5WH1102C		Electro-fin coat	None		

7 SUPPLY FAN SECTION(40 ins)					SECTION	**5**
Air volume	4182	cfm	Motor power	7.5		HP
External static pressure	2.00	ins WC	Motor type	TEFC		
Total static pressure	4.02	ins WC	Frame size	213 T frame		
			Electrical supply	575/60/3		
Type	-		Motor efficiency	High		
Blade type/Class	Airfoil / 2		Motor speed	1750		rpm
Fan wheel diameter	13.22	ins	Motor pole	4		
Brake horsepower	4.70	HP	Full load current	8.2		A
Operating/Max speed	3298 / 4335	rpm	Lock rotor current	49		A
Orientation	Top horizontal		Motor supplier	Generic		
Air modulation	None		Actual drive service fac.	1.10		
Drain pan	None		Bearing type	Standard - L50 (200K)		
Drain pan side	-		Outlet velocity	1963		ft/m
Wheel guard	None		Inlet screen	None		
Belt guard	None		Outlet screen	None		
Inspection port	None					
DRIVES						
Fan sheave	AK59H		Motor sheave	AK109H		
Number of belts	1		Belt	A43		
ANTI-VIBRATION MOUNTS / SPRINGS						
Type	Spring					
Seismic restraint	None					
DOOR DATA						
Door location	Drive side		Window size	None		
Door width	30	ins	Light	None		
Door opening	Outward					

NOTES

As a standalone component, unit meets or exceeds requirements of ASHRAE 90.1 - 1999. The approving authority is responsible for compliance of multi-component building systems.

LIST OF SCHEDULES

SHIPPING SECTION DETAILS			
	Length (inches)	**Weight (lb)**	
Section 1	54	406	
Section 2	54	331	
Section 3	68	547	
Section 4	76	671	
Section 5	76	963	
TOTALS	**198.00 (Lower level total)**	**2918 (Entire unit weight)**	

UNIT SOUND	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Radiated	70	71	64	61	58	47	40	38
Unit discharge	87	89	87	88	82	76	72	64
Unit return	84	89	84	81	86	82	77	76

1.2 Air Handling Unit Schedule

Tag	T610-AHU	S780-AHU
Location	DAF Electrical Room	Aeration Basin Elec. Rm.
Area Served	DAF Electrical Room	Aeration Basin Elec. Rm
Type	Air Purification System	Air Purification System
Manufacturer	Circul-Aire	Circu-Aire
Model	A.P.S.–1500-H	A.P.S.–500-H
Volume, *L/S (cfm)*	566 (1200)	283 (600)
ESP, *Pa (in. wg.)*	300 (1.20)	300 (1.20)
Fan Type	Belt Driven	Direct Drive
Fan Speed, (rpm)	1700	n/a
Motor Power, *kW (HP)*	1.1 (1.5)	0.75 (1.0)
Power Supply	600/3/60	600/3/60
Minimum Outdoor Air, L/S (cfm)	56.6 (120)	28.3 (60)
Heating Section		
Type	Electric Resistance w/ SCR (full modulation)	Electric Resistance w/ SCR (full modulation)
Heating Output, *kW*	4.0	3.0
Temperature rise *°C (°F)*	55.5 (100)	55.5 (100)
Arrangement	Horizontal Ceiling Mounted	Horizontal Ceiling Mounted
Filter Sections		
Pre-filter	50mm 30% filter	50mm 30% filter
1st Stage	MULTI-MIX® MM-1000	MULTI-MIX® MM-1000
2nd Stage	MULTI-MIX® MM-1000	MULTI-MIX® MM-1000
Physical Data		
Overall Length *mm (inch)*	1803 (71.0)	1981 (78.0)
Overall Width *mm (inch)*	991 (39.0)	794 (31.25)
Overall Height *mm (inch)*	762 (30.0)	381 (15.0)
Overall Weight *kg (lb)*	361 (795)	140.6 (310)
Remarks	T630-CU will be connected to this unit to provide cooling via DX coil located in duct.	S790-CU will be connected to this unit to provide cooling via DX coil located in duct.

1.3 Air Fan Schedule

Tag	F610-SF	F620-SF
Function	Fermenter Supply Exhaust	Fermenter Supply Exhaust
Location	Fermenter Gallery	Fermenter Gallery
Air Flow, L/S (cfm)	165 (350)	165 (350)
E.S.P. Press Pa. (inch wg)	187 (0.75)	187 (0.75)
Fan RPM	2478	2478
Motor Power kW (HP)	0.19 (0.25)	0.19 (0.25)
Motor size kW (HP)	0.25 (0.33)	0.25 (0.33)
Power Supply (V/Ph/Hz)	208/1/60	208/1/60
Drive	Belt	Belt
Control Type	Single speed	Single speed
Arrangement		
Manufacturer	Cook	Cook
Model	70 SQN-B	70 SQN-B
Configuration	Vertical – Inline	Vertical – Inline
Control		
Accessories & Options	1,3,4,5,6,8,11,13	1,3,4,5,6,8,11,13
Other Remarks	• c/w spare motor, spare parts	-

Tag	F650-EF	F660-EF
Function	Fermenter Exhaust	T.O. Exhaust
Location	Fermenter Gallery	Fermenter Gallery
Air Flow, L/S (cfm)	330 (700)	660 (1400)
E.S.P. Press Pa. (inch wg)	105 (0.42)	127 (0.51)
Fan RPM	1053	1058
Motor Power kW (HP)	0.06 (0.08)	0.16 (0.22)
Motor size kW (HP)	0.37 (0.50)	0.37 (0.50)
Power Supply (V/Ph/Hz)	600/3/60	600/3/60
Drive	Belt	Belt
Control Type	VFD	VFD
Arrangement	Arrangement 9	Arrangement 9
Manufacturer	Universal Fan & Blower	Universal Fan & Blower
Model	FBIXB-122-9Z136	FBIXB-150-9Z190
Configuration	CCW – Upblast	CCW – Top Horizontal
Motor Position	Z	W
Control		
Accessories & Remarks	2,3,4,6,8,13,14	2,3,4,6,8,13,14
Other Remarks	• Spark resistant fan construction	• Spark resistant fan construction

1.3 Air Fan Schedule (Continued)

Tag	H655-EF	H710-EF
Function	Truck Fill Exhaust	H.W./DAF Exhaust
Location	Sludge Truck Bay	Headworks
Air Flow, L/S (cfm)	165 (350)	330 (700)
E.S.P. Press Pa. (in.wg)	373 (1.5)	311 (1.25)
Fan RPM	1619	1520
Motor Power kW (HP)	0.15 (0.20)	0.16 (0.21)
Motor size kW (HP)	0.25 (0.33)	0.37 (0.50)
Power Supply (V/Ph/Hz)	208/1/60	600/3/60
Drive	Belt	Belt
Control Type	Single speed	VFD
Arrangement	Arrangement 10	Arrangement 9
Manufacturer	Universal Fan & Blower	Universal Fan & Blower
Model	FRBJC-125-0V___	FBIXB-122-9W090
Configuration	CCW- Down Blast	CW – Top Discharge
Motor Position	V	W
Control	On/Off	
Accessories & Remarks	2,3,4,8,13,14	2,3,4,6,8,13,14
Other Remarks	• Spark resistant fan construction • Spark resistant motor construction	• Spark resistant fan construction • Spark resistant motor construction

Tag	H-715-EF	S780-SF
Function	DAF Building Exhaust	Mechanical Room S/A
Location	Headworks Main Level	Area S Mechanical Room
Air Flow, L/S (cfm)	3166 (6708)	320 (678)
E.S.P. Press Pa. (in.wg)	373.1 (1.5)	31.1 (0.125)
Fan RPM	845	1050
Motor Power kW (HP)	1.95 (2.61)	
Motor size kW (HP)	3.73 (5.0)	0.037 (1/20)
Power Supply (V/Ph/Hz)	600/3/60	120/1/60
Drive	Belt	Direct Drive
Control Type	VFD	Single Speed
Arrangement	See drawing	See drawing
Manufacturer	Northern Blower	Greenheck
Model	Series 8000 Size 3000	S1-12-432-E
Configuration	Horizontal Inline	Sidewall
Motor Position	Bottom	Centre
Control		
Accessories & Remarks	2,3,4,6,8,11,13,15	11,12
Other Remarks	• Spark resistant fan construction • Spark resistant motor construction	• Spark resistant fan construction • Spark resistant motor construction

1.3 Air Fan Schedule (Continued)

Tag	S638-EF	S639-EF
Function	Aeration Basin No. 1 EF	Aeration Basin No. 2 EF
Location	Area S – Tunnels	Area S – Tunnels
Air Flow, L/S (cfm)	3000 (6350)	3000 (6350)
E.S.P. Press Pa. (inch wg)	75 (0.30)	75 (0.30)
Fan RPM	608	608
Motor Power kW (HP)	0.64 (0.86)	0.64 (0.86)
Motor Size kW (HP)	0.75 (1.0)	0.75 (1.0)
Power Supply (V/Ph/Hz)	600/3/60	600/3/60
Drive	Belt	Belt
Control Type	VFD	VFD
Arrangement	Arrangement 9	Arrangement 9
Manufacturer	Universal Fan & Blower	Universal Fan & Blower
Model	FBIXB-365-9Z027	FBIXB-365-9Z190
Configuration	CW - Bottom Horizontal	CCW - Top Horizontal
Motor Position	Z	Z
Control		
Accessories & Remarks	2,3,4,6,8,13,15	2,3,4,6,8,13,15
Other Remarks	• Spark resistant fan construction • Spark resistant motor construction	• Spark resistant fan construction • Spark resistant motor construction

Accessories:

1. Gasketed bolted access door
2. Housing drain with plug
3. Totally enclosed belt guard
4. Shaft and bearing guard
5. Extended grease fittings
6. Fan base
7. Weatherproof motor
8. Drive cover
9. Shaft seal
10. Service platform
11. Epoxy coated interior for corrosion protection
12. Insect screen
13. Motor mount
14. Rubber in shear isolators
15. Spring isolators

1.4 Gas Heater (Boiler) Schedule

Tag	S760-GH	S765-GH
Service	Area S and Area F Hydronic heating	Area S and Area F Hydronic heating
Location	Clarifier 3 Mech Rm.	Clarifier 3 Mech Rm.
Manufacturer	RBI, Water Heaters	RBI, Water Heaters
Model	Dominator 1350	Dominator 1350
Input, MBH (kW)	1350 (396)	1350 (396)
Rated Output, MBH (kW)	1134 (333)	1134 (333)
Flow Rate, usgpm, (L/s)	113.1 (7.1)	113.1 (7.1)
Operating Pressure, psi (KPa)	50 (345)	50 (345)
EWT °F (°C)	160 (72)	160 (72)
LWT °F (°C)	180 (82)	180 (82)
PD, ft wc, (KPa)	13.5 (40.6)	13.5 (40.6)
Fluid	40% ethylene glycol	40% ethylene glycol
Efficiency	85.1%	85.1%
Comments	Stacked with S765-GH	Stacked with S760-GH
Features	• Low NOx, • Stainless burners, • Cast iron headers, • 4 stage firing, • Stackable frame, • Slide-out heat exchanger, • Sealed combustion	• Low NOx, • Stainless burners, • Cast iron headers, • 4 stage firing, • Stackable frame, • Slide-out heat exchanger, • Sealed combustion
Complete with	• isolation valves, • Safety relief valve, • PID burner sequencing control, • Temp. & pressure gauges, • LWCO • Gas Pressure Regulator	• isolation valves, • Safety relief valve, • PID burner sequencing control, • Temp. & pressure gauges, • LWCO • Gas Pressure Regulator

1.4 Gas Heater (Boiler) Schedule (Continued)

Tag	T650-GH	T655-GH
Service	Area T Hydronic heating	Area T Hydronic heating
Location	Clarifier 3 Mechanical Room	Clarifier 3 Mechanical Room
Manufacturer	RBI, Water Heaters	RBI, Water Heaters
Model	Dominator 1350	Dominator 1350
Input, MBH (kW)	1350 (396)	1350 (396)
Rated Output, MBH (kW)	1134 (333)	1134 (333)
Flow Rate, usgpm, (L/s)	113.1 (7.1)	113.1 (7.1)
Operating Pressure, psi (KPa)	50 (345)	50 (345)
EWT °F (°C)	160 (72)	160 (72)
LWT °F (°C)	180 (82)	180 (82)
PD, ft wc, (KPa)	13.5 (40.6)	13.5 (40.6)
Fluid	40% ethylene glycol	40% ethylene glycol
Efficiency	85.1%	85.1%
Comments	Stacked with T655-GH	Stacked with T650-GH
Features	• Low NOx, • Stainless burners, • Cast iron headers, • 4 stage firing, • Stackable frame, • Slide-out heat exchanger, • Sealed combustion	• Low NOx, • Stainless burners, • Cast iron headers, • 4 stage firing, • Stackable frame, • Slide-out heat exchanger, • Sealed combustion
Complete with	• isolation valves, • Safety relief valve, • PID burner sequencing control, • Temp. & pressure gauges, • LWCO • Gas Pressure Regulator	• isolation valves, • Safety relief valve, • PID burner sequencing control, • Temp. & pressure gauges, • LWCO • Gas Pressure Regulator

1.5 Hot Water Unit Heater Schedule

Tag	T615-UH	T620-UH
Location	DAF Area	DAF Area
Service	DAF Area	DAF Area
Air Flow *L/S (CFM)*	3710 (7860)	3710 (7860)
Fan Motor Power *kW (Hp)*	0.75 (1.0)	0.75 (1.0)
Fan Motor Power Supply *(V/Ph/Hz)*	208/3/60	208/3/60
Heating Output *kW (MBH)*	90.2 (308)	90.2 (308)
Water Flow Rate, *L/S (gpm)*	1.96 (31.1)	1.96 (31.1)
Water Pressure Drop, *Pa (ft HD)*	418 (1.68)	418 (1.68)
Fluid	40% E.G.	40% E.G.
Manufacturer	Rittling	Rittling
Model No.	RV-385	RV-385
Weight *kg (lbs)*	103 (227)	103 (227)
Complete with	• Explosion-proof motor • Explosion-proof wall thermostat • One-way louvre	• Explosion-proof motor • Explosion-proof wall thermostat • One-way louvre

1.6 Pump Schedule

Tag	**S770-GP**	**S775-GP**	**T665-GP**	**T670-GP**
Service	Glycol Heating	Glycol Heating	Glycol Heating	Glycol Heating
Location	Clarifier 3 Mech. Rm.	Clarifier 3 Mech. Rm.	DAF Mech. Rm.	DAF Mech. Rm.
Type	Vertical, in-line, single stage	Vertical, in-line, single stage	Vertical, in-line, single stage	Vertical, in-line, single stage
Manufacturer	Grundfos	Grundfos	Grundfos	Grundfos
Model	2.5LM-8	2.5LM-8	2.5LM-8	2.5LM-8
Pump				
Impeller diameter, inch (mm)	8.0 (200)	8.0 (200)	8.0 (200)	8.0 (200)
Casing	Cast Iron	Cast Iron	Cast Iron	Cast Iron
Suction/Discharge Connection & Sizes	Flanged, 2-1/2" ANSI 125 lb. F.F.	Flanged, 2-1/2" ANSI 125 lb. F.F.	Flanged, 2-1/2" ANSI 125 lb. F.F.	Flanged, 2-1/2" ANSI 125 lb. F.F.
Design Pressure- psi (KPa)	175	175	175	175
Operating Conditions				
Capacity, usgpm (L/s)	125 (7.88)	125 (7.88)	125 (7.88)	125 (7.88)
Total Head, ft wc (m)	62 (18.89)	62 (18.89)	62 (18.89)	62 (18.89)
RPM	1750	1750	1750	1750
Hydraulic Power, HP	3	3	3	3
Required NPSH, ft wc	5	5	5	5
Efficiency %	70	70	70	70
Motor Power, kW (HP)	3.75 (5.0)	3.75 (5.0)	3.75 (5.0)	3.75 (5.0)
Voltage/phase/Hz	600/3/60	600/3/60	600/3/60	600/3/60
Duty	continuous	continuous	continuous	continuous
Fluid Pumped				
Type	40% ethylene glycol	40% ethylene glycol	40% ethylene glycol	40% ethylene glycol
Temperature, °F (°C)	180 (82)	180 (82)	180 (82)	180 (82)

Tag	**F630-SMP**	**F640-SMP**	**T700-SMP**	**T705-SMP**
Service	Weeping tile & floor drain	Weeping tile & floor drain	Floor drains	Floor drains
Location	Fermenter Gallery	Fermenter Gallery	DAF Building	DAF Building
Type	Self priming centrifugal	Self priming centrifugal	Self priming centrifugal	Self priming centrifugal
Manufacturer	Gormann-Rupp	Gormann-Rupp	Gormann-Rupp	Gormann-Rupp
Model	11-1/2A3-B	11-1/2A3-B	11-1/2A3-B	11-1/2A3-B
Pump				
Impeller diameter, inch (mm)				
Casing	Gray Iron	Gray Iron	Gray Iron	Gray Iron
Suction/Discharge Connection & Sizes	1-1/2" x 1-1/2" NPT Female	1-1/2" x 1-1/2" NPT Female	1-1/2" x 1-1/2" NPT Female	1-1/2" x 1-1/2" NPT Female
Design Pressure- kPa (psi)	434.4 (63)	434.4 (63)	434.4 (63)	434.4 (63)
Operating Conditions				
Capacity, L/s (usgpm)	3.15 (50)	3.15 (50)	3.15 (50)	3.15 (50)
Total Head, m (ft wc)	7.3 (24)	7.3 (24)	12.8 (42)	12.8 (42)
RPM	2200	2200	2600	2600
Hydraulic Power, HP	0.65 (0.87)	0.65 (0.87)	0.89 (1.2)	0.89 (1.2)
Required NPSH, ft wc				
Efficiency %	41	41	41	41
Motor Power, HP (kW)	0.75 (1.0)	0.75 (1.0)	1.1 (1.5)	1.1 (1.5)
Voltage/phase/Hz	600/3/60	600/3/60	600/3/60	600/3/60
Duty	Duty/Standby	Duty/Standby	Duty/Standby	Duty/Standby
Fluid Pumped				
Type	Water	Water	Water	Water
Temperature, °C (°F)	21 (70)	21 (70)	21 (70)	21 (70)
Complete with	Duplex Control Panel	See F630-SMP	Duplex Control Panel	See T700-SMP

1.6 Pump Schedule (Continued)

Tag	**T680-DWP**	**T685-DWP**	**S768-SMP**	**S769-SMP**
Service	Polymer System	Polymer System	Rain Water	Rain Water
Location	DAF Mechanical Room	DAF Mechanical Room	Aeration Basin Tunnel	Aeration Basin Tunnel
Type	Centrifugal	Centrifugal	Self priming centrifugal	Self priming centrifugal
Manufacturer	Grundfos	Grundfos	Gormann-Rupp	Gormann-Rupp
Model	CRN 4-50	CRN 4-50	11-1/2A3-B	11-1/2A3-B
Pump				
Impeller diameter, inch (mm)				
Casing	Cast Iron	Cast Iron	Gray Iron	Gray Iron
Suction/Discharge Connection & Sizes mm/mm (inch/inch)	32/32 (1.25/1.25)	32/32 (1.25/1.25)	1-1/2" x 1-1/2" NPT Female	1-1/2" x 1-1/2" NPT Female
Design Pressure- kPa (Psi)	1586 (230)	1586 (230)	434.4 (63)	434.4 (63)
Operating Conditions				
Capacity, L/s (USgpm)	1.7 (27)	1.7 (27)	3.79 (60)	3.79 (60)
Total Head, m (ft wc)			8.5 (27.8)	8.5 (27.8)
RPM	3450	3450	2400	2400
Hydraulic Power, HP			0.75 (1.0)	0.75 (1.0)
Required NPSH, ft wc				
Efficiency %	59	59	42	42
Motor Power, kW (HP)	1.5 (2.0)	1.5 (2.0)	1.1 (1.5)	1.1 (1.5)
Voltage/phase/Hz	600/3/60	600/3/60	600/3/60	600/3/60
Duty	Duty/Standby	Duty/Standby	Duty/Standby	Duty/Standby
Fluid Pumped				
Type	DCW	DCW	Water	Water
Temperature, °C (°F)	15 (60)	15 (60)	15 (60)	15 (60)
Complete with			Duplex Control Panel	See S768-SMP

Tag	**H686-CP**
Service	DHW circ. pump
Location	Headworks Mechanical Room
Type	Cartridge Circulator
Manufacturer	Taco
Model	006-BT4
Pump	
Casing	Bronze
Suction/Discharge Connection & Sizes	¾" NPT / ¾" NPT
Design Pressure- kPa (Psi)	860 (125)
Operating Conditions	
Capacity, L/s (USgpm)	0.22 (3.5)
Total Head, m (ft wc)	1.74 (5.7)
Motor Power, kW (HP)	0.02 (0.025)
RPM	3250
Voltage/phase/Hz	120/1/60
Duty	Continuous
Fluid Pumped	
Type	DHW
Temperature, °C (°F)	60 (140)

1.7 Grilles, Registers and Diffusers Schedule

Tag	Manufacturer Model No.	Border/ Frame	Core	Module Size (mm)	Neck Size (mm)	Finish	Fastening	Options	Remarks
SA-1	E.H. Price 720D	32 mm Frame		N/A	See Drawings	None	Counter-sunk		
SA-2	E.H. Price DR180 Series	N/A		N/A	See Drawings	None	Comes with wall mounting hardware		
SA-3	E.H. Price DF3 Series	N/A		N/A	See Drawings	None	Comes with wall mounting hardware		
SA-4	E.H. Price LBPH 16B	Type 187		N/A	See Drawings	None	Counter-sunk		
RA-1	E.H. Price 710Z	32 mm Frame		N/A	See Drawings	None	Comes with wall mounting hardware		
RA-2	E.H. Price 610Z	32 mm Frame		N/A	See Drawings	None	Comes with wall mounting hardware		
RA-3	---------	-------		Cut to Suit	See Drawings	None	SS Screw fastener		1

Finishes:

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

Remarks:

1. 13 mm (0.5 inch) mesh welded stainless, 1.2 mm (0.047 inch) wire diameter. Cut size to suit opening. Secured to duct with stainless steel screws/fasteners.

1.8 Louvre Schedule

Tag	Manufacturer Model No.	Frame	Core	Size – mm (in) Width x Height	Cap. – l/s (cfm)	Vel. – m/s (fpm)	ΔP – Pa (in)	Fast.	Finishes	Options
LV-A	Airolite 638C1004x	Drainable	Drainable	See Drawings	See Drawings	2.3 (450)	(0.03)	Mtg. angle	3, 4	1, 2, 3
LV-B	Airolite 638C1004x	Drainable	Drainable	See Drawings	See Drawings	3.0 (600)	(0.06)	Mtg. angle	3, 4	1, 3

Finishes:
1. Baked enamel
2. Duranar
3. Duranar XL
4. Match adjacent panelling

Options:
1. Formed metal sill
2. Aluminum insect screen
3. Aluminum bird screen
4. Removable access door

Notes:
LV-A louvres are for air intake into building.
LV-B louvres are for air exhaust out of building.

1.9 Air Compressor Schedule

Tag	T640-AC	T641-AC
Location	DAF Mechanical Room	DAF Mechanical Room
Area Served	DAF	DAF
Type	Reciprocating	Duplex Reciprocating
Manufacturer	Ingersoll-Rand	Ingersoll-Rand
Model		
Compressor		
Bore (mm)		
Stroke (mm)		
Speed (RPM)		
Displacement @ psi		
Motor		
Type		
Power (hp)		
Voltage/Ph/Hz		
Air Receiver		
Volume – L (USgal)		
Discharge Connection – NPT mm (inch)	20 (3/4)	
Physical Data		
Overall Length - mm (inch)	919 (36.2)	
Overall Height - mm (inch)	1846 (72.7)	
Overall Width - mm (inch)	754 (29.7)	
Overall Weight - kg (lbs)		
Acceptable Manufacturers	Quincy	

Note: Air compressor part of process mechanical DAF package.

1.10 Plumbing Fixtures

Tag	**SK-1**
Location	Various – see drawings
Type	Sewage Sampling Sink w/ anti-splash rim
Construction	Type 304 Stainless Steel, 14 gauge, grade 18-8
Width *mm (inch)*	1143 (45)
Depth *mm (inch)*	533 (21)
Height *mm (inch)*	889 (35)
Manufacturer	Aristaline
Model No.	SSS1827SDSR
Facet	
Manufacturer	Sloan
Model No.	SL-0231
Connection Size	½" NPT female
Cartridge	ceramic
Faucet Features	• Cast brass construction • Swivel spout • Adjustable inlets • Wing handles with color coded index buttons • Polished chrome finish

LIST OF SCHEDULES

1.11 Variable Frequency Drive Schedule

Tag	F650-SF-VFD	F650-EF-VFD
Service	F650-SF	F650-EF
Driven Motor kW (Hp)	0.37 (0.50)	0.37 (0.50)
Power Supply (V/ph/Hz)	600/3/60	600/3/60
Manufacturer	See Division 16	See Division 16
Model No.	See Division 16	See Division 16

Tag	F600-SF-VFD	F600-EF-VFD
Service	F600 MUA SF	F600 MUA EF
Driven Motor kW (Hp)	5.2 (7.5)	5.2 (7.5)
Power Supply (V/ph/Hz)	600/3/60	600/3/60
Manufacturer	See Division 16	See Division 16
Model No.	See Division 16	See Division 16

Tag	H715-EF-VFD	H710-EF-VFD
Service	H715-EF	H710-EF
Driven Motor kW (Hp)	3.75 (5.0)	0.37 (0.50)
Power Supply (V/ph/Hz)	600/3/60	600/3/60
Manufacturer	See Division 16	See Division 16
Model No.	See Division 16	See Division 16

Tag	S638-SF-VFD	S639-EF-VFD
Service	S638-SF	S639-EF
Driven Motor kW (Hp)	0.75 (1.0)	0.75 (1.0)
Power Supply (V/ph/Hz)	600/3/60	600/3/60
Manufacturer	See Division 16	See Division 16
Model No.	See Division 16	See Division 16

Tag	S750-SF-VFD	S750-EF-VFD
Service	S750 MUA SF	S750 MUA EF
Driven Motor kW (Hp)	14.9 (20.0)	14.9 (20.0)
Power Supply (V/ph/Hz)	600/3/60	600/3/60
Manufacturer	See Division 16	See Division 16
Model No.	See Division 16	See Division 16

Tag	T600-SF-VFD	T600-EF-VFD
Service	T600 MUA SF	T600 MUA EF
Driven Motor kW (Hp)	7.5 (10.0)	5.6 (7.5)
Power Supply (V/ph/Hz)	600/3/60	600/3/60
Manufacturer	See Division 16	See Division 16
Model No.	See Division 16	See Division 16

Tag	T605-SF-VFD	T605-EF-VFD
Service	T605 MUA SF	T605 MUA EF
Driven Motor kW (Hp)	5.6 (7.5)	3.7 (5.0)
Power Supply (V/ph/Hz)	600/3/60	600/3/60
Manufacturer	See Division 16	See Division 16
Model No.	See Division 16	See Division 16

1.12 Tank Schedule

Tag	T690-PT
Service	Pressure Tank
Location	DAF Mech. Rm
Type	Diaphragm
Acceptance Volume, litres (USgal)	43.3 (11.4)
Tank Volume	76 (20.0)
Diameter mm (inch)	390 (15.4)
Height mm (inch)	803 (31.6)
Manufacturer	AMTROL
Model	WX-202P

Tag	S776-GFT	T660-GFT
Service	Glycol fill	Glycol fill
Location	Clarifier 3 Mech. Rm	DAF Mech. Rm
Type	Package	Package
Storage Volume, Litres (USgal)	180 (48)	180 (48)
Tank Volume, Litres (USgal)	48 (180)	48 (180)
Electrical Supply	120/1/60	120/1/60
Electrical Load, amps	0.7	0.7
Diameter mm (inch)	610 (24)	610 (24)
Height mm (inch)	1245 (49)	1245 (49)
Manufacturer	Axiom	Axiom
Model	SF100	SF100

Tag	S750- ET	T675- ET
Service	Hydronic System	Hydronic System
Location	Area S Mech. Room	DAF Mech. Room
Type	Diaphragm	Diaphragm
Tank Volume, Litres (USgal)	797.7(211)	168.5(44.5)
Max. Accept. Volume, Litres (USgal)	318.0(84)	85.6(22.6)
Electrical Supply	N/A	N/A
Maximum Working Pressure (psi/kPa)	125 psig	125 psig
Manufacturer	Amtrol	Amtrol
Model	AX-280	AX-80
Accessories & Remarks	Horizontal	Horizontal

1.12 Tank Schedule (cont'd)

Tag	HWT-1	T-1
Service	DHW Generation	DHW storage
Location	Headworks Mech. Rm.	Headworks Mech. Rm.
Type	Electric	Storage
Storage Volume, litres (USgal)	454 (120)	435 (115)
Total Input kW	12	
Number of Elements	3	
Electrical Supply	600/3/60	
FLA	12	
Recovery @ 78°C(140°F) *LPH (GPH)*	134 (35)	
Inlet Connection Size mm (inch)	30 (1.5)	50 (2)
Outlet Connection Size mm (inch)	30 (1.5)	50 (2)
Diameter mm (inch)	768 (30.25)	718 (28.25)
Height mm (inch)	1718 (67.63)	1505 (59.25)
Empty Weight kg (lbs)	185 (430)	154 (340)
Manufacturer	Rheem	Rheem
Model	EG120	ST120(A)

1.13 Gravity Hood Schedule

Tag	GRH-1	GRH-2	GRH-3
Service	Exhaust (Electrical Room)	Exhaust (UV Process)	Exhaust (DAF Thickener)
Volume - l/s (cfm)	6130 (13000)	2590 (5500)	565 (1200)
Static Press - Pa (inch wg)	82 (0.33)	67 (0.27)	35 (0.14)
Throat Size - mm (inch)	750x1500 (30x60)	600x900 (24x36)	400 x 400 (16 x 16)
Throat Area - m^2 (ft^2)	1.16 (12.50)	0.56 (6.00)	0.17 (1.78)
Curb Cap - mm (inch)	950x1700 (38x68)	800x1100 (32x44)	600x600 (24x24)
Hood Dimensions			
Width - mm (inch)	1250 (50)	900 (36)	650 (26)
Length - mm (inch)	1800 (72)	1200 (48)	900 (36)
Height - mm (inch)	475 (19)	475 (19)	400 (16)
Manufacturer	Greenheck	Greenheck	Greenbeck
Model No.	Fabra Hood	Fabra Hood	Fabra Hood
Options	1, 2, 3, 4	1, 2, 3, 4	1, 2, 3, 4

Tag	GRH-4	GIH-1
Service	Exhaust (Electrical Room)	Intake (Fermenter Gallery)
Volume – 1/s (cfm)	285 (600)	2497 (5290)
Static Press – Pa (inch wg)	30 (0.12)	35 (0.14)
Throat Size – mm (inch)	300x300 (12x12)	450x1650 (18x66)
Throat Area - m^2 (ft^2)	0.093 (1.0)	0.77 (8.25)
Curb Cap – mm (inch)	500x500 (20x20)	650x1850 (26x74)
Hood Dimensions		
Width - mm (inch)	550 (22)	1050 (42)
Length - mm (inch)	600 (24)	2100 (84)
Height - mm (inch)	350 (14)	400 (16)
Manufacturer	Greenheck	Greenheck
Model No.	Fabra Hood	Fabra Hood
Options	1, 2, 3, 4	2, 3, 4

Finishes:
1. Back draft dampers
2. Roof curb
3. Aluminum insect screen
4. Fibreglass hood insulation

1.14 Condensing Unit Schedule

Tag	**T630-CU**	**S790-CU**
Unit Served	T610-AHU	S780-AHU
Location	DAF Building Roof	See drawings
Manufacturer	Aaon	Aaon
Model	CA 01-03	CA 01-02
No. of Cond. Fans	1	1
Fan & Motor – *RPM*	1050 / 875	1050 / 875
No. of Compressors	1	1
Compressor Type	Scroll	Scroll
Capacity – *kW (MBH)*	10.6 (36.1)	7.9 (27.0)
Efficiency – *EER (COP)*	3.9 (13.5)	3.5 (11.9)
Refrigerant Type	R407	R407
Power Supply	208/3/60	208/3/60
Elec. Loads – *FLA/MCA/MOP*	13.2/15.6/25	11.4/13.4/20
Depth – *mm (inch)*	511 (20.13)	511 (20.13)
Width – *mm (inch)*	1273 (50.13)	1273 (50.13)
Height – *mm (inch)*	826 (32.5)	826 (32.5)
Weight - *kg (lbs)*	93 (205)	93 (205)

1.15 Coil Schedule

Tag	CC-1	CC-2
Duty	Cooling	Cooling
Location	S/A Duct of T610-AHU	S/A Duct of S780-AHU
Dimension H x W *mm x mm (inch x inch)*	457x610 (18x24)	
Rows/FPI	3	
Air Data		
Flow *L/S (cfm)*	566 (1200)	
EAT db/wb *℃/℃ (℉/℉)*	30.6/22.2 (87.0/72.0)	
LAT db/wb *℃/℃ (℉/℉)*	20.9/18.0 (69.6/64.4)	
PD *Pa. (in. wg)*	47.3 (0.19)	
Capacity *kW (MBH)*	9.6 (32.86)	
Fluid	R407	R407
Weight *kg (lbs)*	61.4 (135)	
Notes	Connected to T630-CU	Connected to S790-CU

1.16 Emergency Eyewash/Shower Schedule

Tag	T710-EWS
Location	DAF Building
Service	DAF Building
Type	Combination emergency eyewash and shower unit.
Manufacturer	Haws
Model No.	8300CRP
Thermostatic Mixing Valve	Haws TWBS.SH

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DIVISION 16

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 Equipment: 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 Comply with all rules of the Canadian Electrical Code, CSA Standard C22.1 and the applicable building codes. Do underground cable systems in accordance with CAN/CSA-C22.3 No.7 except where specified otherwise.

.3 Quality of Work specified and/or shown on the Drawings shall not be reduced by the foregoing requirements.

.4 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.

.5 Give all required notices, submit Drawings, obtain all permits, licences, and certificates, and pay all fees required for this Work.

.6 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 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 Shop Drawings shall 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.

.6 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.

.7 Manufacture of products shall conform to revised Shop Drawings.

.8 Keep one complete set of Shop Drawings at jobsite during construction.

1.6 As-Constructed Drawings

.1 The Contractor shall keep one complete set of white prints at the Site office, including all addenda, change orders, field instructions, clarifications, and revisions for the purpose of As-Constructed Drawings. As the Work on-site proceeds, the Contractor shall clearly record in red pencil all As-Constructed conditions which deviate from the original Contract Documents. As-Constructed 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-Constructed information, including: addenda, change orders, clarifications, revisions, Site instructions and Shop Drawings. Upon completion, the Contractor shall certify, in writing, that the As-Constructed 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 weeks prior to final inspection, submit As-Constructed Drawings to Contract Administrator for review.

.4 Within one month after return of As-Constructed Drawings by the Contract Administrator, obtain and pay for a complete set of original reproducible sepias. Transfer all changes from As-Constructed 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 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 16820

.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 Administrator, 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 Guarantee

.1 Furnish a written guarantee to the City prior to final Contract payment, which will be in effect for one 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.

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 Work.

.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, ULC 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 ANSI 61 grey enamel unless otherwise specified.

.2 Apply primer on all items, which are to be finished on-site.

.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, 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 3000 mm 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:

.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 Terminal cabinets and pull boxes (system, voltage)

.6 Transformers (designation, capacity, primary and secondary voltage)

.2 Nameplate sizes

.1 Size 1: 10 x 50 mm, one line, 3 mm high letters

.2 Size 2: 12 x 70 mm, one line, 5 mm high letters

.3 Size 3: 12 x 70 mm, two lines, 3 mm high letters

.4 Size 4: 20 x 90 mm, one line, 8 mm high letters

.5 Size 5: 20 x 90 mm, two lines, 5 mm high letters

.6 Size 6: 25 x 100 mm, one line, 12 mm high letters

.7 Size 7: 25 x 100 mm, two lines, 6 mm high letters

.3 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 as follows:

.1 High voltage systems: major band – Red; minor band – Purple

.2 347/600 V normal systems: major band – Dark Blue; minor band – N/A

.3 120/208 V normal systems: major band – Light Blue; minor band – N/A

.4 UPS systems: major band – Light Blue; minor band – White

.5 Fire alarm systems: major band – Red; minor band – N/A

.6 Communications circuit systems: major band – Black; minor band – Yellow

.4 Provide neatly typed circuit directories in panelboards to indicate the area or equipment controlled by each branch circuit.

.5 All conductors shall be identifiable by coloured insulation and permanent markers at every terminal and accessible points throughout its entire run.

.1 Equipment grounding: Green

.2 Neutral conductor: White

.3 347/600 V systems:

.1 Phase A: orange

.2 Phase B: brown

.3 Phase C: yellow

.4 120/208 V systems:

.1 Phase A: red

.2 Phase B: black

.3 Phase C: blue

3.5 Wiring to Equipment Supplied by Other Divisions

.1 Make all required electrical connections to the equipment supplied by other Divisions.

3.6 Testing

.1 Refer to Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

3.7 Single Line Diagram

.1 Provide and mount a new framed As-Constructed single line diagram to be located adjacent to the main electrical equipment to replace the existing single line diagram. Use a clear plexiglass cover. The diagram shall be 914 mm x 600 mm minimum.

3.8 Instructions to City's Personnel

.1 Refer to Section 16990 - Electrical Equipment and Systems Demonstration and Instruction.

3.9 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 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.

3.10 Mounting Heights

.1 Unless a conflict exists, use the following as mounting heights from finished floors to centre of device.

.1 Thermostats: 1400 mm

.2 Panelboards, starters and disconnects (to top of cover): 2000 mm

.3 End-of-line resistors: 1800 mm

.4 Receptacles: 1400 mm

.5 Light switches: 1400 mm

.6 Fire Alarm Pull Station: 1400 mm

.7 Fire Alarm Bells: 2100 mm

.8 Telephone: 1400 mm

.9 Wall Mounted Speakers: 2100 mm

3.11 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.

3.12 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 30 days after the award of Contract.

3.13 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 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 Precisely locate and position sleeves prior to construction of walls and floors.

.5 Failure to comply with the above requirements shall be remedied at the Contractor's expense.

3.14 Temporary Lighting and Power

.1 Provide grounded extension cords and temporary lights as required for the Work.

.2 Coordinate with 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 Provide adequate notice to Contractor of any power outage required for this Work. Schedule outages to provide least interference with other Work.

3.15 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.

3.16 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 installation 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.

1.2 Related Work

.1 The administrative sections under Parts A, B, C, D and Division 1 shall be considered shall be part of these Specifications.

1.3 General Requirements

.1 General clean-up

.2 All inspections and obtaining all permits and licenses required by various inspection agencies and local regulations related to electrical trade.

.3 Scaffolding

.4 Shop Drawings

.5 As-Constructed Drawings where specified

.6 Operating and maintenance data, where specified

1.4 Specific Requirements Included but Not Limited to Scope of Work

.1 Area T: DAF Thickeners

.1 Provide new Motor Control Centres 1T and 2T to be located in the mezzanine of the DAF Thickeners Area. MCC shall be fed from new breakers in MCCs 1H and 2H located in the Head Works Electrical Room. Refer to Drawings for cable installation and size.

.2 Provide single power connections to DAF Controllers (2 units) fed from MCCs 1T and 2T. Refer to Motor Control Schedule for cable sizing and drawing for cable routing.

.3 Provide single power connection to Primary Clarifier Polymer Systems 1 and 2 fed from MCCs 1T and 2T. Refer to Motor Control Schedule for cable sizing and drawing for cable routing.

.4 Provide power supplies for all process (Section 11) and mechanical (Section 15) from MCCs 1T and 2T as indicated on the Motor Control Schedule. Provide wire routing and starters as indicated.

.5 Provide two Surge Protection Devises (TVSS) for MCCs 1T and 2T (one per MCC).

.6 Provide 600 V panel in DAF Electrical Room for lighting and specific related equipment.

.7 Provide 600 V-120/208 V dry type transformer in DAF Electrical Room to provide power supply to 120/208 V panel.

.8 Provide 120/208 V Panel board in DAF Thickener Electrical Room for general power and controls

.9 Provide all lighting and controls in the DAF Thickener Area and service areas of this section. Refer to electrical Drawing for location and mounting arrangements.

.10 Provide power outlets as indicated on Electrical Drawings.

.11 Provide installation and connect VFDs being supplied by Division 11 and 15.

.12 Provide 2- 30A-600Vwelding receptacle, to match existing, in this area as indicated on the Drawings.

.2 Area H: Headworks

.1 Provide modifications to existing MCCs 1H, 1HA, and 2H as indicated on the Drawings. Relocate MCC 1HA, and associated electrical loads, as indicated on the Drawings. Extend cable from existing shunt trip breaker in MCC 1A to new location for MCC 1HA.

.2 Provide new molded case switches to replace the main lug connections in existing MCC 1H and 2H. Provide molded case switches with a minimum rating of 400 A, 600 V.

.3 Provide new molded case tie switch, located in MCC 1H, and connect from MCC 1H to MCC 2H. Provide molded case tie switch with a minimum of 400 A, 600 V. Provide key interlocks for the main switches and the tie switch so only two devices can be closed at any one time.

.4 Provide for disconnecting exiting equipment motors as indicated on the Process Drawings and the Electrical Drawings. Remove exiting power cables for motors that are increasing in size. Provide new cables as indicated for motors replaces as required. Remove existing starters and replace with starters suitable for new motor requirements as indicated on the Drawings.

.5 Provide installation and connects for VFDs being supplied by Division 11 and 15 for new and existing upgraded motor as indicated on the Drawings.

.6 Provide two Surge Protection Devises (TVSS) for MCCs 1H and 2H (one per MCC).

.3 Area P: Primary Clarifiers

.1 Modify the existing MCCs 1H, and 2H as indicated on the Drawings for motor starters and breakers. These motors are located in the Primary Clarifiers Area.

.2 Disconnect exiting equipment motors as indicated on the Process Drawings and the Electrical Drawings. Remove exiting power cables for motors that are increasing in size. Provide new cables as indicated for motors replaces as required. Remove existing

starters and replace with starters suitable for new motor requirements as indicated on the Drawings

.3 Provide installation and connects for VFDs being supplied by Division 11 and 15 for new and existing upgraded motor as indicated on the Drawings. The VFDs for these loads will be installed in CSA 4 ventilated enclosure supplied with the VFD. The VFDs for these loads will be installed in CSA 4 ventilated enclosure supplied with the VFDs to be provide by Div. 11 and Div. 15.

.4 Disconnect existing control equipment for existing pumps SP-310 and SP-320. Extend control cable to new location and reconnect all devices. Refer to Process and Electrical Drawings for location and details.

.4 Area F: Primary Sludge Fermenters

.1 Provide wiring and connection for Process (Division 11) and Mechanical (Division 15) motors. Motors shall be connected to MCCs 1H and 2H located in the Head Works Electrical Room.

.2 Provide install and connection for VFDs for the motors located in this area as indicated on the Drawings. The VFDs for these loads will be install in CSA 4 ventilated enclosure supplied with the VFDs to be provide by Div. 11 and Div. 15.

.3 Provide lighting, lighting control switches and general power outlets in the pump gallery and on the walkway around the top of the fermenter tanks as indicated on the Drawings.

.4 Provide 1-30A-600V welding outlet, to match existing, in the Fermenter pump room as indicated on the Drawings.

.5 Area S: Bioreactors

.1 Provide new MCCs 1SB and 2SB in new Electrical Room adjacent to existing Mixed Liquor Testing Penthouse. Provide two new feeders for these MCCs from existing spare breakers (2) in the Main Electrical Room. Refer to Drawings for cable routing. Provide additional 10 metres of cables (two) in room below existing Main Electrical Distribution Room.

.2 Provide new trip plugs, set for 400A, for the two spare existing breakers, Feeding MCC 1SB and 2SB installed in the existing Main Distribution gear located in the existing Electrical Room.

.3 Provide Main molded case switches for MCC 1SB and MCC 2SB for incoming cables. Provide a molded case tie switch to interlock MCC 1SB and 2SB. Provide key interlocks for the main switches and the tie switch so only two devices can be closed at any one time.

.4 Provide two Surge Protection Devises (TVSS) for MCCs 1SB and 2SB (one per MCC).

.5 Provide lighting, lighting controls and general power for New electrical room.

.6 Provide wiring and connections for Process (Div. 11) and Mechanical (Div. 15) motors. Motors will be connected to MCCs 1SB and 2SB located in the new Electrical Room adjacent to the Mixed Liquor Testing Penthouse. Install VFDs for the motors located in this area as indicated on the Drawings that are to be supplied by Div. 11 and Div.15. The VFDs, not installed in the electrical room, for these loads will be install in CSA 4 ventilated enclosure supplied with the VFDs to be provided by Div. 11 and Div. 15.

.7 Provide enclosed cable tray from the new electrical room to the bioreactor tanks roof to provide feeder cables for mixer pumps. Refer to Drawings for location.

.8 Provide a WP disconnect on the roof of the Bioreactor tank at each hatch for the mixer pumps access. Disconnect shall be mounted on self-supporting backboard. Wiring for each mixer pump shall be shall be terminate in the disconnect switch. Pump cable (supplied with pump) shall be feed up from the mixer pump, through the tank roof and terminate on the load side of the disconnect switch via a cored hole with a weather tight acid proof seal (Roxtec RS seal ES) sized to suite cable.

.9 Provide installation and connections for VFDs for Nitrified Recycle Pump (2) in the walkway adjacent to the Bioreactor Tanks and indicated on the Drawings. Cable to these VFD,s shall be installed, from MCC 1SB and 2SB, via cable tray from the new electrical room. Roof of walkway shall be cored and a weather tight acid proof seal shall be installed to allow cable from VFDs to exit the walkway and be terminated on the line side of the WP disconnect for these motors. Cable from load side of disconnect to the pump in the tank will be supplied with the pump. Cable entree to the tank will be similar to the mixer pump installation.

.10 Provide installation and connections for VFDs for WAS Pumps (2) located in the walkway adjacent to the Bioreactor Tanks. Provide cables from load side of VFD to motor and connect.

.6 Area S: Secondary Clarifiers

.1 Provide modifications for existing Motor Control Centres 1S and 2S. Provide one additional cell for MCC 1S and MCC 2S. Remove main lugs from each MCC and replace with main molded case 400 A switches. Provide a molded case tie switch in MCC 1S and connect tie switch so that one feeder may carry the full load or both MCC units. Provide key interlocks on the two main switches and the tie switch to allow only two devices can be closed at any one time.

.2 Three RAS pumps are to be removed (Div. 11) and replaced with new pumps. Existing VFDs located in the Secondary Clarifier Electrical Room shall be reused for new RAS pumps including the cables to the pump motors. Disconnection and reconnection will be provided under Div.16.

.3 Provide wiring and connection for Process (Division 11) and Mechanical (Division 15) motors. Motors will be connected to MCCs 1S and 2S located in the Secondary Clarifier Electrical Room. Install VFDs for the motors located in this area as indicated on the Drawings. The VFDs for these loads will be located in Electrical room.

.4 Provide two Surge Protection Devises (TVSS) for MCCs 1S and 2S (one per MCC).

1.5 Modifications Required for Existing Equipment

.1 Provide modifications to upgrade MCC 1H, MCC 1HA and MCC 2H located in the Head Works Electrical Room as indicated on the Drawings and hereafter specified.

.2 Provide modifications to upgrade MCC 1S and MCC 2S Located in the Secondary Clarifier Electrical Room as indicated on the Drawings and hereafter specified.

.3 Provide modifications to existing process pumps as indicated on the Process and Electrical Drawings indicating pump motors being upgraded. Modify power cables as indicated on the Drawings.

.4 Provide modifications to existing panel boards as indicated on the Drawings. These modifications are mainly related to lighting and general power circuits in upgraded areas.

.5 Provide Surge Protection Devices (TVSS) units to the Existing Main Distribution located in the Main Electrical Room. Provide two TVSS units to be installed on each of the incoming buss for this distribution.

.6 Provide Surge Protection Devices (TVSS) for each of the main buss for existing Motor Control Centres 1H, 2H, 1S and 2S. TVSS units are to be installed as close as possible to the main bus.

1.6 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.

1.7 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 other Divisions, 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 in Division 15.

.9 Electronic data processing and transmission systems, including auxiliary equipment, interface and components.

1.8 Work Excluded

.1 Special starters, including multi-speed switches, which are associated with packaged units not detailed in Division 16.

.2 VFDs for Division 11 equipment

.3 VFDs for Division 15 equipment

.4 Perforations through roofing materials for electrical servicing or attachments (Division 7)

.5 Field painting, except touch-up of electrical equipment (Division 9)

.6 Ducted fans (Division 15)

.7 Ducted heaters (Division 15)

.8 Pneumatic tube systems (Division 15)

.9 Control transformers supplied in Division 15

.10 All control wiring between equipment supplied by Division 15 HVAC system will be performed by Division 17.

1.9 Units of Measure

.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.

1.10 Conversions

.1 The following conversion methods were used in product and location dimensions:

.1 Hard conversion: industry available products that are manufactured in metric measurements

.2 Soft conversion: products that are still manufactured in imperial units and are converted in specifications using arithmetic conversion factors

.3 Rationalized conversion: dimensions that 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.

1.11 Definitions

.1 All terminologies, abbreviations, and acronyms used in this document are as listed in the various standards, codes, rules, and bulletins used herein.

1.12 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.

1.13 Codes

.1 All codes, standards, rules, regulations, bulletins, by-laws etc., shall be those that are currently enforced in the locality of jobsite, unless otherwise specified herein.

2. PRODUCTS

.1 Not used

3. EXECUTION

.1 Not used

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 luminaires

.2 Provide a separate insulated ground wire in all flexible conduits.

3.3 Liquid-Tight Flexible Conduit

.1 Use as raceways 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 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 the Canadian Electrical Code.

.7 For all runs of conduits, do not include more than equivalent of four 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 conduit 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 conduit shown exposed in finished areas is to be free of unnecessary labels and trade marks.

.13 Install a 0.40 kN (90 lb) test line in all conduits left empty by the 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

CABLETROUGHS

1. GENERAL

1.1 Description

.1 Provide a complete system of cable trays as shown on the Drawings.

.2 Coordinate the location of the support channels so as not to interfere with other services.

1.2 Related Work

.1 Wire and Cables 0 - 1000V: Section 16122

.2 Fastenings and Supports: Section 16191

1.3 Shop Drawings and Product Data

.1 Submit Shop Drawings and product data in accordance with Section 16010 - Electrical General Requirements.

.2 Indicate various types of cabletroughs with terminology used in Part 2.

2. PRODUCTS

2.1 Cabletrough

.1 Cabletroughs and fittings: to EEMAC F5-1

.2 Ventilated type, Class C1 to CSA C22.2 No.126

.3 Ladder tray, 150 mm rung space, class C1 to CSA C22.2 No. 126

.4 Galvanized steel tray 150, 300, 450 or 600 mm wide as required with depth of 75 mm

.5 Horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints, reducers and other fittings where required. Radii on fittings: 600 mm minimum.

.6 Barriers where different voltage systems or electrical systems are in the same cabletrough, or as indicated.

.7 Approved materials: Pilgrim, Enduro, Canstrut, Pursley, Newton Instrument Co., or approved equal.

2.2 Supports

.1 Provide hardened steel (HS) rod hangers, rod hanger clamps, and accessories as required.

.2 Provide U-channel support structures for cabletroughs supported from floor.

.3 Approved materials: same as cabletrough.

3. EXECUTION

3.1 Installation

.1 Install complete cabletrough system. Provide concrete curbs around openings passing through floors.

.2 Support cabletrough on both sides at 1500 mm, on centre, spacing.

.3 Provide additional support system for cabletroughs as may be deemed necessary to provide a secure system.

.4 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.

.5 Fire stop all penetrations of fire barriers.

.6 Install bare ground cable in all new trough system and bond to trough as required by the Canadian Electrical Code.

3.2 Cables in Cabletrough

.1 Install cables individually.

.2 Lay cables into cabletrough. Use rollers when necessary to pull cables.

.3 Secure cables in cabletrough at 5 m centers, with nylon ties.

.4 Identify cables every 30 m with nameplates in accordance with Section 16010 - Electrical General Requirements.

.5 Mark power and communication runs in accordance with colour coding outlined in Section 16010 - Electrical General Requirements.

END OF SECTION

CABLETROUGHS

RACEWAY SCHEDULE					
RACEWAY MUMBER	RACEWAY SIZE	RACEWAY TYPE	CABLE NUMBERS	RACEWAY REFERENCE DRAWINGS	REMARKS
CABLE TRAY					
CT001	300mm	Aluminum CSA C1 - 75mmDeep Aluminum Cover	SB005, SB006, SB007	SE1.02, SE1.03	
CT002	450mm	Aluminum CSA C1 - 75mmDeep Aluminum Cover	SB008	SE1.02, SE1.03	
CT003	300mm	Aluminum CSA C1 - 75mmDeep Aluminum Cover	SB001, SB002, SB003, SB004	SE1.02, SE1.03	
CT004	450mm	Aluminum CSA C1 - 75mmDeep Aluminum Cover	SB001, SB002, SB003,SB004,SB005, SB008	SE1.02, SE1.03	
CT005	450mm	Aluminum CSA C1 - 75mmDeep Aluminum Cover	SB004	SE1.02, SE1.03	
CT006	450mm	Aluminum CSA C1 - 75mmDeep	SB009,SB010, SB011, SB012,	SE1.01	
CT007	450mm	Aluminum CSA C1 - 75mmDeep	S007,S008, S009, S010,	SE3.3, SE4.1	
CT008	600mm	Aluminum CSA C1 - 75mmDeep	H005, H006, H007,H008, H009, H010,H011,H01	FE1.02	
CT009	300mm	Aluminum CSA C1 - 75mmDeep	H016, H017	LE1.02, TE1.03	

Notes
1. All Cable Tray to be rigidly supported from wall, roof structure or floor to suit the specific application.

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 shall 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 ename

.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 Canadian Electrical Code 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 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 (1) hole malleable iron straps to secure surface cables 50 mm and smaller. Two (2) 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°C 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°C insulation, rated at 600 VAC, 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 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°C (dry) and 600 V. Conductor size shall be minimum #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 #12 AWG except for luminaire drops which can be #14 AWG if fed from 15 A 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 #12 AWG, except where specifically indicated otherwise, i.e., for fire alarm system station circuits, public address system 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 any problems are 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 As-Constructed branch circuiting shown as required for optimum balancing. Record all changes on "As-Constructed 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 #471 plastic film tape 48 mm wide.

.4 Conductors sized #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

WIRES AND CABLES -- 0 - 1000 V

POWER CABLE SCHEDULE

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
S001	3/C 250 MCM Plus Ground	Existing Cable Tray	Main Electrical Room	Bioreactor Electrical Rm. MCC 1SB	Teck 90	Provide spacers in tray
S002	3/C 250 MCM Plus Ground	Existing Cable Tray	Main Electrical Room	Bioreactor Electrical Rm. MCC 2SB	Teck 90	Provide spacers in tray
SB001	3/C #12 Plus Ground	Tray CT003,CT004	MCC 1SB	Bio. Mixer S760-MXR	Teck 90	
SB002	3/C #12 Plus Ground	Tray CT003,CT004	MCC 1SB	Bio. Mixer S761-MXR	Teck 90	
SB003	3/C #12 Plus Ground	Tray CT003,CT004	MCC 1SB	Bio. Mixer S762-MXR	Teck 90	
SB004	3/C #12 Plus Ground	Tray CT003,CT004,CT005	MCC 1SB	Bio. Mixer S763-MXR	Teck 90	
SB005	3/C #12 Plus Ground	Tray CT001,CT002,CT004	MCC 2SB	Bio. Mixer S765-MXR	Teck 90	
SB006	3/C #12 Plus Ground	Tray CT001,CT002,CT004	MCC 2SB	Bio. Mixer S766-MXR	Teck 90	
SB007	3/C #12 Plus Ground	Tray CT001,CT002,CT004	MCC 2SB	Bio. Mixer S767-MXR	Teck 90	
SB008	3/C #12 Plus Ground	Tray CT002,CT004	MCC 2SB	Bio. Mixer S768-MXR	Teck 90	
SB009	3/C #8 Plus 100% Ground	Tray CT006	MCC 1SB	VFD S770-P	Teck 90	
SB009A	3/C #8 Plus 100% Ground	Wall support, through Roof	VFD S770-P	Recycle Pump A770-P	Teck 90	
SB010	3/C #8 Plus 100% Ground	Tray CT006	MCC 2SB	VFD S771-P	Teck 90	
SB010A	3/C #8 Plus 100% Ground	Wall support, through Roof	VFD S771-P	Recycle Pump A771-P	Teck 90	
SB011	3/C #10 Plus 100% Ground	Tray CT006	MCC 1SB	VFD S810-WAP	Teck 90	
SB011A	3/C #10 Plus 100% Ground	Wall Support	VFD S810-WAP	WAS Pump S810 WAP	Teck 90	
SB012	3/C #10 Plus 100% Ground	Tray CT006	MCC 2SB	VFD S820-WAP	Teck 90	
SB012A	3/C #10 Plus 100% Ground	Wall Support	VFD S820-WAP	WAS Pump S820 WAP	Teck 90	
SB013	3/C #10 Plus 100% Ground	Existing Tray to Bio. Elec. Rm.	MCC 1SB	VFD S638-EF	Teck 90	Provide spacers in tray
SB013A	3/C #10 Plus 100% Ground	Wall Support	VFD S638-EF	Exhaust Fan S638-EF	Teck 90	
SB014	3/C #10 Plus 100% Ground	Existing Tray to Bio. Elec. Rm.	MCC 2SB	VFD S639-EF	Teck 90	Provide spacers in tray
SB014A	3/C #10 Plus 100% Ground	Wall Support	VFD S639-EF	Exhaust Fan S639-EF	Teck 90	
SB015	3/C #12 Plus Ground	Ceiling and Wall support	MCC 2SB	Air Handling Unit S780-AHU	Teck 90	
S003	3/C #12 Plus Ground	Supported from walk way	MCC 1S	Secondary Clarifier #3 S530-CM	Teck HL 90	
S004	3/C #4 Plus 100% Gound	Wall support to MCC	MCC 1S	RAS VFD S740 RAP	Teck HL 90	Provide spacers in tray
S004A	3/C #4 Plus 100% Gound	Exisitng cable tray	RAS VFD S740 RAP	RAS Motor S740 RAP	Teck HL 90	
S005	3/C #4 Plus 100% Gound	Wall support to MCC	MCC 2S	RAS VFD S750 RAP	Teck HL 90	Provide spacers in tray
S005A	3/C #4 Plus 100% Gound	Existing cable tray	RAS VFD S750 RAP	RAS Motor S750 RAP	Teck HL 90	
S006	3/C #1 Plus 100% Ground	Existing Cable Tray	MCC 2S	Flushing Water Pump S230 FWP	Teck HL 90	Provide spacers in tray
S007	3/C #8 Plus 100% Ground	Tray CT007	MCC 1S	VFD S750-MUA-SF	Teck 90	
S007A	3/C #8 Plus 100% Ground	Ceiling and Wall support	VFD S750-MUA-SF	S750 MUA SF Motor	Teck 90	
S008	3/C #8 Plus 100% Ground	Tray CT007	MCC 1S	VFD S750-MUA-EF	Teck 90	
S008A	3/C #8 Plus 100% Gound	Ceiling and Wall support	VFD S750-MUA-EF	S750 MUA EF Motor	Teck 90	
S009	3/C #12 Plus Ground	Tray CT007	MCC 1S	S770 GP	Teck 90	
S010	3/C #12 Plus Ground	Tray CT007	MCC 2S	S775 GP	Teck 90	
H001	3/C #8 Plus 100% Gound	Ceiling Support	MCC 1H	VFD P250-SLP	Teck HL 90	
H001A	3/C #8 Plus 100% Gound	Existing Cable Tray	VFD P250-SLP	Prim. Sludge Pump P250-SLP	Teck HL 90	Provide spacers in tray
H002	3/C #8 Plus 100% Gound	Ceiling Support	MCC 2H	VFD P260-SLP	Teck HL 90	
H002A	3/C #8 Plus 100% Gound	Existing Cable Tray	VFD P260-SLP	Prim. Sludge Pump P260-SLP	Teck HL 90	Provide spacers in tray
H003	3/C #12 Plus Ground	Supported to rail, down stair to Tray C	MCC 1H	Ferm. Sludge Pump F550-FM	Teck HL 90	
H004	3/C #12 Plus Ground	Supported to rail, down stair to Tray C	MCC 2H	Ferm. Sludge Pump F560-FM	Teck HL 90	
H005	3/C #10 Plus 100% Ground	Tray CT008	MCC 1H	VFD F551-P	Teck HL 90	
H005A	3/C #10 Plus 100% Ground	Ceiling Support	VFD F551-P	Ferm. Sludge Pump F551-P	Teck HL 90	
H006	3/C #10 Plus 100% Ground	Tray CT008	MCC 2H	VFD F552-P	Teck HL 90	
H006A	3/C #10 Plus 100% Ground	Ceiling Support	VFD F552-P	Ferm. Sludge Pump F552-P	Teck HL 90	
H007	3/C #12 Plus 100% Ground	Tray CT008	MCC 1H	VFD F556-P	Teck HL 90	
H007A	3/C #12 Plus 100% Ground	Ceiling Support	VFD F556-P	Ferm. Super. Pump F556-P	Teck HL 90	
H008	3/C #12 Plus 100% Ground	Tray CT008	MCC 2H	VFD F557-P	Teck HL 90	
H008A	3/C #12 Plus 100% Ground	Ceiling Support	VFD F557-P	Ferm. Super. Pump F557-P	Teck HL 90	
H009	3/C #12 Plus 100% Ground	Tray CT008	MCC 2H	VFD F558-P	Teck HL 90	
H009A	3/C #12 Plus 100% Ground	Ceiling Support	VFD F558-P	Ferm. Super. Pump F558-P	Teck HL 90	

WIRES AND CABLES -- 0 - 1000 V

POWER CABLE SCHEDULE

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
H010	3/C #12 Plus 100% Ground	Tray CT008	MCC 1H	VFD F650-EF	Teck HL 90	
H010A	3/C #12 Plus 100% Ground	Ceiling Support	VFD F650-EF	Ferm. Exhaust Fan F650-EF	Teck HL 90	
H011	3/C #12 Plus 100% Ground	Tray CT008	MCC 2H	VFD F660-EF	Teck HL 90	
H011A	3/C #12 Plus 100% Ground	Ceiling Support	VFD F660-EF	Ferm. T.P. Cont. Fan F660-EF	Teck HL 90	
H012	3/C #10 Plus 100% Ground	Tray CT008	MCC 2H	VFD F600-SF	Teck HL 90	
H012A	3/C #10 Plus 100% Ground	Ceiling Support	VFD F600-SF	Make Up Air F600-SF	Teck HL 90	
H013	3/C #10 Plus 100% Ground	Tray CT008	MCC 2H	VFD F600-EF	Teck HL 90	
H013A	3/C #10 Plus 100% Ground	Ceiling Support	VFD F600-EF	Make Up Air F600-EF	Teck HL 90	
H014	3/C #12 Plus 100% Ground	Ceiling Support	MCC 2H	VFD H710-EF	Teck HL 90	
H014A	3/C #12 Plus 100% Ground	Ceiling Support & Existing Tray	VFD H710-EF	H.W./DAF Exhaust H710-EF	Teck HL 90	Provide spacers in tray
H015	3/C #10 Plus 100% Ground	Ceiling Support	MCC 2H	VFD H715-EF	Teck HL 90	
H015S	3/C #10 Plus 100% Ground	Ceiling Support & Existing Tray	VFD H715-EF	DAF Building Exhaust H715-EF	Teck HL 90	Provide spacers in tray
H016	3/C #4/0 Plus Ground	Tray CT009	MCC 1H Headworks El. Rm.	MCC 1T DAF El. Rm.	Teck HL 90	
H017	3/C #4/0 Plus Ground	Tray CT009	MCC 2H Headworks El. Rm	MCC 2T DAF El. Rm.	Teck HL 90	
T003	3/C #3 Plus Ground	Support structure to Control Panel	MCC 1T	DAF Control Panel T110	Teck HL 90	
T004	3/C #3 Plus Ground	Support structure to Control Panel	MCC 2T	DAF Control panel T120	Teck HL 90	
T005	3/C #10 Plus 100% Ground	Ceiling and Wall support	MCC 1T	VFD T125-SBP	Teck HL 90	
T005A	3/C #10 Plus 100% Ground	Support structure	VFD T125-SBP	DAF Supnatant Pump 1 T125-SBP	Teck HL 90	
T006	3/C #10 Plus 100% Ground	Ceiling and Wall support	MCC 2T	VFD T126-SBP	Teck HL 90	
T006A	3/C #10 Plus 100% Ground	Support structure	VFD T126-SBP	DAF Supnatant Pump 2 T126-SBP	Teck HL 90	
T007	3/C #12 Plus 100% Ground	Ceiling and Wall support	MCC 1T	VFD T131-POF	Teck HL 90	
T007A	3/C #12 Plus 100% Ground	Support structure	VFD T131-POF	DAF Poly Pump 1 T131-POF	Teck HL 90	
T008	3/C #12 Plus 100% Ground	Ceiling and Wall support	MCC 2T	VFD T132-POF	Teck HL 90	
T008A	3/C #12 Plus 100% Ground	Support structure	VFD T132-POF	DAF Poly Pump 2 T132-POF	Teck HL 90	
T009	3/C #12 Plus 100% Ground	Ceiling and Wall support	MCC 1T	VFD T136-POF	Teck HL 90	
T009A	3/C #12 Plus 100% Ground	Support structure	VFD T136-POF	CEPT DAF Poly Pump 1 T136-POF	Teck HL 90	
T010	3/C #12 Plus 100% Ground	Ceiling and Wall support	MCC 2T	VFD T137-POF	Teck HL 90	
T010A	3/C #12 Plus 100% Ground	Support structure	VFD T137-POF	CEPT DAF Poly Pump 2 T137-POF	Teck HL 90	
T011	3/C #12 Plus 100% Ground	Ceiling and Wall support	MCC 1T	VFD T141-MP	Teck HL 90	
T011A	3/C #12 Plus 100% Ground	Support structure	VFD T141-MP	FeC13 Pump 1 T141-MP	Teck HL 90	
T012	3/C #12 Plus 100% Ground	Ceiling and Wall support	MCC 2T	VFD T142-MP	Teck HL 90	
T012A	3/C #12 Plus 100% Ground	Support structure	VFD T142-MP	FeC13 Pump 2 T142-MP	Teck HL 90	
T013	3/C #12 Plus 100% Ground	Ceiling and Wall support	MCC 1T	VFD T143-MP	Teck HL 90	
T013A	3/C #12 Plus 100% Ground	Support structure	VFD T143-MP	FeC13 Pump 3 T143-MP	Teck HL 90	
T014	3/C #12 Plus 100% Ground	Ceiling and Wall support	MCC 2T	VFD T144-MP	Teck HL 90	
T014A	3/C #12 Plus 100% Ground	Support structure	VFD T144-MP	FeC13 Pump 4 T144-MP	Teck HL 90	
T015	3/C #10 Plus Ground	Support structure	MCC 1T	DAF Poly System 1	Teck HL 90	
T016	3/C #10 Plus Ground	Support structure	MCC 2T	CEPT Poly System 2	Teck HL 90	
T017	3/C #10 Plus 100% Ground	Ceiling and Wall support	MCC 1T	VFD T600-MUA-EF	Teck HL 90	
T017A	3/C #10 Plus 100% Ground	Support structure	VFD T600-MUA-EF	Make-Up Air Return T600-MUA-EF	Teck HL 90	
T018	3/C #10 Plus 100% Ground	Ceiling and Wall support	MCC 1T	VFD T600-MUA-SF	Teck HL 90	
T018A	3/C #10 Plus 100% Ground	Support structure	VFD T600-MUA-SF	Make-Up Air Supply T600-MUA-SF	Teck HL 90	
T019	3/C #10 Plus 100% Ground	Ceiling and Wall support	MCC 2T	VFD T605 MUA-EF	Teck HL 90	
T019A	3/C #10 Plus 100% Ground	Support structure	VFD T605 MUA-EF	Make-Up Air Return T605-MUA-EF	Teck HL 90	
T020	3/C #10 Plus 100% Ground	Ceiling and Wall support	MCC 2T	VFD T605 MUA-SF	Teck HL 90	
T020A	3/C #10 Plus 100% Ground	Support structure	VFD T605 MUA-SF	Make-Up Air Supply T605-MUA-SF	Teck HL 90	
T021	3/C #12 Plus Ground	Ceiling and Wall support	MCC 2T	Air Handling Unit T610-AUH	Teck HL 90	
T022	3/C #12 Plus Ground	Ceiling and Wall support	MCC 1T	Hot Water Unit Heater T615-UH	Teck HL 90	
T023	3/C #12 Plus Ground	Ceiling and Wall support	MCC 2T	Hot Water Unit Heater T620-UH	Teck HL 90	
T024	3/C #10 Plus Ground	Ceiling and Wall support	MCC 1T	Air Compressor T640-CA	Teck HL 90	
T025	3/C #12 Plus Ground	Ceiling and Wall support	MCC 1T	Glycol Feed Pump T665-GP	Teck HL 90	
T026	3/C #12 Plus Ground	Ceiling and Wall support	MCC 2T	Glycol Feed Pump T670-GP	Teck HL 90	

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 panelboards

.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 (3) 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-Canadian Electrical Code, 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, two coats corrosion resistant 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 Conduit Boxes

.1 Cast FS or FD Feraloy™ boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle

2.4 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 Canadian Electrical Code.

.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

.1 347 V, 15 A, single and double pole, 3 and 4-way: As Hubbell No. 18221, 18222, 18223 and 18224.

.2 120-277 V, 20 A, single and double pole, 3 and 4-way: As Hubbell No. 1221, 1222, 1223 and 1224

.3 For wet locations use the following switches: 20 A, 120 V single pole brown, side wired press-switch, as Hubbell No. 1281.

.4 Manually-operated, general-purpose AC switches shall have the following features:

.1 Terminal holes approved by AWG #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 moulded housing

.2 Suitable for #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 in the on the exterior of the building to be weatherproof construction.

.5 Welding outlets to be 30 A 600 V, Crouse-Hinds Cat. No. DBR56742. Contractor shall 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 1 mm stainless steel 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 door frame unless otherwise indicated on Drawings.

.4 Install receptacles vertically in gang type outlet box when more than one receptacle is required in 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 Canadian Electrical Code requirements or in accordance with 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 non-insulated ring type compression lugs for terminating #10 AWG and smaller motor connections. Tape with rubber and scotch tape. Lugs to accept ten 32 x 3/8 inch machine bolts.

.3 Terminate conductors #8 AWG and larger with Thomas & Betts Colour-Keyed compression connectors Series 54000 or on lugs provided with equipment.

.4 Thomas & Betts "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

CONNECTORS AND TERMINATIONS

1. GENERAL

1.1 Product Data

.1 Submit product data sheets in accordance with Section 16010 - Electrical General Requirements.

2. PRODUCTS

2.1 Connectors and Terminations

.1 Copper long barrel compression connectors as required and sized for conductors

.2 Contact aid for aluminum cables where applicable

3. EXECUTION

3.1 Installation

.1 Install stress cones, terminations, and splices in accordance with manufacturer's instructions.

.2 Bond and ground as required.

END OF SECTION

FASTENINGS AND SUPPORTS

1. GENERAL

1.1 Work Included

.1 Supply and installation of 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 manufacturers 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 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 Metal studs, ceiling hangers, etc.: "Caddy-Clips"

.5 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 1000 mm span and 8 mm over a 2000 mm 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 diameter 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

INTERLOCK SYSTEMS

1. GENERAL

1.1 Shop Drawings and Product Data

.1 Submit Shop Drawings in accordance with Section 16010 - Electrical General Requirements.

2. PRODUCTS

2.1 Interlock Systems

.1 Kirk key interlocks, Type F for load interrupter switch and Type D for switchgear cubicle door to prevent:

.1 Opening cubicle door for access to fuses while load interrupter is in closed position

.2 Closing load interrupter while cubicle door is open

.2 Key interlocks mounted in switchgear so that interlocks cannot be removed when operating switch or breaker is in closed position.

2.2 Manufacturer

.1 Kirk Interlocks

3. EXECUTION

.1 Install interlocks on switch or breakers cubicle for new and existing modified Motor Control Centres as indicated on the Drawings.

END OF SECTION

COORDINATION AND SHORT CIRCUIT STUDY

1. GENERAL

1.1 Description

.1 Provide a coordination/protective study and short circuit study of all equipment specified herein and submit for review.

.2 Include the following:

.1 15 kV cable thermal damage curves

.2 347/600 V and 120/208 V panelboards, and switchgear, connecting feeder cables and bus duct

.3 12.6 kV, and 600 V transformer damage curves, magnetizing currents for all transformers 150 kVA and larger

.4 Locked rotor currents, acceleration times and damage curves for motors 75 kW and larger

.5 Any additional data necessary for successful completion of the coordination and short circuit study.

.6 Study to be inclusive for existing distribution equipment Main WEWPCC Building and pole mounted switches and fuses (12.6 kV) at service.

.3 Data shall clearly state the operating time in cycles of each breaker and indicate whether the time current curves for relays are inclusive of breaker tripping times or otherwise.

.4 Prepare a summation chart showing all ratings and settings with easy reference to the appropriate curve.

.5 Symmetrical and asymmetrical fault current calculations shall be submitted to verify the correct choice of the protective elements of the system.

.6 Prepare a systems single line diagram on which the resultant short circuit values, device numbers and equipment ratings are shown.

.7 Include a list of recommended settings for each relay.

1.2 Related Work

.1 Existing 12.6 kV Distribution Transformer Liquid-filled

.2 Existing Outdoor Load Break Switches and Fuses

.3 Existing Secondary Switchgear

.4 Dry Type Transformers up to 600 V Primary: Section 16461

1.3 Qualifications

.1 This study shall be provided by the supplier of the existing main switchgear.

.2 This study shall be signed and sealed by a Professional Engineer registered in the Province of Manitoba.

1.4 Submittals

.1 Submit the complete study for review prior to carrying out calibration and verification.

.2 Submit typed results of coordination and short circuit study in maintenance manuals.

2. PRODUCTS

2.1 Tripping Devices

.1 Relay style, CT ratios and fuse sizes are existing. Equipment modification shall be based on the results of this study.

3. EXECUTION

3.1 Data

.1 Provide the main switchboard supplier with all relevant data for equipment not provided by that supplier.

END OF SECTION

INSTRUMENT TRANSFORMERS

1. GENERAL

1.1 References

.1 CAN3-C13, Instrument Transformers

1.2 Product Data

.1 Submit Product data in accordance with Section 16010 - Electrical General Requirements

.2 Indicate dimensions and connection details

2. PRODUCTS

2.1 Potential Transformers

.1 Potential transformers: to CAN3-C13, dry type for indoor use, with following characteristics:

.1 Nominal voltage class: as indicated

.2 Rated frequency: 60 Hz

.3 Basic impulse level: 10 kV

.4 Voltage ratio: as required

.5 Accuracy rating: 0.3B2.0

.2 Potential transformers fused with separate fuse block, fuses: as required

2.2 Current Transformers

.1 Current transformers: to CAN3-C13, dry type for indoor use with following characteristics:

.1 Nominal voltage class: as indicated

.2 Rated frequency: 60 Hz

.3 Basic impulse level: 10 kV

.4 Metering accuracy ratio: 0.3B2.0

.5 Relay accuracy rating: 2.5H100

.6 Rated primary and secondary current: as indicated

.7 Continuous-current rating factor: 150 percent

.8 Short-time mechanical current rating: 1.5 times primary rating

.9 Short-time thermal current rating: 1.5 times primary rating

.2 Positive action automatic short-circuiting device in secondary terminals

2.3 Mounting Brackets

.1 Potential transformers with brackets as required

.2 Fabricate brackets and channels from electrogalvanized code gauge painted steel

3. EXECUTION

3.1 Installation

.1 Install instrument transformers and ensure accessibility

END OF SECTION

DISCONNECT SWITCHES FUSED AND NON-FUSED UP TO 600 V

1. GENERAL

1.1 Description

.1 Provide disconnect switches for 347/600 V and 120/208 V 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, 4-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 rated at least equivalent to the motor power.

.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 or wet locations. Disconnect switches located in the Classified areas shall be classified to the environment they are located in. Provide ON-OFF switch position indication on switch enclosure cover.

.3 Finish: one 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 A 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 A (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 lamicoid plate in accordance with Section 16010 - Electrical General Requirements, on each switch showing voltage, source of supply, and load being fed

.5 Name plate to be Size 3.

END OF SECTION

GROUNDING - SECONDARY

1. GENERAL

1.1 Description

.1 Existing grounding system shall be extended to the new equipment being supplied 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 cable tray or conduit (as required).

1.2 References

.1 ANSI/IEEE 837, Qualifying Permanent Connections Used in Substation Grounding

.2 CSA Z32.1, Safety in Anaesthetizing Locations

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 manufactureres' 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 new transformers, switchgear, motor control centres, panelboards and splitters fed from the main distribution centre, directly or indirectly, 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 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 Protect exposed grounding conductors from mechanical injury.

.13 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.

.14 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

.15 Soldered joints shall not be permitted.

.16 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

.17 Install electrical room ground bus to wall as indicated, utilizing insulated off sets.

3.2 Equipment Grounding

.1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels distribution panels.

3.3 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: 3-phase, 4-wire Y 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 primary input to 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 Hi-pot: 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 3-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 manufacturer

.1 Install circuit breakers in panelboards before shipment.

.2 In addition to CSA requirements, the manufacturer's nameplate must indicate the fault current that the panel, including breakers, has been built to withstand.

.2 Panelboards: 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 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated

.5 Two (2) keys for each panelboard and key panelboards 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 panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Mount panelboards 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

PANEL BOARDS - BREAKER TYPE

PANEL SCHEDULE

Panel HA

DESCRIPTION	LOAD	BKR	CCT	A	B	C	CCT	BKR	LOAD	DESCRIPTION	DESCRIPTION	LOAD	BKR	CCT	A	B	C	CCT	BKR	LOAD	DESCRIPTION
Receptacles		15A	1	*			2	20A		Heat Trace	H.W. Equip. H452-LIT	0.5	15A	31	*			32	70A	9	Subfeed to Panel PA
Receptacles		15A	3		*		4	2P		Grit Truck Bay	H.W. Equip. H462-LIT	0.5	15A	33		*		34	3P		
S90 Exhaust Fan	0.2	15A	5			*	6	15A	0.1	H615 CUH	H.W. Equip. H472-LIT	0.5	15A	35			*	36			
Pressure Washer		15A	7	*			8	-		Space	H.W. Equip. H446-LIT		15A	37	*			38	20A	2.4	Control Room FDP
HWH U/L WR		15A	9		*		10	15A		Space	H930 Sampler		15A	39		*		40	2P		
Spare		15A	11			*	12	15A		Spare	Exhaust Fan H655-EF	0.25	15A	41			*	42	15A	off	Blue wire terminated FDP
Spare		15A	13	*			14	15A		Spare			2P	43	*			44			Rotork H445
Head Works	2.8	20A	15		*		16	15A	0.02	H686-CP	Supply Fan F610-SF		15A	45		*		46			Rotork H446
H775 SCU		2P	17			*	18	15A		Thermal Oxidizer LCP			2P	47			*	48	15A		F551-FIT
Fountain		15A	19	*			20	15A		Spare	Supply Fan F620-SF		15A	49	*			50	15A		F556-FIT
Receptacles		15A	21		*		22	15A	1.2	Receptacles			2P	51		*		52	15A		F558-FIT
Receptacles		15A	23			*	24	15A	1	Receptacles	Receptacles-Fermenter Area	5	15A	53			*	54	15A		F551-FCV
Receptacles		15A	25	*			26	15A	1.2	Receptacles	Receptacles-Fermenter Area	4	15A	55	*			56	15A		F552-FCV
Receptacles		15A	27		*		28	15A	0.2	Receptacles	Receptacles-Fermenter Area	1	15A	57		*		58	15A		F556-FCV
H610 CUH, H635 CUH	0.2	15A	29			*	30	15A	0.1	H795 CUH	Receptacles-Fermenter Area	3	15A	59			*	60	15A		F558-FCV

Voltage: 120/208V/3Ø/4W — Feeder: -

Mains: 225A — Main Breaker: N/A

Location: Head Works Control Room — Power Source: XFMR HA (30kVA)

PANEL BOARDS - BREAKER TYPE

PANEL SCHEDULE

PANEL HAA

DESCRIPTION	LOAD	BKR	CCT	A	B	C	CCT	BKR	LOAD	DESCRIPTION
Prim. Low. Fl. Ltg	2.5	15A	1	*			2	15A	1.6	P.C. Clar. #1 Ltg
Prim. Low. Fl. Ltg	2.7	15A	3		*		4	15A	1.6	P.C. Clar. #2 Ltg
Prim. Exterior Lighting	0.3	15A	5			*	6	15A	0.3	P.C. Serv. Tunnel Ltg
Prim. Gatehouse Ltg.	1.7	15A	7	*			8	15A	0.4	H.W. Odor Cont. Rm. Ltg
H.W. West Screen Ltg.	2.1	15A	9		*		10	15A	1.1	H.W. Control Rm. Ltg
Spare		15A	11			*	12	15A	3.5	H.W. Lower Fl. Ltg
H.W. Grit/Sudge HID Ltg	3.1	15A	13	*			14	15A	2.9	H.W. Lower Fl. Ltg
H.W. Mezz. Fan Rm. Ltg	3.6	15A	15		*		16	15A	1.4	Lighting Below Tanks
H.W. Exterior Ltg.	1.6	15A	17			*	18	-		Space
H.W. Screen Room Ltg.	1.6	15A	19	*			20	-		Space
Fermenter Low. Fl. Ltg.	2.1	15A	21		*		22	-		Space
Fermenter Low. Fl. Ltg.	1.8	15A	23			*	24	20A	6	Hot Water Htr
Fermenter Mezzanine	1.3	15A	25	*			26	3P		
Fermenter Tank Ltg.	2.4	15A	27		*		28			
Fermenter Tank Ltg.	0.6	15A	29			*	30	-		Space
Welder	2	30A	31	*			32	50A	30	30 kVA Transf HA
		2P	33		*		34	3P		
Space		-	35			*	36			
Welder	2	30A	37	*			38	30A	1	Welding Receptacle
		3P	39		*		40	2P		
			41			*	42			Space

Voltage: 347/600V/3Ø/4W

Feeder: -

Mains: 225A

Main Breaker: N/A

Location: Headworks Control Room

Power Source: 2UAA-CDP

PANEL BOARDS - BREAKER TYPE

PANEL SCHEDULE										
PANEL HEAA										
DESCRIPTION	LOAD	BKR	CCT	A	B	C	CCT	BKR	LOAD	DESCRIPTION
Grit Truck Bay Ltg	2.9	15	1	*			2	15A	0.5	Control Rm Ltg
Spare		15	3		*		4	15A	0.9	H.W. Proc. Lower Fl. Ltg
Spare		15	5			*	6	15A	0.4	H.W. Stairway Up-Low Ltg
Space		-	7	*			8	15A	1	H.W. Proc. Main Fl Ltg
Space		-	9		*		10	15A		Spare
Space		-	11			*	12	15A		Spare
Space		-	13	*			14	15A	1.1	Serv. Tun. Ltg. H.W./Prim
Space		-	15		*		16	15A	0.8	Prim. Gatehouse Ltg
Space		-	17			*	18	15A		Lower Process Area Ltg
Space		-	19	*			20	15A	1.2	Fermenter Pump Room Lighting
Space		-	21		*		22	15A	2.3	DAF Building Lighting
Space		-	23			*	24	-		Space
Space		-	25	*			26	-		Space
Space		-	27		*		28	-		Space
Space		-	29			*	30	-		Space
Space		-	31	*			32	-		Space
Space		-	33		*		34	-		Space
Space		-	35			*	36	-		Space
15kVA Transformer HEA	15	30A	37	*			38	-		Space
		3P	39		*		40	-		Space
			41			*	42	-		Space

Voltage: 347/600V/3Ø/4W

Feeder: -

Mains: 225A

Main Breaker: N/A

Location: Headworks Control Room

Power Source: MCC-HE

PANEL BOARDS - BREAKER TYPE

PANEL SCHEDULE

PANEL SAA

DESCRIPTION	LOAD	BKR	CCT	A	B	C	CCT	BKR	LOAD	DESCRIPTION
Lower Fl. Ltg	2.6	15A	1	*			2	15A	1.6	Sec. Clar. #1 Ltg
Lower Fl. Ltg	2.5	15A	3		*		4	15A	1.6	Sec. Clar. #2 Ltg
Exterior Ltg	0.1	15A	5			*	6	15A	2.3	Sec. Upper Level Ltg
Spare		15A	7	*			8	15A		**Sec. Clar. #3 Ltg**
Spare		15A	9		*		10	15A		**Mechanical Room Ltg**
Spare		15A	11			*	12	15A	3.3	Sec Tunnel Ltg
Spare		15A	13	*			14	15A	1.8	Aeration Basin Tun. Ltg
Spare		15A	15		*		16	15A		Spare
Space		-	17			*	18	15A		Spare
S645-ACU	0.8	15A	19	*			20	15A	5	S627-CUH
		3P	21		*		22	3P		
			23			*	24			
30kVA XFMR SB	30	40A	25	*			26	20A	6	Hot Water Heater
		3P	27		*		28	3P		Mixed Liquor Bldg
			29			*	30			
HWH Sec lower		20A	31	*			32	20A		HWH
		3P	33		*		34	3P		Outfall Chamber
			35			*	36			
30 kVA XFMR SA	30	50A	37	*			38	20A		S642/S643 UH
		3P	39		*		40	3P		
			41			*	42			

Voltage: 347/600V/3Ø/4W

Feeder: -

Mains: 225A

Main Breaker: N/A

Location: Secondary Clarifier Elec. Room

Power Source: 2UAA-CDP

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 to eight 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 comes with 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, EEMAC-1 unless shown otherwise. Use EEMAC-12, for industrial application, enclosure for wet environment, CSA 3 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 panelboard.

.4 Identification: provide lamicoid 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 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 MCOV of the suppressor unit shall be greater than 125 percent for 120/208 V systems and 115 percent for 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

.1 Peak surge currrent per phase: 120,000 A (panel branch applications)

.2 Let-through voltage (L-N) 208 V units: 500 V

.3 Let-through voltage (L-N) 600 V units: 1200 V

.4 TVSS clamping components response time: less than 1 nanosecond

2.3 Filtering

.1 TVSS shall contain a high frequency extended range-tracking filter

.2 Noise attenuation greater or equal to 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: over center toggle mechanism type which use bolt-on connectors to line side panelboard connectors.

.3 Panelboard enclosure: EEMAC-1 enclosure. The TVSS/filter status indicators shall be visible without the need to open the panelboard 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.

.4 Neutral bus: the unit shall be equipped with a copper 200 percent rated neutral bus suitable for use with non-linear loads, which shall include a sufficient quantity at solderless type lugs to service the total unit circuit capacity.

.5 Wiring gutters: the integrated TVSS filtering panel shall be equipped with a complete perimeter wiring gutter with a cross-sectional dimensions of not less that 0.0122 square metres.

.6 Safety and insulated/isolated ground bus: the integrated filter panel shall have a safety and insulated/isolated ground bus equipped with solderless type lugs of quantity to sufficiently service the circuit loads.

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, ULC rating, and CSA approval on the exterior enclosure.

.8 Warranty: the manufacturer shall provide a five year warranty on the TVSS filter, a one year warranty on the panelboard and circuit breakers, and a one 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 times rated voltage plus 1000 V per ULC 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 the 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 installation of 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 are not acceptable. All contactors shall have 120 V operating coils.

.3 Breaker combination contactor as indicated.

.4 Complete with two normally open and two 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 installation of 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 Electric 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 (1) copy of this booklet at the 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 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 PowerSmart 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 Self-Luminous

.2 Housing: Extruded vinyl frame with aluminum back plate

.3 Face: Polycarbonate

.4 Letters: 150 mm high x with 13 mm thick stroke, red on white, reading EXIT

.5 Universal arrows

.6 Universal mounting

.7 20 Year guarantee

.8 Sealed housing to prevent tampering

.9 Suitable for hazardous locations

2.2 Accepted Manufacture

.1 Emergenci-Lite

.2 UNIGLO

.3 Luxnet Inc.

3. EXECUTION

3.1 Installation

.1 Install exit lights

END OF SECTION

MULTIPLEX FIRE ALARM SYSTEM

1. GENERAL

1.1 Related Work

.1 Conduits, Conduit Fastenings and Conduit Fittings: Section 16111

.2 Wires and Cables 0-1000 V: Section 16122

1.2 References

.1 CAN/ULC-S524, Installation of Fire Alarm Systems

.2 ULC-S525, Audible Signal Appliances for Fire Alarm

.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-S531, Smoke Alarms

.9 CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems

.10 CAN/ULC-S537, Verification of Fire Alarm Systems

.11 NBC, National Building Code of Canada

.12 Local Building Code

1.3 System Description

.1 Fully supervised, microprocessor-based, fire alarm system, utilizing digital techniques for data control and digital, and multiplexing techniques for data transmission.

.2 System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signaling to fire department.

.3 Zoned, non-coded single stage

.4 Modular in design to allow for future expansion

.5 Operation of system shall not require personnel with special computer skills.

.6 System to include:

.1 Central Control Unit in separate enclosure with power supply, stand-by batteries, central processor with microprocessor and logic interface, main system memory, input-output interfaces for alarm receiving, annunciation/display, and program control/signalling.

.2 Data Gathering Panels/Transponders with stand-alone capabilities.

.3 Power supplies

.4 Initiating/input circuits

.5 Output circuits

.6 Auxiliary circuits

.7 Wiring

.8 Manual and automatic initiating devices

.9 Audible and visual signaling devices

.10 End-of-line resistors

.11 Local and Remote annunciators displays

.12 Historic event recorder

1.4 Requirements of Regulatory Agencies

.1 System components: listed by ULC and comply with applicable provisions of Local/Provincial Building Code, and meet requirements of local authority having jurisdiction.

1.5 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 16010 - Electrical General Requirements.

.2 Include:

.1 Detail assembly and internal wiring diagrams for control units. Auxiliary cabinets.

.2 Overall system riser wiring diagram identifying control equipment, initiating zones and signaling circuits]; identifying terminations, terminal numbers, conductors and raceways.

.3 Details for devices

.4 Details and performance specifications for control, annunciation, and peripherals with item by item cross reference to specification for compliance.

.5 Step-by-step operating sequence, cross referenced to logic flow diagram.

1.6 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 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 with corrections completed and marks removed except review stamps.

.4 List of recommended spare parts for system.

1.7 Maintenance Materials

.1 Provide maintenance materials in accordance with Division 01 - Maintenance Materials, Special Tool and Spare Parts.

.2 Include:

.1 Manual pull box stations (total of 4)

.2 Smoke detectors (total of 6)

.3 Heat detectors (total of 6)

.4 Alarm and visual alarm devices

1.8 Maintenance

.1 Provide one year's free maintenance with two inspections by manufacturer during warranty period. Inspection tests to conform to CAN/ULC-S536. Submit inspection report to Contract Administrator.

.2 Provide individual price on Bid form for subsequent PROM re-burns. Price: good for five years from date of project completion.

1.9 Training

.1 Provide on-site lectures and demonstration by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

2. PRODUCT

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: Single Stage - Signals Only

.1 Actuation of any alarm initiating device to:

.1 Cause electronic latch to lock-in alarm state at central control unit and data gathering panel/transponder.

.2 Indicate zone of alarm at central control unit and remote annunciators display.

.3 Cause audible signalling devices to sound continuously throughout building and at central control unit.

.4 Transmit signal to fire department via central station.

.5 Cause air conditioning and ventilation fans to shut down or to function to provide required control of smoke movement.

.6 Cause fire doors and smoke control doors, if normally held open, to close automatically.

.2 Acknowledging alarm: indicated at central control unit.

.3 Possible to silence signals by "alarm silence" switch at control unit, after 60 s period of operation.

.4 Subsequent alarm, received after previous alarm has been silenced, to re-activate signals.

.5 Actuation of supervisory devices to:

.1 Cause electronic latch to lock-in supervisory state at central control unit and data gathering panel/transponder.

.2 Indicate respective supervisory zone at central control unit and at remote annunciator.

.3 Cause audible signal at central control unit to sound.

.4 Activate common supervisory sequence.

.6 Resetting alarm device not to return system indications/functions back to normal until control unit has been reset.

.7 Trouble on system to:

.1 Indicate circuit in trouble at central control unit.

.2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; whereas visual indication to remain until trouble is cleared and system is back to normal.

.8 Trouble on system: suppressed during course of alarm.

.9 Trouble condition on any circuit in system not to initiate alarm conditions.

2.3 Control Panel

.1 Central control unit

.1 Suitable for DCLB communication style: to CAN/ULC-S524.

.2 Features specified are minimum requirements for microprocessor-based system with digital data control and digital multiplexing techniques for data transmission.

.3 Minimum capacity of 500 addressable monitoring and 250 addressable control/signal points.

.4 System to provide for priority reporting levels, with fire alarm points assigned highest priority, supervisory and monitoring lower priority, and third priority for troubles. Possible to assign control priorities to control points in system to guarantee operation or allow emergency override as required.

.5 Integral power supply, battery charger and standby batteries.

.6 Basic life safety software: retained in non volatile Erasable Programmable Read-Only-Memory (EPROM). Extra memory chips: easily field-installed. Random-Access-Memory (RAM) chips in panel to facilitate password-protected field editing of simple software functions (e.g. zone labels, priorities) and changing of system operation software.

.7 Circuitry to continuously monitor communications and data processing cycles of microprocessor. Upon failure, audible and visual trouble indication to activate.

.8 Communication between central control unit and remote DGPs/TPRs to be supervised, DCLB. Should communications fail between central control unit and remote units, audible and visual trouble to be indicated at central control unit. Data communication to be binary DC, baseband, time-division multiplex, half-duplex. Each data channel: capable of communicating up to distance of 3,000 m.

.9 Support up to 4 RS-232-C I/O ports. Central control unit output: parallel ASCII with adjustable baud rates to allow interface of any commercially available printer, terminal, or PC.

.10 Equipped with software routines to provide Event-Initiated-Programs (EIP); change is status of one or more monitor points, may be programmed to operate any or all of system's control points.

.11 Software and hardware to maintain time of day, day of week, day of month, month and year.

.12 Software to operate variable sensitivity addressable smoke detectors and annunciate their status and sensitivity settings at control panel.

2.4 Data Gathering Panels (DGPs)/Transponders

.1 Fire control modules: distributed throughout complex in separately enclosed units (DGPs) and interconnected to central control unit utilizing multiplex data transmission techniques.

.2 Modules: concentrated in single central location in modular central control panel.

.3 Fire alarm integrated DGPs: microprocessor based, provide interface between standard alarm input/output devices and central control unit.

.4 Each DGP: circuitry with ability to detect failure in communication with central control unit resulting from faults in communication wiring. In event of loss of communication with central control unit, DGP capable of operating in stand-alone mode. In this mode, DGP capable of reacting to connected input devices, and apply stand-alone programming to determine state of connected outputs. Stand-alone programming instructions: independent of, but capable of executing same type of algorithms as, that of central control unit.

.5 Each DGP: self-contained unit, with integral power supply, battery charger and standby batteries. Short circuit, over voltage, and brown-out monitoring to protect powered components by automatically switching to standby batteries whenever trouble condition exists in power supply.

.6 Addressable DGPs

.1 DGPs: addressable type, provide two-way data communication with up to 30 addressable devices/interface modules, utilizing digital poll/response protocol communication format. Each addressable device: uniquely identified by own address, set at time of installation.

.2 Addressable DGPs: stand-alone capability.

.3 Interface modules: facilitate connection of non-addressable devices (e.g. flow switch) to addressable DGP; provided in different types for connection to monitoring devices (e.g. flow/tamper switch), signalling devices (e.g. bells, horns), and control functions (e.g. fan shutdown, door release); communicate with addressable DGP over minimum number of wires (specified by manufacturer).

.4 Addressable DGPs: self-contained, as specified.

.5 Possible to connect variable-sensitivity addressable smoke detectors together with other addressable devices to same addressable communication loop.

2.5 Power Supplies

.1 120 V, 60 Hz as primary source of power for system.

.2 Voltage regulated, current limited distributed system power.

.3 Primary power failure or power loss (less than 102 V) will activate common trouble sequence.

.4 Interface with battery charger and battery to provide uninterruptible transfer of power to standby source during primary power failure or loss.

.5 During normal operating conditions fault in battery charging circuit, short or open in battery leads to activate common trouble sequence and standby power trouble indicator.

.6 Standby batteries: sealed, maintenance free.

.7 Continuous supervision of wiring for external initiating and alarm circuits to be maintained during power failure.

2.6 Initiating/Input Circuits

.1 Receiving circuits for alarm initiating devices such as manual pull stations, smoke detectors, heat detectors and water flow switches, wired in DCLB configuration to central control unit.

.2 Alarm receiving circuits (active and spare): compatible with smoke detectors and open contact devices.

.3 Actuation of alarm initiating device: cause system to operate as specified in "System Operation".

.4 Receiving circuits for supervisory, N/O devices. Devices: wired in DCLB configuration to central control unit.

.5 Actuation of supervisory initiating device: cause system to operate as specified in "System Operation".

2.7 Alarm Output Circuits

.1 Alarm output circuit: connected to signals, wired in class B configuration to central control unit.

.1 Signal circuits' operation to follow system programming; capable of sounding horns continuously. Each signal circuit: rated at 2 A, 24 VDC; fuse-protected from overloading/overcurrent.

.2 Manual alarm silence, automatic alarm silence and alarm silence inhibit to be provided by system's common control.

2.8 Auxiliary Circuits

.1 Auxiliary contacts for control functions.

.2 Actual status indication (positive feedback) from controlled device.

.3 Alarm or supervisory trouble on system to cause operation of programmed auxiliary output circuits.

.4 Upon resetting system, auxiliary contacts to return to normal or to operate as pre-programmed.

.5 Fans: stagger-started upon system reset; timing circuit to separate starting of each fan or set of fans connected to auxiliary contact on system. Timing circuit: controlled by central control unit.

.6 Auxiliary circuits: rated at 2 A, 24 VDC or 120 VAC, fuse-protected.

2.9 Wiring

.1 Twisted copper conductors: rated 300 V.

.2 To initiating circuits: 18 AWG minimum, and in accordance with manufacturer's requirements.

.3 To signal circuits: 16 AWG minimum, and in accordance with manufacturer's requirements.

.4 To control circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.

2.10 Manual Alarm Stations

.1 Addressable manual pull station

.1 Pull lever, surface wall mounted type, single action, single stage, electronics to communicate station's status to addressable module/transponder over 2 wires and to supply power to station. Station address to be set on station in field.

2.11 Automatic Alarm Initiating Devices

.1 Heat detectors, fixed temperature, non- restorable, rated 57°C

.1 Electronics to communicate detector's status to addressable module/transponder

.2 Detector address to be set on detector base in field

.2 Addressable variable-sensitivity smoke detectors

.1 Ionization type

.2 Electronics to communicate detector's status to addressable module/transponder

.3 Detector address to be set on detector base in field

.4 Sensitivity settings: 3 settings, determined and operated by control panel. No shifting in detector sensitivity due to atmospheric conditions (dust, dirt) within certain parameters.

.5 Ability to annunciate minimum of 2 levels of detector contamination automatically with trouble condition at control panel.

2.12 Audible Signal Devices

.1 Horns: 112 db, weatherproof mounting, 24 VDC.

.2 Mini-horns: 97 db, surface mounting, red colour, 24 VDC.

2.13 Visual Alarm Signal Devices

.1 Strobe type: flashing red, 24 VDC.

.2 Designed for surface mounting on walls

2.14 End-of-Line Devices

.1 End-of-line devices to control supervisory current in alarm circuits and signalling 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.

2.15 Remote Annunciators

.1 LED type, with designation cards to indicate zones.

.2 Display:

.1 Alarms and troubles for alarm initiating circuits.

.2 Supervisory alarms and troubles for supervisory initiating circuits.

.3 Trouble buzzer

.1 Acknowledging trouble at main panel to silence trouble buzzers in system.

.4 Supervised, with LED test button and alarm and trouble acknowledge button.

.5 Minimum wiring configuration with main panel and other remote annunciators.

2.16 As-Built Riser Diagram

.1 Fire alarm system riser diagram: in glazed frame minimum size 600 x 600 mm.

2.17 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 central control unit and connect to ac power supply.

.3 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 Install signal horns and visual signal devices and connect to signalling circuits.

.7 Connect signalling circuits to main control panel.

.8 Install end-of-line devices at end of alarm and signalling circuits.

.9 Install remote annunciator panels and connect to annunciator circuit wiring.

.10 Install door releasing devices.

.11 Install remote relay units to control fan shut down.

.12 Room detection system

.1 Install detectors. Make necessary connections between room detection panel and main fire alarm panel.

.2 Locate and install audible signals and visual alarms.

.13 Splices are not permitted.

.14 Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment and CCU, as required by equipment manufacturer.

.15 Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.

.16 Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.

3.2 Field Quality Control

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems and CAN/ULC-S537.

.2 Fire alarm system:

.1 Test such device and alarm circuit to ensure manual stations, thermal and smoke detectors transmit alarm to control panel and actuate general alarm and ancillary devices.

.2 Check annunciator panels to ensure zones are shown correctly.

.3 Simulate grounds and breaks on alarm and signaling circuits to ensure proper operation of systems.

.4 Addressable circuits system style DCLB:

.1 Test each conductor on all DCLB addressable links for capability of providing 3 or more subsequent alarm signals on line side of single open-circuit fault condition imposed near electrically most remote device on each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.

.2 Test each conductor on all DCLB addressable links for capability of providing 3 or more subsequent alarm signals during ground-fault condition imposed near electrically most remote device on each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.

.3 Provide final PROM program re-burn for system Contract Administrator incorporating program changes made during construction.

END OF SECTION

MOTOR STARTERS TO 600 V

1. GENERAL

1.1 References

.1 NEMA Contactors and Motor Starters

1.2 Related Work

.1 Connections to Mechanical Equipment: Section 16950

1.3 Starter Requirements

.1 In general, there are three categories of starting equipment for 3-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 and magnetic starters for 3-phase motors as 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 01 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 For all motors 22.4 kW and above, the starters shall contain thermistor control relay and accessories.

2.4 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

2.5 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 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.

2.6 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, 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, 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

MOTOR SCHEDULE

MOTOR				STARTER									POWER						
EQUIP. NO.	DESCRIPTION	EQUIP. LOAD	VOLT/PH	SIZE	TYPE	MAN.	MAG.	S/S	PL	H.O.A.	OVERCURR DEVICE	LOCATION	PANEL	CCT.	FEEDER	Cable Type	DISC. TYPE	DETAIL SCHEMATIC	REMARKS
DAF Area																			
T650-GH	Natural Gas Boiler	0.4kW	120/1								20A-1P	DAF Mech Rm.	TA	15	2/C#12	Teck			
T655-GH	Natural Gas Boiler	0.4kW	120/1								20A-1P	DAF Mech Rm.	TA	17	2/C#12	Teck			
T660-GFT	Glycol Feed Pump	0.25kW	120/1								15A-1P	DAF Mech Rm.	TA	13	2/C#12	Teck			
T630-CU	Condensing Unit	16A	208/3								20A-3P	DAF Roof	TA	8,10,12	3/C#12	Teck			
T615-UH	Hot Water Unit Heater T615-UH		208/3								15A-3P			16,18,20	3/C#12	Teck			
T620-UH	Hot Water Unit Heater T620-UH		208/3								15A-3P	DAF Area	TA	22,24,26	3/C#12	Teck			
	Overhead Door Opener	0.38kW	600/3								15A-3P		TAA	2,4,6	3/C#12	Teck			
	Overhead Door Opener	0.38kW	600/3								15A-3P	DAF Area	TAA	8,10,12	3/C#12	Teck			
XFMR-TA	Transformer	45kVA	600/3								80A-3P	DAF Electrical Rm	TAA	38,40,42	3/C#6	Teck			
Headworks Building																			
H686-CP	DHW Circulation Pump	.02kW	120/1								15A-3P	Headwork Upper Level	HAA	16	3/C#12	Teck			
H655-EF	Truck Fill		208/1								15A-2P	Sludge Truck Bay	HA	41,43	3/C#12	Teck			
Fermenter Pump Room																			
F610-EF	Sampling Sink Exhaust Fan	0.25kW	208/1								15A-2P	Fermenter Pump Room	HA	45,47	2/C#12	Teck			
F620-EF	Sampling Sink Exhaust Fan	0.25kW	208/1								15A-2P	Fermenter Pump Room	HA	49,51	2/C#12	Teck			
Bioreactor																			
S790-CU	Condensing Unit		208/3								20A-3P	Bioreactor Electrica Rm	SAB	3,5,7	3/C#12	Teck			
Secondary Clarifier																			
S760-GH	Boiler	0.4kW	120/1								20A-1P	Sec Clar Mech. Rm	SB	4	2/C#12	Teck			
S765-GH	Boiler	0.4kW	120/1								20A-1P	Sec Clar Mech. Rm	SB	6	2/C#12	Teck			
S776-GFT	Glycol Feed Tank		120/1								15A-1P	Sec Clar Mech. Rm	SB	2	2/C#12	Teck			

VARIABLE FREQUENCY DRIVES

1. GENERAL

1.1 Related Work

.1 Mechanical: Division 15

.2 Process: Division 11

1.2 Scope

.1 Division 15 shall supply VFD controllers for HVAC equipment as herein specified.

.2 Division 16 shall install, wire and connect HVAC VFD controllers and indicated on the drawings.

.3 Division 11 shall supply all VFD drives for all Process Equipment as herein specified.

.4 Division 16 shall install, wire and connect Process Equipment VFD controllers and indicated on the drawings.

1.3 Standards Motor

.1 All VFDs supplied under this Contract meet or exceed the following 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 unit 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 (PCC) will be taken as the secondaries of the main distribution transformers.

6. The Contractor shall conduct a harmonic analysis for the entire electrical system upon completion of the fine-tuning and commissioning of the installation. The harmonic analysis shall be conducted at 50%, 75%, and 100% speed of all VFDs and at 50%, 75%, and 100% loading of all other non-linear loads and perform a Fourier (FFT) transform analysis spectrum for each waveform covering the fundamental to the 31st harmonic. The contractor shall submit a report to the Contract Administrator. The harmonic analysis shall be done by J.R. Stephenson Mtg. Ltd.

   Should the waveform analysis indicate that the harmonic levels (voltage and current) at the various points and under various load conditions as defined in the previous paragraph exceed recommended levels as stated in the IEEE 519 Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems, then the contractor shall provide all the necessary line filtering equipment to correct the harmonic distortion.

   The contractor shall allow in his bid a lump some of $80,000 to cover the cost of additional filtering equipment, if the additional filtering is required.

.3 Provide certified copies of all production test results required by CSA and NEMA.

1.5 Warranty

.1 The VFD supplier shall provide a warranty coverage for a period of two 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 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) - ACS 800 series.

.2 Variable speed controller shall be electronic adjustable frequency and voltage output unit.

.3 The VFD shall employ a minimum 6-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 347/600 V systems (Not 575 V). 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 0-10 VDC. Output speed monitoring signal shall be selective between 4-20 mA or 0-10 VDC.

.7 Enclosure:

.1 Drives located in Electrical Rooms:

.1 Drive shall be installed in individual CSA 1 enclosure, 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 in a typical building electrical room 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 VFD(s) is 1 m.

.2 Drives Located in Other Than Electrical Rooms:

.1 Drive shall be installed in individual CSA 4 enclosure, 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 in pump rooms and shall be able to operate under these conditions with special cleaning requirements as needed. 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 VFD(s) is 1 m.

.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 60 seconds.

.4 Overcurrent instantaneous trip 250 percent

.5 Programmable short-circuit protection

.6 Programmable ground fault protection

.7 Overvoltage/overcurrent DC bus monitor/protection

.8 Undervoltage protection

.9 Loss of phase and phase unbalance protection

.10 Inverter over-temperature protection

.11 Capable of running without motor for start-up

.12 Output filter package (as required) to limit motor voltage to 1200 V 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 for programming, monitoring and operating of drive, accessible through password or other acceptable security measure only. Remote keypads, completely duplicating functions of integral keypads, shall also be provided for all VFD(s) located inside a fan plenum. The remote keypads in these cases shall be located adjacent to the door entering the plenum.

.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)

.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 push buttons 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 Stopped

.4 At speed

.5 Under speed

.6 Forward/Reverse

.7 Low reference

.8 Manual/Auto Mode

.9 Local/Remote Mode

.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.

.19 Data communication link

.1 Data communication links shall be provided with various components in the electrical distribution system as defined in various sections of this division and as shown on drawings. The data communication link shall Ethernet/IP.

.1 Motor control data communication link.

.2 Each variable frequency drive connected to operating motors 20HP (15kW) or larger shall be provided with an Ethernet data communication link capable of communicating with the DCS System.

.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 and/or sufficient 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 347/600 V systems.

.3 Line voltage sags down to 85 percent of rated voltage of up to one 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 (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 1 m. 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. 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 MCC 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/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 re-commission the VFD during the two 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 Upon the award of the Contract to the successful Contractor, the Prime 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/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 labels/lamacoids on each VFD, MCC 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

VARIABLE FREQUENCY DRIVES

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** _____

MOTOR CONTROL CENTRE

1. GENERAL

1.1 Related Work

.1 Motor Starters to 600 V: Section 16811

.2 Connections to Mechanical Equipment: Section 16950

1.2 References

.1 CAN/CSA-Q9000, Quality Management and Quality Assurance Standards - Guidelines for Selection and Use.

1.3 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 16010 - Electrical General Requirements. and Division 1

.2 Indicate:

.1 Outline dimensions

.2 Configuration of identified compartments

.3 Floor anchoring method and dimensioned foundation template

.4 Cable entry and exit locations

.5 Dimensioned position and size of busbars and details of provision for future extension

.6 Schematic and wiring diagrams

1.4 Operation and Maintenance Data

.1 Provide operation and maintenance data for MCC for incorporation into manual specified in Section 16010 - Electrical General Requirements.

.2 Include data for each type and style of starter

1.5 Maintenance Materials

.1 Provide maintenance materials in accordance with Section 01300 – Submittals, O&M Manuals.

.2 Provide spare parts as recommended by the manufacturer.

1.6 Source Quality Control

.1 Provide manufacturer's type test certificates including short circuit fault damage certification up to short circuit values specified under bus bracing.

.2 Manufacturer to provide proof of quality control program in accordance with CAN/CSA-Q9000.

2. PRODUCTS

2.1 Supply Characteristics

.1 600 V, 60 Hz, delta connected, 3-phase, 3 wire, grounded.

2.2 General Description

.1 Compartmentalized vertical sections with common power busbars

.2 Metal enclosed, free standing, enclosed dead front

.3 Indoor, EEMAC, type 1A gasketted enclosure, front mounting

.4 Class I Type B

.5 Pre Approved: Square D, Siemens, Allen-Bradley, Eaton Cutler-Hammer

2.3 Vertical Section Construction

.1 Independent vertical sections fabricated from rolled flat steel sheets bolted together to form rigid, completely enclosed assembly.

.2 Each vertical section divided into compartment units, minimum 305 mm high, as indicated.

.3 Each unit to have complete top and bottom steel plate for isolation between units.

.4 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of MCC, isolated from busbars by steel barriers.

.5 Vertical wireways comes with doors for load and control conductors extending full height of vertical sections, and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place.

.6 Openings, with removable coverplates, in side of vertical sections for horizontal wiring between sections.

.7 Incoming cables to enter at bottom as indicated.

.8 Provision for outgoing cables to exit via top or bottom.

.9 Removable lifting means.

.10 Provision for future extension of both ends of MCC including busbars without need for further drilling, cutting or preparation in field.

.11 Divide assembly for shipment to Site, complete with hardware and instructions for re-assembly.

2.4 Sills

.1 Continuous 75 mm x 25 mm channel iron floor sills for mounting bases with 19 mm diameter holes for bolts.

2.5 Busbars

.1 Main horizontal and branch vertical, three phase high conductivity tin plated copper busbars in separate compartment self-cooled, extending entire width and height of MCC, supported on insulators and rated:

.1 MCC 1C and 2C:

.1 Main Horizontal busbars: 1200A

.2 Branch vertical busbars: 600A

.2 Branch vertical busbars for distribution of power to units in vertical sections.

.3 No other cables, wires, equipment in main and branch busbar compartments.

.4 Brace buswork to withstand effects of short-circuit current of 65 kA rms symmetrical.

.5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.

2.6 Ground Bus

.1 Copper ground bus extending entire width of MCC.

.2 Vertical ground bus strap, full height of section, tied to horizontal ground bus, engaged by plug-in unit ground stab.

2.7 Motor Starters and Devices

.1 Equip the MCC with the combination starters as specified in Section 16811 - Motor Starters to 600 V, and as shown on the Drawings.

2.8 Starter Unit Compartments

.1 Units EEMAC Size 5 and smaller, circuit breaker units 225 A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.

.2 Unit mounting:

.1 Engaged position - unit stabbed into vertical bus.

.2 Withdrawn position - unit isolated from vertical bus but supported by structure.

.3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.

.4 Stab-on connectors free floating tin plated clips, self-aligning, backed up with steel springs.

.3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for one (1) and four (4) padlocks to lock operating handle in "off" position and lock door closed.

.4 Hinge unit doors on same side.

.5 Overload relays manually reset from front with door closed.

.6 Pushbuttons and indicating lights mounted on door front.

.7 Devices and components by one manufacturer to facilitate maintenance.

.8 Pull-apart terminal blocks for power and control to allow removal of starter units without removal of field wiring.

2.9 MCC Tie Switch

.1 Tie breakers shall be provided for each set of redundant MCC’s. Space shall be provided for the bus connections for the tie switch to the installed.

.2 Tie breakers shall be key interlocked with the breaker feeding each side of the MCC.

2.10 Wiring Identification

.1 Provide wiring identification in accordance with Section 16010 - Electrical General Requirements.

2.11 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

.1 MCC main nameplate: Size 7, engraved as indicated

.2 Individual compartment nameplates: Size 5, engraved as indicated

2.12 Finishes

.1 Apply finishes in accordance with Section 16010 - Electrical General Requirements

.2 Paint MCC exterior light grey and interiors white

3. EXECUTION

3.1 Installation

.1 Set and secure MCC in place on channel bases, rigid, plumb and square to building floor and wall.

.2 Make field power and control connections as indicated.

.3 Ensure correct overload heater elements are installed.

.4 Some re-arrangement of compartments is permitted from that indicated to suite manufacturer's standards, provided that re-arrangement given approximately the spaces shown on the Drawings. Submit arrangement Drawings to the Contract Administrator before starting detailed Drawings.

.5 Coordinate concrete pad with bevelled edges as shown on the Drawings, sized to suit MCC, install and level channel sills and mount MCC.

.6 Provide control centres with vertical sections, each 2286 mm high, 508 m deep and 508 mm wide, assembled into a group having a common power bus and forming an enclosure to which additional sections may be readily added.

.7 Design for all power and control connections to be made from the front. All bus and feeder bolted connections shall be accessible from the front.

.8 Sections with horizontal wiring spaces top and bottom and with 102 mm full height vertical wiring spaces with cable tile supports. Insulate wireways from horizontal and vertical bus.

.9 Incorporate starters, circuit breakers, panels, etc. as detailed. Provide Shop Drawings for review before commencing fabrication.

.10 Provide all spaces complete with bussing hardware and other accessories required so that additional combination starter units can be readily installed. Provide barriers to isolate the space from all buswork.

.11 For each section of structure, provide a 3-phase horizontal bus rated as shown, and a 3-phase vertical bus rated 300 amperes. Tin plate vertical and horizontal bus at each joint. Provide a continuous copper ground bus in bottom of each section; where indicated on MCC schedule, provide fully rated neutral. Bus shall be copper with labyrinth design insulation - isolation for vertical bus.

.12 Contain each complete control device within an individual metal enclosure complete isolated from all other equipment. Provide plug-in type units.

.13 Provide tin-plated copper busbar stabs reinforced with strong spring steel to ensure high contact pressure.

.14 Equip door of each individual unit with a removable plate replaceable with similar plate complete with pushbuttons, pilot lights or selector switches as required. Use pilot lights of push-to-test type and push button of heavy-duty oil tight construction.

.15 Provide appropriate flanges and bus connections for incoming line and feeders.

.16 All joints and connections to be tin plated, cadmium plate all bolts, nuts and lock washers to resist corrosion.

.17 Provide pull apart terminal block plug in each starter for all external control connections, such that each starter unit may be easily removed. All terminals shall be identified.

.18 Provide barriers to isolate all buswork to prevent accidental contact when starter units are removed or spaced are provided. Barriers shall also provide phase-to-phase isolation of the vertical bus.

.19 Complete control wiring diagrams for each starter with conductor identification clearly shown shall be affixed to the interior cover of the starter section or provide a book of wiring diagrams for all starters in each MCC.

.20 MCCs shall be fitted with on main 600 V / 120 V control transformer of sufficient V.A. capacity to handle the control requirements of the whole unit plus capacity for external control devices.

.21 Primary and secondary HRC fusing shall be installed on the control transformer.

.22 Each MCC containing three or more vertical sections shall contain a control terminal section consisting of one full stack in height and depth. It shall be barriered from the adjacent 600 V section. The control terminal section shall be complete with a solid back pan at the rear for the installation of control terminals.

.23 Control wiring shall be extended from each starter module to the control terminal section, including all auxiliary contacts. A multi unit style terminal block having screw type terminal connections shall be installed on standoff supports on back plate.

.24 All terminals shall be number coded or otherwise suitably identified to indicate which section or module of the MCC they are associated with and their function.

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 in 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, temperature differences between motor and starter locations. Monitor motor operation during start-up to ensure motor operation is satisfactory and relays provide proper protection. For side inlet fans and other long acceleration time motors, provide special overload relays to suit 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.

.2 Ensure moving and working parts are lubricated where required.

.3 Operate starters in sequence to prove satisfactory performance of MCC during an eight hour period.

3.5 Existing MCC Field Modifications

.1 Existing MCC units shall be modified to accept the new starter required. Existing starter being removed shall be turned over to the City. Refer to Drawing for details.

.2 Modify existing MCC units to allow for the installation of main MCC breakers (where indicated) and tie switches as indicated on the Drawings. Tie switches shall be key interlocked with MCC main breaker, either in the MCC of remote.

END OF SECTION

MCC SCHEDULE

Motor						Stater							Over-			Detail	
MCC	Equip. No.	Description	Location	HP/kW	Volt/ Phase	Size	Type	Man.	Mag.	S/S	PL	HOA	Current Breaker	Feeder	Cable Type	Schem DWG	Remarks
DAF Process - Area T - MCC 1T and 2T																	
1T	T110-DAF	DAF Control Panel	DAF	40kW	600/3								100A-3P	3/C #3	Teck		Package supply skid complete with control
																	panel, wiring, motor starters and VFD unit
																	Skimmer VFD unit to be connected by Div 16
2T	T120-DAF	DAF Control Panel	DAF	40kW	600/3								100A-3P	3/C #3	Teck		Package supply skid complete with control
																	panel, wiring, motor starters and VFD unit
																	Skimmer VFD unit to be connected by Div 16
1T	T125-SBP	DAF Subnatant Pump No.1	DAF	5kW	600/3								20A-3P	3/C#10	Teck		VFD Supplied by Div. 11
2T	T126-SBP	DAF Subnatant Pump No. 2	DAF	5kW	600/3								20A-3P	3/C#10	Teck		VFD Supplied by Div. 11
1T	T131-POF	DAF Polymer Pump No. 1	Poly	0.38kW	600/3								15A-3P	3/C#12	Teck		VFD Supplied by Div. 11
2T	T132-POF	DAF Polymer Pump No. 2	Poly	0.38kW	600/3								15A-3P	3/C#12	Teck		VFD Supplied by Div. 11
1T	T136-POF	CEPT Polymer Pump No. 1	Poly	0.38kW	600/3								15A-3P	3/C #12	Teck		VFD Supplied by Div. 11
2T	T137-POF	CEPT Polymer Pump No. 2	Poly	0.38kW	600/3								15A-3P	3/C #12	Teck		VFD Supplied by Div. 11
1T	T141-MP	FeC13 Pump (Secondary polish	Poly	0.75kW	600/3								15A-3P	3/C #12	Teck		VFD Supplied by Div. 11
2T	T142-MP	FeC13 Pump (Secondary polish	Poly	0.75kW	600/3								15A-3P	3/C #12	Teck		VFD Supplied by Div. 11
1T	T143-MP	FeC13Pump (Odour/CEPT) No	Poly	0.75kW	600/3								15A-3P	3/C #12	Teck		VFD Supplied by Div. 11
2T	T144-MP	FeC13Pump (Odour/CEPT) No	Poly	0.75kW	600/3								15A-3P	3/C #12	Teck		VFD Supplied by Div. 11
1T	T130-POL	DAF Polymer System 1	Poly		600/3								30A-3P	3/C #10	Teck		Package Supply. Div 16 to wire and connect
2T	T135-POL	CEPT Polymer System 2	Poly		600/3								30A-3P	3/C #10	Teck		Package Supply. Div 16 to wire and connect
DAF Mechanical - Area T - MCC-1T and 2T																	
1T	T600-EF	Make-up Air Unit Return	Mech Rm	5.6kW	600/3								20A-3P	3/C #10	Teck		VFD Supplied by Div. 15
1T	T600-SF	Make-up Air Unit Supply	Mech Rm	7.5kW	600/3								25A-3P	3/C #10	Teck		VFD Supplied by Div. 15
2T	T605-EF	Make-up Air Unit Return	Mech Rm	3.75kW	600/3								15A-3P	3/C #10	Teck		VFD Supplied by Div. 15
2T	T605-SF	Make-up Air Unit Supply	Mech Rm	5.6kW	600/3								20A-3P	3/C #10	Teck		VFD Supplied by Div. 15
2T	T610-AHU	Air Handling Unit (Fan)	Elect Rm	1.1kW	600/3	1	FVNR		*		*	*	3MCP	3/C#12	Teck		
2T	T610-AHU	Air Handling Unit (Heater)	Elect Rm	4.0kW	600/3								15A-3P	3/C#12	Teck		
1T	T640-CA	Air Compressor	Poly	3.75kW	600/3								30A-3P	3/C#12	Teck		Starter Supplied with Compressor
1T	T665-GP	Glycol Feed Pump	Poly	3.75kW	600/3	1	FVNR		*		*	*	15MCP	3/C#12	Teck		
2T	T670-GP	Glycol Feed Pump	Poly	3.75kW	600/3	1	FVNR		*		*	*	15MCP	3/C#12	Teck		
1T	T680-DWP	Domestic Water Pump	Poly	1.5kW	600/3								15A-3P	3/C#12	Teck		Pump Controller supplied with pumps
	T685-DWP	Domestic Water Pump	Poly	1.5kW	600/3												Div. 16 to wire and connect
2T	T700-SMP	Sump Pump	Poly	1.1kW	600/3								15A-3P	3/C#12	Teck		Pump Controller supplied with pumps
	T705-SMP	Sump Pump	Poly	1.1kW	600/3												Div. 16 to wire and connect
1T	XFMR-TAA	Transformer	Elect Rm	30kVA	600/3								40A-3P	3/C#8	Teck		
Headworks Process - Area H - Existing MCC-1H and 2H																	
1H	H410-STP	Sludge Transfer Pump (Up-grad	Headworks	37.5kW	600/3	3	FVNR		*		*	*	100MCP	3/C#4	Teck		Existing Unit to be Replaced
2H	H420-STP	Sludge Transfer Pump (Up-grad	Headworks	37.5kW	600/3	3	FVNR		*		*	*	100MCP	3/C#4	Teck		Existing Unit to be Replaced
Headworks Mechanical - Area H - Existing MCC-1H and 2H																	
2H	H710-EF	H.W./DAF Exhaust Fan	Headworks	0.38kW	600/3								15A-3P	3/C#12	Teck		VFD Supplied by Div. 15
2H	H715-EF	DAF Building Exhaust Fan	Headworks	3.75kW	600/3								15A-3P	3/C#12	Teck		VFD Supplied by Div. 15
1H	HWT-1	Hot Water Heater	Headworks	12kW	600/3								15A-3P	3/C#12	Teck		
Primary Clarifier - Area P - Existing MCC 1H and 2H																	
1H	P250-SLP	Primary Sludge Pump No.1	Primary	2.2kW	600/3								15A-3P	3/C#12	Teck		VFD Supplied by Div. 11
2H	P260-SLP	Primary Sludge Pump No.2	Primary	2.2kW	600/3								15A-3P	3/C#12	Teck		VFD Supplied by Div. 11
1H	P270-P	Emergency Sump Pump	Primary	11.2kW	600/3	2	FVNR		*		*	*	50MCP	3/C#10	Teck		Controls Supplied by Div. 11
Fermenter Process - Area F - Existing MCC 1H and 2H																	
1H	F550-FM	Primary Sludge Fermenter No.	Fermenter	0.75kW	600/3	1	FVNR		*		*	*	3MCP	3/C#12	Teck		
2H	F560-FM	Primary Sludge Fermenter No.	Fermenter	0.75kW	600/3	1	FVNR		*		*	*	3MCP	3/C#12	Teck		
1H	F551-P	Fermenter Sludge Pump	Fermenter	5kW	600/3								20A-3P	3/C#12	Teck		VFD Supplied by Div. 11
2H	F552-P	Fermenter Sludge Pump	Fermenter	5kW	600/3								20A-3P	3/C#12	Teck		VFD Supplied by Div. 11
1H	F556-P	Fermenter Supernatant Pump	Fermenter	5.6kW	600/3								20A-3P	3/C#12	Teck		VFD Supplied by Div. 11
2H	F557-P	Fermenter Supernatant Pump	Fermenter	5.6kW	600/3								20A-3P	3/C#12	Teck		VFD Supplied by Div. 11
2H	F558-P	Fermenter Supernatant Pump	Fermenter	5.6KW	600/3								20A-3P	3/C#12	Teck		VFD Supplied by Div. 11

MCC SCHEDULE

Motor						Stater							Over-			Detail	
MCC	Equip. No.	Description	Location	HP/kW	Volt/ Phase	Size	Type	Man.	Mag.	S/S	PL	HOA	Current Breaker	Feeder	Cable Type	Schem DWG	Remarks
Fermenter Mechanical - Area F - Existing MCC 1H and 2H																	
2H	F600-SF	Make-up Air Unit Supply Fan	Fermenter	5.6kW	600/3								20A-3P	3/C#12	Teck		VFD Supplied by Div. 15
2H	F600-EF	Make-up Air Unit Exhaust Fan	Fermenter	5.6kW	600/3								20A-3P	3/C#12	Teck		VFD Supplied by Div. 15
1H	F630-SMP	Sump Pump	Fermenter	0.75kW	600/3								15A-3P	3/C#12	Teck		Pump Controller supplied with pumps
	F640-SMP	Sump Pump	Fermenter	0.75kW	600/3												Div. 16 to wire and connect
1H	F650-EF	Fermenter Exhaust Fan	Fermenter	0.38kW	600/3								15A-3P	3/C#12	Teck		VFD Supplied by Div. 15
2H	F660-EF	Fermenter T.O. Exhaust Contro	Fermenter	0.38kW	600/3								15A-3P	3/C#12	Teck		VFD Supplied by Div. 15
Seconday Clarifier - Area S - Existing MCC 1S and 2S																	
1S	S510-CM	Secondary Clarifier No.1	Sec. Clar	0.75kW	600/3												Existing Unit to be replaced
2S	S520-CM	Secondary Clarifier No.2	Sec. Clar.	0.75kW	600/3												Existing Unit to be replaced
1S	S530-CM	Secondary Clarifier No. 3	Sec. Clar.	0.75kW	600/3	1	FVNR		*		*	*	3MCP	3/C#12	Teck		
1S	S710-RAP	RAS Pump	Sec. Clar.	22.5kW	600/3												Existing Unit to be replaced
2S	S720-RAP	RAS Pump	Sec. Clar.	22.5kW	600/3												Existing Unit to be replaced
1S	S730-RAP	RAS Pump	Sec. Clar.	22.5kW	600/3								80A-3P	3/C#4	Teck		Existing Unit to be replaced
1S	S740-RAP	RAS Pump	Sec. Clar.	22.5kW	600/3								80A-3P	3/C#4	Teck		VFD Supplied by Div. 11
2S	S750-RAP	RAS Pump	Sec. Clar.	22.5kW	600/3								80A-3P	3/C#4	Teck		VFD Supplied by Div. 11
2S	S230-FWP	Flushing Water Pump	Sec. Clar.	64kW	600/3	4	FVNR		*		*	*	150MCP	3C#1	Teck		Existing Unit to be replaced
Bioreactor Mechanical Room Mechanical - Area S - MCC-1S and 2S																	
1S	S750-SF	Make-up Air Unit-Supply Fan	Mech Rm	15kW	600/3								50A-3P	3/C#8	Teck		VFD Supplied by Div. 15
1S	S750-EF	Make-up Air Unit-Return Fan	Mech Rm	15kW	600/3								50A-3P	3/C#8	Teck		VFD Supplied by Div. 15
1S	S770-GP	Glycol Circ. Pump	Mech Rm	3.75kW	600/3	1	FVNR		*		*	*	15MCP	3/C#12	Teck		
2S	S775-GP	Glycol Circ. Pump	Mech Rm	3.75kW	600/3	1	FVNR		*		*	*	15MCP	3/C#12	Teck		
2S	XFMR-SB	Transformer	Elect Rm	30kW	600/3								40A-3P	3/C#8	Teck		
Bioreactor Process - Area S - MCC 1SB and 2SB																	
1SB	S760-MXR	Bioreactor Mixer	Bioreactor	3.75kW	600/3	1	FVNR		*		*	*	15MCP	3/C#12	Teck		
1SB	S761-MXR	Bioreactor Mixer	Bioreactor	3.75kW	600/3	1	FVNR		*		*	*	15MCP	3/C#12	Teck		
1SB	S762-MXR	Bioreactor Mixer	Bioreactor	3.75kW	600/3	1	FVNR		*		*	*	15MCP	3/C#12	Teck		
1SB	S763-MXR	Bioreactor Mixer	Bioreactor	3.75kW	600/3	1	FVNR		*		*	*	15MCP	3/C#12	Teck		
2SB	S765-MXR	Bioreactor Mixer	Bioreactor	3.75kW	600/3	1	FVNR		*		*	*	15MCP	3/C#12	Teck		
2SB	S766-MXR	Bioreactor Mixer	Bioreactor	3.75kW	600/3	1	FVNR		*		*	*	15MCP	3/C#12	Teck		
2SB	S767-MXR	Bioreactor Mixer	Bioreactor	3.75kW	600/3	1	FVNR		*		*	*	15MCP	3/C#12	Teck		
2SB	S768-MXR	Bioreactor Mixer	Bioreactor	3.75kW	600/3	1	FVNR		*		*	*	15MCP	3/C#12	Teck		
1SB	S770-P	Mixed Liquor Nitrified Recycle P	Bioreactor	11.5kW	600/3								40A-3P	3/C#8	Teck		VFD Supplied by Div. 11
2SB	S771-P	Mixed Liquor Nitrified Recycle P	Bioreactor	11.5kW	600/3								40A-3P	3/C#8	Teck		VFD Supplied by Div. 11
1SB	S810-WAP	WAS Pump	Bio. Corr.	5kW	600/3								20A-3P	3/C#10	Teck		VFD Supplied by Div. 11
2SB	S820-WAP	WAS Pump	Bio. Corr.	5kW	600/3								20A-3P	3/C#10	Teck		VFD Supplied by Div. 11
Bioreactor Mechanical - Area S - MCC 1SB and 2SB																	
1SB	S638-EF	Aeration Basen No. 1 Exhaust F	East Corr.	0.75kW	600/3								15A-3P	3/C#12	Teck		VFD Supplied by Div. 15
2SB	S639-EF	Aeration Basen No. 2 Exhaust F	East Corr.	0.75kW	600/3								15A-3P	3/C#12	Teck		VFD Supplied by Div. 15
2SB	S780-AHU	Air Handling Unit (Fan)	Elect Rm	0.75kW	600/3	1	FVNR		*		*	*	3MCP	3/C#12	Teck		
2SB	S780-AHU	Air Handling Unit (Heater)	Elect Rm	3.0kW	600/3								15A-3P	3/C#12	Teck		
2SB	S768-SMP	Sump Pump	Bio. Corr.	1.1kW	600/3								15A-3P	3/C#12	Teck		Pump Controller supplied with pumps
2SB	S769-SMP	Sump Pump	Bio. Corr.	1.1kW	600/3												Div. 16 to wire and connect
2SB		Overhead Door Controller	Bio. Corr.	0.38kW	600/3								15A-3P	3/C#12	Teck		
2SB		Welding Receptacle	Bioreactor		600/3								60A-3P	3/C#6	Teck		
1SB	XFMR-SAB	Transformer	Elect Rm	30kVA	600/3								40A-3P	3/C#8	Teck		

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 Division 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 NO to 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 VAC, 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 second, maximum 60 seconds

2.4 Instantaneous Trip Current Relays

.1 Enclosure: 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, 2- or 3-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 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: 600 V, 60 Hz AC

.3 Secondary: 120 VAC

.4 Rating: 150 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 Divisions 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 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 Control 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 shall be HP rated, Eaton Cutler-Hammer, heavy-duty type.

2.2 120 V, 1 Phase Disconnect Switches

.1 Manual switch without overload relay

2.3 208 V, 3 Phase Motor Disconnect Switches

.1 Manual switch without overload relay

2.4 600 V, 3 Phase Motor Disconnect Switches

.1 Manual switch without overload relays.

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 confirm motor nameplate data with motor starter heater overloads.

3.3 Energizing Equipment

.1 Prior to energizing equipment provided under other sections, confirm equipment nameplate with characteristics of power supply.

END OF SECTION

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 weeks prior to test.

1.2 Related Work

.1 Electrical General Requirements: Section 16010

.2 Starting of Electrical Equipment and System: 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 services of appropriately qualified manufacturer's representatives where on-site testing, adjusting, or balancing of electrical equipment or systems performed by manufacturer's representatives is specified, or 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 the Canadian Electrical Code.

3.3 Load Balance Testing

.1 Perform load tests when as many loads as possible, prior to Substantial Performance 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 panelboards

.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 BIL 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:

.1 480 V switchgear

.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 Related Work in Other Sections

.1 Coordination and Short Circuit Study: Section 16405

.4 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-Constructed conditions.

.5 Qualification

.1 Work shall be performed by a firm specializing in and with relevant experience in testing 480 V switchgear and protective relaying.

.2 This firm shall also perform the final checkout and testing of the equipment specified in Item 3.7.7 of this Section.

.6 Products (Not applicable)

.7 Calibration and Verification

.1 The calibration and verification shall be carried out in the following stages:

.1 480 V switchgear

.2 The 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, CT and PT ratios, etc. and certify that the installation is in accordance with the requirements of the manufacturer and the coordination and 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 free 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 the operation and maintenance of the electrical systems.

.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 Coordination

.1 The Contract Administrator will chair demonstration and instruction sessions.

.2 Establish agenda for demonstration and instruction sessions in conjunction with Contract Administrator. Coordinate scheduling of sessions with Contract Administrator.

2. PRODUCTS

.1 Not Used

3. EXECUTION

3.1 Systems Demonstration

.1 Demonstrate operation of the following systems:

.1 600/347 V electrical system

.2 208/120 V electrical system.

.3 Mechanical equipment connections and controls (including interface with the fire alarm system).

MOTOR SURVEY SHEET

Motor Name & Number _____

Manufacturer_____

HP _____ 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.

_____

_____

SYSTEM COMPLETION AND COMMISSIONING

SYSTEM: _____

The above system is installed as per the Drawings and Specifications, is complete and has been commissioned.

Electrical Sub-contractor

Signed by: _____Dated: _____

Contractor

Signed by: _____Dated: _____

Deficiencies attached:

This system has been reviewed by:

Contract Administrator

Signed by: _____Dated _____

The City's personnel have been instructed in the operation and maintenance of the above system:

City

Signed by: _____Dated _____

The above does not constitute a waiver of any of the requirements of the Contract Documents.

	ELECTRICAL SUBCONTRACTOR	CONTRACTOR
	_____	_____
Address:	_____	_____
	_____	_____
	_____	_____
Phone:	_____	_____

END OF SECTION

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DIVISION 15

TABLE OF CONTENTS

DIVISION 15

Section Title

1. GENERAL

1.1 Requirements of Work

.1 Supply, install, commission, provide warranty and fully document a complete instrumentation and control (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 and marshalling panels

.5 Instrumentation cabling

.6 Instrumentation power supplies

.7 Conduit and cable tray

.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, O&M Manuals and recommended spare parts lists

.3 Schematics and interconnection wiring diagrams sealed by a Professional Engineer registered in the Province of Manitoba.

.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 sealed by a Professional Engineer registered in the Province of Manitoba.

.6 Records of as-built information for the complete instrumentation system.

.6 Documentation provided is formatted as follows:

.1 *Piping & 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 *Input/Output (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 Sheet* – detail the relevant data for the supply of devices.

.5 *Instrument Loop Diagrams (ILDs)* – 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) ACAD Drawings and associated files will be made available to the successful Contractor.

.6 *Location Drawings* – indicate in plan and/or 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 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 Systems
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 (NEC)
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 instrumentation Subcontractor 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 Qualified journeyman instrument mechanics that are familiar with the devices being installed shall perform all instrument hook-ups, calibrations, and checkouts.

.3 Qualified journeyman electricians shall perform all control wiring installation and connections.

.11 Codes, Rules, Permits & 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, the 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 E*x*ecute 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.

.4 Install products in accordance with the recommendations and ratings of the product manufacturers.

.13 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 Tender.

.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 Tender Submittals

.1 Submit with the Tender 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 shall 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 Submittals

.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 by this Division. Submit Shop Drawings for review prior to delivery of any products or equipment to jobsite 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 indicated 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 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.

.8 The submission consists of sufficient information to adequately convey the scope of supply and the specific product to be supplied is highlighted.

.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 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 jobsite during the construction period. Record modifications as they arise and incorporate these changes in the Record Drawings.

.7 Refer to Division 1 for further information on Shop Drawing submittals.

.2 Operations and Maintenance Manuals

.1 Refer to Division 1 for general O&M Manual submittal information.

.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. Label tabs of dividers between each to match section numbers in the Table of Contents.

.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 operation and maintenance of this installation.

.4 A copy of all wiring diagrams complete with wire coding.

.5 Include type and accuracy of instruments used.

.6 Set of final reviewed Shop Drawings.

.7 Provide a tabulated list of all consumables utilized (fuses, lamps, etc.) indicating where used, type, rating and reorder details.

.3 Construction Record Drawings

.1 Maintain on-site a complete set of Construction Record Drawings as listed in Division 1 of this Specification.

.2 In addition to the requirements as stated in Division 1, record the following information on the Drawings:

.1 All changes, alterations or additions

.2 All instrumentation cable and control tubing

.3 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 Certificate of Total Performance, 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:

.1 Provide products and materials that are new and free from all defects.

.2 The design have been based on the use of the first named product where multiple products have been listed.

.3 Alternate Products

.1 Refer to Division 1 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 shall be borne by the Contractor.

.4 Quality of Products

.1 All products provided to be CSA 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.

.5 Uniformity of Manufacture

.1 Unless otherwise specifically called for in the Specification, uniformity of manufacture to be maintained for similar products throughout the Work.

.6 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.

.7 Use of Products During Construction

.1 Any equipment used for temporary or construction purposes is to be approved by the Contract Administrator. Clean and restore to "as new" condition all equipment prior to the time of Substantial Performance.

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 protection, 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 6 mm black lettering on white 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 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 and/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 Division of the Contract from all surfaces.

3.4 Separation of Services

.1 Maintain separation between the electrical wiring system, 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 Classifications of Circuits

.1 The circuit categorization shall of first priority follow Canadian Electrical Code with respect to separation for electrical safety and the following shall apply with respect to electro-magnetic compatibility:

Very Noisy	High voltage circuits and their associated grounding
	High current (>200 A) LV circuits.
	Harmonic-rich LV circuits.
	DC circuits: un-suppressed or above 50 V.
Noisy	Low current class two (2) circuits.
	Medium power pulsed or radio frequency circuits.
Indifferent	ELV digital status circuits.
	Intrinsically safe circuits.
	Telecommunications circuits.
	Fire alarm and emergency lighting circuits (note that some fire alarm circuits may fall into the category of signal circuits).
	Any other emergency, shutdown, or high integrity circuit (e.g. toxic gas alarm).
Sensitive	Analogue signal circuits.
	Data communication circuits.
Very Sensitive	Low level voltage and current signals (e.g. from instrument sensors).

.4 Separation of Circuits

.1 This Section relates to the running of cables carrying differing types of circuit in close proximity to one another and to other services. Sensitive circuits shall normally be run in overall shielded cable. Very sensitive circuits shall normally be run in individually twisted pair shielded cable.

.2 For cables sharing the same support/containment system, the following shall provide guidance to minimize extraneous interference.

Segregation between circuits	**Very Noisy**	**Noisy**	**Indifferent**	**Sensitive**	**Very Sensitive**
Very Noisy	Thermal grouping as per CE Code.	150 mm	300 mm	300 mm	300 mm
Noisy	150 mm	Thermal grouping as per CE Code.	150 mm	150 mm	150 mm
Indifferent	300 mm	150 mm	Separation of circuit types.	100 mm	100 mm
Sensitive	300 mm	150 mm	100 mm	Touching	50 mm
Very Sensitive	300 mm	150 mm	100 mm	50 mm	Touching

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 manufacturers 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 and PLC/DCS input/outputs sourced from the panel. Provide local power disconnect switches for all 120VAC power instruments. Mount adjacent to the instrument.

.4 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 water proof junction box.

3.7 Wiring To Equipment Supplied By Other Divisions

.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 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 and caulk 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 Tagging Standards for Devices and Wiring

.1 Tag all devices, wires, and I/O using the assigned loop, equipment, or device tag name. Where tag naming and numbering is not specified, the Contract Administrator will provide naming and numbering that is consistent with the plant naming conventions.

3.14 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 Check and simulate all alarms and shutdown functions.

.4 Verify the status of all points connected or accessible to the Distributed Control System.

.5 Test all tubing for leaks in compliance with ISA RP7.1. Isolate all instruments when tubing is being tested to protect against over pressure.

.6 Perform tests and record results on the test data forms that are included in this Section. Develop additional and/or more detailed test forms as necessary to suit more complex instrumentation.

.7 Sign and date all test reports. Submit the test reports to the Contract Administrator within five Business Days of testing.

.8 Coordinate and cooperate with City staff while they verify the Distributed Control System I/O.

3.15 Calibration

.1 Instruments are to be factory pre-calibrated. Verify calibration after installation for all instruments installed under these Specifications. 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 serial numbers against their assigned tag number with all programmed parameters.

.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 flow meters by a draw-down test

.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 sample

.5 Calibrate temperature instruments against a standard lab thermometer.

.6 Calibrate online analyzers with known samples.

3.16 Commissioning

.1 Refer to the requirements of Division 1 for additional 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 Verify installation of components, wiring connections and piping connections.

.2 Supervise wiring continuity and pipe leak tests.

.3 Verify instrument calibration and provide written report.

.4 Function check and adjust the instruments and control equipment under operational conditions.

.5 Coordinate manufacturer’s service personnel as required for complete system testing.

.6 Instruct plant personnel in correct method of instruments and control equipment operation.

.7 Direct plant personnel at hand-over as to final adjustment of the system for correct plant operation.

.8 Ensure that the Manufacturer’s representatives 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 to commission the Distributed Control System I/O points.

3.17 Training

.1 Provide training, as described in detail in Division 1, in the proper operation and maintenance of all control devices, control valves, and ancillary instrumentation described under this Division of the Specification.

3.18 Test Forms

	Form No.	Title
.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 & I DWG. 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: _____

SCOPE OF INSTRUMENTATION AND CONTROL WORK

1. GENERAL

.1 Supply and installation all material, equipment, wiring and labour necessary for the installation of the systems detailed on the Drawings in accordance with the Specifications and the latest edition of the Canadian Electrical Code.

2. WORK EXCLUDED

.1 Supply of the Polymer Make Up and Dissolved Air Flotation (DAF) equipment packages and the Fermenter Sludge and Ferric Chloride Pump system packages. These systems shall be supplied as packages by pre-approved vendors.

.2 Supply of HVAC equipment. This equipment shall be supplied under Division 15.

.3 Distributed Control System (DCS) software configuration as required for the plant expansion shall be carried out by the City.

3. WORK INCLUDED

3.1 Related Work

.1 Supply and installation of instrumentation and control equipment including all ancillary equipment and connection of all new instrumentation and equipment to the existing DCS.

3.2 General Requirements

.1 Shop Drawings

.2 Record Drawings

.3 Operating and Maintenance Data, where specified

3.3 Specific Requirements Included but Not Limited to Scope of Work

.1 Supply, install, test and commission all instrumentation, control cabinets and marshalling panel, DCS cabinets and components, materials and ancillary equipment covered under Division 17 of this Contract.

.2 Wire the HVAC equipment and instrumentation supplied by Division 15 to the DCS and assist Division 15 and the City with the commissioning of the HVAC systems.

.3 Coordinate with package plant vendors to install, test and commission the Polymer Make Up and Dissolved Air Flotation (DAF) equipment packages and the Fermenter Sludge and Ferric Chloride Pump system packages.

.4 Supply and install all required DCS I/O hardware and I/O termination components necessary to expand the existing control system Process Control Units (PCU's) to accommodate the plant upgrade I/O requirements. All hardware components shall be purchased from ABB Inc. to ensure compatibility with existing system hardware.

.5 Coordinate with and assist the City during the DCS commissioning of the plant expansion.

3.4 Additional Requirements

.1 Provide all necessary testing, detailed wiring continuity checks, installation integrity checks, equipment functional operation checks, and written system verification reports to provide a complete system that is ready for commissioning and start-up.

.2 Provide Performance Verification and startup of all systems included in the Scope of Work.

4. PRODUCTS

4.1 Materials

.1 Conductors, including all types of wires, conductors, cables, which form an integral part of the instrumentation and control system.

.2 Junction boxes, terminals, fuses/circuit breakers and wiring accessories associated with any electrical equipment and instrumentation covered under this contract.

.3 Grounding systems, as required by the Canadian Electrical Code, or as otherwise specified in the Bid Documents.

.4 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.

.5 Electronic data processing and transmission systems, including auxiliary equipment, interface and components.

.6 PCU components, I/O termination hardware and termination panels for expansion of the plant DCS as required.

.7 DAF and Polymer Make up system control panels. Each vendor supplied DAF and Polymer make up system package shall be furnished by the contractor with an individual dedicated control and marshalling panel. Termination points for all instrumentation I/O, and power requirements and door mounted hand controls and indicators for each package shall be included in these control panels.

5. EXECUTION

.1 Not used

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 Local control stations shall be supplied to house local control switches, push buttons and indictor lights associated with field devices (valves, drives etc). The control stations shall be located in close proximity to their associated devices. Where a group of devices are located within close proximity to each other, the local controls may be combined into a single common local control panel. Line of site must be maintained between all devices and the respective local controls.

.3 DAF and Polymer make up packaged systems shall be equipped with individual dedicated local control panels that house the controls and termination points for all signals and devices associated with the individual package. Control panel locations are shown on the location Drawings.

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 Electrical 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 die cast enclosures.

.6 Enclosures for mounting field control indicator lamps and switches in Class 1 areas to be Allen Bradley model 800H 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 convenience 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 Fans and filters shall be installed to pressurize all control panels thus discouraging dust accumulation and providing air purging for temperature and corrosion control.

.5 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.

.6 Control and marshalling panel layouts and wiring diagrams are to be provided by the Contractor as Shop Drawings.

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 Install cables in accordance with the requirements of Division 16.

ENCLOSURES

.2 Tag each wire at both ends with a heat shrink sleeve that is machine printed. Allow approximately 20 mm of wire insulation between the tag and the bare wire.

.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 wire way.

.5 Provide a minimum clearance of 50 mm between wire ways 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 end device terminal number appended to it.

.2 Identify every joint and/or 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 S740-FIT located in the field has a 1 PR-TPSH 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 S740-FIT all the way to the marshaling panel.

.4 Identify spare wires by using the cable tag, wire number and an “-SP” suffix.

.5 Arrange wiring on terminal blocks such that all internal panel wiring terminates on the inboard side of the terminal blocks and all external wiring terminates on the outboard side.

.7 Provide a 120 VAC panel power distribution system and a 24 VDC power distribution system in each panel. Provide 12 VAC power for the CCTV fiber converters as required. Provide a thermal magnetic circuit breaker on each main power circuit and a fused terminal block for each branched circuit off the main.

.8 Provide disconnect type terminal blocks Weidmuller WTR 4 series to isolate field wiring that is powered sourced from the panel. Provide a dedicated fused disconnect type terminal block to isolate each individual DCS input and output.

.9 Provide sufficient terminals so that not more than two wires are connected under the same terminal. Provide 20 percent spare terminal capacity at each terminal block assembly.

.10 Terminals shall be Weidmuller W Series color coded as follows:

Red	=	positive 24 VDC
Black	=	analog signal plus
White	=	analog signal common and VAC neutral
Grey	=	120 VAC
Green	=	ground

.11 Provide nameplates for each device on or within the panels and enclosures. Nameplates shall be white lamicoid with black 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.

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) #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 energizing 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 multi-conductor 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 CSA-C22.2

2.3 Teck Cables

.1 As per Division 16

2.4 Wire

.1 As per Division 16

2.5 100 Base TX Category 5E Communication Cable

.1 Category 5E cable shall be CSA approved and constructed as follows:

.1 4 pairs, solid stranded, #24 AWG

.2 PVC inner and outer jackets

.3 UL verified to Category 5E

.4 Insulated for 300 V

2.6 Fiber Optic Cables

.1 Provide fiber optic cable assemblies where indicated in the Specification and Drawings.

.2 Fibre optic cables shall be indoor/outdoor direct burial rated loose tube, rodent protected and constructed with specified quantity of 62.5/125 µm multi-mode glass fibres, spiral interlocked armour, and outer polyethylene jacket. Maximum attenuation shall be 3.5/1.0 dB/km. Minimum modal bandwidth shall be 220 MHz*km

.3 Provide terminations for fiber optic cables including; buffer tube fan out kits, connectors, termination panels, and wall mount enclosure.

.4 Provide 62.5/125 µm multi-mode duplex fiber patch cords 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, 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.

3.3 Instrument Power

.1 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.

3.4 Installation

.1 Install instrumentation cables in conduit systems or in cable trays. Use a minimum of 300 mm and a maximum of 1000 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.

.5 Cable shields shall be terminated on insulated terminals and carried through to the extent of the cable.

.6 Ground cable shields at one end only. Unless otherwise specified, ground the shields at the marshalling panel.

.7 Protect all conductors against moisture during and after installation.

.8 Fiber Installation:

.1 Always follow the manufacturer's guidelines for minimum bend radius and tension. Minimum bend radius shall be a minimum of 20 times the cable diameter

.2 When installing loose-tube cables, use a silicone injection or sealer to prevent gel migration.

.3 All fiber installations and terminations shall be performed by an experienced fiber optic cable installation contractor.

3.5 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 Fiber Terminations:

.1 Ensure that the fibres are not damaged when the buffer tubes and fibre coatings are removed.

.2 After the coating is removed, clean the fibre with isopropyl alcohol to assure the fibre is clean.

.3 Use only high performance connectors as classified and required by TIA-568-A.

3.6 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 conformity to manufacturer's specifications. Submit results to the City.

3.7 Identification

.1 Identify all instrumentation cables.

.2 Identify each conductor with wire numbers using a machine printed Raychem TMS heat shrink wire marker or approved equal.

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 (1) 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 CEC Part I Section 16.

.4 Unless otherwise required, all DC power supplies to be rated 28 VDC, adjustable ±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 amps.

2.2 Noise Suppression

.1 Provide power conditioners in each panel to power AC instrumentation and control loads. Power conditioners are Oneac Series CX.

3. EXECUTION

3.1 References - General

.1 Refer to Section 17010, Part 3

END OF SECTION

INSTRUMENT AIR SUPPLY AND TRANSMISSION

1. GENERAL

1.1 Description

.1 The Work includes the provision of all instrument air supply and transmission devices.

.2 Refer to Section 17010 for general instrumentation and control requirements related to instrument air supply and transmission.

2. PRODUCTS

2.1 Pneumatic and Process Connections

.1 Pipe, fittings, valves, tubing, tube fittings, etc. required under this Section of the Contract to be Swagelok and rated for the service in which they are to be employed.

.2 Except for the last 300 mm, tubing and fittings to be made of stainless steel. For the last 300 mm (nominal), use reinforced neoprene tubing with a pressure rating of at least 1000 kPa.

.3 Dimensions:

.1 Process connections - 12 mm (nominal) O.D. tubing

.2 Output/signal - 10 mm (nominal) O.D. tubing

.3 Air supply - 12 mm pipe (nominal) to isolation valves and 10 mm O.D. tubing (nominal) from isolation valves to end devices (e.g. valves).

.4 Provide a continuous support channel or raceway for all tubing.

2.2 Air Sets

.1 Provide all pneumatic actuator assemblies with an air set.

.2 Provide Fisher 67FR air sets unless specified otherwise in the Instrument Specification Sheets of Section 17701.

.3 Air set to be complete with filter regulator and output pressure gauge.

.4 Filter rating shall be 40 um or less as called for in actuator manufacturer’s specification.

2.3 Solenoid Valves

.1 Provide Asco Redhat type solenoid valves unless specified otherwise in the Instrument Specification Sheets of Section 17701.

.2 Solenoid enclosures to be minimum EEMAC 4; corrosive areas require EEMAC 4X and hazardous areas require EEMAC Type 9. Refer to Division 16 for area classifications.

.3 Provide manual overrides on coils when solenoid is used to actuate a valve.

.4 Standard coil voltage: 120 VAC

.5 Pipe size: 3-way valve - 6mm; 4-way valve – 10 mm

.6 Maximum operating pressure: 850 kPa instrument air

.7 Minimum operating pressure: 20 kPa instrument air

3. EXECUTION

3.1 Tubing and Fitting Installation

.1 Group instruments logically together. Orient instrument air and process connection isolation valves to provide consistent handle indication of normal open/closed status.

.2 Complete final location of field instruments to provide sufficient clearance for access to all maintenance settings, to provide unobstructed viewing of instrument indicators and to permit instrument calibration and maintenance during normal operation of the site.

.3 Slope tubing installations 20 mm per 2 m of run down to process connection.

.4 Support tubing in channel or raceway if exposed or in close proximity to rotating equipment or high traffic areas. Otherwise do not exceed 1 m between tubing supports.

.5 All turns shall have a minimum bending radius of 50 mm.

.6 Avoid non-terminal connections in tubing runs.

.7 Use teflon tape on all threaded fittings. Do not apply tape on the first two threads.

.8 Complete the final 300 mm (nominal) of air tubing to instruments or control valves installed in process equipment with flexible reinforced neoprene hose. Support the tubing at the hose connection. Tubing shall terminate with fittings or 90° bends, to allow removal of neoprene tubing without disturbing the fixed tubing mounting. Locate the hose connection to facilitate unrestricted removal of the instrument or control valve and to minimize transmission of process equipment vibration into the tubing.

.9 Air tubing with out door runs to be insulated against cold.

.10 Ensure air supply is blown down and free from debris before connecting end devices.

END OF SECTION

PROCESS TAPS AND PRIMARY ELEMENTS

1. GENERAL

1.1 References - General

.1 Equipment, products, and execution must meet all requirements detailed in Section 17010 – Instrumentation and Controls General Requirements.

2. PRODUCTS

2.1 Process Taps

.1 Supply pressure gauge and thermowell taps. Products shall be as specified in Division 15.

2.2 Primary Elements

.1 Supply and install primary elements and transmitters as specified on the Instrumentation Specification Sheets of Section 1770.

.2 Supply written assurance that the instrument manufacturer approves the selection for the primary element materials that are in contact with the specified process fluid and certifies that the materials are inert to the effects of the process fluid.

.3 Supply and install drip pots for sensing elements measuring gas. Supply seamless, stainless steel drip pots consisting of a 50 x 300 mm pipe with an isolating valve and a drain valve. Install a separate drip pot on each sensing line. Locate the drain valve within 500 mm of the floor.

.4 Supply diaphragm seals for any fluid other than water or glycol.

.5 When diaphragm seals are specified with a pressure gauge or a pressure switch provide the assembly filled with ethylene glycol and calibrated by the manufacturer.

.6 Supply and install an ethylene glycol filled assembly calibrated by the manufacturer when in-line pressure sensors are specified with a pressure gauge or a pressure switch or in combination.

3. EXECUTION

.1 Not used

END OF SECTION

TRANSMITTERS AND INDICATORS

1. GENERAL

1.1 References - General

.1 Equipment, products and execution must meet all requirements detailed in Section 17010.

2. PRODUCTS

2.1 Transmitters and Indicators

.1 Provide transmitters and indicators as specified on the Instrument Specification Sheets of Section 17701.

.2 Transmitters shall have adequate power output to drive all devices associated with the signal loop. Provide signal boosters as required to achieve adequate signal strength or to isolate the signal.

.3 All transmitters to have local indication scaled in engineering units as specified in the engineering Specifications. Provide a lamicoid label indicating the calibrated range and engineering units and mount adjacent to the transmitter. Mount the transmitter so the indicator is visible by operations personnel.

.4 Provide remote indicators similar to Action Instruments model V560 for use in unclassified areas. Action Instruments model V560-EP for use in Class 1 areas is acceptable.

.5 Where the loop specification calls for a transmitter and an indicator to be mounted in the same panel, an indicating transmitter may be considered acceptable, provided the indicator is normally visible from outside the enclosure.

.6 Where available as an option, the transmitter shall be supplied with an isolated fault contact.

.7 Standard of acceptance for instrumentation shall be as follows:

.1 Magnetic flow transmitters: Rosemount 8700 Series, ABB Magmaster, Krohne, Endress and Hauser

.2 Pressure Transmitters: Rosemount Model 3051, ABB, or Foxboro complete with stainless steel two and three-valve manifolds as manufactured by Anderson Greenwood

.3 Pressure Gauges: Ashcroft, H.O. Trerice, Budenberg.

.4 Ultrasonic Level Transmitters: Siemens Multiranger 100/200, Magnetrol, Endress & Hauser

.5 Magnetic Level Indication: Krohne, Magnetrol, K-Tek KM26

.6 Temperature Transmitters (RTD): Rosemount, ABB, Foxboro

.7 pH Sensors: Rosemount, Endress and Hauser, ABB, Foxboro 870 Series

.8 Turbidity Sensors: Hach, Rosemount, Endress and Hauser, GLI

.9 Suspended Solids Analyzer: Hach, Cerlic

.10 Dissolved Oxygen (DO) Sensors: Royce Instruments, Aysix Technologies

3. EXECUTION

3.1 References - General

.1 Refer to Section 17010

END OF SECTION

POWERED ACTUATORS

1. GENERAL

1.1 Work Included

.1 Supply installation and testing of electrical and/or pneumatic powered actuators and accessories for controlled devices such as valves, gates dampers, etc. In the case of controlled valves, supply actuator and accessories complete with the valve body. Conform to Sections 15100 and 15105 for valve construction. In the case of controlled gates, supply actuator and accessories. Conform to Section 11181.

.2 Sizing and selection of modulating control valve components.

.3 Size and match powered actuators to controlled devices.

1.2 Related Work

.1 General Process Provisions: Division 11

.2 Process Piping: Division 15

.3 Process Valves: Division 15

.4 Detailed Valve Specification Sheets: Division 15

.5 Controls and Instrumentation: Section 17010

1.3 Submittals for Review

.1 Submittals in accordance with Division 1 and Section 17010.

.2 Furnish Shop Drawings for complete actuator assemblies and accessories prior to delivery.

.3 Provide calculations for sizing, noise, cavitation and actuator torque calculations, etc., in addition to the requirements of other Divisions.

.4 Submit a completed ISA S20.50 Instrument Specification Sheet for each device.

1.4 Submittals For Information Only

.1 Submit the following in addition to the requirements of Division 1 and Section 17010:

.1 Factory calibration and testing reports. Handwritten reports not to be accepted.

.2 O&M Manuals in accordance with Division 11.

1.5 Service Conditions

.1 Provide electrical enclosures rated for the area classification. Refer to Division 16 for classification of plant areas.

.2 Control air to be instrument quality, oil free, supplied between 555 kPa minimum to 810 kPa maximum pressure.

.3 Refer to Section 17010 for additional details.

1.6 Shipment

.1 Ship equipment in accordance with Division 1 and Section 17010.

1.7 Delivery and Storage

.1 Deliver valves and actuators to Site using loading methods that do not damage casings or coatings.

.2 Clearly tag all control valves and actuators, stating size, type, coatings and mating parts.

.3 When stored on-site use storage methods recommended by the manufacturer to prevent damage, undue stresses and to ensure weatherproofing.

1.8 Process Valve and Actuator Schedules

.1 Refer to the Drawings for valve and actuator identification. Power actuated devices which require automation, as shown on the P&ID's, have their actuators and all ancillary instrumentation specified under Division 17. The device material specifications are found under Division 11 or Division 15.

.2 Actuator type abbreviations are described in part 2.2 of this Section.

.3 Devices and actuators whenever possible should be shipped pre-assembled with all accessories.

1.9 Coordination

.1 The valve and gate suppliers are to provide verification that the control actuators are compatible with their valves and gates and are correctly sized.

.2 The actuator manufacturer is responsible for mating the actuator to the valve. The valve manufacturer is responsible for providing the actuator mounting flange. The actuator supplier shall supply the actuator mounting bolts and machine the actuator stem and nut to meet the valve stem requirements. Refer to Section 15100.

.3 The actuator manufacturer is responsible for mating the actuator to the gate. The gate manufacturer is responsible for providing the actuator mounting flange.

2. PRODUCTS

2.1 General

.1 Provide new material only.

.2 Provide all actuator mounting hardware and accessories mounted on the device prior to shipment.

.3 Provide actuators of EEMAC 4 construction, suitable for use in an industrial environment.

.4 Provide device and actuator as a matched set from the same manufacturer wherever possible.

.5 Where shown on the P&ID's provide actuators with 4-20mA including HART data communication link.

.6 Tag the control devices, accessories and actuators to indicate operating characteristics. Tag the actuator inlet and outlet ports for electric or pneumatic services. Electric actuators must be CSA approved.

.7 Refer to Section 17140 for air sets.

.8 Refer to Section 17140 for solenoid valves.

2.2 Actuator Types

.1 Pneumatic Diaphragm Actuators – General

.1 Provide diaphragm quarter turn and linear actuators capable of continuous duty over the full operating range.

.2 Actuator fail positions as shown on the P&IDs. Unless depicted otherwise, the actuators shall fail in the last 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 Fit each actuator with a hand wheel and gear actuator which will enable manual override control of the valve.

.5 House all internal components in a cast iron enclosure, drip-proof and corrosion-proof.

.2 Pneumatic Diaphragm Quarter Turn Actuators, Modulating Type (PDQM)

.1 Diaphragm operators to be suitable for mounting on quarter turn valves intended for modulating service.

.3 Pneumatic Diaphragm Linear Actuators, Modulating-Type (PDLM)

.1 Diaphragm operators to be suitable for mounting on sliding-stem valves and dampers requiring linear actuation intended for modulating service.

.4 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 airset and accessories 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 one to thirty (1 to 30) seconds with separate adjustments for each direction of travel.

.5 Pneumatic Piston Actuators - General

.1 Provide rack and pinion, opposed piston, double acting actuators. Actuators are to be capable of continuous duty over the full operating range.

.2 Actuators will fail in the last position when the control function fails or when pressure is removed from the actuator.

.3 Fit each actuator with a hand wheel to enable manual override control of the valve. Where actuators are mounted in lines above 1800 mm, they should include provision for chain operation of hand wheel.

.4 Each actuator shall be capable of operating in any horizontal or vertical orientation.

.5 House internal components in a drip-proof and corrosion proof extruded aluminum alloy enclosure.

.6 Provide an equalizing valve in the control lines of double acting actuators.

.6 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 Provide positioner and position transmitter where required.

.7 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 where required.

.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 of one to thirty (1 to 30) seconds with separate adjustments for each direction.

.8 Electro-Mechanical Actuators, General

.1 Provide electric actuators of type shown on the P&IDs.

.2 Unless noted otherwise, the actuator will fail to the last position when the control function or power fails.

.3 Unless otherwise specified, electric actuators to be 120 V/-1 phase/60 Hz for service where required torque is less than 115 N-m and 600 VAC, 3 phase/60 Hz for service with torque above 115 N.m. Provide each actuator with a high torque, reversible motor which is capable of continuous duty over the full operating range.

.9 Electric Quarter Turn Actuators, Open/Close Type (EMQO) and Modulating Type (EMQM)

.1 Provide electric operators suitable for mounting on quarter turn valves or dampers intended for on/off and modulating service.

.2 Provide each actuator with built-in motor overload protection.

.3 Fit each actuator with a hand wheel, which will enable manual override control of the valve. Where actuators are mounted in lines above 1800 mm, they should include provision for chain operation of hand wheel

.4 Each actuator shall be capable of operating in any horizontal or vertical orientation.

.5 Provide external mechanical indication of valve position. Provide an external visual position indicator for each positioner.

.6 House internal components in a moisture-resistant and corrosion-resistant EEMAC 4 enclosure. Internal components shall be permanently lubricated.

.7 Motors will be rated at 20 percent intermittent duty cycle.

.8 For remote indication provide the actuator with two SPDT travel limit switches, 10 A, 125 VAC, CSA listed. The travel limit switches shall be adjustable.

.9 Provide the actuator with two SPDT torque limit switches, 10 A, 125 VAC. The torque limit switches are to be factory preset and field adjustable.

.10 Provide adjustable mechanical limit stops to ensure over-turning of the valve does not occur.

.11 Protect exterior mounted actuators against low temperature and condensation.

.12 The actuator speed will be field adjustable.

.13 Provide a terminal board for field wiring. Include contacts to indicate the open/closed status of the valve.

.14 Modulating actuators shall accept a 4-20 mA control signal for remote proportional control.

.10 Electric Linear Actuators, Open/Close Type (EMLO) and Modulating Type (EMLM)

.1 Electric actuators for gates to be comprised of an electric motor and one or two gear boxes, depending on the gate design.

.2 Provide a sufficiently sized motor to seat and unseat gates and, if necessary, for control to traverse from full open to full closed position in small increments, in response to control signals.

.3 The actuator will impart a travel speed of 2.5 m/hr to modulating gates and 18.0 m/hr to open/close gates unless otherwise specified on the Instrument Specification Sheets. The actuator speed to be field adjustable.

.4 The actuator shall be fully compatible with the gate. Mount at operating height on the frame.

.5 Actuators to accept 3 phase/60 Hz power. Protect motors against reversed phase rotation.

.6 The drive train to be rated for heavy duty, continuous service. Connect the actuator drive shaft to gear box shaft(s) through a removable flexible mechanical coupling. Where the actuator is fitted to two stems, ensure that the gearing in each gearbox allows both stems to move identically.

.7 House the internal components of actuators and related gear boxes in weather proof, corrosion proof metal enclosures. Electrical components shall be contained in EEMAC 6 enclosures. All electrical and mechanical components shall be capable of continuous operation in an ambient temperature range of -40°C to +40°C.

.8 Provide a space heater for each actuator.

.9 Fit actuators with a capstan hand wheel operator. Fit hand wheel assemblies with a clutching mechanism which prevents hand wheel operation during normal motor operation. Provide a 1:1 gearing ratio with respect to the main drive shaft for the hand wheel.

.10 Fit removable safety guards over all moving drive train components between the actuator and each gear box.

.11 Provide adjustable limit switches on each actuator to define the upper and lower limit of the stroke.

.12 High torque switches will protect the equipment and the structure against excessive gate travel. Provide high torque protection at the lower and upper ends of the stroke.

.13 Provide a controller enclosure to contain a motor contactor complete with overload protection. Provide line, load, and external control terminal strips.

.14 Fit each actuator with an electronic positioner to control gate elevation in response to a 4-20mA control command.

.15 Provide a local operating station with a Local-Off-Remote switch and an Open-Close switch.

2.3 Current to Pneumatic (I/P) Converters

.1 Supply all required hardware for mounting the I/P converter on the controlled device.

.2 I/P converter to be of EEMAC 4 construction or as specified in the Instrument Specification Sheet.

.3 I/P converter to operate with instrument quality, control air at an operating pressure range of 20 to 200 kPa.

.4 Approved I/P converter manufacturers are Omega and Moore.

2.4 Valve Positioners

.1 Provide positioners pre-mounted to each actuator. Do not mount the positioner upside down.

.2 Each positioner shall service the entire operating range of the actuator. The equipment position shall be fed back to the positioner through a mechanical linkage.

.3 Positioner shall 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.

2.5 Position Switches and Indicators

.1 Actuator position switches shall include two (2) form C, 2 amp contacts in an EEMAC 4 (minimum) rated enclosure.

.2 Cams shall be fastened to a splined shaft and adjustable without set screws.

.3 Provide a visual indicator with beacon type display showing green when the controlled device is closed and red when the controlled device is open.

.4 Supply all required hardware for mounting of position monitor in accordance with the specified valve/actuator orientation.

.5 Enclosures shall be suitable for environment to which they are exposed.

2.6 Manual Loading Station

.1 Manual loading stations 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 an air supply isolating valve.

.2 Mount the loading station on a galvanized plate attached to a floor stand. Locate station within 2 m of the controlled device.

2.7 Minimum monitoring and control signal requirements

.1 Open Close actuators

.1 Open Command Input (From a remote dry contact)

.2 Close Command Input (From a remote dry contact)

.3 Open Status (Dry contact for remote indication)

.4 Closed Status (Dry contact for remote indication)

.5 Remote Mode (Dry contact for remote indication)

.6 Remote dry contacts will be rated 2 Amps at 120 VAC minimum.

.2 Modulating actuators

.1 Input signal: 4-20 mA signal for position control

.2 Output signal: 4-20 mA signal for position monitoring.

2.8 Acceptable Manufacturers

.1 Pneumatic Actuators – Bettis (RPC Series), Bray (Series 92)

.2 Electro-Mechanical Actuators – Rotork, Limitorque

3. EXECUTION

3.1 Preparation

.1 Prior to installation of the valve and/or gate actuators, field measure and check all equipment locations, pipe alignments, and structural installations. Ensure that sufficient space and accessibility is available for pneumatic and electric actuators.

.2 Where conflicts are identified, inform the Contract Administrator, and initiate the necessary modifications at no cost to the City.

3.2 Installation

.1 Install actuators, related panels, and the interconnecting air tubing and wiring as shown in the drawings, and as recommended by the manufacturer.

.2 Install control valves as described in Division 11.

3.3 Field Testing and Commissioning

.1 Provide testing and commissioning in accordance with Division 1 and Section 17010, Part 3.

.2 Factory test each actuator assembly prior to shipment.

.3 The manufacturer's representative will be required to commission the electric and/or pneumatic actuators to verify the installation and make final travel limits and torque adjustments.

3.4 Training

.1 Provide training in accordance with Division 1.

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. The contacts 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 electro-magnetic 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.

.7 120 VAC switches to have a 4 A rating.

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.

.2 All control indicator lamps, pushbutton switches, and selector switches in classified or corrosive (includes outdoors) areas to be Allen Bradley 800H series.

.3 Enclosures to be as specified under Section 17110.

.4 All control indicator lamps shall be push-to-test type.

2.3 Relays

.1 The Quality and type of relays shall be based on Omron relays.

.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 sixteen (16) time ranges and four (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 five (5) timing ranges and eight (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.

2.4 Process Switches

.1 Standard of acceptance for instrumentation shall be as follows:

.1 Thermal Flow Switches: Ifm, Weber

.2 Pressure Switches (Electronic): Ifm, United Electric

.3 Pressure Switches (Conventional): Ashcroft, United Electric, Barksdale.

.4 Conductivity Level Switches: Endress & Hauser

.5 Vibration Type Level Switches: Endress & Hauser

.6 Float Switches: Flygt, Consolidated Electric, Warwick, Magnetrol

.7 Capacitance Level Switches: Siemens, Endress & Hauser

.8 Admittance Level Switches: Magnetrol, Bestobell

.9 Temperature Switches: Ifm

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 ±0.01 percent per °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 volts per meter 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 must meet all requirements detailed in 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, including bar-graph displays with not less than 200 segments. Backlit LCD indication is also acceptable when located in a control room environment.

.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. Approved manufacturers are Crompton Instruments and Simpson.

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 LED transformer type pilot lights for extended lamp life, oil tight, push to test, complete with appropriate colour lenses. Normal colours used are run=red, stop=green. Refer to Division 16 for additional information

.2 Terminals

.1 Provide strap screw type terminal blocks rated for 600 V.

.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

2.2 Signal Current Isolator

.1 Isolators shall be installed to provide galvanic isolation of milliampere transmission signals from transmitters with inadequately isolated output circuits.

.2 Isolator shall 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 shall 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 Approved manufacturers are Moore Industries, Weidmuller or Phoenix.

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 approved 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 Institute of Electrical and Electronic Engineers (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 1A @ 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.

.7 Supply port locks on all unused Ethernet Ports.

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 Connection and termination of all new plant instrumentation, control system I/O, communications media and vendor packages to the existing Distributed Control System (DCS).

.2 Supply and install all hardware and ancillary components required for the expansion of the DCS to meet the new connection, termination, and communications requirements.

.3 Start-up and Commissioning of the complete control system and associated field devices and wiring.

.4 Cooperate with Package Plant Vendors and City programming, maintenance and operations staff to interface, test and commission the interface between the DCS and the equipment installed under this Contract.

2. PRODUCTS

2.1 Existing Distributed Control System

.1 General

.1 All new DCS equipment shall be Infi90 compatible ABB / Bailey Controls / Symphony equipment.

.2 City personnel will provide the DCS logic configuration.

.3 Provide at least 10 percent spare DCS I/O and termination point capability of each type of I/O in each panel assembly.

.4 Provide all necessary mounting bases, din rails, power supplies, cables, communication cards, cabling and accessories etc.

.5 Provide power supply units as required. Each unit to be rated to provide a minimum 25 percent spare capacity above the required configured load.

.2 DCS Components

.1 Supply of DCS Equipment is expected to include the following items. This list is for budgetary purposes only and a final list of required components shall be prepared by the contractor with input from ABB and issued to the engineer for approval prior to purchase.

DCS Component		Required Quantity		
Part No	Description	PCU A	PCU B	**Total**
IMDSI22	Digital Input Slave Card	15	11	**26**
IMDS014	Digital Output Slave Card	6	2	**8**
IMFEC12	Analog Input Slave Card	1	3	**4**
IMASO11	Analog Output Slave Card	1	3	**4**
NRDI01	Digital Input Term. Assembly	15	11	**26**
NRDO02	Digital Output Term. Assembly	6	2	**8**
---------	Digital Output Term. Relay	96	32	**128**
NTAI05	Analog Input Term. Unit	1	3	**4**
NTDI01	Analog Output Term. Unit	1	3	**4**
NKTU02	Cable (Slave To T.A.)	21	13	**34**
NKTU01	Cable (Slave To T.U.)	2	6	**8**
CABINET	Infi-90 Cabinet For T.U.'s	1	-	**1**
IEPASO1	Power Supply	1	1	**2**
IEMMU21	Module Mounting Unit	1	-	**1**

2.2 System Integration Requirements

.1 Cooperate and coordinate activities with other Contractors, the City, and the Contract Administrator to facilitate installation, testing, validation, and Commissioning of all components and equipment required under the BNR upgrade.

.2 Supply, install, test and commission control panels for local operator controls as specified in this Division.

.3 The facility's existing Bailey Infi-90 DCS system will require additional hardware components to meet the increased I/O requirements created under the plant expansion. The components will include but not be limited to DCS I/O cards and racks, wiring termination modules, I/O card/termination module interconnection cables, marshalling panels and power supplies, mounting devices and miscellaneous terminals and wiring accessories etc as required.

.4 All hardware involved in the expansion of the DCS and its related components to be ABB sourced and approved equipment.

.5 Prior to purchase, submit to the Contract Administrator for approval a detailed schedule showing all DCS and associated hardware required for the expansion. The schedule shall show all required hardware grouped by individual PCU area and be detailed to show as a minimum item description, part number and required quantity.

.6 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 Construction Period. Refer to the requirements of Division 1.

END OF SECTION

DCS I/O INDEX

1. GENERAL

1.1 References - General

.1 Refer to Section 17010

1.2 DCS I/O Index

.1 The following spreadsheet gives an itemized list of the new Distributed Control System inputs and outputs. 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

END OF SECTION

DCS INPUT/OUTPUT LIST

NO.	REV. NO.	TAG NAME				DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION						
		PCU	AREA	LOOP	DEVICE ID	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS LOW	ALARMS HIGH	I/O POINT TYPE	I/O POINT NO.	PCU AREA
001	0	FA	F	111	ZB	Position Close	D.A.F. Thickener 1 - FCV	LI3.06					DO		A
002	0	FA	F	111	ZD	Position Open	D.A.F. Thickener 1 - FCV	LI3.06					DO		A
003	0	FA	F	121	ZB	Position Close	D.A.F. Thickener 2 - FCV	LI3.06					DO		A
004	0	FA	F	121	ZD	Position Open	D.A.F. Thickener 2 - FCV	LI3.06					DO		A
005	0	FA	F	550	LAHH	High High Alarm Level	Fermenter No. 1	LI3.02				1	DI		A
006	0	FA	F	550	MM	Motor ON/OFF Status	Fermenter No. 1	LI3.02					DI		A
007	0	FA	F	550	MN	Motor Start/Stop	Fermenter No. 1	LI3.02					DO		A
008	0	FA	F	550	OAH	Torque Alarm High	Fermenter No. 1	LI3.02				1	DI		A
009	0	FA	F	550	OAHH	Torque Alarm High High	Fermenter No. 1	LI3.02				1	DI		A
010	0	FA	F	550	UA	Faulty Alarm	Fermenter No. 1	LI3.02					DI		A
011	0	FA	F	550	YS	Computer Selected	Fermenter No. 1	LI3.02					DI		A
012	0	FA	F	550	ZB	Position Close	Primary Sludge Fermenter 1 - FCV	LI3.06					DO		A
013	0	FA	F	550	ZD	Position Open	Primary Sludge Fermenter 1 - FCV	LI3.06					DO		A
014	0	FA	F	550	ZI	Position Indicator	Fermenter No. 1	LI3.02					DI		A
015	0	FA	F	551	FT	Flow Transmit	Fermenter Sludge Pump No.1	LI3.04	L/s	0-15			AI		A
016	0	FA	F	551	MN	Motor Start	Fermenter Sludge Pump No.1	LI3.04					DO		A
017	0	FA	F	551	MQ	Pulse Input Counter	Fermenter Sludge Pump No.1	LI3.04					DI		A
018	0	FA	F	551	PAH	High Alarm Pressure	Fermenter Sludge Pump No.1	LI3.04				1	DI		A
019	0	FA	F	551	SC	Speed Control	Fermenter Sludge Pump No.1	LI3.04	%	0-100			AO		A
020	0	FA	F	551	ST	Speed Feedback	Fermenter Sludge Pump No.1	LI3.04	%	0-100			AI		A
021	0	FA	F	551	YS	Computer Selected	Fermenter Sludge Pump No.1	LI3.04					DI		A
022	0	FA	F	551	ZB	Position Close	Fermenter No. 1 Primary Sludge - FCV	LI3.04					DO		A
023	0	FA	F	551	ZD	Position Open	Fermenter No. 1 Primary Sludge - FCV	LI3.04					DO		A
024	0	FA	F	551	ZSB	Position Switch Closed	Fermenter No. 1 Primary Sludge - FCV	LI3.04					DI		A
025	0	FA	F	551	ZSD	Position Switch Opened	Fermenter No. 1 Primary Sludge - FCV	LI3.04					DI		A
026	0	FA	F	552	MN	Motor Start	Fermenter Sludge Pump No.2	LI3.04					DO		A
027	0	FA	F	552	MQ	Pulse Input Counter	Fermenter Sludge Pump No.2	LI3.04					DI		A
028	0	FA	F	552	PAH	High Alarm Pressure	Fermenter Sludge Pump No.2	LI3.04				1	DI		A
029	0	FA	F	552	SC	Speed Control	Fermenter Sludge Pump No.2	LI3.04	%	0-100			AO		A
030	0	FA	F	552	ST	Speed Feedback	Fermenter Sludge Pump No.2	LI3.04	%	0-100			AI		A
031	0	FA	F	552	YS	Computer Selected	Fermenter Sludge Pump No.2	LI3.04					DI		A
032	0	FA	F	552	ZB	Position Close	Fermenter No. 2 Primary Sludge - FCV	LI3.04					DO		A
033	0	FA	F	552	ZD	Position Open	Fermenter No. 2 Primary Sludge - FCV	LI3.04					DO		A
034	0	FA	F	552	ZSB	Position Switch Closed	Fermenter No. 2 Primary Sludge - FCV	LI3.04					DI		A
035	0	FA	F	552	ZSD	Position Switch Opened	Fermenter No. 2 Primary Sludge - FCV	LI3.04					DI		A
036	0	FA	F	553	PAL	Low Alarm Pressure	Compressed Air Feed	LI3.04			1		DI		A
037	0	FA	F	553	YS	Computer Selected	Fermenter No. 1 Sec Effluent - SV	LI3.02					DI		A
038	0	FA	F	553	ZD	Position Open	Fermenter No. 1 Sec Effluent - SV	LI3.02					DO		A
039	0	FA	F	555	LAHH	High High Alarm Level	Fermenter Sprnatnt Wet Well	LI3.05				1	DI		A
040	0	FA	F	555	LT	Level Transmit	Fermenter Sprnatnt Wet Well - PIT	LI3.05	Meter				AI		A

I/O POINT TYPES: AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output, MB/TCP = Modbus TCP/IP

DCS INPUT/OUTPUT LIST

NO.	REV. NO.	TAG NAME				DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION						
		PCU	AREA	LOOP	DEVICE ID	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS LOW	ALARMS HIGH	I/O POINT TYPE	I/O POINT NO.	PCU AREA
041	0	FA	F	555	PALL	Low Low Alarm Pressure	Fermenter Sprnatnt Wet Well	LI3.05			1		DI		A
042	0	FA	F	555	YS	Computer Selected	Fermenter Sprnatnt Wet Well Spray - SV	LI3.05					DI		A
043	0	FA	F	555	ZD	Position Open	Fermenter Sprnatnt Wet Well Spray - SV	LI3.05					DO		A
044	0	FA	F	556	FT	Flow Transmit	Bioreactor 1 Sprnatnt Feed	LI3.05	L/s	0-21			AI		A
045	0	FA	F	556	MM	Motor ON/OFF Status	Fermenter Sprnatnt Pump No.3	LI3.05					DI		A
046	0	FA	F	556	MN	Motor Start	Fermenter Sprnatnt Pump No.3	LI3.05					DO		A
047	0	FA	F	556	SC	Speed Control	Fermenter Sprnatnt Pump No.3	LI3.05	%	0-100			AO		A
048	0	FA	F	556	ST	Speed Feedback	Fermenter Sprnatnt Pump No.3	LI3.05	%	0-100			AI		A
049	0	FA	F	556	UA	Faulty Alarm	Fermenter Sprnatnt Pump No.3	LI3.05					DI		A
050	0	FA	F	556	YS	Computer Selected	Fermenter Sprnatnt Pump No.3	LI3.05					DI		A
051	0	FA	F	556	ZB	Position Close	Bioreactor 1 Sprnatnt Feed - FCV	LI3.05					DO		A
052	0	FA	F	556	ZD	Position Open	Bioreactor 1 Sprnatnt Feed - FCV	LI3.05					DO		A
053	0	FA	F	556	ZSB	Position Switch Closed	Bioreactor 1 Sprnatnt Feed - FCV	LI3.05					DI		A
054	0	FA	F	556	ZSD	Position Switch Opened	Bioreactor 1 Sprnatnt Feed - FCV	LI3.05					DI		A
055	0	FA	F	557	MM	Motor ON/OFF Status	Fermenter Sprnatnt Pump No.2	LI3.05					DI		A
056	0	FA	F	557	MN	Motor Start	Fermenter Sprnatnt Pump No.2	LI3.05					DO		A
057	0	FA	F	557	PT	Pressure Transmitter	Fermenter Supernatant Wetwell	LI3.06	kPa				AI		A
058	0	FA	F	557	SC	Speed Control	Fermenter Sprnatnt Pump No.2	LI3.05	%	0-100			AO		A
059	0	FA	F	557	ST	Speed Feedback	Fermenter Sprnatnt Pump No.2	LI3.05	%	0-100			AI		A
060	0	FA	F	557	UA	Faulty Alarm	Fermenter Sprnatnt Pump No.2	LI3.05					DI		A
061	0	FA	F	557	YS	Computer Selected	Fermenter Sprnatnt Wet Well - SV	LI3.05					DI		A
062	0	FA	F	557	YS	Computer Selected	Fermenter Sprnatnt Pump No.2	LI3.05					DI		A
063	0	FA	F	557	ZD	Position Open	Fermenter Sprnatnt Wet Well - SV	LI3.05					DO		A
064	0	FA	F	558	FT	Flow Transmit	Bioreactor 2 Sprnatnt Feed	LI3.05	L/s	0-21			AI		A
065	0	FA	F	558	MM	Motor ON/OFF Status	Fermenter Sprnatnt Pump No.1	LI3.05					DI		A
066	0	FA	F	558	MN	Motor Start	Fermenter Sprnatnt Pump No.1	LI3.05					DO		A
067	0	FA	F	558	SC	Speed Control	Fermenter Sprnatnt Pump No.1	LI3.05	%	0-100			AO		A
068	0	FA	F	558	ST	Speed Feedback	Fermenter Sprnatnt Pump No.1	LI3.05	%	0-100			AI		A
069	0	FA	F	558	UA	Faulty Alarm	Fermenter Sprnatnt Pump No.1	LI3.05					DI		A
070	0	FA	F	558	YS	Computer Selected	Fermenter Sprnatnt Pump No.1	LI3.05					DI		A
071	0	FA	F	558	ZB	Position Close	Bioreactor 2 Sprnatnt Feed - FCV	LI3.05					DO		A
072	0	FA	F	558	ZD	Position Open	Bioreactor 2 Sprnatnt Feed - FCV	LI3.05					DO		A
073	0	FA	F	558	ZSB	Position Switch Closed	Bioreactor 2 Sprnatnt Feed - FCV	LI3.05					DI		A
074	0	FA	F	558	ZSD	Position Switch Opened	Bioreactor 2 Sprnatnt Feed - FCV	LI3.05					DI		A
075	0	FA	F	560	LAHH	High High Alarm Level	Fermenter No. 2	LI3.03				1	DI		A
076	0	FA	F	560	MM	Motor ON/OFF Status	Fermenter No. 2	LI3.03					DI		A
077	0	FA	F	560	MN	Motor Start/Stop	Fermenter No. 2	LI3.03					DO		A
078	0	FA	F	560	OAH	Torque Alarm High	Fermenter No. 2	LI3.03				1	DI		A
079	0	FA	F	560	OAHH	Torque Alarm High High	Fermenter No. 2	LI3.03				1	DI		A
080	0	FA	F	560	UA	Faulty Alarm	Fermenter No. 2	LI3.03					DI		A

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DCS INPUT/OUTPUT LIST

NO.	REV. NO.	TAG NAME				DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION						
		PCU	AREA	LOOP	DEVICE ID	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS LOW	ALARMS HIGH	I/O POINT TYPE	I/O POINT NO.	PCU AREA
081	0	FA	F	560	YS	Computer Selected	Fermenter No. 2	LI3.03					DI		A
082	0	FA	F	560	ZB	Position Close	Primary Sludge Fermenter 2 - FCV	LI3.06					DO		A
083	0	FA	F	560	ZD	Position Open	Primary Sludge Fermenter 2 - FCV	LI3.06					DO		A
084	0	FA	F	560	ZI	Position Indicator	Fermenter No. 2	LI3.03					DI		A
085	0	FA	F	561	YS	Computer Selected	Fermenter No. 2 Sec Effluent - SV	LI3.03					DI		A
086	0	FA	F	561	ZD	Position Open	Fermenter No. 2 Sec Effluent - SV	LI3.03					DO		A
087	0	FA	F	610	IA	High-Low Current Alarm	Supply Air Fan 1	LI3.06					DI		A
088	0	FA	F	610	MM	Motor ON/OFF Status	Supply Air Fan 1	LI3.06					DI		A
089	0	FA	F	610	MN	Motor Start/Stop	Supply Air Fan 1	LI3.06					DO		A
090	0	FA	F	610	YS	Computer Selected	Supply Air Fan 1	LI3.06					DI		A
091	0	FA	F	620	IA	High-Low Current Alarm	Supply Air Fan 2	LI3.06					DI		A
092	0	FA	F	620	MM	Motor ON/OFF Status	Supply Air Fan 2	LI3.06					DI		A
093	0	FA	F	620	MN	Motor Start/Stop	Supply Air Fan 2	LI3.06					DO		A
094	0	FA	F	620	YS	Computer Selected	Supply Air Fan 2	LI3.06					DI		A
095	0	FA	F	650	IA	High-Low Current Alarm	Fermenter Odour Control Fan	LI3.06					DI		A
096	0	FA	F	650	MM	Motor ON/OFF Status	Fermenter Odour Control Fan	LI3.06					DI		A
097	0	FA	F	650	MN	Motor Start	Fermenter Odour Control Fan	LI3.06					DO		A
098	0	FA	F	650	SC	Speed Control	Fermenter Odour Control Fan	LI3.06	%	0-100			AO		A
099	0	FA	F	650	ST	Speed Feedback	Fermenter Odour Control Fan	LI3.06	%	0-100			AI		A
100	0	FA	F	650	UA	Faulty Alarm	Fermenter Odour Control Fan	LI3.06					DI		A
101	0	FA	F	650	YS	Computer Selected	Fermenter Odour Control Fan	LI3.06					DI		A
102	0	FA	F	651	ZB	Position Close	Fermenter Odour Control Fan - FCV	LI3.06					DO		A
103	0	FA	F	651	ZD	Position Open	Fermenter Odour Control Fan - FCV	LI3.06					DO		A
104	0	FA	F	652	ZB	Position Close	Fermenter Odour Control Fan Outlet -FCV	LI3.06					DO		A
105	0	FA	F	652	ZD	Position Open	Fermenter Odour Control Fan Outlet -FCV	LI3.06					DO		A
106	0	FA	F	660	IA	High-Low Current Alarm	Thermal Oxidizer Inlet	LI3.06					DI		A
107	0	FA	F	660	MM	Motor ON/OFF Status	Thermal Oxidizer Inlet	LI3.06					DI		A
108	0	FA	F	660	MN	Motor Start	Thermal Oxidizer Inlet	LI3.06					DO		A
109	0	FA	F	660	PT	Pressure Transmitter	Fermenter Odour Control Fan Outlet	LI3.06	kPa				AI		A
110	0	FA	F	660	SC	Speed Control	Thermal Oxidizer Inlet	LI3.06	%	0-100			AO		A
111	0	FA	F	660	ST	Speed Feedback	Thermal Oxidizer Inlet	LI3.06	%	0-100			AI		A
112	0	FA	F	660	UA	Faulty Alarm	Thermal Oxidizer Inlet	LI3.06					DI		A
113	0	FA	F	660	YS	Computer Selected	Thermal Oxidizer Inlet	LI3.06					DI		A
114	0	FA	F	661	MM	Motor ON/OFF Status	New Thermal Oxidier Local Control Panel	LI3.06					DI		A
115	0	FA	F	661	MN	Motor Start	New Thermal Oxidier Local Control Panel	LI3.06					DO		A
116	0	FA	F	661	MO	Motor Stop	New Thermal Oxidier Local Control Panel	LI3.06							A
117	0	FA	F	661	UA	Faulty Alarm	New Thermal Oxidier Local Control Panel	LI3.06					DI		A
118	0	FA	F	661	ZB	Position Close	Thermal Oxidizer Inlet -FCV N.O.	LI3.06					DO		A
119	0	FA	F	661	ZD	Position Open	Thermal Oxidizer Inlet -FCV N.O.	LI3.06					DO		A
120	0	FA	F	662	ZB	Position Close	Foul Air Outlet -FCV N.C.	LI3.06					DO		A

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DCS INPUT/OUTPUT LIST

NO.	REV. NO.	TAG NAME				DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION						
		PCU	AREA	LOOP	DEVICE ID	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS LOW	ALARMS HIGH	I/O POINT TYPE	I/O POINT NO.	PCU AREA
121	0	FA	F	662	ZD	Position Open	Foul Air Outlet -FCV N.C.	LI3.06					DO		A
122	0	FA	F		ZB	Position Close	Headworks Existing Sludge Storage Tank - FCV	LI3.06					DO		A
123	0	FA	F		ZD	Position Open	Headworks Existing Sludge Storage Tank - FCV	LI3.06					DO		A
124	0	HA	H	655	IA	High-Low Current Alarm	Headworks Existing Sludge Storage Tanks	LI3.06					DI		A
125	0	HA	H	655	MM	Motor ON/OFF Status	Headworks Existing Sludge Storage Tanks	LI3.06					DI		A
126	0	HA	H	655	MN	Motor Start/Stop	Headworks Existing Sludge Storage Tanks	LI3.06					DO		A
127	0	HA	H	655	YS	Computer Selected	Headworks Existing Sludge Storage Tanks	LI3.06					DI		A
128	0	FA	H	710	IA	High-Low Current Alarm	Hworks & DAF Odour Control Fan	LI3.06					DI		A
129	0	FA	H	710	MN	Motor Start	Hworks & DAF Odour Control Fan	LI3.06					DO		A
130	0	FA	H	710	PAH	High Alarm Pressure	Hworks & DAF Odour Control Fan	LI3.06				1	DI		A
131	0	FA	H	710	SC	Speed Control	Hworks & DAF Odour Control Fan	LI3.06	%	0-100			AO		A
132	0	FA	H	710	ST	Speed Feedback	Hworks & DAF Odour Control Fan	LI3.06	%	0-100			AI		A
133	0	FA	H	710	UA	Faulty Alarm	Hworks & DAF Odour Control Fan	LI3.06					DI		A
134	0	FA	H	710	YS	Computer Selected	Hworks & DAF Odour Control Fan	LI3.06					DI		A
135	0	PA	P	110	ZB	Position Close	Primary Clarifier No.1 - FCV	LI1.01					DO		A
136	0	PA	P	110	ZD	Position Open	Primary Clarifier No.1 - FCV	LI1.01					DO		A
137	0	PA	P	110	ZSB	Position Switch Closed	Primary Clarifier No.1 - FCV	LI1.01					DI		A
138	0	PA	P	110	ZSD	Position Switch Opened	Primary Clarifier No.1 - FCV	LI1.01					DI		A
139	0	PA	P	120	ZB	Position Close	Primary Clarifier No.2 - FCV	LI1.01					DO		A
140	0	PA	P	120	ZD	Position Open	Primary Clarifier No.2 - FCV	LI1.01					DO		A
141	0	PA	P	120	ZSB	Position Switch Closed	Primary Clarifier No.2 - FCV	LI1.01					DI		A
142	0	PA	P	120	ZSD	Position Switch Opened	Primary Clarifier No.2 - FCV	LI1.01					DI		A
143	0	FA	P	235	FT	Flow Transmit	Fermenters Primary Sludge Feed	LI3.01	L/s	0-20			AI		A
144	0	FA	P	236	FT	Flow Transmit	Fermenter No. 2 Primary Sludge	LI3.03	L/s	0-20			AI		A
145	0	FA	P	236	ZC	Position Controller	Fermenter No. 2 Primary Sludge - FCV	LI3.03	%	0-100			AO		A
146	0	FA	P	236	ZSB	Position Switch Closed	Fermenter No. 2 Primary Sludge - FCV	LI3.03					DI		A
147	0	FA	P	236	ZSD	Position Switch Opened	Fermenter No. 2 Primary Sludge - FCV	LI3.03					DI		A
148	0	FA	P	236	ZT	Position Transmit	Fermenter No. 2 Primary Sludge - FCV	LI3.03	%	0-100			AI		A
149	0	PA	P	250	MM	Motor ON/OFF Status	Duty Primary Sludge Pump 1	LI1.01					DI		A
150	0	PA	P	250	MN	Motor Start	Duty Primary Sludge Pump 1	LI1.01					DO		A
151	0	PA	P	250	SC	Speed Control	Duty Primary Sludge Pump 1	LI1.01	%	0-100			AO		A
152	0	PA	P	250	ST	Speed Feedback	Duty Primary Sludge Pump 1	LI1.01	%	0-100			AI		A
153	0	PA	P	250	UA	Faulty Alarm	Duty Primary Sludge Pump 1	LI1.01					DI		A
154	0	PA	P	250	YS	Computer Selected	Duty Primary Sludge Pump 1	LI1.01					DI		A
155	0	PA	P	260	MM	Motor ON/OFF Status	Standby Primary Sludge Pump 2	LI1.01					DI		A
156	0	PA	P	260	MN	Motor Start/Stop	Standby Primary Sludge Pump 2	LI1.01					DO		A
157	0	PA	P	260	SC	Speed Control	Standby Primary Sludge Pump 2	LI1.01	%	0-100			AO		A
158	0	PA	P	260	ST	Speed Feedback	Standby Primary Sludge Pump 2	LI1.01	%	0-100			AI		A
159	0	PA	P	260	UA	Faulty Alarm	Standby Primary Sludge Pump 2	LI1.01					DI		A
160	0	PA	P	260	YS	Computer Selected	Standby Primary Sludge Pump 2	LI1.01					DI		A

I/O POINT TYPES: AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output, MB/TCP = Modbus TCP/IP

DCS INPUT/OUTPUT LIST

NO.	REV. NO.	TAG NAME				DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION						
		PCU	AREA	LOOP	DEVICE ID	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS LOW	ALARMS HIGH	I/O POINT TYPE	I/O POINT NO.	PCU AREA
161	0	SA	S	110	ZC	Position Controller	Bioreactor 1 Anoxic Zones - FCV	LI2.01	%	0-100			AO		B
162	0	SA	S	110	ZSB	Position Switch Closed	Bioreactor 1 Anoxic Zones - FCV	LI2.01					DI		B
163	0	SA	S	110	ZSD	Position Switch Opened	Bioreactor 1 Anoxic Zones - FCV	LI2.01					DI		B
164	0	SA	S	110	ZT	Position Transmit	Bioreactor 1 Anoxic Zones - FCV	LI2.01	%	0-100			AI		B
165	0	SA	S	111	FT	Flow Transmit	Bioreactor 1 Anaerobic Zone	LI2.01	L/s				AI		B
166	0	SA	S	111	ZC	Position Controller	Bioreactor 1 Anoxic Zone No.2 - FCV	LI2.01	%	0-100			AO		B
167	0	SA	S	111	ZSB	Position Switch Closed	Bioreactor 1 Anoxic Zone No.2 - FCV	LI2.01					DI		B
168	0	SA	S	111	ZSD	Position Switch Opened	Bioreactor 1 Anoxic Zone No.2 - FCV	LI2.01					DI		B
169	0	SA	S	111	ZT	Position Transmit	Bioreactor 1 Anoxic Zone No.2 - FCV	LI2.01	%	0-100			AI		B
170	0	SA	S	112	FT	Flow Transmit	Bioreactor 1 Anoxic Zones	LI2.01	L/s				AI		B
171	0	SA	S	112	ZC	Position Controller	Bioreactor 1 Anoxic Zone No.1 - FCV	LI2.01	%	0-100			AO		B
172	0	SA	S	112	ZSB	Position Switch Closed	Bioreactor 1 Anoxic Zone No.1 - FCV	LI2.01					DI		B
173	0	SA	S	112	ZSD	Position Switch Opened	Bioreactor 1 Anoxic Zone No.1 - FCV	LI2.01					DI		B
174	0	SA	S	112	ZT	Position Transmit	Bioreactor 1 Anoxic Zone No.1 - FCV	LI2.01	%	0-100			AI		B
175	0	SA	S	113	ZC	Position Controller	Bioreactor 1 Anaerobic Zone - FCV	LI2.01	%	0-100			AO		B
176	0	SA	S	113	ZSB	Position Switch Closed	Bioreactor 1 Anaerobic Zone - FCV	LI2.01					DI		B
177	0	SA	S	113	ZSD	Position Switch Opened	Bioreactor 1 Anaerobic Zone - FCV	LI2.01					DI		B
178	0	SA	S	113	ZT	Position Transmit	Bioreactor 1 Anaerobic Zone - FCV	LI2.01	%	0-100			AI		B
179	0	SA	S	114	ZC	Position Controller	Bioreactor 1 - FCV	LI2.01	%	0-100			AO		B
180	0	SA	S	114	ZSB	Position Switch Closed	Bioreactor 1 - FCV	LI2.01					DI		B
181	0	SA	S	114	ZSD	Position Switch Opened	Bioreactor 1 - FCV	LI2.01					DI		B
182	0	SA	S	114	ZT	Position Transmit	Bioreactor 1 - FCV	LI2.01	%	0-100			AI		B
183	0	SA	S	120	ZC	Position Controller	Bioreactor 2 Anoxic Zones - FCV	LI2.03	%	0-100			AO		B
184	0	SA	S	120	ZSB	Position Switch Closed	Bioreactor 2 Anoxic Zones - FCV	LI2.03					DI		B
185	0	SA	S	120	ZSD	Position Switch Opened	Bioreactor 2 Anoxic Zones - FCV	LI2.03					DI		B
186	0	SA	S	120	ZT	Position Transmit	Bioreactor 2 Anoxic Zones - FCV	LI2.03	%	0-100			AI		B
187	0	SA	S	121	FT	Flow Transmit	Bioreactor 2 Anaerobic Zone	LI2.03	L/s				AI		B
188	0	SA	S	121	ZC	Position Controller	Bioreactor 2 Anoxic Zone No.2 - FCV	LI2.03	%	0-100			AO		B
189	0	SA	S	121	ZSB	Position Switch Closed	Bioreactor 2 Anoxic Zone No.2 - FCV	LI2.03					DI		B
190	0	SA	S	121	ZSD	Position Switch Opened	Bioreactor 2 Anoxic Zone No.2 - FCV	LI2.03					DI		B
191	0	SA	S	121	ZT	Position Transmit	Bioreactor 2 Anoxic Zone No.2 - FCV	LI2.03	%	0-100			AI		B
192	0	SA	S	122	FT	Flow Transmit	Bioreactor 2 Anoxic Zones	LI2.03	L/s				AI		B
193	0	SA	S	122	ZC	Position Controller	Bioreactor 2 Anoxic Zone No.1 - FCV	LI2.03	%	0-100			AO		B
194	0	SA	S	122	ZSB	Position Switch Closed	Bioreactor 2 Anoxic Zone No.1 - FCV	LI2.03					DI		B
195	0	SA	S	122	ZSD	Position Switch Opened	Bioreactor 2 Anoxic Zone No.1 - FCV	LI2.03					DI		B
196	0	SA	S	122	ZT	Position Transmit	Bioreactor 2 Anoxic Zone No.1 - FCV	LI2.03	%	0-100			AI		B
197	0	SA	S	123	ZC	Position Controller	Bioreactor 2 Anaerobic Zone - FCV	LI2.03	%	0-100			AO		B
198	0	SA	S	123	ZSB	Position Switch Closed	Bioreactor 2 Anaerobic Zone - FCV	LI2.03					DI		B
199	0	SA	S	123	ZSD	Position Switch Opened	Bioreactor 2 Anaerobic Zone - FCV	LI2.03					DI		B
200	0	SA	S	123	ZT	Position Transmit	Bioreactor 2 Anaerobic Zone - FCV	LI2.03	%	0-100			AI		B

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DCS INPUT/OUTPUT LIST

NO.	REV. NO.	TAG NAME				DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION						
		PCU	AREA	LOOP	DEVICE ID	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS LOW	ALARMS HIGH	I/O POINT TYPE	I/O POINT NO.	PCU AREA
201	0	SA	S	124	ZC	Position Controller	Bioreactor 2 - FCV	LI2.03	%	0-100			AO		B
202	0	SA	S	124	ZSB	Position Switch Closed	Bioreactor 2 - FCV	LI2.03					DI		B
203	0	SA	S	124	ZSD	Position Switch Opened	Bioreactor 2 - FCV	LI2.03					DI		B
204	0	SA	S	124	ZT	Position Transmit	Bioreactor 2 - FCV	LI2.03	%	0-100			AI		B
205	0	FA	S	125	FT	Flow Transmit	Fermenters Sec Effluent Feed	LI3.01	L/s				AI		A
206	0	FA	S	125	ZC	Position Controller	Fermenters Sec Effluent Feed - FCV	LI3.01	%	0-100			AO		A
207	0	FA	S	125	ZSB	Position Switch Closed	Fermenters Sec Effluent Feed - FCV	LI3.01					DI		A
208	0	FA	S	125	ZSD	Position Switch Opened	Fermenters Sec Effluent Feed - FCV	LI3.01					DI		A
209	0	FA	S	125	ZT	Position Transmit	Fermenters Sec Effluent Feed - FCV	LI3.01	%	0-100			AI		A
210	0	SB	S	230	IT	Current Feedback	Flushing Water Pump		Amps				AI/TCP		B
211	0	SB	S	230	MF	Not Faulted Status	Flushing Water Pump						DI		B
212	0	SB	S	230	MM	Running Status	Flushing Water Pump						DI		B
213	0	SB	S	230	MN	Start Command	Flushing Water Pump						DO		B
214	0	SB	S	230	SC	Speed Control	Flushing Water Pump		%	0-100			AO		B
215	0	SB	S	230	ST	Speed Feedback	Flushing Water Pump		%	0-100			AI		B
216	0	SB	S	230	YS	Computer Selected	Flushing Water Pump						DI		B
217	0	SA	S	451	AT	Analysis Transmit	Bioreactor 1 Aerobic Zone 1	LI2.02	ppm	0-100			AI		B
218	0	SA	S	451	ZC	Position Controller	Bioreactor 1 Aerobic Zone 1 - FCV	LI2.02	%	0-100			AO		B
219	0	SA	S	451	ZSB	Position Switch Closed	Bioreactor 1 Aerobic Zone 1 - FCV	LI2.02					DI		B
220	0	SA	S	451	ZSD	Position Switch Opened	Bioreactor 1 Aerobic Zone 1 - FCV	LI2.02					DI		B
221	0	SA	S	451	ZT	Position Transmit	Bioreactor 1 Aerobic Zone 1 - FCV	LI2.02	%	0-100			AI		B
222	0	SA	S	452	AT	Analysis Transmit	Bioreactor 1 Aerobic Zone 2	LI2.02	ppm	0-100			AI		B
223	0	SA	S	452	ZC	Position Controller	Bioreactor 1 Aerobic Zone 1 - FCV	LI2.02	%	0-100			AO		B
224	0	SA	S	452	ZSB	Position Switch Closed	Bioreactor 1 Aerobic Zone 1 - FCV	LI2.02					DI		B
225	0	SA	S	452	ZSD	Position Switch Opened	Bioreactor 1 Aerobic Zone 1 - FCV	LI2.02					DI		B
226	0	SA	S	452	ZT	Position Transmit	Bioreactor 1 Aerobic Zone 1 - FCV	LI2.02	%	0-100			AI		B
227	0	SA	S	453	AT	Analysis Transmit	Bioreactor 1 Aerobic Zone 3	LI2.02	ppm	0-100			AI		B
228	0	SA	S	453	ZC	Position Controller	Bioreactor 1 Aerobic Zone 2 - FCV	LI2.02	%	0-100			AO		B
229	0	SA	S	453	ZSB	Position Switch Closed	Bioreactor 1 Aerobic Zone 2 - FCV	LI2.02					DI		B
230	0	SA	S	453	ZSD	Position Switch Opened	Bioreactor 1 Aerobic Zone 2 - FCV	LI2.02					DI		B
231	0	SA	S	453	ZT	Position Transmit	Bioreactor 1 Aerobic Zone 2 - FCV	LI2.02	%	0-100			AI		B
232	0	SA	S	454	AT	Analysis Transmit	Bioreactor 1 Aerobic Zone 4	LI2.02	ppm	0-100			AI		B
233	0	SA	S	454	ZC	Position Controller	Bioreactor 1 Aerobic Zone 2 - FCV	LI2.02	%	0-100			AO		B
234	0	SA	S	454	ZSB	Position Switch Closed	Bioreactor 1 Aerobic Zone 2 - FCV	LI2.02					DI		B
235	0	SA	S	454	ZSD	Position Switch Opened	Bioreactor 1 Aerobic Zone 2 - FCV	LI2.02					DI		B
236	0	SA	S	454	ZT	Position Transmit	Bioreactor 1 Aerobic Zone 2 - FCV	LI2.02	%	0-100			AI		B
237	0	SA	S	455	ZC	Position Controller	Bioreactor 1 Aerobic Zone 3 - FCV	LI2.02	%	0-100			AO		B
238	0	SA	S	455	ZSB	Position Switch Closed	Bioreactor 1 Aerobic Zone 3 - FCV	LI2.02					DI		B
239	0	SA	S	455	ZSD	Position Switch Opened	Bioreactor 1 Aerobic Zone 3 - FCV	LI2.02					DI		B
240	0	SA	S	455	ZT	Position Transmit	Bioreactor 1 Aerobic Zone 3 - FCV	LI2.02	%	0-100			AI		B

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DCS INPUT/OUTPUT LIST

NO.	REV. NO.	TAG NAME				DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION						
		PCU	AREA	LOOP	DEVICE ID	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS LOW	ALARMS HIGH	I/O POINT TYPE	I/O POINT NO.	PCU AREA
241	0	SA	S	456	ZC	Position Controller	Bioreactor 1 Aerobic Zone 4 - FCV	LI2.02	%	0-100			AO		B
242	0	SA	S	456	ZSB	Position Switch Closed	Bioreactor 1 Aerobic Zone 4 - FCV	LI2.02					DI		B
243	0	SA	S	456	ZSD	Position Switch Opened	Bioreactor 1 Aerobic Zone 4 - FCV	LI2.02					DI		B
244	0	SA	S	456	ZT	Position Transmit	Bioreactor 1 Aerobic Zone 4 - FCV	LI2.02	%	0-100			AI		B
245	0	SA	S	457	ZC	Position Controller	Bioreactor 1 Aerobic Zone 4 - FCV	LI2.02	%	0-100			AO		B
246	0	SA	S	457	ZSB	Position Switch Closed	Bioreactor 1 Aerobic Zone 4 - FCV	LI2.02					DI		B
247	0	SA	S	457	ZSD	Position Switch Opened	Bioreactor 1 Aerobic Zone 4 - FCV	LI2.02					DI		B
248	0	SA	S	457	ZT	Position Transmit	Bioreactor 1 Aerobic Zone 4 - FCV	LI2.02	%	0-100			AI		B
249	0	SA	S	458	PAH	High Alarm Pressure	Bioreactor 1 Discharge Chamber	LI2.02				1	DI		B
250	0	SA	S	458	ZB	Position Close	Bioreactor 1 Discharge Chamber - FCV	LI2.02					DO		B
251	0	SA	S	458	ZD	Position Open	Bioreactor 1 Discharge Chamber - FCV	LI2.02					DO		B
252	0	SA	S	458	ZSB	Position Switch Closed	Bioreactor 1 Discharge Chamber - FCV	LI2.02					DI		B
253	0	SA	S	458	ZSD	Position Switch Opened	Bioreactor 1 Discharge Chamber - FCV	LI2.02					DI		B
254	0	SA	S	461	AT	Analysis Transmit	Bioreactor 2 Aerobic Zone 1	LI2.04	ppm	0-100			AI		B
255	0	SA	S	461	ZC	Position Controller	Bioreactor 2 Aerobic Zone 1 - FCV	LI2.04	%	0-100			AO		B
256	0	SA	S	461	ZSB	Position Switch Closed	Bioreactor 2 Aerobic Zone 1 - FCV	LI2.04					DI		B
257	0	SA	S	461	ZSD	Position Switch Opened	Bioreactor 2 Aerobic Zone 1 - FCV	LI2.04					DI		B
258	0	SA	S	461	ZT	Position Transmit	Bioreactor 2 Aerobic Zone 1 - FCV	LI2.04	%	0-100			AI		B
259	0	SA	S	462	AT	Analysis Transmit	Bioreactor 2 Aerobic Zone 2	LI2.04	ppm	0-100			AI		B
260	0	SA	S	462	ZC	Position Controller	Bioreactor 2 Aerobic Zone 1 - FCV	LI2.04	%	0-100			AO		B
261	0	SA	S	462	ZSB	Position Switch Closed	Bioreactor 2 Aerobic Zone 1 - FCV	LI2.04					DI		B
262	0	SA	S	462	ZSD	Position Switch Opened	Bioreactor 2 Aerobic Zone 1 - FCV	LI2.04					DI		B
263	0	SA	S	462	ZT	Position Transmit	Bioreactor 2 Aerobic Zone 1 - FCV	LI2.04	%	0-100			AI		B
264	0	SA	S	463	AT	Analysis Transmit	Bioreactor 2 Aerobic Zone 3	LI2.04	ppm	0-100			AI		B
265	0	SA	S	463	ZC	Position Controller	Bioreactor 2 Aerobic Zone 2 - FCV	LI2.04	%	0-100			AO		B
266	0	SA	S	463	ZSB	Position Switch Closed	Bioreactor 2 Aerobic Zone 2 - FCV	LI2.04					DI		B
267	0	SA	S	463	ZSD	Position Switch Opened	Bioreactor 2 Aerobic Zone 2 - FCV	LI2.04					DI		B
268	0	SA	S	463	ZT	Position Transmit	Bioreactor 2 Aerobic Zone 2 - FCV	LI2.04	%	0-100			AI		B
269	0	SA	S	464	AT	Analysis Transmit	Bioreactor 2 Aerobic Zone 4	LI2.04	ppm	0-100			AI		B
270	0	SA	S	464	ZC	Position Controller	Bioreactor 2 Aerobic Zone 2 - FCV	LI2.04	%	0-100			AO		B
271	0	SA	S	464	ZSB	Position Switch Closed	Bioreactor 2 Aerobic Zone 2 - FCV	LI2.04					DI		B
272	0	SA	S	464	ZSD	Position Switch Opened	Bioreactor 2 Aerobic Zone 2 - FCV	LI2.04					DI		B
273	0	SA	S	464	ZT	Position Transmit	Bioreactor 2 Aerobic Zone 2 - FCV	LI2.04	%	0-100			AI		B
274	0	SA	S	465	ZC	Position Controller	Bioreactor 2 Aerobic Zone 3 - FCV	LI2.04	%	0-100			AO		B
275	0	SA	S	465	ZSB	Position Switch Closed	Bioreactor 2 Aerobic Zone 3 - FCV	LI2.04					DI		B
276	0	SA	S	465	ZSD	Position Switch Opened	Bioreactor 2 Aerobic Zone 3 - FCV	LI2.04					DI		B
277	0	SA	S	465	ZT	Position Transmit	Bioreactor 2 Aerobic Zone 3 - FCV	LI2.04	%	0-100			AI		B
278	0	SA	S	466	ZC	Position Controller	Bioreactor 2 Aerobic Zone 4 - FCV	LI2.04	%	0-100			AO		B
279	0	SA	S	466	ZSB	Position Switch Closed	Bioreactor 2 Aerobic Zone 4 - FCV	LI2.04					DI		B
280	0	SA	S	466	ZSD	Position Switch Opened	Bioreactor 2 Aerobic Zone 4 - FCV	LI2.04					DI		B

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DCS INPUT/OUTPUT LIST

NO.	REV. NO.	TAG NAME				DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION						
		PCU	AREA	LOOP	DEVICE ID	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS LOW	ALARMS HIGH	I/O POINT TYPE	I/O POINT NO.	PCU AREA
281	0	SA	S	466	ZT	Position Transmit	Bioreactor 2 Aerobic Zone 4 - FCV	LI2.04	%	0-100			AI		B
282	0	SA	S	467	ZC	Position Controller	Bioreactor 2 Aerobic Zone 4 - FCV	LI2.04	%	0-100			AO		B
283	0	SA	S	467	ZSB	Position Switch Closed	Bioreactor 2 Aerobic Zone 4 - FCV	LI2.04					DI		B
284	0	SA	S	467	ZSD	Position Switch Opened	Bioreactor 2 Aerobic Zone 4 - FCV	LI2.04					DI		B
285	0	SA	S	467	ZT	Position Transmit	Bioreactor 2 Aerobic Zone 4 - FCV	LI2.04	%	0-100			AI		B
286	0	SA	S	468	ZB	Position Close	Bioreactor 2 Discharge Chamber - FCV	LI2.04					DO		B
287	0	SA	S	468	ZD	Position Open	Bioreactor 2 Discharge Chamber - FCV	LI2.04					DO		B
288	0	SA	S	468	ZSB	Position Switch Closed	Bioreactor 2 Discharge Chamber - FCV	LI2.04					DI		B
289	0	SA	S	468	ZSD	Position Switch Opened	Bioreactor 2 Discharge Chamber - FCV	LI2.04					DI		B
290	0	SA	S	510	MM	Motor ON/OFF Status	Secondary Clarifier No.1	LI2.08					DI		B
291	0	SA	S	510	MN	Motor Start/Stop	Secondary Clarifier No.2	LI2.08					DO		B
292	0	SA	S	510	OAH	Torque Alarm High	Secondary Clarifier No.2	LI2.08				1	DI		B
293	0	SA	S	510	OAHH	Torque Alarm High High	Secondary Clarifier No.2	LI2.08				1	DI		B
294	0	SA	S	510	UA	Faulty Alarm	Secondary Clarifier No.1	LI2.08					DI		B
295	0	SA	S	510	YS	Computer Selected	Secondary Clarifier No.1	LI2.08					DI		B
296	0	SA	S	510	ZI	Position Indicator	Secondary Clarifier No.2	LI2.08					DI		B
297	0	SA	S	520	MM	Motor ON/OFF Status	Secondary Clarifier No.2	LI2.08					DI		B
298	0	SA	S	520	MN	Motor Start/Stop	Secondary Clarifier No.2	LI2.08					DO		B
299	0	SA	S	520	OAH	Torque Alarm High	Secondary Clarifier No.3	LI2.08				1	DI		B
300	0	SA	S	520	OAHH	Torque Alarm High High	Secondary Clarifier No.3	LI2.08				1	DI		B
301	0	SA	S	520	UA	Faulty Alarm	Secondary Clarifier No.2	LI2.08					DI		B
302	0	SA	S	520	YS	Computer Selected	Secondary Clarifier No.2	LI2.08					DI		B
303	0	SA	S	520	ZI	Position Indicator	Secondary Clarifier No.3	LI2.08					DI		B
304	0	SA	S	530	FT	Flow Transmit	Secondary Clarifier 3 Mixed Liquor Feed	LI2.06	L/s				AI		B
305	0	SA	S	530	MM	Motor ON/OFF Status	Secondary Clarifier No.3	LI2.06					DI		B
306	0	SA	S	530	MN	Motor Start/Stop	Secondary Clarifier No.3	LI2.06					DO		B
307	0	SA	S	530	OAH	Torque Alarm High	Secondary Clarifier No.3	LI2.06				1	DI		B
308	0	SA	S	530	OAHH	Torque Alarm High High	Secondary Clarifier No.3	LI2.06				1	DI		B
309	0	SA	S	530	UA	Faulty Alarm	Secondary Clarifier No.3	LI2.06					DI		B
310	0	SA	S	530	YS	Computer Selected	Secondary Clarifier No.3	LI2.06					DI		B
311	0	SA	S	530	ZC	Position Controller	Secondary Clarifier 3 Mixed Liquor Feed - FCV	LI2.06	%	0-100			AO		B
312	0	SA	S	530	ZI	Position Indicator	Secondary Clarifier No.3	LI2.06					DI		B
313	0	SA	S	530	ZSB	Position Switch Closed	Secondary Clarifier 3 Mixed Liquor Feed - FCV	LI2.06					DI		B
314	0	SA	S	530	ZSD	Position Switch Opened	Secondary Clarifier 3 Mixed Liquor Feed - FCV	LI2.06					DI		B
315	0	SA	S	530	ZT	Position Transmit	Secondary Clarifier 3 Mixed Liquor Feed - FCV	LI2.06	%	0-100			AI		B
316	0	SA	S	710	FT	Flow Transmit	Sec Clarifier No.1 R.A.S. - Feed	LI2.07	L/s				AI		B
317	0	SA	S	710	MM	Motor ON/OFF Status	R.A.S. Pump No.1	LI2.08					DI		B
318	0	SA	S	710	MN	Motor Start	R.A.S. Pump No.1	LI2.08					DO		B
319	0	SA	S	710	SC	Speed Control	R.A.S. Pump No.1	LI2.08	%	0-100			AO		B
320	0	SA	S	710	ST	Speed Feedback	R.A.S. Pump No.1	LI2.08	%	0-100			AI		B

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DCS INPUT/OUTPUT LIST

NO.	REV. NO.	TAG NAME				DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION						
		PCU	AREA	LOOP	DEVICE ID	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS LOW	ALARMS HIGH	I/O POINT TYPE	I/O POINT NO.	PCU AREA
321	0	SA	S	710	UA	Faulty Alarm	R.A.S. Pump No.1	LI2.08					DI		B
322	0	SA	S	710	YS	Computer Selected	R.A.S. Pump No.1	LI2.08					DI		B
323	0	SA	S	720	FT	Flow Transmit	Sec Clarifier No.2 R.A.S. - Feed	LI2.07	L/s				AI		B
324	0	SA	S	720	MM	Motor ON/OFF Status	R.A.S. Pump No.2	LI2.08					DI		B
325	0	SA	S	720	MN	Motor Start	R.A.S. Pump No.2	LI2.08					DO		B
326	0	SA	S	720	SC	Speed Control	R.A.S. Pump No.2	LI2.08	%	0-100			AO		B
327	0	SA	S	720	ST	Speed Feedback	R.A.S. Pump No.2	LI2.08	%	0-100			AI		B
328	0	SA	S	720	UA	Faulty Alarm	R.A.S. Pump No.2	LI2.08					DI		B
329	0	SA	S	720	YS	Computer Selected	R.A.S. Pump No.2	LI2.08					DI		B
330	0	SA	S	730	MM	Motor ON/OFF Status	R.A.S. Pump No.3	LI2.08					DI		B
331	0	SA	S	730	MN	Motor Start	R.A.S. Pump No.3	LI2.08					DO		B
332	0	SA	S	730	SC	Speed Control	R.A.S. Pump No.3	LI2.08	%	0-100			AO		B
333	0	SA	S	730	ST	Speed Feedback	R.A.S. Pump No.3	LI2.08	%	0-100			AI		B
334	0	SA	S	730	UA	Faulty Alarm	R.A.S. Pump No.3	LI2.08					DI		B
335	0	SA	S	730	YS	Computer Selected	R.A.S. Pump No.3	LI2.08					DI		B
336	0	SA	S	740	MM	Motor ON/OFF Status	R.A.S. Pump No.4	LI2.07					DI		B
337	0	SA	S	740	MN	Motor Start	R.A.S. Pump No.4	LI2.07					DO		B
338	0	SA	S	740	SC	Speed Control	R.A.S. Pump No.4	LI2.07	%	0-100			AO		B
339	0	SA	S	740	ST	Speed Feedback	R.A.S. Pump No.4	LI2.07	%	0-100			AI		B
340	0	SA	S	740	UA	Faulty Alarm	R.A.S. Pump No.4	LI2.07					DI		B
341	0	SA	S	740	YS	Computer Selected	R.A.S. Pump No.4	LI2.07					DI		B
342	0	SA	S	740	ZC	Position Controller	R.A.S. to Bioreactor 1 - FCV	LI2.01	%	0-100			AO		B
343	0	SA	S	740	ZSB	Position Switch Closed	R.A.S. to Bioreactor 1 - FCV	LI2.01					DI		B
344	0	SA	S	740	ZSD	Position Switch Opened	R.A.S. to Bioreactor 1 - FCV	LI2.01					DI		B
345	0	SA	S	740	ZT	Position Transmit	R.A.S. to Bioreactor 1 - FCV	LI2.01	%	0-100			AI		B
346	0	SA	S	740	AT-1	NH3 Transmitter	Final Effluent to Discharge	LI2.08	mg/l				AI		B
347	0	SA	S	740	AT-2	NO3 Transmitter	Final Effluent to Discharge	LI2.08	mg/l				AI		B
348	0	SA	S	740	AT-3	PO4 Transmitter	Final Effluent to Discharge	LI2.08	mg/l				AI		B
349	0	SA	S	741	ZC	Position Controller	R.A.S. to Bioreactor 2 - FCV	LI2.03	%	0-100			AO		B
350	0	SA	S	741	ZSB	Position Switch Closed	R.A.S. to Bioreactor 2 - FCV	LI2.03					DI		B
351	0	SA	S	741	ZSD	Position Switch Opened	R.A.S. to Bioreactor 2 - FCV	LI2.03					DI		B
352	0	SA	S	741	ZT	Position Transmit	R.A.S. to Bioreactor 2 - FCV	LI2.03	%	0-100			AI		B
353	0	SA	S	750	FT	Flow Transmit	R.A.S. Pump Discharge	LI2.07	L/s	0-460			AI		B
354	0	SA	S	750	MM	Motor ON/OFF Status	R.A.S. Pump No.5	LI2.07					DI		B
355	0	SA	S	750	MN	Motor Start	R.A.S. Pump No.5	LI2.07					DO		B
356	0	SA	S	750	SC	Speed Control	R.A.S. Pump No.5	LI2.07	%	0-100			AO		B
357	0	SA	S	750	ST	Speed Feedback	R.A.S. Pump No.5	LI2.07	%	0-100			AI		B
358	0	SA	S	750	UA	Faulty Alarm	R.A.S. Pump No.5	LI2.07					DI		B
359	0	SA	S	750	YS	Computer Selected	R.A.S. Pump No.5	LI2.07					DI		B
360	0	SA	S	760	MM	Motor ON/OFF Status	Bioreactor 1 Pre Anoxic Zone Mixer	LI2.01					DI		B

I/O POINT TYPES: AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output, MB/TCP = Modbus TCP/IP

DCS INPUT/OUTPUT LIST

NO.	REV. NO.	TAG NAME				DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION						
		PCU	AREA	LOOP	DEVICE ID	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS LOW	ALARMS HIGH	I/O POINT TYPE	I/O POINT NO.	PCU AREA
361	0	SA	S	760	MN	Motor Start/Stop	Bioreactor 1 Pre Anoxic Zone Mixer	LI2.01					DO		B
362	0	SA	S	760	UA	Faulty Alarm	Bioreactor 1 Pre Anoxic Zone Mixer	LI2.01					DI		B
363	0	SA	S	760	YS	Computer Selected	Bioreactor 1 Pre Anoxic Zone Mixer	LI2.01					DI		B
364	0	SA	S	761	MM	Motor ON/OFF Status	Bioreactor 1 Anaerobic Zone Mixer	LI2.01					DI		B
365	0	SA	S	761	MN	Motor Start/Stop	Bioreactor 1 Anaerobic Zone Mixer	LI2.01					DO		B
366	0	SA	S	761	UA	Faulty Alarm	Bioreactor 1 Anaerobic Zone Mixer	LI2.01					DI		B
367	0	SA	S	761	YS	Computer Selected	Bioreactor 1 Anaerobic Zone Mixer	LI2.01					DI		B
368	0	SA	S	762	MM	Motor ON/OFF Status	Bioreactor 1 Anoxic Zone 1 Mixer	LI2.01					DI		B
369	0	SA	S	762	MN	Motor Start/Stop	Bioreactor 1 Anoxic Zone 1 Mixer	LI2.01					DO		B
370	0	SA	S	762	UA	Faulty Alarm	Bioreactor 1 Anoxic Zone 1 Mixer	LI2.01					DI		B
371	0	SA	S	762	YS	Computer Selected	Bioreactor 1 Anoxic Zone 1 Mixer	LI2.01					DI		B
372	0	SA	S	763	MM	Motor ON/OFF Status	Bioreactor 1 Anoxic Zone 2 Mixer	LI2.01					DI		B
373	0	SA	S	763	MN	Motor Start/Stop	Bioreactor 1 Anoxic Zone 2 Mixer	LI2.01					DO		B
374	0	SA	S	763	UA	Faulty Alarm	Bioreactor 1 Anoxic Zone 2 Mixer	LI2.01					DI		B
375	0	SA	S	763	YS	Computer Selected	Bioreactor 1 Anoxic Zone 2 Mixer	LI2.01					DI		B
376	0	SA	S	765	MM	Motor ON/OFF Status	Bioreactor 2 Pre Anoxic Zone Mixer	LI2.03					DI		B
377	0	SA	S	765	MN	Motor Start/Stop	Bioreactor 2 Pre Anoxic Zone Mixer	LI2.03					DO		B
378	0	SA	S	765	UA	Faulty Alarm	Bioreactor 2 Pre Anoxic Zone Mixer	LI2.03					DI		B
379	0	SA	S	765	YS	Computer Selected	Bioreactor 2 Pre Anoxic Zone Mixer	LI2.03					DI		B
380	0	SA	S	766	MM	Motor ON/OFF Status	Bioreactor 2 Anaerobic Zone Mixer	LI2.03					DI		B
381	0	SA	S	766	MN	Motor Start/Stop	Bioreactor 2 Anaerobic Zone Mixer	LI2.03					DO		B
382	0	SA	S	766	UA	Faulty Alarm	Bioreactor 2 Anaerobic Zone Mixer	LI2.03					DI		B
383	0	SA	S	766	YS	Computer Selected	Bioreactor 2 Anaerobic Zone Mixer	LI2.03					DI		B
384	0	SA	S	767	MM	Motor ON/OFF Status	Bioreactor 2 Anoxic Zone 1 Mixer	LI2.03					DI		B
385	0	SA	S	767	MN	Motor Start/Stop	Bioreactor 2 Anoxic Zone 1 Mixer	LI2.03					DO		B
386	0	SA	S	767	UA	Faulty Alarm	Bioreactor 2 Anoxic Zone 1 Mixer	LI2.03					DI		B
387	0	SA	S	767	YS	Computer Selected	Bioreactor 2 Anoxic Zone 1 Mixer	LI2.03					DI		B
388	0	SA	S	768	MM	Motor ON/OFF Status	Bioreactor 2 Anoxic Zone 2 Mixer	LI2.03					DI		B
389	0	SA	S	768	MN	Motor Start/Stop	Bioreactor 2 Anoxic Zone 2 Mixer	LI2.03					DO		B
390	0	SA	S	768	UA	Faulty Alarm	Bioreactor 2 Anoxic Zone 2 Mixer	LI2.03					DI		B
391	0	SA	S	768	YS	Computer Selected	Bioreactor 2 Anoxic Zone 2 Mixer	LI2.03					DI		B
392	0	SA	S	770	MM	Motor ON/OFF Status	Bioreactor 1 Recycle Pump	LI2.02					DI		B
393	0	SA	S	770	MN	Motor Start	Bioreactor 1 Recycle Pump	LI2.02					DO		B
394	0	SA	S	770	SC	Speed Control	Bioreactor 1 Recycle Pump	LI2.02	%	0-100			AO		B
395	0	SA	S	770	ST	Speed Feedback	Bioreactor 1 Recycle Pump	LI2.02	%	0-100			AI		B
396	0	SA	S	770	UA	Faulty Alarm	Bioreactor 1 Recycle Pump	LI2.02					DI		B
397	0	SA	S	770	YS	Computer Selected	Bioreactor 1 Recycle Pump	LI2.02					DI		B
398	0	SA	S	771	MM	Motor ON/OFF Status	Bioreactor 2 Recycle Pump	LI2.04					DI		B
399	0	SA	S	771	MN	Motor Start	Bioreactor 2 Recycle Pump	LI2.04					DO		B
400	0	SA	S	771	SC	Speed Control	Bioreactor 2 Recycle Pump	LI2.04	%	0-100			AO		B

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DCS INPUT/OUTPUT LIST

NO.	REV. NO.	TAG NAME				DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION						
		PCU	AREA	LOOP	DEVICE ID	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS LOW	ALARMS HIGH	I/O POINT TYPE	I/O POINT NO.	PCU AREA
401	0	SA	S	771	ST	Speed Feedback	Bioreactor 2 Recycle Pump	LI2.04	%	0-100			AI		B
402	0	SA	S	771	UA	Faulty Alarm	Bioreactor 2 Recycle Pump	LI2.04					DI		B
403	0	SA	S	771	YS	Computer Selected	Bioreactor 2 Recycle Pump	LI2.04					DI		B
404	0	SA	S	810	MM	Motor ON/OFF Status	W.A.S. Pump No.1	LI2.05					DI		B
405	0	SA	S	810	MN	Motor Start	W.A.S. Pump No.1	LI2.05					DO		B
406	0	SA	S	810	SC	Speed Control	W.A.S. Pump No.1	LI2.05	%	0-100			AO		B
407	0	SA	S	810	ST	Speed Feedback	W.A.S. Pump No.1	LI2.05	%	0-100			AI		B
408	0	SA	S	810	UA	Faulty Alarm	W.A.S. Pump No.1	LI2.05					DI		B
409	0	SA	S	810	YS	Computer Selected	W.A.S. Pump No.1	LI2.05					DI		B
410	0	SA	S	810	ZB	Position Close	Bioreactor 1 W.A.S. - FCV	LI2.05					DO		B
411	0	SA	S	810	ZD	Position Open	Bioreactor 1 W.A.S. - FCV	LI2.05					DO		B
412	0	SA	S	810	ZSB	Position Switch Closed	Bioreactor 1 W.A.S. - FCV	LI2.05					DI		B
413	0	SA	S	810	ZSD	Position Switch Opened	Bioreactor 1 W.A.S. - FCV	LI2.05					DI		B
414	0	SA	S	820	FT	Flow Transmit	Thickeners W.A.S. Feed	LI2.05	L/s	0-15			AI		B
415	0	SA	S	820	MM	Motor ON/OFF Status	W.A.S. Pump No.2	LI2.05					DI		B
416	0	SA	S	820	MN	Motor Start	W.A.S. Pump No.2	LI2.05					DO		B
417	0	SA	S	820	SC	Speed Control	W.A.S. Pump No.2	LI2.05	%	0-100			AO		B
418	0	SA	S	820	ST	Speed Feedback	W.A.S. Pump No.2	LI2.05	%	0-100			AI		B
419	0	SA	S	820	UA	Faulty Alarm	W.A.S. Pump No.2	LI2.05					DI		B
420	0	SA	S	820	YS	Computer Selected	W.A.S. Pump No.2	LI2.05					DI		B
421	0	SA	S	820	ZB	Position Close	Bioreactor 2 W.A.S. - FCV	LI2.05					DO		B
422	0	SA	S	820	ZD	Position Open	Bioreactor 2 W.A.S. - FCV	LI2.05					DO		B
423	0	SA	S	820	ZSB	Position Switch Closed	Bioreactor 2 W.A.S. - FCV	LI2.05					DI		B
424	0	SA	S	820	ZSD	Position Switch Opened	Bioreactor 2 W.A.S. - FCV	LI2.05					DI		B
425	0	TA	S	821	FT	Flow Transmit	D.A.F. 2 W.A.S. Feed	LI4.03	L/s	0-15			AI		A
426	0	TA	S	822	ZC	Position Controller	D.A.F. 2 W.A.S. Feed - FCV	LI4.03	%	0-100			AO		A
427	0	TA	S	822	ZSB	Position Switch Closed	D.A.F. 2 W.A.S. Feed - FCV	LI4.03					DI		A
428	0	TA	S	822	ZSD	Position Switch Opened	D.A.F. 2 W.A.S. Feed - FCV	LI4.03					DI		A
429	0	TA	S	822	ZT	Position Transmit	D.A.F. 2 W.A.S. Feed - FCV	LI4.03	%	0-100			AI		A
430	0	TA	T	110	LAH	High Alarm Level	D.A.F. 1 Float Hopper	LI4.02				1	DI		A
431	0	TA	T	110	YS	Computer Selected	D.A.F. 1 Skimmer Flush - SV	LI4.02					DI		A
432	0	TA	T	110	ZD	Position Open	D.A.F. 1 Skimmer Flush - SV	LI4.02					DO		A
433	0	TA	T	111	LT	Level Transmit	D.A.F. 1 Subnatant Wet Well	LI4.02	Meter				AI		A
434	0	TA	T	111	MM	Motor ON/OFF Status	D.A.F. 1 Skimmer Drive	LI4.02					DI		A
435	0	TA	T	111	MN	Motor Start	D.A.F. 1 Skimmer Drive	LI4.02					DO		A
436	0	TA	T	111	OAH	Torque Alarm High	D.A.F. 1 Skimmer Drive	LI4.02				1	DI		A
437	0	TA	T	111	OAL	Torque Alarm Low	D.A.F. 1 Skimmer Drive	LI4.02				1	DI		A
438	0	TA	T	111	UA	Faulty Alarm	D.A.F. 1 Skimmer Drive	LI4.02					DI		A
439	0	TA	T	111	YS	Computer Selected	D.A.F. 1 Skimmer Drive	LI4.02					DI		A
440	0	TA	T	111	ZB	Position Close	D.A.F. 1 Sludge Discharge Valve - FCV	LI4.02					DO		A

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DCS INPUT/OUTPUT LIST

NO.	REV. NO.	TAG NAME				DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION						
		PCU	AREA	LOOP	DEVICE ID	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS LOW	ALARMS HIGH	I/O POINT TYPE	I/O POINT NO.	PCU AREA
441	0	TA	T	111	ZD	Position Open	D.A.F. 1 Sludge Discharge Valve - FCV	LI4.02					DO		A
442	0	TA	T	111	ZSB	Position Closed	D.A.F. 1 Sludge Discharge Valve - FCV	LI4.02					DI		A
443	0	TA	T	111	ZSD	Position Opened	D.A.F. 1 Sludge Discharge Valve - FCV	LI4.02					DI		A
444	0	TA	T	112	FT	Flow Transmit	D.A.F. 1 Recycle Loop	LI4.02	L/s	0-120			AI		A
445	0	TA	T	112	LAH	High Alarm Level	D.A.F. 1 Saturator 1	LI4.02				1	DI		A
446	0	TA	T	112	LAL	Low Alarm Level	D.A.F. 1 Saturator 1	LI4.02			1		DI		A
447	0	TA	T	112	MM	Motor ON/OFF Status	D.A.F. 1 Air Compressor	LI4.02					DI		A
448	0	TA	T	112	MN	Motor Start/Stop	D.A.F. 1 Air Compressor	LI4.02					DO		A
449	0	TA	T	112	PAH	High Alarm Pressure	D.A.F. 1 Air Compressor	LI4.02				1	DI		A
450	0	TA	T	112	PAL	Low Alarm Pressure	D.A.F. 1 Air Control Panel	LI4.02			1		DI		A
451	0	TA	T	112	UA	Faulty Alarm	D.A.F. 1 Air Compressor	LI4.02					DI		A
452	0	TA	T	112	YS	Computer Selected	D.A.F. 1 Air Control Panel-SV	LI4.02					DI		A
453	0	TA	T	112	YS	Computer Selected	D.A.F. 1 Air Compressor	LI4.02					DI		A
454	0	TA	T	112	ZD	Position Open	D.A.F. 1 Air Control Panel-SV	LI4.02					DO		A
455	0	TA	T	113	MM	Motor ON/OFF Status	D.A.F. 1 Recycle Pump	LI4.02					DI		A
456	0	TA	T	113	MN	Motor Start/Stop	D.A.F. 1 Recycle Pump	LI4.02					DO		A
457	0	TA	T	113	UA	Faulty Alarm	D.A.F. 1 Recycle Pump	LI4.02					DI		A
458	0	TA	T	113	YS	Computer Selected	D.A.F. 1 Recycle Pump	LI4.02					DI		A
459	0	TA	T	120	LAH	High Alarm Level	D.A.F. 2 Float Hopper	LI4.03				1	DI		A
460	0	TA	T	120	YS	Computer Selected	D.A.F. 2 Skimmer Flush - SV	LI4.03					DI		A
461	0	TA	T	120	ZD	Position Open	D.A.F. 2 Skimmer Flush - SV	LI4.03					DO		A
462	0	TA	T	121	LT	Level Transmit	D.A.F. 2 Subnatant Wet Well	LI4.03	Meter				AI		A
463	0	TA	T	121	MM	Motor ON/OFF Status	D.A.F. 2 Skimmer Drive	LI4.03					DI		A
464	0	TA	T	121	MN	Motor Start	D.A.F. 2 Skimmer Drive	LI4.03					DO		A
465	0	TA	T	121	OAH	Torque Alarm High	D.A.F. 2 Skimmer Drive	LI4.03				1	AI		A
466	0	TA	T	121	OAL	Torque Alarm Low	D.A.F. 2 Skimmer Drive	LI4.03				1	AI		A
467	0	TA	T	121	UA	Faulty Alarm	D.A.F. 2 Skimmer Drive	LI4.03					DI		A
468	0	TA	T	121	YS	Computer Selected	D.A.F. 2 Skimmer Drive	LI4.03					DI		A
469	0	TA	T	121	ZB	Position Close	D.A.F. 2 Sludge Discharge Valve - FCV	LI4.03					DO		A
470	0	TA	T	121	ZD	Position Open	D.A.F. 2 Sludge Discharge Valve - FCV	LI4.03					DO		A
471	0	TA	T	121	ZSB	Position Closed	D.A.F. 2 Sludge Discharge Valve - FCV	LI4.03					DI		A
472	0	TA	T	121	ZSD	Position Opened	D.A.F. 2 Sludge Discharge Valve - FCV	LI4.03					DI		A
473	0	TA	T	122	FT	Flow Transmit	D.A.F. 2 Recycle Loop	LI4.03	L/s	0-120			AI		A
474	0	TA	T	122	LAH	High Alarm Level	D.A.F. 2 Saturator	LI4.03				1	DI		A
475	0	TA	T	122	LAL	Low Alarm Level	D.A.F. 2 Saturator	LI4.03			1		DI		A
476	0	TA	T	122	MM	Motor ON/OFF Status	D.A.F. 2 Air Compressor	LI4.03					DI		A
477	0	TA	T	122	MN	Motor Start/Stop	D.A.F. 2 Air Compressor	LI4.03					DO		A
478	0	TA	T	122	PAH	High Alarm Pressure	D.A.F. 2 Air Compressor	LI4.03				1	DI		A
479	0	TA	T	122	PAL	Low Alarm Pressure	D.A.F. 2 Air Control Panel	LI4.03			1		DI		A
480	0	TA	T	122	UA	Faulty Alarm	D.A.F. 2 Air Compressor	LI4.03					DI		A

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DCS INPUT/OUTPUT LIST

NO.	REV. NO.	TAG NAME				DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION						
		PCU	AREA	LOOP	DEVICE ID	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS LOW	ALARMS HIGH	I/O POINT TYPE	I/O POINT NO.	PCU AREA
481	0	TA	T	122	YS	Computer Selected	D.A.F. 2 Air Control Panel-SV	LI4.03					DI		A
482	0	TA	T	122	YS	Computer Selected	D.A.F. 2 Air Compressor	LI4.03					DI		A
483	0	TA	T	122	ZD	Position Open	D.A.F. 2 Air Control Panel-SV	LI4.03					DO		A
484	0	TA	T	123	MM	Motor ON/OFF Status	D.A.F. 2 Recycle Pump	LI4.03					DI		A
485	0	TA	T	123	MN	Motor Start/Stop	D.A.F. 2 Recycle Pump	LI4.03					DO		A
486	0	TA	T	123	UA	Faulty Alarm	D.A.F. 2 Recycle Pump	LI4.03					DI		A
487	0	TA	T	123	YS	Computer Selected	D.A.F. 2 Recycle Pump	LI4.03					DI		A
488	0	TA	T	125	MM	Motor ON/OFF Status	Subnatant Pump No.1	LI4.04					DI		A
489	0	TA	T	125	MN	Motor Start	Subnatant Pump No.1	LI4.04					DO		A
490	0	TA	T	125	SC	Speed Control	Subnatant Pump No.1	LI4.04	%	0-100			AO		A
491	0	TA	T	125	ST	Speed Feedback	Subnatant Pump No.1	LI4.04	%	0-100			AI		A
492	0	TA	T	125	UA	Faulty Alarm	Subnatant Pump No.1	LI4.04					DI		A
493	0	TA	T	125	YS	Computer Selected	Subnatant Pump No.1	LI4.04					DI		A
494	0	TA	T	126	MM	Motor ON/OFF Status	Subnatant Pump No.2	LI4.04					DI		A
495	0	TA	T	126	MN	Motor Start	Subnatant Pump No.2	LI4.04					DO		A
496	0	TA	T	126	SC	Speed Control	Subnatant Pump No.2	LI4.04	%	0-100			AO		A
497	0	TA	T	126	ST	Speed Feedback	Subnatant Pump No.2	LI4.04	%	0-100			AI		A
498	0	TA	T	126	UA	Faulty Alarm	Subnatant Pump No.2	LI4.04					DI		A
499	0	TA	T	126	YS	Computer Selected	Subnatant Pump No.2	LI4.04					DI		A
500	0	TA	T	127	FT	Flow Transmit	Fermenters D.A.F. Subnatant Feed	LI4.04	L/s	0-36			AI		A
501	0	TA	T	130	LAH	High Alarm Level	D.A.F. Polymer Run Tank	LI4.01				1	DI		A
502	0	TA	T	130	LAL	Low Alarm Level	D.A.F. Polymer Run Tank	LI4.01			1		DI		A
503	0	TA	T	130	LALL	Low Low Alarm Level	D.A.F. Polymer Run Tank	LI4.01			1		DI		A
504	0	TA	T	130	MM	Motor ON/OFF Status	D.A.F. Polymer Blower	LI4.01					DI		A
505	0	TA	T	130	MN	Motor Start/Stop	D.A.F. Polymer Blower	LI4.01					DO		A
506	0	TA	T	130	PAL	Low Alarm Pressure	D.A.F. Polymer Tank Inlet Pressure	LI4.01			1		DI		A
507	0	TA	T	130	UA	Faulty Alarm	D.A.F. Polymer Blower	LI4.01					DI		A
508	0	TA	T	130	YS	Computer Selected	D.A.F. Polymer Blower	LI4.01					DI		A
509	0	TA	T	130	YS	Computer Selected	D.A.F. Dry Polymer Feed - SV	LI4.01					DI		A
510	0	TA	T	130	ZD	Position Open	D.A.F. Dry Polymer Feed - SV	LI4.01					DO		A
511	0	TA	T	131	FT	Flow Transmit	D.A.F. Polymer Metering Pumps Discharge	LI4.01	L/s	0-120			AI		A
512	0	TA	T	131	LAL	Low Alarm Level	D.A.F. Polymer Run Tank	LI4.01			1		DI		A
513	0	TA	T	131	LALL	Low Low Alarm Level	D.A.F. Polymer Run Tank	LI4.01			1		DI		A
514	0	TA	T	131	MM	Motor ON/OFF Status	D.A.F. Polymer Metering Pump No.1	LI4.01					DI		A
515	0	TA	T	131	MN	Motor Start	D.A.F. Polymer Metering Pump No.1	LI4.01					DO		A
516	0	TA	T	131	PAH	High Alarm Pressure	D.A.F. Polymer Metering Pump No.1	LI4.01				1	DI		A
517	0	TA	T	131	SC	Speed Control	D.A.F. Polymer Metering Pump No.1	LI4.01	%	0-100			AO		A
518	0	TA	T	131	ST	Speed Feedback	D.A.F. Polymer Metering Pump No.1	LI4.01	%	0-100			AI		A
519	0	TA	T	131	UA	Faulty Alarm	D.A.F. Polymer Metering Pump No.1	LI4.01					DI		A
520	0	TA	T	131	YS	Computer Selected	D.A.F. Polymer Metering Pump No.1	LI4.01					DI		A

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DCS INPUT/OUTPUT LIST

NO.	REV. NO.	TAG NAME				DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION						
		PCU	AREA	LOOP	DEVICE ID	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS LOW	ALARMS HIGH	I/O POINT TYPE	I/O POINT NO.	PCU AREA
521	0	TA	T	131	YS	Computer Selected	D.A.F. Polymer Sec Effluent Feed - SV	LI4.01					DI		A
522	0	TA	T	131	ZD	Position Open	D.A.F. Polymer Sec Effluent Feed - SV	LI4.01					DO		A
523	0	TA	T	132	FT	Flow Transmit	D.A.F. Polymer Metering Pumps Discharge	LI4.01	L/s	0-120			AI		A
524	0	TA	T	132	MM	Motor ON/OFF Status	D.A.F. Polymer Metering Pump No.2	LI4.01					DI		A
525	0	TA	T	132	MN	Motor Start	D.A.F. Polymer Metering Pump No.2	LI4.01					DO		A
526	0	TA	T	132	PAH	High Alarm Pressure	D.A.F. Polymer Metering Pump No.2	LI4.01				1	DI		A
527	0	TA	T	132	SC	Speed Control	D.A.F. Polymer Metering Pump No.2	LI4.01	%	0-100			AO		A
528	0	TA	T	132	ST	Speed Feedback	D.A.F. Polymer Metering Pump No.2	LI4.01	%	0-100			AI		A
529	0	TA	T	132	UA	Faulty Alarm	D.A.F. Polymer Metering Pump No.2	LI4.01					DI		A
530	0	TA	T	132	YS	Computer Selected	D.A.F. Polymer Metering Pump No.2	LI4.01					DI		A
531	0	TA	T	132	YS	Computer Selected	D.A.F. Polymer Sec Effluent Feed - SV	LI4.01					DI		A
532	0	TA	T	132	ZD	Position Open	D.A.F. Polymer Sec Effluent Feed - SV	LI4.01					DO		A
533	0	TA	T	133	LAL	Low Alarm Level	D.A.F. Dry Polymer Hopper Level	LI4.01			1		DI		A
534	0	TA	T	133	MM	Motor ON/OFF Status	D.A.F. Dry Polymer Hopper	LI4.01					DI		A
535	0	TA	T	133	MN	Motor Start/Stop	D.A.F. Dry Polymer Hopper	LI4.01					DO		A
536	0	TA	T	133	UA	Faulty Alarm	D.A.F. Dry Polymer Hopper	LI4.01					DI		A
537	0	TA	T	133	YS	Computer Selected	D.A.F. Dry Polymer Hopper	LI4.01					DI		A
538	0	TA	T	134	MM	Motor ON/OFF Status	D.A.F. Dry Polymer Mixer	LI4.01					DI		A
539	0	TA	T	134	MN	Motor Start/Stop	D.A.F. Dry Polymer Mixer	LI4.01					DO		A
540	0	TA	T	134	UA	Faulty Alarm	D.A.F. Dry Polymer Mixer	LI4.01					DI		A
541	0	TA	T	134	YS	Computer Selected	D.A.F. Dry Polymer Mixer	LI4.01					DI		A
542	0	TA	T	134	YS	Computer Selected	D.A.F. Polymer Mix Tank Outlet - SV	LI4.01					DI		A
543	0	TA	T	134	ZD	Position Open	D.A.F. Polymer Mix Tank Outlet - SV	LI4.01					DO		A
544	0	TA	T	135	LAH	High Alarm Level	Clarifier Polymer Run Tank	LI4.07				1	DI		A
545	0	TA	T	135	LAL	Low Alarm Level	Clarifier Polymer Run Tank	LI4.07			1		DI		A
546	0	TA	T	135	LALL	Low Low Alarm Level	Clarifier Polymer Run Tank	LI4.07			1		DI		A
547	0	TA	T	135	MM	Motor ON/OFF Status	Clarifier Polymer Blower	LI4.07					DI		A
548	0	TA	T	135	MN	Motor Start/Stop	Clarifier Polymer Blower	LI4.07					DO		A
549	0	TA	T	135	PAL	Low Alarm Pressure	Clarifier Polymer Tank Inlet Pressure	LI4.07			1		DI		A
550	0	TA	T	135	UA	Faulty Alarm	Clarifier Polymer Blower	LI4.07					DI		A
551	0	TA	T	135	YS	Computer Selected	Clarifier Polymer Blower	LI4.07					DI		A
552	0	TA	T	135	YS	Computer Selected	Clarifier Polymer Water Feed - SV	LI4.07					DI		A
553	0	TA	T	135	ZD	Position Open	Clarifier Polymer Water Feed - SV	LI4.07					DO		A
554	0	TA	T	136	FT	Flow Transmit	Clarifier Polymer Metering Pumps Discharge	LI4.07	L/s	0-240			AI		A
555	0	TA	T	136	LAL	Low Alarm Level	Clarifier Polymer Run Tank	LI4.07			1		DI		A
556	0	TA	T	136	LALL	Low Low Alarm Level	Clarifier Polymer Metering Run Tank	LI4.07			1		DI		A
557	0	TA	T	136	LALL	Low Low Alarm Level	Clarifier Polymer Run Tank	LI4.07			1		DI		A
558	0	TA	T	136	MM	Motor ON/OFF Status	Clarifier Polymer Metering Pump No.1	LI4.07					DI		A
559	0	TA	T	136	MN	Motor Start	Clarifier Polymer Metering Pump No.1	LI4.07					DO		A
560	0	TA	T	136	PAH	High Alarm Pressure	Clarifier Polymer Metering Pump No.1	LI4.07				1	DI		A

I/O POINT TYPES: AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output, MB/TCP = Modbus TCP/IP

DCS INPUT/OUTPUT LIST

NO.	REV. NO.	TAG NAME				DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION						
		PCU	AREA	LOOP	DEVICE ID	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS LOW	ALARMS HIGH	I/O POINT TYPE	I/O POINT NO.	PCU AREA
561	0	TA	T	136	SC	Speed Control	Clarifier Polymer Metering Pump No.1	LI4.07	%	0-100			AO		A
562	0	TA	T	136	ST	Speed Feedback	Clarifier Polymer Metering Pump No.1	LI4.07	%	0-100			AI		A
563	0	TA	T	136	UA	Faulty Alarm	Clarifier Polymer Metering Pump No.1	LI4.07					DI		A
564	0	TA	T	136	YS	Computer Selected	Clarifier Polymer Metering Pump No.1	LI4.07					DI		A
565	0	TA	T	136	YS	Computer Selected	Clarifier Polymer Water Feed - SV	LI4.07					DI		A
566	0	TA	T	136	ZD	Position Open	Clarifier Polymer Water Feed - SV	LI4.07					DO		A
567	0	TA	T	137	MM	Motor ON/OFF Status	Clarifier Polymer Metering Pump No.2	LI4.07					DI		A
568	0	TA	T	137	MN	Motor Start	Clarifier Polymer Metering Pump No.2	LI4.07					DO		A
569	0	TA	T	137	PAH	High Alarm Pressure	Clarifier Polymer Metering Pump No.2	LI4.07				1	DI		A
570	0	TA	T	137	SC	Speed Control	Clarifier Polymer Metering Pump No.2	LI4.07	%	0-100			AO		A
571	0	TA	T	137	ST	Speed Feedback	Clarifier Polymer Metering Pump No.2	LI4.07	%	0-100			AI		A
572	0	TA	T	137	UA	Faulty Alarm	Clarifier Polymer Metering Pump No.2	LI4.07					DI		A
573	0	TA	T	137	YS	Computer Selected	Clarifier Polymer Metering Pump No.2	LI4.07					DI		A
574	0	TA	T	138	LAL	Low Alarm Level	Clarifier Dry Polymer Hopper Level	LI4.07			1		DI		A
575	0	TA	T	138	MM	Motor ON/OFF Status	Clarifier Dry Polymer Hopper	LI4.07					DI		A
576	0	TA	T	138	MN	Motor Start/Stop	Clarifier Dry Polymer Hopper	LI4.07					DO		A
577	0	TA	T	138	UA	Faulty Alarm	Clarifier Dry Polymer Hopper	LI4.07					DI		A
578	0	TA	T	138	YS	Computer Selected	Clarifier Dry Polymer Hopper	LI4.07					DI		A
579	0	TA	T	139	MM	Motor ON/OFF Status	Clarifier Dry Polymer Mixer	LI4.07					DI		A
580	0	TA	T	139	MN	Motor Start/Stop	Clarifier Dry Polymer Mixer	LI4.07					DO		A
581	0	TA	T	139	UA	Faulty Alarm	Clarifier Dry Polymer Mixer	LI4.07					DI		A
582	0	TA	T	139	YS	Computer Selected	Clarifier Dry Polymer Mixer	LI4.07					DI		A
583	0	TA	T	139	YS	Computer Selected	Clarifier Polymer Mix Tank Outlet - SV	LI4.07					DI		A
584	0	TA	T	139	ZD	Position Open	Clarifier Polymer Mix Tank Outlet - SV	LI4.07					DO		A
585	0	TA	T	140	LAH	High Alarm Level	Ferric Chloride Tank	LI4.05				1	DI		A
586	0	TA	T	140	LAL	Low Alarm Level	Ferric Chloride Tank	LI4.05			1		DI		A
587	0	TA	T	140	LT	Level Transmit	Ferric Chloride Tank	LI4.05	Meter				AI		A
588	0	TA	T	141	FAL	Low Alarm Flow	Ferric Chloride Dosing Pump No.1	LI4.06			1		DI		A
589	0	TA	T	141	MM	Motor ON/OFF Status	Ferric Chloride Dosing Pump No.1	LI4.06					DI		A
590	0	TA	T	141	MN	Motor Start	Ferric Chloride Dosing Pump No.1	LI4.06					DO		A
591	0	TA	T	141	SC	Speed Control	Ferric Chloride Dosing Pump No.1	LI4.06	%	0-100			AO		A
592	0	TA	T	141	ST	Speed Feedback	Ferric Chloride Dosing Pump No.1	LI4.06	%	0-100			AI		A
593	0	TA	T	141	UA	Faulty Alarm	Ferric Chloride Dosing Pump No.1	LI4.06					DI		A
594	0	TA	T	141	YS	Computer Selected	Ferric Chloride Dosing Pump No.1	LI4.06					DI		A
595	0	TA	T	142	FAL	Low Alarm Flow	Ferric Chloride Dosing Pump No.2	LI4.06			1		DI		A
596	0	TA	T	142	MM	Motor ON/OFF Status	Ferric Chloride Dosing Pump No.2	LI4.06					DI		A
597	0	TA	T	142	MN	Motor Start	Ferric Chloride Dosing Pump No.2	LI4.06					DO		A
598	0	TA	T	142	SC	Speed Control	Ferric Chloride Dosing Pump No.2	LI4.06	%	0-100			AO		A
599	0	TA	T	142	ST	Speed Feedback	Ferric Chloride Dosing Pump No.2	LI4.06	%	0-100			AI		A
600	0	TA	T	142	UA	Faulty Alarm	Ferric Chloride Dosing Pump No.2	LI4.06					DI		A

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DCS INPUT/OUTPUT LIST

NO.	REV. NO.	TAG NAME				DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION						
		PCU	AREA	LOOP	DEVICE ID	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS		I/O POINT TYPE	I/O POINT NO.	PCU AREA
											LOW	HIGH			
601	0	TA	T	142	YS	Computer Selected	Ferric Chloride Dosing Pump No.2	LI4.06					DI		A
602	0	TA	T	143	FAL	Low Alarm Flow	Ferric Chloride Dosing Pump No.3	LI4.06			1		DI		A
603	0	TA	T	143	MM	Motor ON/OFF Status	Ferric Chloride Dosing Pump No.3	LI4.06					DI		A
604	0	TA	T	143	MN	Motor Start	Ferric Chloride Dosing Pump No.3	LI4.06					DO		A
605	0	TA	T	143	SC	Speed Control	Ferric Chloride Dosing Pump No.3	LI4.06	%	0-100			AO		A
606	0	TA	T	143	ST	Speed Feedback	Ferric Chloride Dosing Pump No.3	LI4.06	%	0-100			AI		A
607	0	TA	T	143	UA	Faulty Alarm	Ferric Chloride Dosing Pump No.3	LI4.06					DI		A
608	0	TA	T	143	YS	Computer Selected	Ferric Chloride Dosing Pump No.3	LI4.06					DI		A
609	0	TA	T	144	FAL	Low Alarm Flow	Ferric Chloride Dosing Pump No.4	LI4.06			1		DI		A
610	0	TA	T	144	MM	Motor ON/OFF Status	Ferric Chloride Dosing Pump No.4	LI4.06					DI		A
611	0	TA	T	144	MN	Motor Start	Ferric Chloride Dosing Pump No.4	LI4.06					DO		A
612	0	TA	T	144	SC	Speed Control	Ferric Chloride Dosing Pump No.4	LI4.06	%	0-100			AO		A
613	0	TA	T	144	ST	Speed Feedback	Ferric Chloride Dosing Pump No.4	LI4.06	%	0-100			AI		A
614	0	TA	T	144	UA	Faulty Alarm	Ferric Chloride Dosing Pump No.4	LI4.06					DI		A
615	0	TA	T	144	YS	Computer Selected	Ferric Chloride Dosing Pump No.4	LI4.06					DI		A
616	0	TA	T	145	LAH	High Alarm Level	Ferric Chloride Containment Sump	LI4.06				1	DI		A
617	0	TA	T	910	ZS	Security Motion Detector	Intruder Securoty System	-				1	DI		A
618	0	TA	T	911	ZS	Security Door Switch	Intruder Securoty System	-				1	DI		A
619	0	TA	T	912	ZS	Security Motion Detector	Intruder Securoty System	-				1	DI		A
620	0	TA	T	913	ZS	Security Door Switch	Intruder Securoty System	-				1	DI		A
621	0	TA	T	914	ZS	Security Motion Detector	Intruder Securoty System	-				1	DI		A
622	0	TA	T	915	ZS	Security Door Switch	Intruder Securoty System	-				1	DI		A

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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

END OF SECTION

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
001	0	F	550	HS-1	Lock Off Stop (LOS) Pushbutton	Fermenter 1	17216	-	LI3.02	ILD-16	FI2.02	CON
002	0	F	550	HS-2	Computer-Off-Hand Selector Switch	Fermenter 1	17216	-	LI3.02	ILD-16	FI2.02	CON
003	0	F	550	LSHH	High High Level Switch	Fermenter 1	17701-A	I102	LI3.02	ILD-02	FI2.02	CON
004	0	F	550	MD1	Motorized Damper Actuator	Primary Sludge Fermenter 1 Supply Air			LI3.06	ILD-11	FM2.01	CON
005	0	F	550	MM-1	Running Pilot Light	Fermenter 1	17216	-	LI3.02	ILD-16	FI2.02	CON
006	0	F	550	MO-1	Stopped Pilot Light	Fermenter 1	17216	-	LI3.02	ILD-16	FI2.02	CON
007	0	F	550	OSH	High Torque Switch	Fermenter 1	11521	-	LI3.02	ILD-16	FI2.02	PKG
008	0	F	550	OSHH	High High Torque Switch	Fermenter 1	11521	-	LI3.02	ILD-16	FI2.02	PKG
009	0	F	550	ZS	Position Switch	Fermenter 1	11521	-	LI3.02	ILD-16	FI2.02	PKG
010	0	F	551	FCV	Motorized Valve Actuator	Fermenter 1 Sludge Control Valve	17701-A	-	LI3.04	ILD-12	FI2.03	CON
011	0	F	551	FE	Magnetic Flow Element	Fermenter Sludge Pumps Discharge	17701-A	I101	LI3.04	ILD-04	PI1.01	CON
012	0	F	551	FIT	Magnetic Flow Transmitter	Fermenter Sludge Pumps Discharge	17701-A	I101	LI3.04	ILD-04	PI1.01	CON
013	0	F	551	PSH	High Pressure Switch	Fermenter Sludge Pump 1 Discharge			LI3.04		FI2.03	PKG
014	0	F	552	FCV	Flow Control Valve	Fermenter 2 Sludge	17701-A	-	LI3.04	ILD-12	FI2.03	CON
015	0	F	552	PSH	High Pressure Switch	Fermenter Sludge Pump 2 Discharge			LI3.04		FI2.03	PKG
016	0	F	553	FV	Solenoid Valve	Fermenter 1 Spray Water	17701-A	I108	LI3.02	ILD-13	FI2.03	CON
017	0	F	553	HS-1	Local-Remote Selector Switch	Fermenter 1 Spray Water Solenoid Valve	17216	-	LI3.02	ILD-13	FI2.03	CON
018	0	F	553	HS-2	Open/Close Selector Switch	Fermenter 1 Spray Water Solenoid Valve	17216	-	LI3.02	ILD-13	FI2.03	CON
019	0	F	553	PSL	Low Pressure Switch	Fermenter Sludge Pumps Process Air	17701-A	I105	LI3.04	ILD-01	FI2.03	CON
020	0	F	555	FV-1	Solenoid Valve	Fermenter Sprnatnt Wet Well Spray	17701-A	I108	LI3.05	ILD-13	FI2.03	CON
021	0	F	555	FV-2	Solenoid Valve	Fermenter Sprnatnt Wet Well Flush Water	17701-A	I108	LI3.05	ILD-13	FI2.03	CON
022	0	F	555	HS-1	Local-Remote Selector Switch	Fermenter Sprnatnt Wet Well SprayValve	17216	-	LI3.05	ILD-13	FI2.03	CON
023	0	F	555	HS-2	Open/Close Selector Switch	Fermenter Sprnatnt Wet Well SprayValve	17216	-	LI3.05	ILD-13	FI2.03	CON
024	0	F	555	HS-3	Local-Remote Selector Switch	Fermenter Sprnatnt Wet Well Flushing Valve	17216	-	LI3.05	ILD-13	FI2.03	CON
025	0	F	555	HS-4	Open/Close Selector Switch	Fermenter Sprnatnt Wet Well Flushing Valve	17216	-	LI3.05	ILD-13	FI2.03	CON
026	0	F	555	LSHH	High High Level Switch	Fermenter Sprnatnt Wet Well	17701-A	I102	LI3.05	ILD-02	FI2.02	CON
027	0	F	555	PIT-1	Pressure Transmitter	Fermenter Sprnatnt Wet Well	17701-A	I106	LI3.05	ILD-05	FI2.03	CON
028	0	F	555	PIT-2	Pressure Transmitter	Fermenter Supernatant Wetwell	17701-A	I106	LI3.06	ILD-05	FI2.02	CON
029	0	F	555	PSLL	Low Low Pressure Switch	Fermenter Sprnatnt Wet Well	17701-A	I105	LI3.05	ILD-01	FI2.03	CON
030	0	F	556	FCV	Motorized Valve Actuator	Fermenter Supernatant Pump 2 Disch. Valve	17213	-	LI3.05	ILD-12	FI2.03	CON
031	0	F	556	FE	Magnetic Flow Element	Bioreactor 1 Fermenter Supernatant Feed	17701-A	I101	LI3.05	ILD-04	FI2.03	CON
032	0	F	556	FIT	Magnetic Flow Transmitter	Bioreactor 1 Fermenter Supernatant Feed	17701-A	I101	LI3.05	ILD-04	FI2.03	CON
033	0	F	556	HS-1	Lock Off Stop (LOS) Pushbutton	Fermenter Supernatant Pump 1	17216	-	LI3.05	ILD-17	FI2.03	CON
034	0	F	556	HS-2	Computer-Off-Hand Selector Switch	Fermenter Supernatant Pump 1	17216	-	LI3.05	ILD-17	FI2.03	CON
035	0	F	556	PI	Pressure Indicator	Fermenter Supernatant Pump 1 Discharge			LI3.05		FI2.03	CON
036	0	F	557	HS-1	Lock Off Stop (LOS) Pushbutton	Fermenter Supernatant Pump 2	17216	-	LI3.05	ILD-17	FI2.03	CON
037	0	F	557	HS-2	Computer-Off-Hand Selector Switch	Fermenter Supernatant Pump 2	17216	-	LI3.05	ILD-17	FI2.03	CON
038	0	F	557	PI	Pressure Indicator	Fermenter Supernatant Pump 2 Discharge			LI3.05		FI2.03	CON
039	0	F	558	FCV	Motorized Valve Actuator	Fermenter Supernatant Pump 2 Disch. Valve	17213	-	LI3.05	ILD-12	FI2.03	CON
040	0	F	558	FE	Magnetic Flow Element	Bioreactor 2 Fermenter Supernatant Feed	17701-A	I101	LI3.05	ILD-04	FI2.03	CON
041	0	F	558	FIT	Magnetic Flow Transmitter	Bioreactor 2 Fermenter Supernatant Feed	17701-A	I101	LI3.05	ILD-04	FI2.03	CON
042	0	F	558	HS-1	Lock Off Stop (LOS) Pushbutton	Fermenter Supernatant Pump 3	17216	-	LI3.05	ILD-17	FI2.03	CON
043	0	F	558	HS-2	Computer-Off-Hand Selector Switch	Fermenter Supernatant Pump 3	17216	-	LI3.05	ILD-17	FI2.03	CON
044	0	F	558	PI	Pressure Indicator	Fermenter Supernatant Pump 3 Discharge			LI3.05		FI2.03	CON
045	0	F	560	HS-1	Lock Off Stop (LOS) Pushbutton	Fermenter 2	17216	-	LI3.03	ILD-16	FI2.02	CON
046	0	F	560	HS-2	Computer-Off-Hand Selector Switch	Fermenter 2	17216	-	LI3.03	ILD-16	FI2.02	CON
047	0	F	560	LSHH	High High Level Switch	Fermenter 2	17701-A	I102	LI3.03	ILD-02	FI2.02	CON
048	0	F	560	MD1	Motorized Damper Actuator	Primary Sludge Fermenter 2 Supply Air			LI3.06	ILD-11	FM2.01	CON

SUPPLY CODES: CON = Contractor Supply, OWN = Owner Suppy, PKG = Part of Equipment Package

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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
049	0	F	560	MM-1	Running Pilot Light	Fermenter 2	17216	-	LI3.03	ILD-16	FI2.02	CON
050	0	F	560	MO-1	Stopped Pilot Light	Fermenter 2	17216	-	LI3.03	ILD-16	FI2.02	CON
051	0	F	560	OSH	High Torque Switch	Fermenter 2	11521	-	LI3.03	ILD-16	FI2.02	PKG
052	0	F	560	OSHH	High High Torque Switch	Fermenter 2	11521	-	LI3.03	ILD-16	FI2.02	PKG
053	0	F	560	ZS	Position Switch	Fermenter 2	11521	-	LI3.03	ILD-16	FI2.02	PKG
054	0	F	561	FV	Solenoid Valve	Fermenter 2 Spray Water	17701-A	I108	LI3.03	ILD-13	FI2.03	CON
055	0	F	561	HS-1	Local-Remote Selector Switch	Fermenter 2 Spray Water Solenoid Valve	17216	-	LI3.03	ILD-13	FI2.03	CON
056	0	F	561	HS-2	Open/Close Selector Switch	Fermenter 2 Spray Water Solenoid Valve	17216	-	LI3.03	ILD-13	FI2.03	CON
057	0	F	610	HS-1	Lock Off Stop (LOS) Pushbutton	Primary Sludge Fermenter 1 Supply Air Fan	17216	-	LI3.06	ILD-15	FM2.01	CON
058	0	F	610	HS-2	Computer-Off-Hand Selector Switch	Primary Sludge Fermenter 1 Supply Air Fan	17216	-	LI3.06	ILD-15	FM2.01	CON
059	0	F	610	IS	Current Switch	Primary Sludge Fermenter 1 Supply Air Fan		-	LI3.06	ILD-15	MCC	CON
060	0	F	610	MM-1	Running Pilot Light	Primary Sludge Fermenter 1 Supply Air Fan	17216	-	LI3.06	ILD-15	FM2.01	CON
061	0	F	610	MO-1	Stopped Pilot Light	Primary Sludge Fermenter 1 Supply Air Fan	17216	-	LI3.06	ILD-15	FM2.01	CON
062	0	F	620	HS-1	Lock Off Stop (LOS) Pushbutton	Primary Sludge Fermenter 2 Supply Air Fan	17216	-	LI3.06	ILD-15	FM2.01	CON
063	0	F	620	HS-2	Computer-Off-Hand Selector Switch	Primary Sludge Fermenter 2 Supply Air Fan	17216	-	LI3.06	ILD-15	FM2.01	CON
064	0	F	620	IS	Current Switch	Primary Sludge Fermenter 2 Supply Air Fan		-	LI3.06	-	MCC	CON
065	0	F	620	MM-1	Running Pilot Light	Primary Sludge Fermenter 2 Supply Air Fan	17216	-	LI3.06	ILD-15	FM2.01	CON
066	0	F	620	MO-1	Stopped Pilot Light	Primary Sludge Fermenter 2 Supply Air Fan	17216	-	LI3.06	ILD-15	FM2.01	CON
067	0	F	650	HS-1	Lock Off Stop (LOS) Pushbutton	Fermenter Odour Control Fan	17216	-	LI3.06	ILD-18	FM2.01	CON
068	0	F	650	HS-2	Computer-Off-Hand Selector Switch	Fermenter Odour Control Fan	17216	-	LI3.06	ILD-18	FM2.01	CON
069	0	F	651	MD1	Motorized Damper Actuator	Fermenter Odour Control Fan Inlet			LI3.06	ILD-11		CON
070	0	F	652	MD1	Motorized Damper Actuator	Fermenter Odour Control Fan Outlet			LI3.06	ILD-11		CON
071	0	F	660	HS-1	Lock Off Stop (LOS) Pushbutton	Thermal Oxidizer Odour Control Fan	17216	-	LI3.06	ILD-18	FM2.01	CON
072	0	F	660	HS-2	Computer-Off-Hand Selector Switch	Thermal Oxidizer Odour Control Fan	17216	-	LI3.06	ILD-18	FM2.01	CON
073	0	F	660	IS	Current Switch	Thermal Oxidizer Odour Control Fan		-	LI3.06	ILD-18	MCC	CON
074	0	F	660	MM-1	Running Pilot Light	Thermal Oxidizer Odour Control Fan			LI3.06		FM2.01	CON
075	0	F	660	MO-1	Stopped Pilot Light	Thermal Oxidizer Odour Control Fan			LI3.06		FM2.01	CON
076	0	F	660	PIT	Pressure Transmitter	Thermal Oxidizer Fan Suction	17701-A	I106	LI3.06	ILD-05		CON
077	0	F	661	HS	Lock Off Stop (LOS) Pushbutton	Thermal Oxidizer	17216	-	LI3.06	-	FI2.03	CON
078	0	F	661	MD1	Motorized Damper Actuator	Thermal Oxidizer Inlet Damper			LI3.06	ILD-11	FM2.01	CON
079	0	F	661	TE	RTD	Thermal Oxidizer			LI3.06		FI2.03	CON
080	0	F	661	TT	Temperature Transmitter	Thermal Oxidizer			LI3.06		FI2.03	CON
081	0	F	662	MD1	Motorized Damper Actuator	Thermal Oxidizer Bypass Damper			LI3.06	ILD-11	FM2.01	CON
082	0	H	655	HS-1	Lock Off Stop (LOS) Pushbutton	Tanker Unloading Odour Control Fan	17216	-	LI3.06	ILD-15	HE1.01	CON
083	0	H	655	HS-2	Computer-Off-Hand Selector Switch	Tanker Unloading Odour Control Fan	17216	-	LI3.06	ILD-15	HE1.01	CON
084	0	H	655	IS	Current Switch	Tanker Unloading Odour Control Fan		-	LI3.06	-	MCC	CON
085	0	H	655	MM-1	Running Pilot Light	Tanker Unloading Odour Control Fan	17216	-	LI3.06	ILD-15	HE1.01	CON
086	0	H	655	MO-1	Stopped Pilot Light	Tanker Unloading Odour Control Fan	17216	-	LI3.06	ILD-15	HE1.01	CON
087	0	H	710	HS-1	Lock Off Stop (LOS) Pushbutton	DAF & Hworks Odour Control Fan	17216	-	LI3.06	ILD-18	HM1.01	CON
088	0	H	710	HS-2	Computer-Off-Hand Selector Switch	DAF & Hworks Odour Control Fan	17216	-	LI3.06	ILD-18	HM1.01	CON
089	0	H	710	IS	Current Switch	DAF & Hworks Odour Control Fan		-	LI3.06	ILD-18	MCC	CON
090	0	H	710	MD1	Motorized Damper Actuator	Headworks Sludge Storage Tanks Exh. Air			LI3.06	ILD-11		CON
091	0	H	710	MM-1	Running Pilot Light	DAF & Hworks Odour Control Fan			LI3.06		HM1.01	CON
092	0	H	710	MO-1	Stopped Pilot Light	DAF & Hworks Odour Control Fan			LI3.06		HM1.01	CON
093	0	H	710	PSH	High Pressure Switch	DAF & Hworks Odour Control Fan Suction	17701-A	I105	LI3.06	ILD-01	HM1.01	CON
094	0	P	110	FCV	Motorized Valve Actuator	Primary Clarifier 1 Discharge Valve	17213	-	LI1.01	ILD-12	PI1.01	CON
095	0	P	120	FCV	Motorized Valve Actuator	Primary Clarifier 2 Discharge Valve	17213	-	LI1.01	ILD-12	PI1.01	CON
096	0	P	235	FE	Magnetic Flow Element	Fermenters Primary Sludge Feed	17701-A	I101	LI3.01	ILD-04	FI2.03	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
097	0	P	235	FIT	Magnetic Flow Transmitter	Fermenters Primary Sludge Feed	17701-A	I101	LI3.01	ILD-04	FI2.03	CON
098	0	P	236	FCV	Pneumatic Valve Actuator	Fermenter 2 Primary Sludge Control Valve	17213	-	LI3.03	ILD-10	FI2.03	CON
099	0	P	236	FE	Magnetic Flow Element	Fermenter 2 Primary Sludge	17701-A	I101	LI3.03	ILD-04	FI2.03	CON
100	0	P	236	FIT	Magnetic Flow Transmitter	Fermenter 2 Primary Sludge	17701-A	I101	LI3.03	ILD-04	FI2.03	CON
101	0	P	250	HS-1	Lock Off Stop (LOS) Pushbutton	Primary Sludge Pump 1	17216	-	LI1.01	ILD-17	PI1.01	CON
102	0	P	250	HS-2	Computer-Off-Hand Selector Switch	Primary Sludge Pump 1	17216	-	LI1.01	ILD-17	PI1.01	CON
103	0	P	260	HS-1	Lock Off Stop (LOS) Pushbutton	Primary Sludge Pump 2	17216	-	LI1.01	ILD-17	PI1.01	CON
104	0	P	260	HS-2	Computer-Off-Hand Selector Switch	Primary Sludge Pump 2	17216	-	LI1.01	ILD-17	PI1.01	CON
105	0	P	270	LSH	High Level Switch	Primary Clarifier Pump Room Sump			LI1.02		PI1.01	Div. 15
106	0	P	270	LSL	Low Level Switch	Primary Clarifier Pump Room Sump			LI1.02		PI1.01	Div. 15
107	0	S	110	FCV	Pneumatic Valve Actuator	Primary Effluent to Bioreactor 1 Control Valve	17213	-	LI2.01	ILD-10	SI5.02	CON
108	0	S	111	FCV	Pneumatic Valve Actuator	Bioreactor 1 Anoxic Zone 2 Control Valve	17213	-	LI2.01	ILD-10	SI5.02	CON
109	0	S	111	FE	Magnetic Flow Element	Bioreactor 1 Anoxic Zones	17701-A	I101	LI2.01	ILD-04	SI5.02	CON
110	0	S	111	FIT	Magnetic Flow Transmitter	Bioreactor 1 Anoxic Zones	17701-A	I101	LI2.01	ILD-04	SI5.02	CON
111	0	S	112	FCV	Pneumatic Valve Actuator	Bioreactor 1 Anoxic Zone 1 Control Valve	17213	-	LI2.01	ILD-10	SI5.02	CON
112	0	S	112	FE	Magnetic Flow Element	Bioreactor 1 Anaerobic Zone	17701-A	I101	LI2.01	ILD-04	SI5.02	CON
113	0	S	112	FIT	Magnetic Flow Transmitter	Bioreactor 1 Anaerobic Zone	17701-A	I101	LI2.01	ILD-04	SI5.02	CON
114	0	S	113	FCV	Pneumatic Valve Actuator	Bioreactor 1 Anaerobic Zone Control Valve	17213	-	LI2.01	ILD-10	SI5.02	CON
115	0	S	114	FCV	Pneumatic Valve Actuator	Bioreactor 1 Pre Anoxic Zone Inlet Valve	17213	-	LI2.01	ILD-10	SI5.02	CON
116	0	S	120	FCV	Pneumatic Valve Actuator	Primary Effluent to Bioreactor 2 Control Valve	17213	-	LI2.03	ILD-10	SI5.03	CON
117	0	S	121	FCV	Pneumatic Valve Actuator	Bioreactor 2 Anoxic Zone 2 Control Valve	17213	-	LI2.03	ILD-10	SI5.03	CON
118	0	S	121	FE	Magnetic Flow Element	Bioreactor 2 Anoxic Zones	17701-A	I101	LI2.03	ILD-04	SI5.03	CON
119	0	S	121	FIT	Magnetic Flow Transmitter	Bioreactor 2 Anoxic Zones	17701-A	I101	LI2.03	ILD-04	SI5.03	CON
120	0	S	122	FCV	Pneumatic Valve Actuator	Bioreactor 2 Anoxic Zone 1 Control Valve	17213	-	LI2.03	ILD-10	SI5.03	CON
121	0	S	122	FE	Magnetic Flow Element	Bioreactor 2 Anaerobic Zone	17701-A	I101	LI2.03	ILD-04	SI5.03	CON
122	0	S	122	FIT	Magnetic Flow Transmitter	Bioreactor 2 Anaerobic Zone	17701-A	I101	LI2.03	ILD-04	SI5.03	CON
123	0	S	123	FCV	Pneumatic Valve Actuator	Bioreactor 2 Anaerobic Zone Control Valve	17213	-	LI2.03	ILD-10	SI5.03	CON
124	0	S	124	FCV	Pneumatic Valve Actuator	Bioreactor 2 Pre Anoxic Zone Inlet Valve	17213	-	LI2.03	ILD-10	SI5.03	CON
125	0	S	125	FCV	Pneumatic Valve Actuator	Fermenters Primary Sludge Dilution Wtr Valve	17213	-	LI3.01	ILD-10	FI2.03	CON
126	0	S	125	FE	Magnetic Flow Element	Fermenters Primary Sludge Dilution Water	17701-A	I101	LI3.01	ILD-04	FI2.03	CON
127	0	S	125	FIT	Magnetic Flow Transmitter	Fermenters Primary Sludge Dilution Water	17701-A	I101	LI3.01	ILD-04	FI2.03	CON
128	0	S	451	AE	Dissolved Oxygen Sensor	Bioreactor 1 Aerobic Zone 1	17701-A	I104	LI2.02	ILD-06	SI5.01	CON
129	0	S	451	AIT	Dissolved Oxygen Transmitter	Bioreactor 1 Aerobic Zone 1	17701-A	I104	LI2.02	ILD-06	SI5.01	CON
130	0	S	451	FCV	Pneumatic Valve Actuator	Bioreactor 1 Aerobic 1 Process Air Ctl Valve	17213	-	LI2.02	ILD-10	SI5.02	CON
131	0	S	451	FV	Solenoid Valve	AE-S451 Water Jet	17701-A	I108	LI2.02	ILD-13	SI5.01	CON
132	0	S	452	AE	Dissolved Oxygen Sensor	Bioreactor 1 Aerobic Zone 2	17701-A	I104	LI2.02	ILD-06	SI5.01	CON
133	0	S	452	AIT	Dissolved Oxygen Transmitter	Bioreactor 1 Aerobic Zone 2	17701-A	I104	LI2.02	ILD-06	SI5.01	CON
134	0	S	452	FCV	Pneumatic Valve Actuator	Bioreactor 1 Aerobic 2 Process Air Ctl Valve	17213	-	LI2.02	ILD-10	SI5.02	CON
135	0	S	452	FV	Solenoid Valve	AE-S452 Water Jet	17701-A	I108	LI2.02	ILD-13	SI5.01	CON
136	0	S	453	FCV	Pneumatic Valve Actuator	Bioreactor 1 Aerobic 2 Process Air Ctl Valve	17213	-	LI2.02	ILD-10	SI5.02	CON
137	0	S	454	AE	Dissolved Oxygen Sensor	Bioreactor 1 Aerobic Zone 3	17701-A	I104	LI2.02	ILD-06	SI5.01	CON
138	0	S	454	AIT	Dissolved Oxygen Transmitter	Bioreactor 1 Aerobic Zone 3	17701-A	I104	LI2.02	ILD-06	SI5.01	CON
139	0	S	454	FCV	Pneumatic Valve Actuator	Bioreactor 1 Aerobic 3 Process Air Ctl Valve	17213	-	LI2.02	ILD-10	SI5.02	CON
140	0	S	454	FV	Solenoid Valve	AE-S454 Water Jet	17701-A	I108	LI2.02	ILD-13	SI5.01	CON
141	0	S	455	FCV	Pneumatic Valve Actuator	Bioreactor 1 Aerobic 3 Process Air Ctl Valve	17213	-	LI2.02	ILD-10	SI5.02	CON
142	0	S	456	AE	Dissolved Oxygen Sensor	Bioreactor 1 Aerobic Zone 4	17701-A	I104	LI2.02	ILD-06	SI5.01	CON
143	0	S	456	AIT	Dissolved Oxygen Transmitter	Bioreactor 1 Aerobic Zone 4	17701-A	I104	LI2.02	ILD-06	SI5.01	CON
144	0	S	456	FCV	Pneumatic Valve Actuator	Bioreactor 1 Aerobic 4 Process Air Ctl Valve	17213	-	LI2.02	ILD-10	SI5.02	CON

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145	0	S	456	FV	Solenoid Valve	AE-S456 Water Jet	17701-A	I108	LI2.02	ILD-13	SI5.01	CON
146	0	S	457	FCV	Pneumatic Valve Actuator	Bioreactor 1 Aerobic 4 Process Air Ctl Valve	17213	-	LI2.02	ILD-10	SI5.02	CON
147	0	S	458	FCV	Motorized Valve Actuator	Bioreactor 1 Aerobic 4 Process Air Ctl Valve	17213	-	LI2.02	ILD-12	SI5.02	CON
148	0	S	458	PSH	High Pressure Switch	Bioreactor 1 Process Air	17701-A	I105	LI2.02	ILD-01	SI5.02	CON
149	0	S	461	AE	Dissolved Oxygen Sensor	Bioreactor 2 Aerobic Zone 1	17701-A	I104	LI2.04	ILD-06	SI5.01	CON
150	0	S	461	AIT	Dissolved Oxygen Transmitter	Bioreactor 2 Aerobic Zone 1	17701-A	I104	LI2.04	ILD-06	SI5.01	CON
151	0	S	461	FCV	Pneumatic Valve Actuator	Bioreactor 2 Aerobic 1 Process Air Ctl Valve	17213	-	LI2.04	ILD-10	SI5.03	CON
152	0	S	461	FV	Solenoid Valve	AE-S461 Water Jet	17701-A	I108	LI2.04	ILD-13	SI5.01	CON
153	0	S	462	AE	Dissolved Oxygen Sensor	Bioreactor 2 Aerobic Zone 2	17701-A	I104	LI2.04	ILD-06	SI5.01	CON
154	0	S	462	AIT	Dissolved Oxygen Transmitter	Bioreactor 2 Aerobic Zone 2	17701-A	I104	LI2.04	ILD-06	SI5.01	CON
155	0	S	462	FCV	Pneumatic Valve Actuator	Bioreactor 2 Aerobic 2 Process Air Ctl Valve	17213	-	LI2.04	ILD-10	SI5.03	CON
156	0	S	462	FV	Solenoid Valve	AE-S462 Water Jet	17701-A	I108	LI2.04	ILD-13	SI5.01	CON
157	0	S	463	FCV	Pneumatic Valve Actuator	Bioreactor 2 Aerobic 2 Process Air Ctl Valve	17213	-	LI2.04	ILD-10	SI5.03	CON
158	0	S	464	AE	Dissolved Oxygen Sensor	Bioreactor 2 Aerobic Zone 3	17701-A	I104	LI2.04	ILD-06	SI5.01	CON
159	0	S	464	AIT	Dissolved Oxygen Transmitter	Bioreactor 2 Aerobic Zone 3	17701-A	I104	LI2.04	ILD-06	SI5.01	CON
160	0	S	464	FCV	Pneumatic Valve Actuator	Bioreactor 2 Aerobic 3 Process Air Ctl Valve	17213	-	LI2.04	ILD-10	SI5.03	CON
161	0	S	464	FV	Solenoid Valve	AE-S464 Water Jet	17701-A	I108	LI2.04	ILD-13	SI5.01	CON
162	0	S	465	FCV	Pneumatic Valve Actuator	Bioreactor 2 Aerobic 3 Process Air Ctl Valve	17213	-	LI2.04	ILD-10	SI5.03	CON
163	0	S	466	AE	Dissolved Oxygen Sensor	Bioreactor 2 Aerobic Zone 4	17701-A	I104	LI2.04	ILD-06	SI5.01	CON
164	0	S	466	AIT	Dissolved Oxygen Transmitter	Bioreactor 2 Aerobic Zone 4	17701-A	I104	LI2.04	ILD-06	SI5.01	CON
165	0	S	466	FCV	Pneumatic Valve Actuator	Bioreactor 2 Aerobic 4 Process Air Ctl Valve	17213	-	LI2.04	ILD-10	SI5.03	CON
166	0	S	466	FV	Solenoid Valve	AE-S466 Water Jet	17701-A	I108	LI2.04	ILD-13	SI5.01	CON
167	0	S	467	FCV	Pneumatic Valve Actuator	Bioreactor 2 Aerobic 4 Process Air Ctl Valve	17213	-	LI2.04	ILD-10	SI5.03	CON
168	0	S	468	FCV	Motorized Valve Actuator	Bioreactor 2 Aerobic 4 Process Air Ctl Valve	17213	-	LI2.04	ILD-12	SI5.03	CON
169	0	S	468	PSH	High Pressure Switch	Bioreactor 2 Process Air	17701-A	I105	LI2.04	ILD-01	SI5.03	CON
170	0	S	510	HS-1	Lock Off Stop (LOS) Pushbutton	Secondary Clarifier 1	17216	-	LI2.08	ILD-16	SI6.01	CON
171	0	S	510	HS-2	Computer-Off-Hand Selector Switch	Secondary Clarifier 1	17216	-	LI2.08	ILD-16	SI6.01	CON
172	0	S	510	MM-1	Running Pilot Light	Secondary Clarifier 1	17216	-	LI2.08	ILD-16	SI6.01	CON
173	0	S	510	MO-1	Stopped Pilot Light	Secondary Clarifier 1	17216	-	LI2.08	ILD-16	SI6.01	CON
174	0	S	510	OSH	High Torque Switch	Secondary Clarifier 1	11525	-	LI2.08	ILD-16	SI6.01	PKG
175	0	S	510	OSHH	High High Torque Switch	Secondary Clarifier 1	11525	-	LI2.08	ILD-16	SI6.01	PKG
176	0	S	510	ZS	Position Switch	Secondary Clarifier 1	11525	-	LI2.08	ILD-16	SI6.01	PKG
177	0	S	520	HS-1	Lock Off Stop (LOS) Pushbutton	Secondary Clarifier 2	17216	-	LI2.08	ILD-16	SI6.01	CON
178	0	S	520	HS-2	Computer-Off-Hand Selector Switch	Secondary Clarifier 2	17216	-	LI2.08	ILD-16	SI6.01	CON
179	0	S	520	MM-1	Running Pilot Light	Secondary Clarifier 2	17216	-	LI2.08	ILD-16	SI6.01	CON
180	0	S	520	MO-1	Stopped Pilot Light	Secondary Clarifier 2	17216	-	LI2.08	ILD-16	SI6.01	CON
181	0	S	520	OSH	High Torque Switch	Secondary Clarifier 2	11525	-	LI2.08	ILD-16	SI6.01	PKG
182	0	S	520	OSHH	High High Torque Switch	Secondary Clarifier 2	11525	-	LI2.08	ILD-16	SI6.01	PKG
183	0	S	520	ZS	Position Switch	Secondary Clarifier 2	11525	-	LI2.08	ILD-16	SI6.01	PKG
184	0	S	530	FCV	Pneumatic Valve Actuator	Sec. Clarifier 3 Mixed Liquor Inlet Valve	17213	-	LI2.06	ILD-10	SI6.04	CON
185	0	S	530	FE	Magnetic Flow Element	Secondary Clarifier 3 Mixed Liquor Feed	17701-A	I101	LI2.06	ILD-04	SI6.04	CON
186	0	S	530	FIT	Magnetic Flow Transmitter	Secondary Clarifier 3 Mixed Liquor Feed	17701-A	I101	LI2.06	ILD-04	SI6.04	CON
187	0	S	530	HS-1	Lock Off Stop (LOS) Pushbutton	Secondary Clarifier 3	17216	-	LI2.06	ILD-16	SI6.02	CON
188	0	S	530	HS-2	Computer-Off-Hand Selector Switch	Secondary Clarifier 3	17216	-	LI2.06	ILD-16	SI6.02	CON
189	0	S	530	MM-1	Running Pilot Light	Secondary Clarifier 3	17216	-	LI2.06	ILD-16	SI6.02	CON
190	0	S	530	MO-1	Stopped Pilot Light	Secondary Clarifier 3	17216	-	LI2.06	ILD-16	SI6.02	CON
191	0	S	530	OSH	High Torque Switch	Secondary Clarifier 3	11525	-	LI2.06	ILD-16	SI6.02	PKG
192	0	S	530	OSHH	High High Torque Switch	Secondary Clarifier 3	11525	-	LI2.06	ILD-16	SI6.02	PKG

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193	0	S	530	ZS	Position Switch	Secondary Clarifier 3	11525	-	LI2.06	ILD-16	SI6.02	PKG
194	0	S	710	FE	Magnetic Flow Element	R.A.S. Pump 1 Discharge	17701-A	I101	LI2.07	ILD-04	SI6.04	CON
195	0	S	710	FIT	Magnetic Flow Transmitter	R.A.S. Pump 1 Discharge	17701-A	I101	LI2.07	ILD-04	SI6.04	CON
196	0	S	710	HS-1	Lock Off Stop (LOS) Pushbutton	R.A.S. Pump 1	17216	-	LI2.08	ILD-17	SI6.04	CON
197	0	S	710	HS-2	Computer-Off-Hand Selector Switch	R.A.S. Pump 1	17216	-	LI2.08	ILD-17	SI6.04	CON
198	0	S	720	FE	Magnetic Flow Element	R.A.S. Pump 2 Discharge	17701-A	I101	LI2.07	ILD-04	SI6.04	CON
199	0	S	720	FIT	Magnetic Flow Transmitter	R.A.S. Pump 2 Discharge	17701-A	I101	LI2.07	ILD-04	SI6.04	CON
200	0	S	720	HS-1	Lock Off Stop (LOS) Pushbutton	R.A.S. Pump 2	17216	-	LI2.08	ILD-17	SI6.04	CON
201	0	S	720	HS-2	Computer-Off-Hand Selector Switch	R.A.S. Pump 2	17216	-	LI2.08	ILD-17	SI6.04	CON
202	0	S	730	HS-1	Lock Off Stop (LOS) Pushbutton	R.A.S. Pump 3	17216	-	LI2.08	ILD-17	SI6.04	CON
203	0	S	730	HS-2	Computer-Off-Hand Selector Switch	R.A.S. Pump 3	17216	-	LI2.08	ILD-17	SI6.04	CON
204	0	S	740	AIT-1	NH3 Analyzer	Final Efflunet	11851		LI2.08	-	SI6.04	PKG
205	0	S	740	AIT-2	NO3 Analyzer	Final Efflunet	11851		LI2.08	-	SI6.04	PKG
206	0	S	740	AIT-3	PO4 Analyzer	Final Efflunet	11851		LI2.08	-	SI6.04	PKG
207	0	S	740	FCV	Pneumatic Valve Actuator	R.A.S. to Bioreactor 1 Flow Control Valve	17213	-	LI2.01	ILD-10	SI5.02	CON
208	0	S	740	HS-1	Lock Off Stop (LOS) Pushbutton	R.A.S. Pump 4	17216	-	LI2.07	ILD-17	SI6.04	CON
209	0	S	740	HS-2	Computer-Off-Hand Selector Switch	R.A.S. Pump 4	17216	-	LI2.07	ILD-17	SI6.04	CON
210	0	S	741	FCV	Pneumatic Valve Actuator	R.A.S. to Bioreactor 2 Flow Control Valve	17213	-	LI2.03	ILD-10	SI5.03	CON
211	0	S	750	FE	Magnetic Flow Element	R.A.S. Pumps 4 & 5 Discharge	17701-A	I101	LI2.07	ILD-04	SI6.04	CON
212	0	S	750	FIT	Magnetic Flow Transmitter	R.A.S. Pumps 4 & 5 Discharge	17701-A	I101	LI2.07	ILD-04	SI6.04	CON
213	0	S	750	HS-1	Lock Off Stop (LOS) Pushbutton	R.A.S. Pump 5	17216	-	LI2.07	ILD-17	SI6.04	CON
214	0	S	750	HS-2	Computer-Off-Hand Selector Switch	R.A.S. Pump 5	17216	-	LI2.07	ILD-17	SI6.04	CON
215	0	S	760	HS-1	Lock Off Stop (LOS) Pushbutton	Bioreactor 1 Pre Anoxic Zone Mixer	17216	-	LI2.01	ILD-15	SI5.01	CON
216	0	S	760	HS-2	Computer-Off-Hand Selector Switch	Bioreactor 1 Pre Anoxic Zone Mixer	17216	-	LI2.01	ILD-15	SI5.01	CON
217	0	S	760	MM-1	Running Pilot Light	Bioreactor 1 Pre Anoxic Zone Mixer	17216	-	LI2.01	ILD-15	SI5.01	CON
218	0	S	760	MO-1	Stopped Pilot Light	Bioreactor 1 Pre Anoxic Zone Mixer	17216	-	LI2.01	ILD-15	SI5.01	CON
219	0	S	761	HS-1	Lock Off Stop (LOS) Pushbutton	Bioreactor 1 Anaerobic Zone Mixer	17216	-	LI2.01	ILD-15	SI5.01	CON
220	0	S	761	HS-2	Computer-Off-Hand Selector Switch	Bioreactor 1 Anaerobic Zone Mixer	17216	-	LI2.01	ILD-15	SI5.01	CON
221	0	S	761	MM-1	Running Pilot Light	Bioreactor 1 Anaerobic Zone Mixer	17216	-	LI2.01	ILD-15	SI5.01	CON
222	0	S	761	MO-1	Stopped Pilot Light	Bioreactor 1 Anaerobic Zone Mixer	17216	-	LI2.01	ILD-15	SI5.01	CON
223	0	S	762	HS-1	Lock Off Stop (LOS) Pushbutton	Bioreactor 1 Anoxic Zone 1 Mixer	17216	-	LI2.01	ILD-15	SI5.01	CON
224	0	S	762	HS-2	Computer-Off-Hand Selector Switch	Bioreactor 1 Anoxic Zone 1 Mixer	17216	-	LI2.01	ILD-15	SI5.01	CON
225	0	S	762	MM-1	Running Pilot Light	Bioreactor 1 Anoxic Zone 1 Mixer	17216	-	LI2.01	ILD-15	SI5.01	CON
226	0	S	762	MO-1	Stopped Pilot Light	Bioreactor 1 Anoxic Zone 1 Mixer	17216	-	LI2.01	ILD-15	SI5.01	CON
227	0	S	763	HS-1	Lock Off Stop (LOS) Pushbutton	Bioreactor 1 Anoxic Zone 2 Mixer	17216	-	LI2.01	ILD-15	SI5.01	CON
228	0	S	763	HS-2	Computer-Off-Hand Selector Switch	Bioreactor 1 Anoxic Zone 2 Mixer	17216	-	LI2.01	ILD-15	SI5.01	CON
229	0	S	763	MM-1	Running Pilot Light	Bioreactor 1 Anoxic Zone 2 Mixer	17216	-	LI2.01	ILD-15	SI5.01	CON
230	0	S	763	MO-1	Stopped Pilot Light	Bioreactor 1 Anoxic Zone 2 Mixer	17216	-	LI2.01	ILD-15	SI5.01	CON
231	0	S	765	HS-1	Lock Off Stop (LOS) Pushbutton	Bioreactor 2 Pre Anoxic Zone Mixer	17216	-	LI2.03	ILD-15	SI5.01	CON
232	0	S	765	HS-2	Computer-Off-Hand Selector Switch	Bioreactor 2 Pre Anoxic Zone Mixer	17216	-	LI2.03	ILD-15	SI5.01	CON
233	0	S	765	MM-1	Running Pilot Light	Bioreactor 2 Pre Anoxic Zone Mixer	17216	-	LI2.03	ILD-15	SI5.01	CON
234	0	S	765	MO-1	Stopped Pilot Light	Bioreactor 2 Pre Anoxic Zone Mixer	17216	-	LI2.03	ILD-15	SI5.01	CON
235	0	S	766	HS-1	Lock Off Stop (LOS) Pushbutton	Bioreactor 2 Anaerobic Zone Mixer	17216	-	LI2.03	ILD-15	SI5.01	CON
236	0	S	766	HS-2	Computer-Off-Hand Selector Switch	Bioreactor 2 Anaerobic Zone Mixer	17216	-	LI2.03	ILD-15	SI5.01	CON
237	0	S	766	MM-1	Running Pilot Light	Bioreactor 2 Anaerobic Zone Mixer	17216	-	LI2.03	ILD-15	SI5.01	CON
238	0	S	766	MO-1	Stopped Pilot Light	Bioreactor 2 Anaerobic Zone Mixer	17216	-	LI2.03	ILD-15	SI5.01	CON
239	0	S	767	HS-1	Lock Off Stop (LOS) Pushbutton	Bioreactor 2 Anoxic Zone 1 Mixer	17216	-	LI2.03	ILD-15	SI5.01	CON
240	0	S	767	HS-2	Computer-Off-Hand Selector Switch	Bioreactor 2 Anoxic Zone 1 Mixer	17216	-	LI2.03	ILD-15	SI5.01	CON

SUPPLY CODES: CON = Contractor Supply, OWN = Owner Suppy, PKG = Part of Equipment Package

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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
241	0	S	767	MM-1	Running Pilot Light	Bioreactor 2 Anoxic Zone 1 Mixer	17216	-	LI2.03	ILD-15	SI5.01	CON
242	0	S	767	MO-1	Stopped Pilot Light	Bioreactor 2 Anoxic Zone 1 Mixer	17216	-	LI2.03	ILD-15	SI5.01	CON
243	0	S	768	HS-1	Lock Off Stop (LOS) Pushbutton	Bioreactor 2 Anoxic Zone 2 Mixer	17216	-	LI2.03	ILD-15	SI5.01	CON
244	0	S	768	HS-2	Computer-Off-Hand Selector Switch	Bioreactor 2 Anoxic Zone 2 Mixer	17216	-	LI2.03	ILD-15	SI5.01	CON
245	0	S	768	MM-1	Running Pilot Light	Bioreactor 2 Anoxic Zone 2 Mixer	17216	-	LI2.03	ILD-15	SI5.01	CON
246	0	S	768	MO-1	Stopped Pilot Light	Bioreactor 2 Anoxic Zone 2 Mixer	17216	-	LI2.03	ILD-15	SI5.01	CON
247	0	S	770	HS-1	Lock Off Stop (LOS) Pushbutton	Bioreactor 1 Recycle Pump	17701-A	-	LI2.02	ILD-17	SI5.02	CON
248	0	S	770	HS-2	Computer-Off-Hand Selector Switch	Bioreactor 1 Recycle Pump	17701-A	-	LI2.02	ILD-17	SI5.02	CON
249	0	S	771	HS-1	Lock Off Stop (LOS) Pushbutton	Bioreactor 2 Recycle Pump	17216	-	LI2.04	ILD-17	SI5.03	CON
250	0	S	771	HS-2	Computer-Off-Hand Selector Switch	Bioreactor 2 Recycle Pump	17216	-	LI2.04	ILD-17	SI5.03	CON
251	0	S	810	FCV	Motorized Valve Actuator	W.A.S. Pump 1 Suction Valve	17213	-	LI2.05	ILD-12	SI5.02	CON
252	0	S	810	HS-1	Lock Off Stop (LOS) Pushbutton	W.A.S. Pump 1	17216	-	LI2.05	ILD-17	SI5.03	CON
253	0	S	810	HS-2	Computer-Off-Hand Selector Switch	W.A.S. Pump 1	17216	-	LI2.05	ILD-17	SI5.03	CON
254	0	S	820	FCV	Motorized Valve Actuator	W.A.S. Pump 2 Suction Valve	17213	-	LI2.05	ILD-12	SI5.03	CON
255	0	S	820	FE	Magnetic Flow Element	W.A.S. Pumps Discharge to DAF	17701-A	I101	LI2.05	ILD-04	SI5.02	CON
256	0	S	820	FIT	Magnetic Flow Transmitter	W.A.S. Pumps Discharge to DAF	17701-A	I101	LI2.05	ILD-04	SI5.02	CON
257	0	S	820	HS-1	Lock Off Stop (LOS) Pushbutton	W.A.S. Pump 2	17216	-	LI2.05	ILD-17	SI5.03	CON
258	0	S	820	HS-2	Computer-Off-Hand Selector Switch	W.A.S. Pump 2	17216	-	LI2.05	ILD-17	SI5.03	CON
259	0	S	821	FE	Magnetic Flow Element	DAF Thickener 2 W.A.S. Feed	17701-A	I101	LI4.03	ILD-04	TI4.01	CON
260	0	S	821	FIT	Magnetic Flow Transmitter	DAF Thickener 2 W.A.S. Feed	17701-A	I101	LI4.03	ILD-04	TI4.01	CON
261	0	S	822	FCV	Pneumatic Valve Actuator	DAF Thickener 2 W.A.S. Control Valve	17213	-	LI4.03	ILD-10	TI4.01	CON
262	0	T	110	FV	Solenoid Valve	DAF Sludge Dilution Water Valve	17701-A	I107	LI4.02	ILD-13	TI4.01	CON
263	0	T	110	HS-1	Local-Remote Selector Switch	DAF 1 Sludge Dilution Water Valve	17216	-	LI4.02	ILD-13	TI4.01	CON
264	0	T	110	HS-2	Open/Close Selector Switch	DAF 1 Sludge Dilution Water Valve	17216	-	LI4.02	ILD-13	TI4.01	CON
265	0	T	110	LSH	High Level Switch	DAF 1 Float Hopper	17701-A	I102	LI4.02	ILD-02	TI4.01	CON
266	0	T	111	FCV	Motorized Valve Actuator	DAF 1 Sludge Discharge Valve	17213	-	LI4.02	ILD-12	TI4.01	CON
267	0	T	111	HS-1	Lock Off Stop (LOS) Pushbutton	DAF 1 Skimmer Drive	17216	-	LI4.02	ILD-17	TI4.01	CON
268	0	T	111	HS-2	Computer-Off-Hand Selector Switch	DAF 1 Skimmer Drive	17216	-	LI4.02	ILD-17	TI4.01	CON
269	0	T	111	LE	Ultrasonic Level Element	DAF 1 Subnatant Wet Well	17701-A	I103	LI4.02	ILD-03	TI4.01	CON
270	0	T	111	LIT	Ultrasonic Level Transmitter	DAF 1 Subnatant Wet Well	17701-A	I103	LI4.02	ILD-03	TI4.01	CON
271	0	T	111	MD1	Motorized Damper Actuator	DAF Thickener 1 Exhaust Air			LI3.06	ILD-11	TM2.02	CON
272	0	T	111	MM-1	Running Pilot Light	DAF 1 Skimmer Drive	17216	-	LI4.02	ILD-15	TI4.01	CON
273	0	T	111	MO-1	Stopped Pilot Light	DAF 1 Skimmer Drive	17216	-	LI4.02	ILD-15	TI4.01	CON
274	0	T	111	OSH	High Torque Switch	DAF 1 Skimmer Drive	11714	-	LI4.02	-	TI4.01	PKG
275	0	T	111	OSL	Low Torque Switch	DAF 1 Skimmer Drive	11714	-	LI4.02	-	TI4.01	PKG
276	0	T	112	FE	Magnetic Flow Element	DAF 1 Saturator Discharge	11714	-	LI4.02	-	TI4.01	PKG
277	0	T	112	FIT	Magnetic Flow Transmitter	DAF 1 Saturator Discharge	11714	-	LI4.02	-	TI4.01	PKG
278	0	T	112	FV	Solenoid Valve	DAF 1 Saturator Air Control Valve	11714	-	LI4.02	ILD-13	TI4.01	PKG
279	0	T	112	HS-1	Lock Off Stop (LOS) Pushbutton	DAF 1 Air Compressor	17216	-	LI4.02	ILD-15	TI4.01	PKG
280	0	T	112	HS-2	Computer-Off-Hand Selector Switch	DAF 1 Air Compressor	17216	-	LI4.02	ILD-15	TI4.01	PKG
281	0	T	112	HS-3	Local-Remote Selector Switch	DAF 1 Saturator Air Control Valve	17216	-	LI4.02	ILD-13	TI4.01	PKG
282	0	T	112	HS-4	Open/Close Selector Switch	DAF 1 Saturator Air Control Valve	17216	-	LI4.02	ILD-13	TI4.01	PKG
283	0	T	112	LSH	High Level Switch	DAF 1 Saturator	11714	-	LI4.02	-	TI4.01	PKG
284	0	T	112	LSL	Low Level Switch	DAF 1 Saturator	11714	-	LI4.02	-	TI4.01	PKG
285	0	T	112	MM-1	Running Pilot Light	DAF 1 Air Compressor	17216	-	LI4.02	ILD-15	TI4.01	PKG
286	0	T	112	MO-1	Stopped Pilot Light	DAF 1 Air Compressor	17216	-	LI4.02	ILD-15	TI4.01	PKG
287	0	T	112	PSH	High Pressure Switch	DAF 1 Air Compressor	11714	-	LI4.02	-	TI4.01	PKG
288	0	T	112	PSL	Low Pressure Switch	DAF 1 Saturator Inlet Air	11714	-	LI4.02	-	TI4.01	PKG

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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
289	0	T	113	HS-1	Lock Off Stop (LOS) Pushbutton	DAF 1 Recycle Pump	17216	-	LI4.02	ILD-15	TI4.01	PKG
290	0	T	113	HS-2	Computer-Off-Hand Selector Switch	DAF 1 Recycle Pump	17216	-	LI4.02	ILD-15	TI4.01	PKG
291	0	T	113	MM-1	Running Pilot Light	DAF 1 Recycle Pump	17216	-	LI4.02	ILD-15	TI4.01	PKG
292	0	T	113	MO-1	Stopped Pilot Light	DAF 1 Recycle Pump	17216	-	LI4.02	ILD-15	TI4.01	PKG
293	0	T	120	FV	Solenoid Valve	DAF Sludge Dilution Water Valve	17701-A	I107	LI4.03	ILD-13	TI4.01	CON
294	0	T	120	HS-1	Local-Remote Selector Switch	DAF 2 Sludge Dilution Water Valve	17216	-	LI4.03	ILD-13	TI4.01	CON
295	0	T	120	HS-2	Open/Close Selector Switch	DAF 2 Sludge Dilution Water Valve	17216	-	LI4.03	ILD-13	TI4.01	CON
296	0	T	120	LSH	High Level Switch	DAF 2 Float Hopper	17701-A	I102	LI4.03	ILD-02	TI4.01	CON
297	0	T	121	FCV	Motorized Valve Actuator	DAF 2 Sludge Discharge Valve	17213	-	LI4.03	ILD-12	TI4.01	CON
298	0	T	121	HS-1	Lock Off Stop (LOS) Pushbutton	DAF 2 Skimmer Drive	17216	-	LI4.03	ILD-17	TI4.01	CON
299	0	T	121	HS-2	Computer-Off-Hand Selector Switch	DAF 2 Skimmer Drive	17216	-	LI4.03	ILD-17	TI4.01	CON
300	0	T	121	LE	Ultrasonic Level Element	DAF 2 Subnatant Wet Well	17701-A	I103	LI4.03	ILD-03	TI4.01	CON
301	0	T	121	LIT	Ultrasonic Level Transmitter	DAF 2 Subnatant Wet Well	17701-A	I103	LI4.03	ILD-03	TI4.01	CON
302	0	T	121	MD1	Motorized Damper Actuator	DAF Thickener 2 Exhaust Air			LI3.06	ILD-11	TM2.02	CON
303	0	T	121	MM-1	Running Pilot Light	DAF 2 Skimmer Drive	17216	-	LI4.03	ILD-17	TI4.01	CON
304	0	T	121	MO-1	Stopped Pilot Light	DAF 2 Skimmer Drive	17216	-	LI4.03	ILD-17	TI4.01	CON
305	0	T	121	OSH	High Torque Switch	DAF 2 Skimmer Drive	11714	-	LI4.03	-	TI4.01	PKG
306	0	T	121	OSL	Low Torque Switch	DAF 2 Skimmer Drive	11714	-	LI4.03	-	TI4.01	PKG
307	0	T	122	FE	Magnetic Flow Element	DAF 2 Saturator Discharge	11714	-	LI4.03	-	TI4.01	PKG
308	0	T	122	FIT	Magnetic Flow Transmitter	DAF 2 Saturator Discharge	11714	-	LI4.03	-	TI4.01	PKG
309	0	T	122	FV	Solenoid Valve	DAF 2 Saturator Air Control Valve	11714	-	LI4.03	ILD-13	TI4.01	PKG
310	0	T	122	HS-1	Lock Off Stop (LOS) Pushbutton	DAF 2 Air Compressor	17216	-	LI4.03	ILD-15	TI4.01	PKG
311	0	T	122	HS-2	Computer-Off-Hand Selector Switch	DAF 2 Air Compressor	17216	-	LI4.03	ILD-15	TI4.01	PKG
312	0	T	122	HS-3	Local-Remote Selector Switch	DAF 2 Saturator Air Control Valve	17216	-	LI4.03	ILD-13	TI4.01	PKG
313	0	T	122	HS-4	Open/Close Selector Switch	DAF 2 Saturator Air Control Valve	17216	-	LI4.03	ILD-13	TI4.01	PKG
314	0	T	122	LSH	High Level Switch	DAF 2 Saturator	11714	-	LI4.03	-	TI4.01	PKG
315	0	T	122	LSL	Low Level Switch	DAF 2 Saturator	11714	-	LI4.03	-	TI4.01	PKG
316	0	T	122	MM-1	Running Pilot Light	DAF 2 Air Compressor	17216	-	LI4.03	ILD-15	TI4.01	PKG
317	0	T	122	MO-1	Stopped Pilot Light	DAF 2 Air Compressor	17216	-	LI4.03	ILD-15	TI4.01	PKG
318	0	T	122	PSH	High Pressure Switch	DAF 2 Air Compressor	11714	-	LI4.03	-	TI4.01	PKG
319	0	T	122	PSL	Low Pressure Switch	DAF 2 Air Control Panel	11714	-	LI4.03	-	TI4.01	PKG
320	0	T	123	HS-1	Lock Off Stop (LOS) Pushbutton	DAF 2 Recycle Pump	17216	-	LI4.03	ILD-15	TI4.01	PKG
321	0	T	123	HS-2	Computer-Off-Hand Selector Switch	DAF 2 Recycle Pump	17216	-	LI4.03	ILD-15	TI4.01	PKG
322	0	T	123	MM-1	Running Pilot Light	DAF 2 Recycle Pump	17216	-	LI4.03	ILD-15	TI4.01	PKG
323	0	T	123	MO-1	Stopped Pilot Light	DAF 2 Recycle Pump	17216	-	LI4.03	ILD-15	TI4.01	PKG
324	0	T	125	HS-1	Lock Off Stop (LOS) Pushbutton	Subnatant Pump 1	17216	-	LI4.04	ILD-17	TI4.01	CON
325	0	T	125	HS-2	Computer-Off-Hand Selector Switch	Subnatant Pump 1	17216	-	LI4.04	ILD-17	TI4.01	CON
326	0	T	126	HS-1	Lock Off Stop (LOS) Pushbutton	Subnatant Pump 2	17216	-	LI4.04	ILD-17	TI4.01	CON
327	0	T	126	HS-2	Computer-Off-Hand Selector Switch	Subnatant Pump 2	17216	-	LI4.04	ILD-17	TI4.01	CON
328	0	T	127	FE	Magnetic Flow Element	DAF Subnatant to Clarifiers	17701-A	I101	LI4.04	ILD-04	TI4.01	CON
329	0	T	127	FIT	Magnetic Flow Transmitter	DAF Subnatant to Clarifiers	17701-A	I101	LI4.04	ILD-04	TI4.01	CON
330	0	T	130	FV	Solenoid Valve	DAF Polymer Mix Tank MakeUp Water	17701-A	I107	LI4.01	ILD-13	TI4.02	PKG
331	0	T	130	HS-1	Lock Off Stop (LOS) Pushbutton	DAF Polymer Blower	17216	-	LI4.01	ILD-15	TI4.02	PKG
332	0	T	130	HS-2	Computer-Off-Hand Selector Switch	DAF Polymer Blower	17216	-	LI4.01	ILD-15	TI4.02	PKG
333	0	T	130	HS-3	Local-Remote Selector Switch	DAF Polymer Mix Tank Water Control Valve	17216	-	LI4.01	ILD-13	TI4.02	PKG
334	0	T	130	HS-4	Open/Close Selector Switch	DAF Polymer Mix Tank Water Control Valve	17216	-	LI4.01	ILD-13	TI4.02	PKG
335	0	T	130	MM-1	Running Pilot Light	DAF Polymer Blower	17216	-	LI4.01	ILD-15	TI4.02	PKG
336	0	T	130	MO-1	Stopped Pilot Light	DAF Polymer Blower	17216	-	LI4.01	ILD-15	TI4.02	PKG

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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
337	0	T	130	PSL	Low Pressure Switch	DAF Polymer Mix Tank Water Supply	17701-A	I105	LI4.01	ILD-01	TI4.02	PKG
338	0	T	131	FE	Magnetic Flow Element	DAF Tank 1 Polymer Feed	17701-A	I101	LI4.01	ILD-04	TI4.02	CON
339	0	T	131	FIT	Magnetic Flow Transmitter	DAF Tank 1 Polymer Feed	17701-A	I101	LI4.01	ILD-04	TI4.02	CON
340	0	T	131	FV	Solenoid Valve	DAF Tank 1 Polymer Flushing Water	17701-A	I107	LI4.01	ILD-13	TI4.02	CON
341	0	T	131	HS-1	Lock Off Stop (LOS) Pushbutton	DAF Polymer Metering Pump 1	17216	-	LI4.01	ILD-17	TI4.02	CON
342	0	T	131	HS-2	Computer-Off-Hand Selector Switch	DAF Polymer Metering Pump 1	17216	-	LI4.01	ILD-17	TI4.02	CON
343	0	T	131	HS-3	Local-Remote Selector Switch	DAF Tank 1 Polymer Flushing Water Valve	17216	-	LI4.01	ILD-13	TI4.02	CON
344	0	T	131	HS-4	Open/Close Selector Switch	DAF Tank 1 Polymer Flushing Water Valve	17216	-	LI4.01	ILD-13	TI4.02	CON
345		T	131	LSL	Low Level Switch	DAF Polymer Run Tank			LI4.01		TI4.02	PKG
346	0	T	131	LSLL	Low Low Level Switch	DAF Polymer Run Tank	17701-A	I102	LI4.01	ILD-02	TI4.02	CON
347	0	T	131	PSH	High Pressure Switch	DAF Polymer Metering Pump 1 Discharge	17701-A	I105	LI4.01	ILD-01	TI4.02	CON
348	0	T	132	FE	Magnetic Flow Element	DAF Tank 2 Polymer Feed	17701-A	I101	LI4.01	ILD-04	TI4.02	CON
349	0	T	132	FIT	Magnetic Flow Transmitter	DAF Tank 2 Polymer Feed	17701-A	I101	LI4.01	ILD-04	TI4.02	CON
350	0	T	132	HS-1	Lock Off Stop (LOS) Pushbutton	DAF Polymer Metering Pump 2	17216	-	LI4.01	ILD-17	TI4.02	CON
351	0	T	132	HS-2	Computer-Off-Hand Selector Switch	DAF Polymer Metering Pump 2	17216	-	LI4.01	ILD-17	TI4.02	CON
352	0	T	132	HS-3	Local-Remote Selector Switch	DAF Tank 2 Polymer Flushing Water Valve	17216	-	LI4.01	ILD-13	TI4.02	CON
353	0	T	132	HS-4	Open/Close Selector Switch	DAF Tank 2 Polymer Flushing Water Valve	17216	-	LI4.01	ILD-13	TI4.02	CON
354	0	T	132	PSH	High Pressure Switch	DAF Polymer Metering Pump 2 Discharge	17701-A	I105	LI4.01	ILD-01	TI4.02	CON
355	0	T	132	SV	Solenoid Valve	DAF Tank 2 Polymer Flushing Water	17701-A	I107	LI4.01	ILD-13	TI4.02	CON
356	0	T	133	FV	Solenoid Valve	DAF Polymer Mix Tank Discharge	17701-A	I107	LI4.01	ILD-13	TI4.02	PKG
357	0	T	133	HS-1	Lock Off Stop (LOS) Pushbutton	DAF Polymer Hopper Screw Conveyer	17216	-	LI4.01	ILD-15	TI4.02	PKG
358	0	T	133	HS-2	Computer-Off-Hand Selector Switch	DAF Polymer Hopper Screw Conveyer	17216	-	LI4.01	ILD-15	TI4.02	PKG
359	0	T	133	HS-3	Local-Remote Selector Switch	DAF Polymer Mix Tank Discharge Valve	17216	-	LI4.01	ILD-13	TI4.02	PKG
360	0	T	133	HS-4	Open/Close Selector Switch	DAF Polymer Mix Tank Discharge Valve	17216	-	LI4.01	ILD-13	TI4.02	PKG
361	0	T	133	MM-1	Running Pilot Light	DAF Polymer Hopper Screw Conveyer	17216	-	LI4.01	ILD-15	TI4.02	PKG
362	0	T	133	MO-1	Stopped Pilot Light	DAF Polymer Hopper Screw Conveyer	17216	-	LI4.01	ILD-15	TI4.02	PKG
363	0	T	134	HS-1	Lock Off Stop (LOS) Pushbutton	DAF Polymer Mixer	17216	-	LI4.01	ILD-15	TI4.02	PKG
364	0	T	134	HS-2	Computer-Off-Hand Selector Switch	DAF Polymer Mixer	17216	-	LI4.01	ILD-15	TI4.02	PKG
365	0	T	134	MM-1	Running Pilot Light	DAF Polymer Mixer	17216	-	LI4.01	ILD-15	TI4.02	PKG
366	0	T	134	MO-1	Stopped Pilot Light	DAF Polymer Mixer	17216	-	LI4.01	ILD-15	TI4.02	PKG
367	0	T	135	FV	Solenoid Valve	Clarifier Polymer Mix Tank MakeUp Water	11771	-	LI4.07	ILD-13	TI4.02	PKG
368	0	T	135	HS-1	Lock Off Stop (LOS) Pushbutton	Clarifier Polymer Blower	17216	-	LI4.07	ILD-15	TI4.02	PKG
369	0	T	135	HS-2	Computer-Off-Hand Selector Switch	Clarifier Polymer Blower	17216	-	LI4.07	ILD-15	TI4.02	PKG
370	0	T	135	HS-3	Local-Remote Selector Switch	Clarifier Polymer Mix Tank Wtr Control Valve	17216	-	LI4.07	ILD-13	TI4.02	PKG
371	0	T	135	HS-4	Open/Close Selector Switch	Clarifier Polymer Mix Tank Wtr Control Valve	17216	-	LI4.07	ILD-13	TI4.02	PKG
372	0	T	135	MM-1	Running Pilot Light	Clarifier Polymer Blower	17216	-	LI4.07	ILD-15	TI4.02	PKG
373	0	T	135	MO-1	Stopped Pilot Light	Clarifier Polymer Blower	17216	-	LI4.07	ILD-15	TI4.02	PKG
374	0	T	135	PSL	Low Pressure Switch	Clarifier Polymer Mix Tank Water Supply	17701-A	I105	LI4.07		TI4.02	PKG
375	0	T	136	FE	Magnetic Flow Element	Primary Clarifier Polymer Feed	17701-A	I101	LI4.07	ILD-04	TI4.02	CON
376	0	T	136	FIT	Magnetic Flow Transmitter	Primary Clarifier Polymer Feed	17701-A	I101	LI4.07	ILD-04	TI4.02	CON
377	0	T	136	FV	Solenoid Valve	Clarifier Polymer Flushing Water	17701-A	I107	LI4.07	ILD-13	TI4.02	CON
378	0	T	136	HS-1	Lock Off Stop (LOS) Pushbutton	Clarifier Polymer Metering Pump 1	17216	-	LI4.07	ILD-17	TI4.02	CON
379	0	T	136	HS-2	Computer-Off-Hand Selector Switch	Clarifier Polymer Metering Pump 1	17216	-	LI4.07	ILD-17	TI4.02	CON
380	0	T	136	HS-3	Local-Remote Selector Switch	Clarifier Polymer Flushing Water Valve	17216	-	LI4.07	ILD-13	TI4.02	CON
381	0	T	136	HS-4	Open/Close Selector Switch	Clarifier Polymer Flushing Water Valve	17216	-	LI4.07	ILD-13	TI4.02	CON
382		T	136	LSL	Low Level Switch	Clarifier Polymer Run Tank			LI4.07		TI4.02	PKG
383	0	T	136	LSLL	Low Low Level Switch	Clarifier Polymer Run Tank	17701-A	I102	LI4.07	ILD-02	TI4.02	CON

SUPPLY CODES: CON = Contractor Supply, OWN = Owner Suppy, PKG = Part of Equipment Package

INSTRUMENT SPECIFICATION SHEETS

1. GENERAL

1.1 References - General

.1 The Work includes the provision of all instrument specification sheets.

.2 Refer to Section 17010

1.2 Instrument Specification Sheets

.1 Provide data sheets to itemize detailed as-built information regarding the Specification of instruments included as part of this Work for each instrument supplied. The data sheets already included in this Section list specific minimum requirements for particular applications.

.2 Use forms in accordance with the ISA Standard S20 as a template for the preparation of the specification sheets.

2. PRODUCTS

.1 Not used

3. EXECUTION

.1 Not used

END OF SECTION

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	**I-101**
DEVICE:	Magnetic Flow Meter/Transmitter
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Primary Effluent, Primary Sludge, Fermenter Supernatant, Mixed Liquor, Return Activated Sludge, Polymer, Waste Activated Sludge, DAF Subnatant
SIZE AND MATERIAL:	Refer to Process Drawings for flow meter size and piping materials
END CONNECTIONS:	Flanged
LINING MATERIAL:	Neoprene
ELECTRODES	316L SST Bulletnose
GROUNDING:	2 – 316L SST Grounding Rings
RANGE:	Refer to Process Drawings and/or Instrument Lists
INACCURACY:	±0.5% of span
OUTPUT:	4 to 20 mA DC into 500 OHM load, HART Protocol
POWER SUPPLY:	120 VAC, 60 HZ
ENCLOSURE:	EEMAC 4X Transmitter Housing EEMAC 4X Sensor
TRANSMITTER MOUNTING:	Wall Mount
SENSOR MOUNTING:	Flange Mount
APPROVALS REQUIRED:	CSA
MANUFACTURER AND MODEL:	Rosemount 8700 Series ABB Magmaster Krohne Endress and Hauser.

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	**I-102**
DEVICE:	Level Switch
TAG:	Refer to Instrument Index, Section 17700
TYPE:	Float Switch
SERVICE:	Ferric Chloride, Polymer, Flushing Water, Fermenter Supernatant
ENCLOSURE:	Polypropylene float casing with preterminated signal cable
SIGNAL CABLE LENGTH:	20m
OUTPUT:	Relay contact resistive – 10A, 250V
MOUNTING:	Provide strain relief-type connectors to suspend float at desired location. Fabricate mounting brackets from 316 SS. Provide anti-sway rings to prevent sway in turbulent tanks.
MANUFACTURER AND MODEL:	Flygt ENM-10 Consolidated Electric Warwick Magnetrol

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	**I-103**
DEVICE:	Liquid Level Transmitter
TAG:	Refer to Instrument Index, Section 17700
TYPE:	Ultrasonic
SERVICE:	Ferric Chloride DAF Subnatant, TWAS
RANGE:	See Process Drawings, to be confirmed during construction
INACCURACY:	±0.5% of span
OUTPUT:	4 to 20 mA DC into 500 OHM load 3 configurable alarm relays
POWER SUPPLY:	120 VAC, 60 HZ
ENCLOSURE:	EEMAC 4X Transmitter Housing EEMAC 4X Sensor
MOUNTING:	
(TRANSMITTER)	Wall Mount
(SENSOR)	Provide PVC pipe stilling well where shown on the drawings and in accordance with manufacturer's recommendations to ensure stable readings in turbulent locations. Mount sensor on stilling well. Install sensors at least 300 mm above maximum liquid level. Provide PVC blind flange for mounting sensor.
ACCESSORIES:	1 - hand-held programmer
MANUFACTURER AND MODEL:	Milltronics MultiRanger 100/200 transmitter and Echomax XPS sensor or approved equal

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	**I-104**
DEVICE:	Dissolved Oxygen Transmitter
TAG:	Refer to Instrument Index, Section 17700
TYPE:	Optical
SERVICE:	Bioreactors – Aerobic Cells – Mixed Liquor
SELF CLEANING/CALIBRATION:	Air Jet Cleaner
RANGE:	0-10 mg/L
INACCURACY:	±0.5% of span
OUTPUT:	Isolated 4 to 20 mA Analog Output(s) 2 configurable Form C Alarm Contacts N/O jet clean relay contact(s)
POWER SUPPLY:	120 VAC, 60 HZ
ENCLOSURE:	EEMAC 4X Transmitter Housing
MOUNTING: **(SENSOR)**	Flange mounted Pole through Bioreactor roof, cable to be connected to local JB with manufacturer approved quick connector. Sensor to be submerged 600mm below surface.
(TRANSMITTER)	Surface/wall Mount
ACCESSORIES:	Sensor Mounting Kit with jet cleaning attachment
MANUFACTURER AND MODEL:	Royce Single/Dual Channel 9800, Model 98 Sensor Aysix 1000/2000 or approved equal

SPECIAL INSTALLATION NOTES: Sensors will be Jet Cleaned with plant Instrument Air.

Instrument Air to be supplied to sensor by solenoid valve mounted near transmitter. D.O. Transmitter relay to control solenoid valve on operator configured schedule.

Air from Solenoid Valve to sensor to be transmitted through 12 mm insulated, copper piping, terminated near local JB with standard air quick coupler (Parker or equal). Air from Quick Coupler to sensor to be flexible ¼" UV resistant HDPE tubing.

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	**I-105**
DEVICE:	Pressure Switch
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Fermenter Supernatant Wetwell Level. Pump discharges
PROCESS CONNECTION:	½" NPT
MOUNTING:	Bottom, Stem Mounted
DIAPHRAGM:	SS316
SWITCH TYPE:	SPDT
RATING:	120 VAC, 60 HZ, 5A
ENCLOSURE:	EEMAC 4X
ACCESSORIES:	Include supplier pre assembled filled isolation Diaphragm
MANUFACTURER AND MODEL:	Ashcroft Type 400, B Series, United Electric, H100 Series or approved equal

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	**I-106**
DEVICE:	Pressure Transmitter (Gage and Absolute)
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Fermenter Supernatant, Foul Air
PROCESS CONNECTIONS:	½" NPTF
RANGE:	See Process Drawings
INACCURACY:	±1% of span or lower
OUTPUT:	4 to 20 mA DC into 500 OHM
POWER SUPPLY:	Loop powered 24 VDC
CONSTRUCTION:	Stainless steel wetted parts
ELECTRONIC ENCLOSURE:	EEMAC 4X
ACCESSORIES:	Stainless steel block and bleed manifold
MANUFACTURER AND MODEL:	Rosemount Type 3051C, ABB 2600T Series or approved equal

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	**I-107**
DEVICE:	Solenoid Valve (Water Service)
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Secondary Effluent, Flushing Water
PROCESS CONNECTIONS:	1” NPT
MATERIALS:	304 SS
OPERATION:	Normally Closed unless shown otherwise on the PID’s
DIFFERENTIAL PRESSURE:	Min: 0 kPa, Max: 800 kPa
ENCLOSURE:	EEMAC 4X
POWER SUPPLY:	120VAC/60Hz
MANUFACTURER AND MODEL:	ASCO 8210 or approved equal

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	**I-108**
DEVICE:	Solenoid Valve (Air Service)
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Instrument air
PROCESS CONNECTIONS:	1/2” NPT
MATERIALS:	Brass
OPERATION:	Normally Closed unless shown otherwise on the PID’s
DIFFERENTIAL PRESSURE:	Min: 0 kPa, Max: 800 kPa
ENCLOSURE:	EEMAC 4X
POWER SUPPLY:	120VAC/60Hz
MANUFACTURER AND MODEL:	ASCO 8210 or approved equal

INSTRUMENT LOOP DRAWINGS

1. GENERAL

1.1 References - General

.1 Refer to Section 17010

1.2 Instrument Loop Drawings

.1 The following sixteen (16) Drawings show typical instrument loop wiring diagrams as referenced by this Specification Section. One (1) Drawing per loop will be completed by the Contractor and submitted for approval after award of Contract.

ILD-01	Instrument Loop Diagram – Optical Dissolved Oxygen Analyzer
ILD-02	Instrument Loop Diagram – Pneumatic Modulating Valve
ILD-03	Instrument Loop Diagram – Two Position Motorized Valve
ILD-04	Instrument Loop Diagram – Magnetic Flow Transmitter
ILD-05	Instrument Loop Diagram – Thermal Flow Switch
ILD-06	Instrument Loop Diagram – Ultrasonic Level Transmitter
ILD-07	Instrument Loop Diagram – Float Type Level Switch
ILD-08	Instrument Loop Diagram – Pressure Transmitter
ILD-09	Instrument Loop Diagram – Pressure Switch
ILD-10	Instrument Loop Diagram – Two / Three Way Solenoid Valve
ILD-11	Instrument Loop Diagram – Torque Switch
ILD-12	Instrument Loop Diagram – Position Switch
ILD-13	Instrument Loop Diagram – Fixed Speed Drive
ILD-14	Instrument Loop Diagram – Fermenter Mechanism Drive
ILD-15	Instrument Loop Diagram – Variable Frequency Drive
ILD-16	Instrument Loop Diagram – Thermal Oxidizer

2. PRODUCTS

.1 Not used

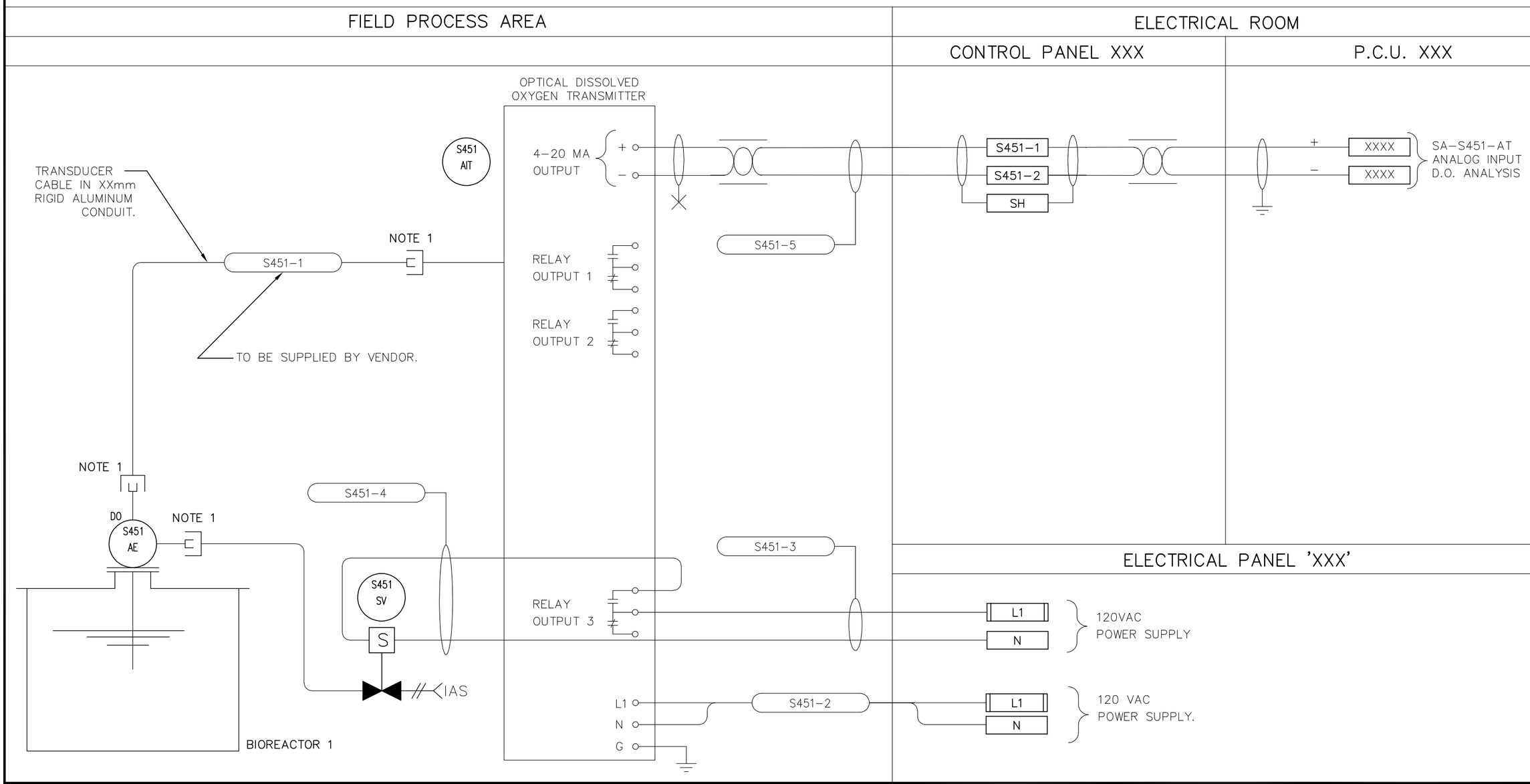
3. EXECUTION

.1 Not used

END OF SECTION

INSTRUMENT LOOP DIAGRAM

LOOP NO. XXXX



NOTE:

1. QUICK DISCONNECT COUPLING.

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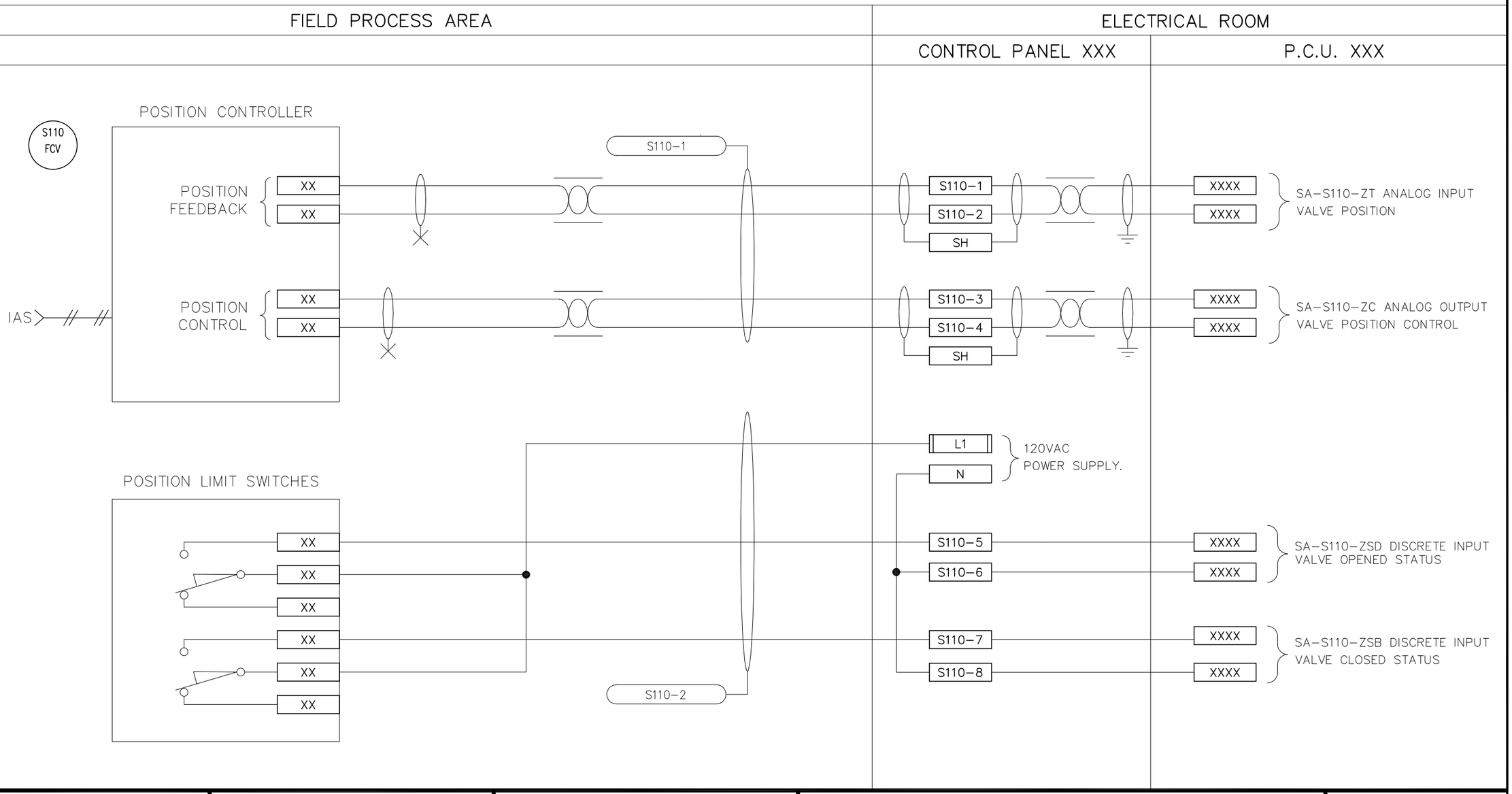
TYPICAL INSTRUMENT LOOP DIAGRAM
OPTICAL DISSOLVED OXYGEN ANALYZER

SCALE AS NOTED
DATE 2005/12/15
DES CD DWN PPL
CKD ES APP SWT

DRAWING NO.
ILD–01

INSTRUMENT LOOP DIAGRAM

LOOP NO. XXXX



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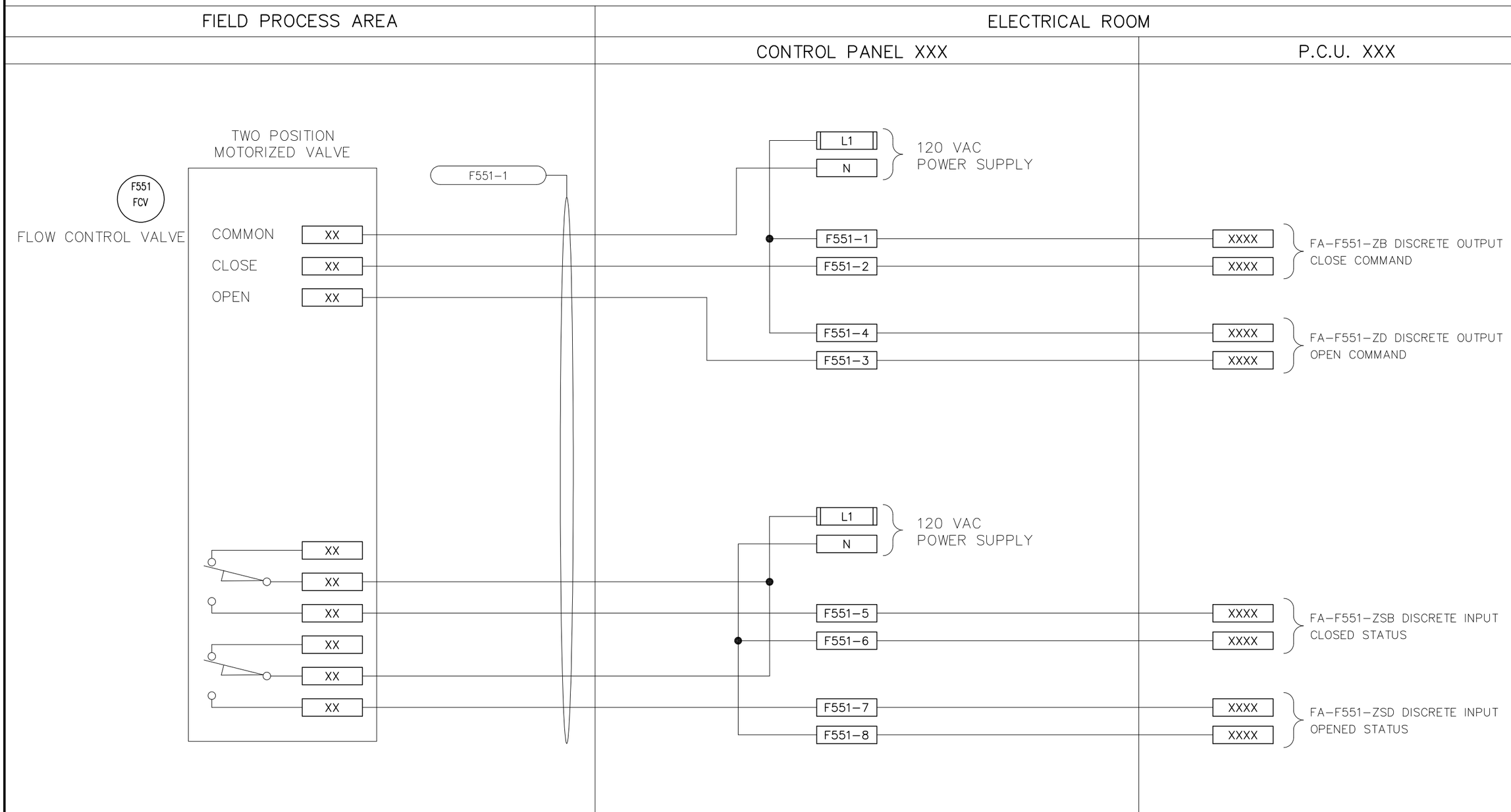
TYPICAL INSTRUMENT LOOP DIAGRAM
PNEUMATIC MODULATING VALVE

SCALE AS NOTED
DATE 2006/01/04
DES CD DWN PPL
CKD ES APP SWT

DRAWING NO.
ILD-02

INSTRUMENT LOOP DIAGRAM

LOOP NO. XXXX



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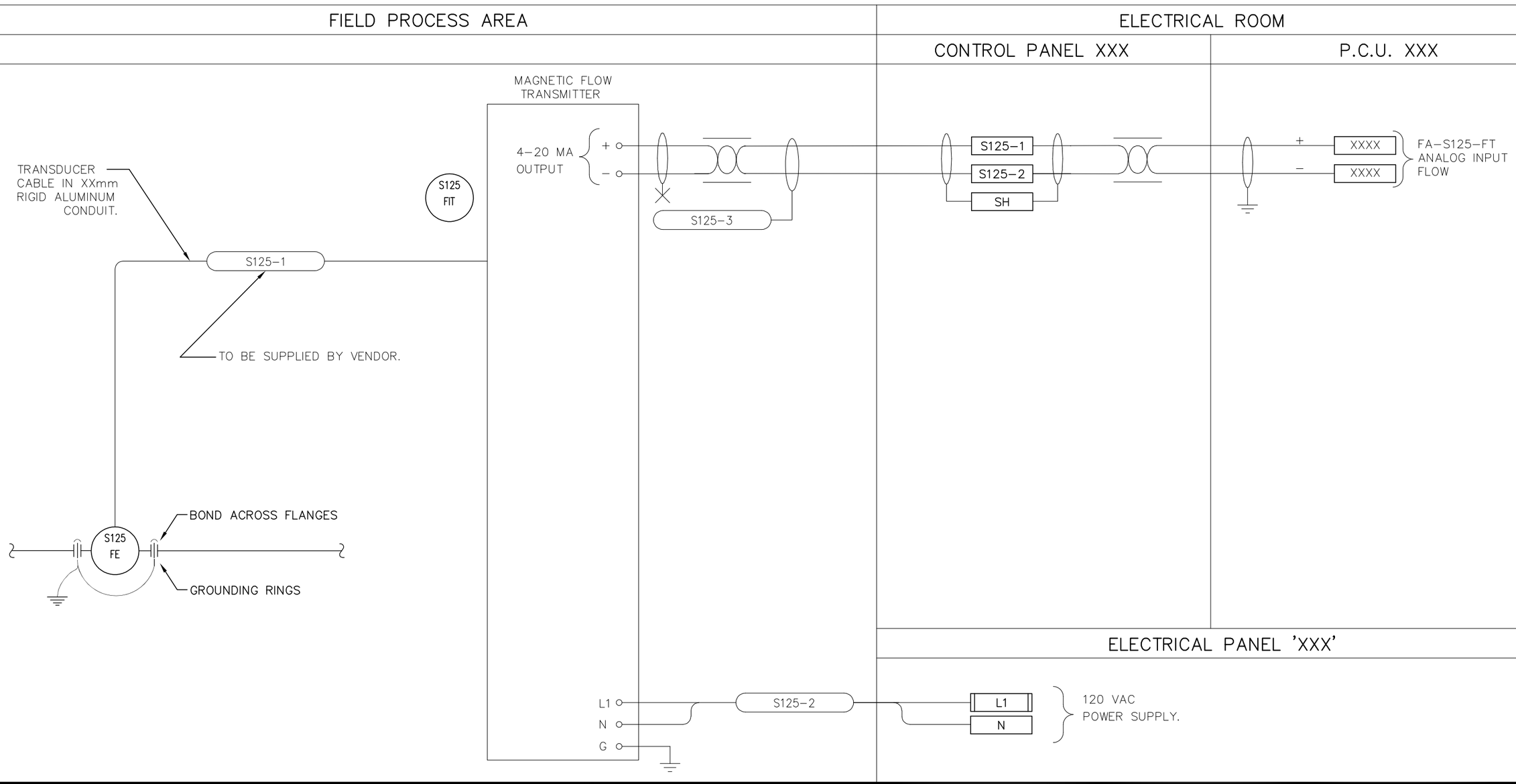
TYPICAL INSTRUMENT LOOP DIAGRAM
TWO POSITION MOTORIZED VALVE

SCALE AS NOTED
DATE 2005/12/19
DES CD DWN PPL
CKD ES APP SWT

DRAWING NO.
ILD-03

INSTRUMENT LOOP DIAGRAM

LOOP NO. XXXX



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TYPICAL INSTRUMENT LOOP DIAGRAM
MAGNETIC FLOW TRANSMITTER

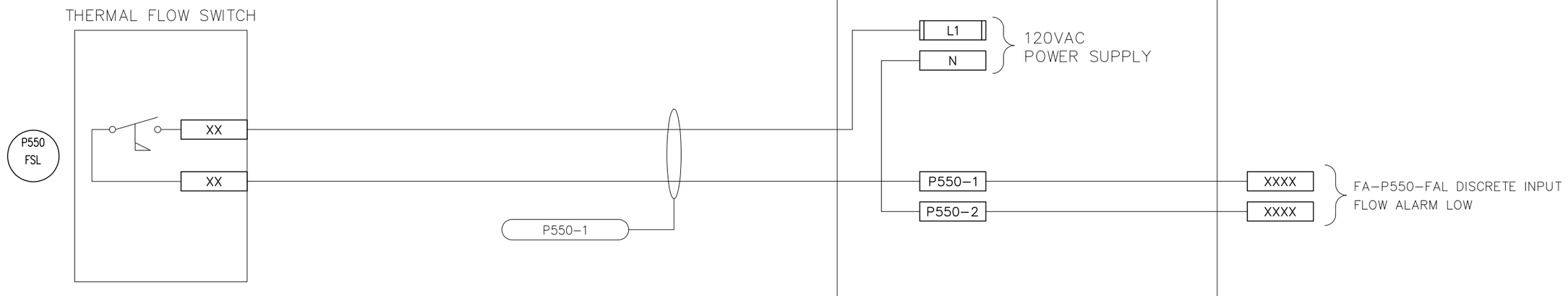
SCALE AS NOTED
DATE 2005/11/18
DES CD DWN PPL
CKD ES APP SWT

DRAWING NO.
ILD–04

INSTRUMENT LOOP DIAGRAM

LOOP NO. XXXX

FIELD PROCESS AREA	ELECTRICAL ROOM	
	CONTROL PANEL XXX	P.C.U. XXX



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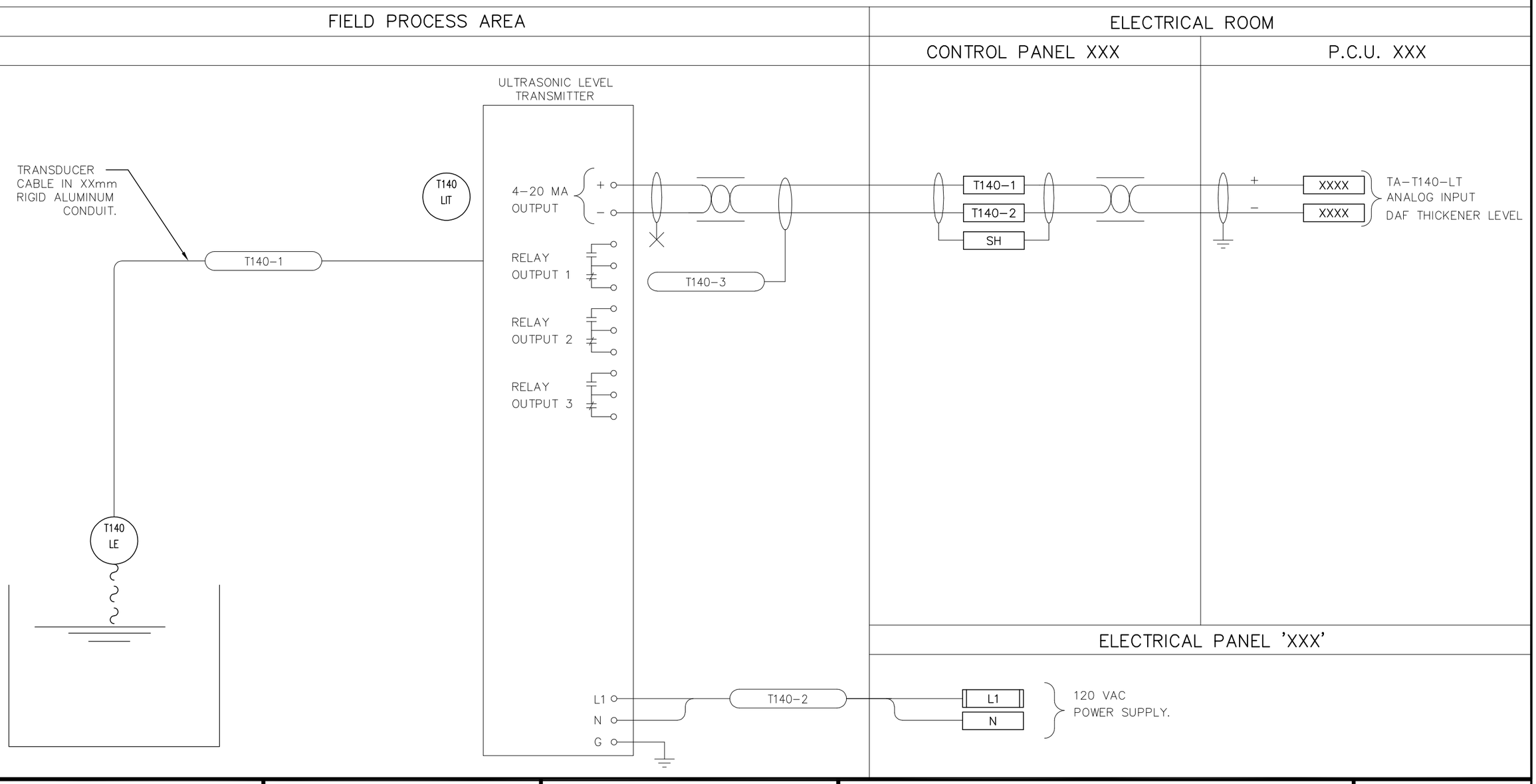
TYPICAL INSTRUMENT LOOP DIAGRAM
THERMAL FLOW SWITCH

SCALE AS NOTED
DATE 2005/12/19
DES CD DWN PPL
CKD ES APP SWT

DRAWING NO.
ILD-05

INSTRUMENT LOOP DIAGRAM

LOOP NO. XXXX



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TYPICAL INSTRUMENT LOOP DIAGRAM
ULTRASONIC LEVEL TRANSMITTER

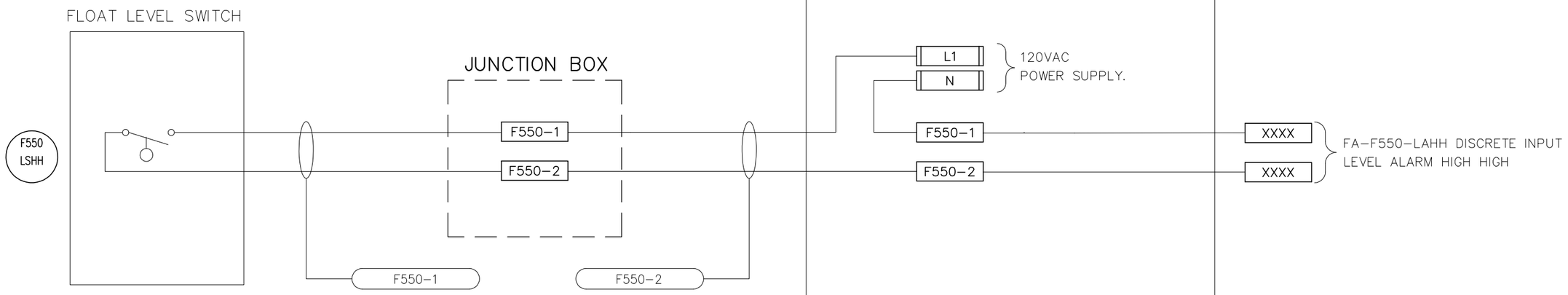
SCALE AS NOTED
DATE 2005/11/18
DES CD DWN PPL
CKD ES APP SWT

DRAWING NO.
ILD-06

INSTRUMENT LOOP DIAGRAM

LOOP NO. XXXX

FIELD PROCESS AREA	ELECTRICAL ROOM	
	CONTROL PANEL XXX	P.C.U. XXX



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TYPICAL INSTRUMENT LOOP DIAGRAM
FLOAT TYPE LEVEL SWITCH

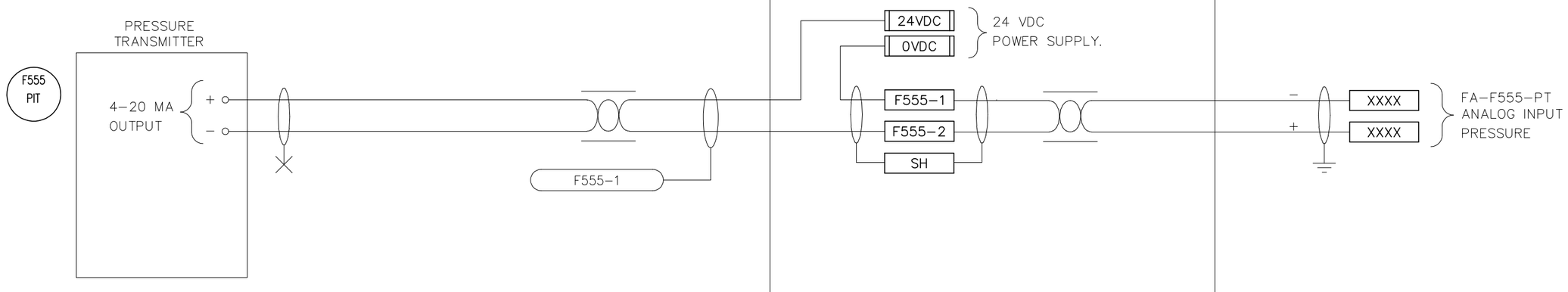
SCALE AS NOTED
DATE 2006/01/04
DES CD DWN PPL
CKD ES APP SWT

DRAWING NO.
ILD–07

INSTRUMENT LOOP DIAGRAM

LOOP NO. XXXX

FIELD PROCESS AREA	ELECTRICAL ROOM	
	CONTROL PANEL XXX	P.C.U. XXX



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TYPICAL INSTRUMENT LOOP DIAGRAM
PRESSURE TRANSMITTER

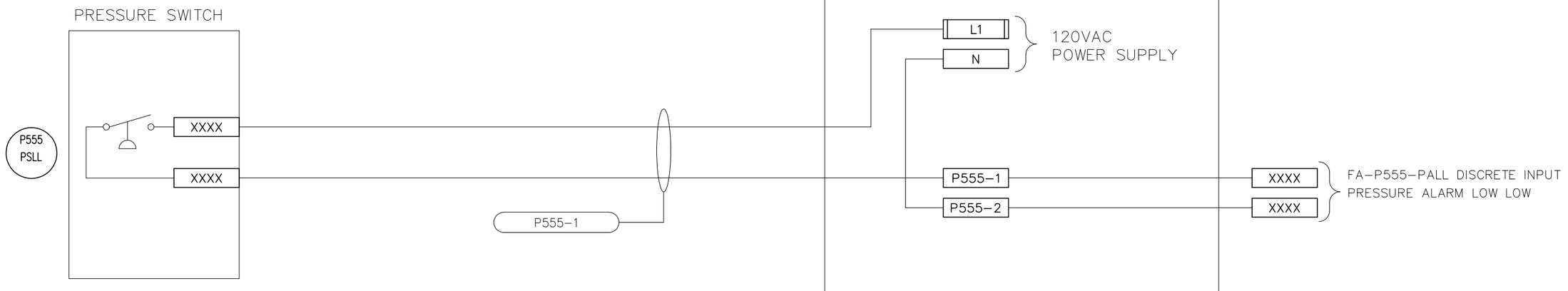
SCALE AS NOTED
DATE 2005/12/19
DES CD DWN PPL
CKD ES APP SWT

DRAWING NO.
ILD–08

INSTRUMENT LOOP DIAGRAM

LOOP NO. XXXX

FIELD PROCESS AREA	ELECTRICAL ROOM	
	CONTROL PANEL XXX	P.C.U. XXX



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TYPICAL INSTRUMENT LOOP DIAGRAM
PRESSURE SWITCH

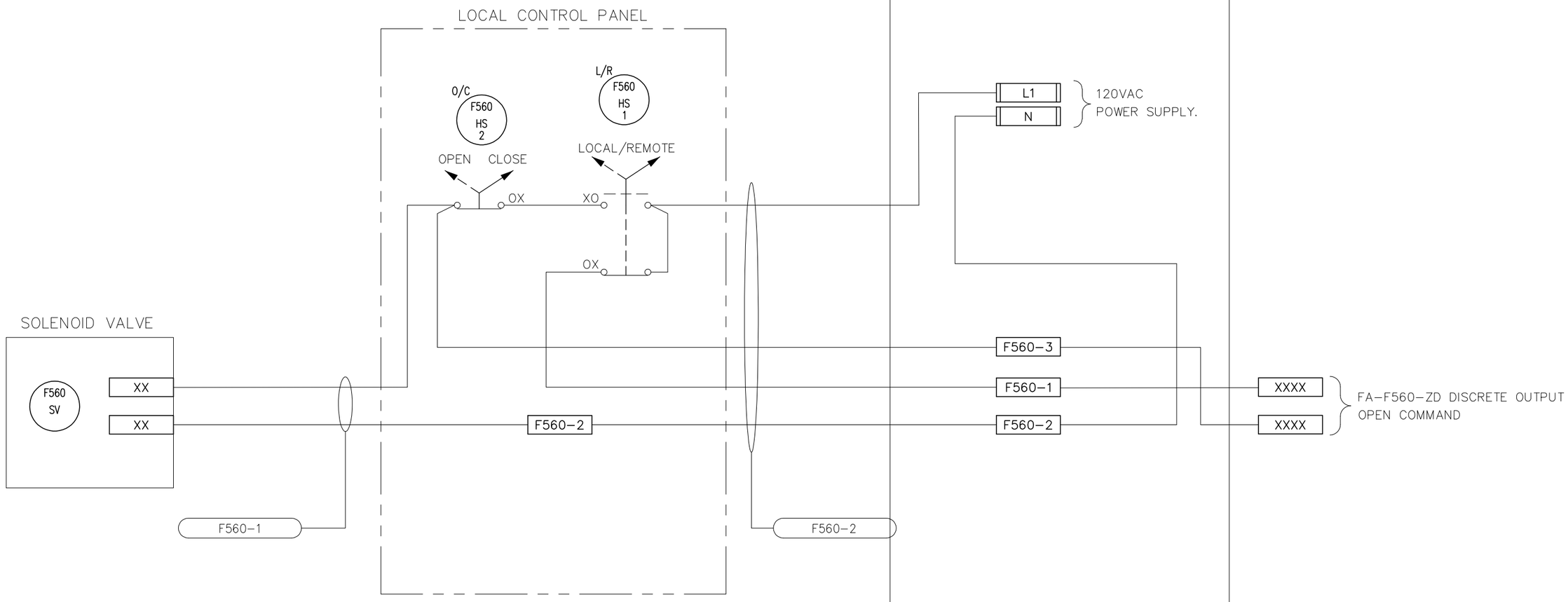
SCALE AS NOTED
DATE 2005/12/19
DES CD DWN PPL
CKD ES APP SWT

DRAWING NO.
ILD-09

INSTRUMENT LOOP DIAGRAM

LOOP NO. XXXX

FIELD PROCESS AREA	ELECTRICAL ROOM	
	CONTROL PANEL XXX	P.C.U. XXX



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TYPICAL INSTRUMENT LOOP DIAGRAM
TWO/THREE WAY SOLENOID VALVE

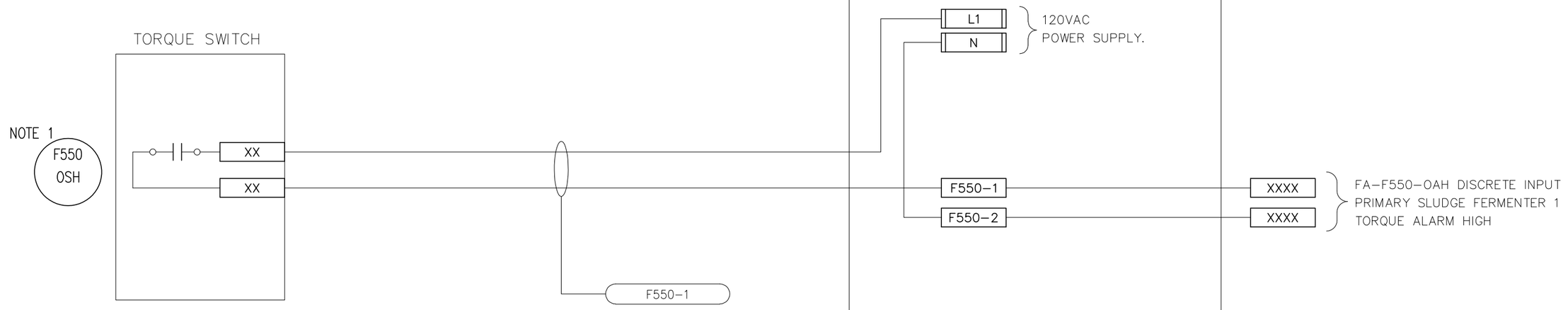
SCALE AS NOTED
DATE 2005/12/16
DES CD DWN PPL
CKD ES APP SWT

DRAWING NO.
ILD-10

INSTRUMENT LOOP DIAGRAM

LOOP NO. XXXX

FIELD PROCESS AREA	ELECTRICAL ROOM	
	CONTROL PANEL XXX	P.C.U. XXX



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TYPICAL INSTRUMENT LOOP DIAGRAM
TORQUE SWITCH

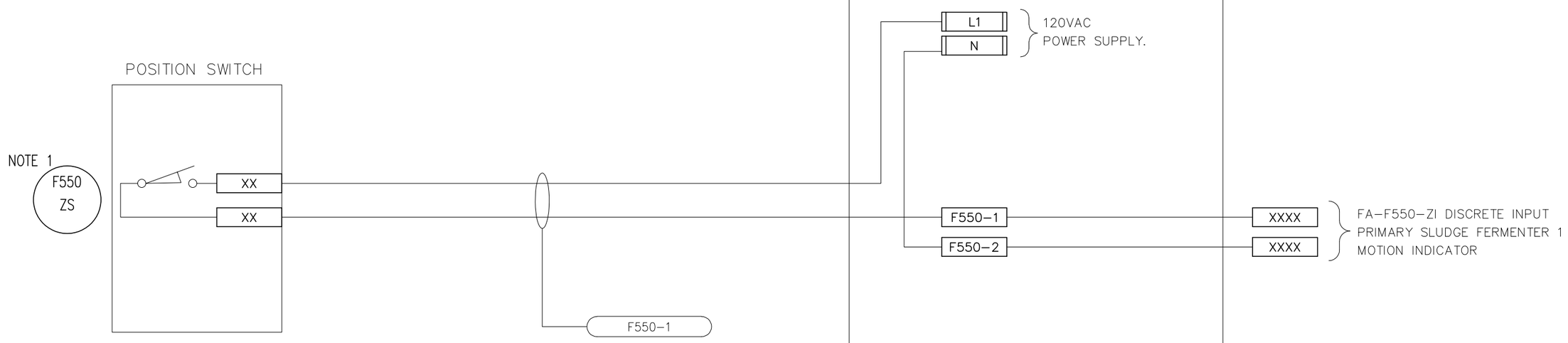
SCALE AS NOTED
DATE 2006/01/12
DES CD DWN PPL
CKD ES APP SWT

DRAWING NO.
ILD-11

INSTRUMENT LOOP DIAGRAM

LOOP NO. XXXX

FIELD PROCESS AREA	ELECTRICAL ROOM	
	CONTROL PANEL XXX	P.C.U. XXX



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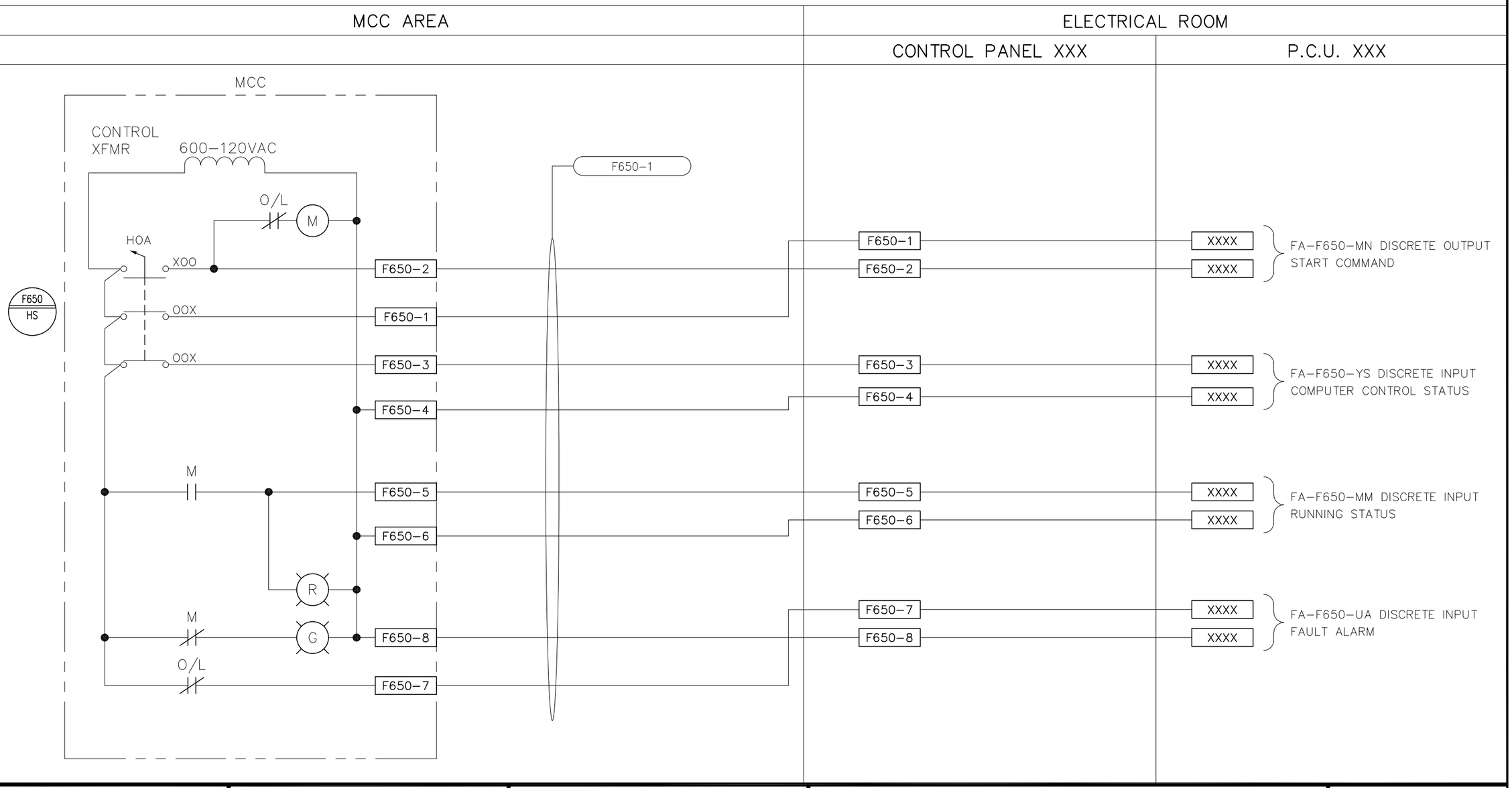
TYPICAL INSTRUMENT LOOP DIAGRAM
POSITION SWITCH

SCALE AS NOTED
DATE 2006/01/12
DES CD DWN PPL
CKD ES APP SWT

DRAWING NO.
ILD-12

INSTRUMENT LOOP DIAGRAM

LOOP NO. XXXX



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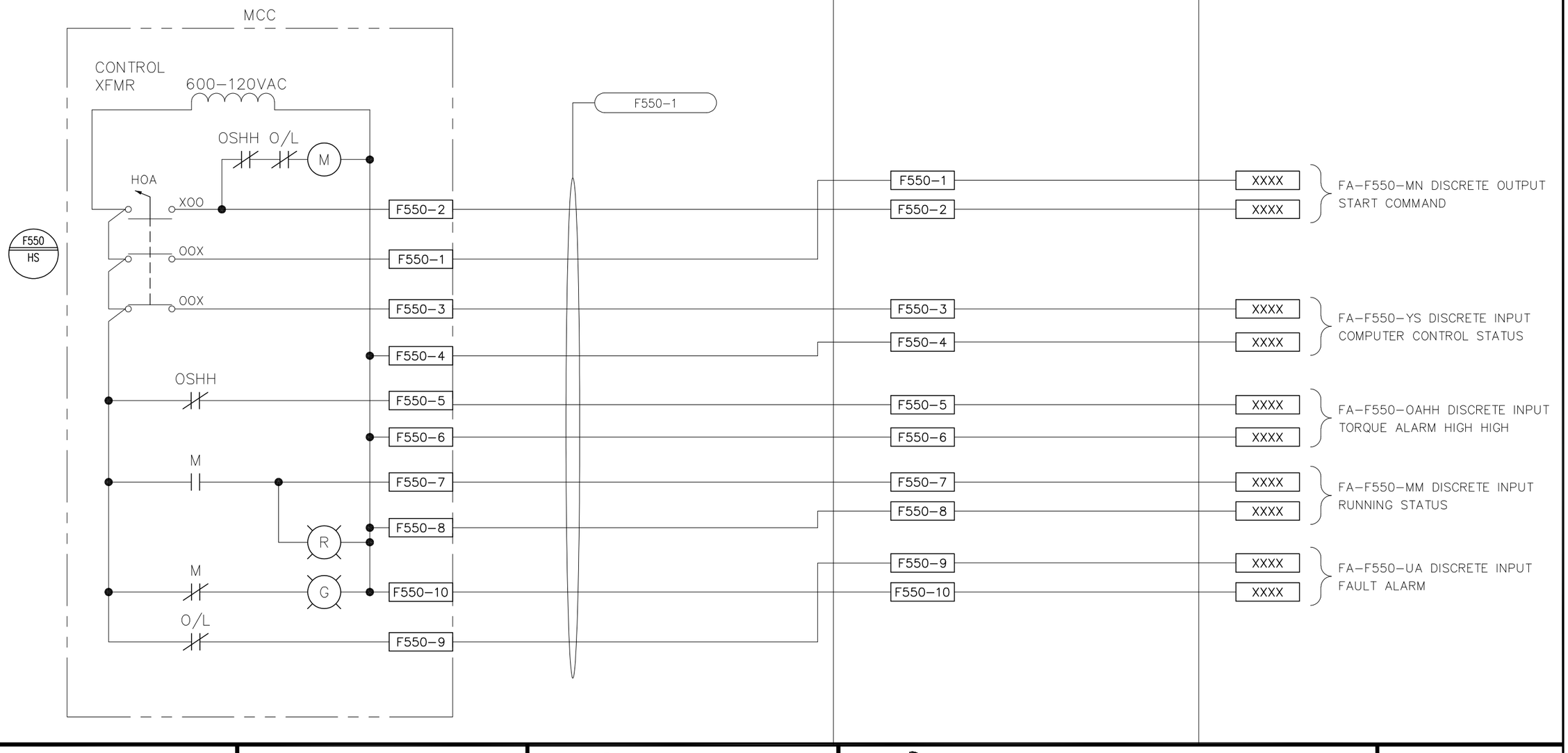
TYPICAL INSTRUMENT LOOP DIAGRAM
FIXED SPEED DRIVE

SCALE AS NOTED
DATE 2006/01/04
DES CD DWN PPL
CKD ES APP SWT

DRAWING NO.
ILD–13

INSTRUMENT LOOP DIAGRAM

LOOP NO. XXXX



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TYPICAL INSTRUMENT LOOP DIAGRAM
FERMENTER MECHANISM DRIVE

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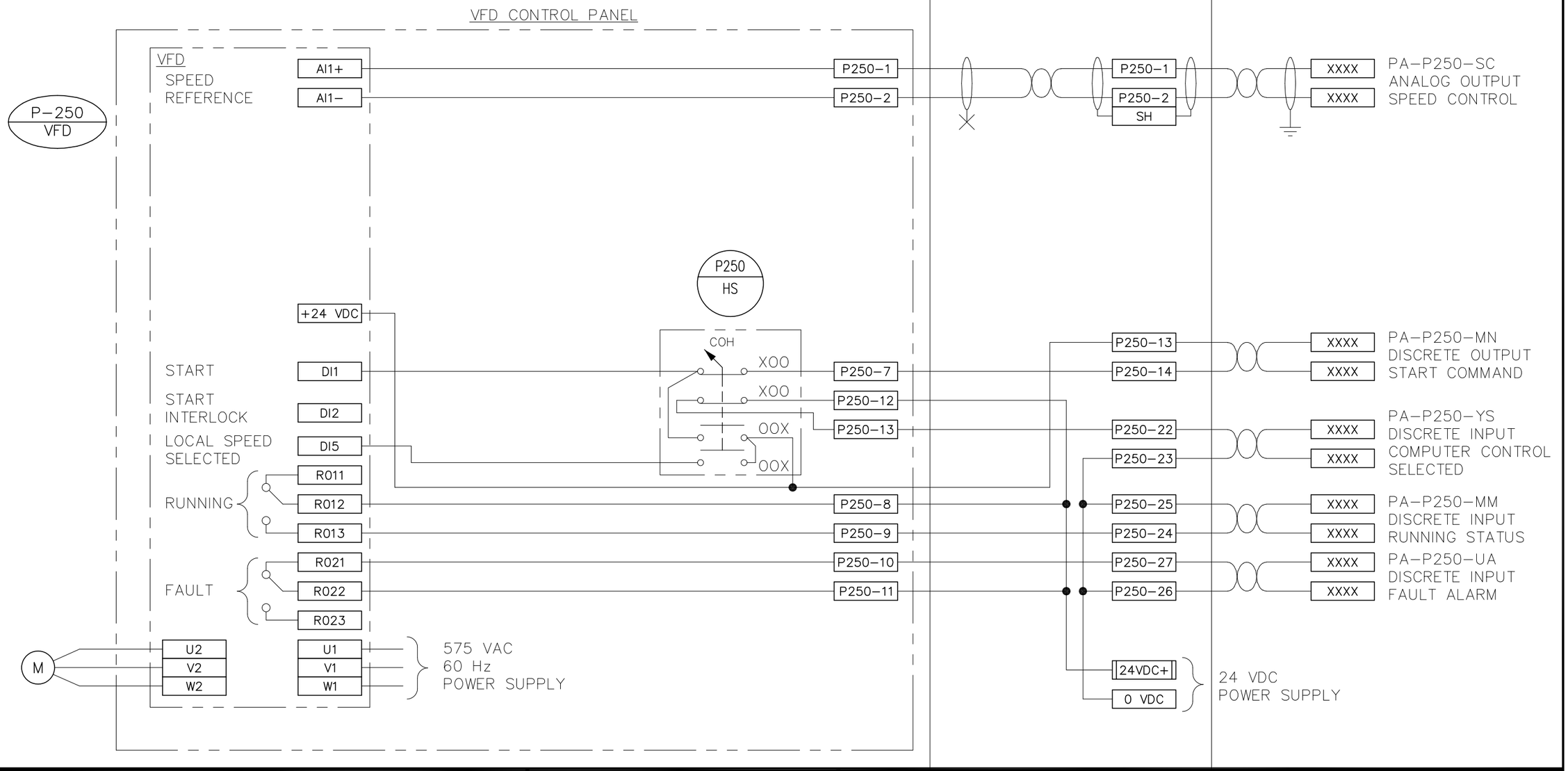
ILD–14

INSTRUMENT LOOP DIAGRAM

LOOP NO. XXXX

ELECTRICAL ROOM

	CONTROL PANEL XXX	P.C.U. XXX



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TYPICAL INSTRUMENT LOOP DIAGRAM
VARIABLE FREQUENCY DRIVE

SCALE AS NOTED
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CKD ES APP SWT

DRAWING NO.
ILD-15

INSTRUMENT STANDARD DETAILS

1. GENERAL

1.1 References - General

.1 Refer to Section 17010 for general requirements for this Section.

1.2 Instrument Standard Details

.1 The following twenty (20) Drawings provide standard instrumentation installation details as referenced by this Specification Section:

ISD-01	Instrument Standard Detail - Magnetic Flow Meter
ISD-02	Instrument Standard Detail - Remote Transmitter Mounting
ISD-03	Instrument Standard Detail - Pressure Switches
ISD-04	Instrument Standard Detail - Pressure Gauges
ISD-05	Instrument Standard Detail - General
ISD-06	Instrument Standard Detail - Pressure Transmitters
ISD-07	Instrument Standard Detail - Pressure Switches and Gauges
ISD-08	Instrument Standard Detail - General
ISD-09	Instrument Standard Detail - General
ISD-10	Instrument Standard Detail - General
ISD-11	Instrument Standard Detail - Pressure Switches and Gauges
ISD-12	Instrument Standard Detail - Ultrasonic Level Element
ISD-13	Instrument Standard Detail - Ultrasonic Level Element
ISD-14	Instrument Standard Detail - Dissolved Oxygen Probe
ISD-15	Instrument Standard Detail - Rotary Valves
ISD-16	Instrument Standard Detail - Rotary Valves
ISD-17	Instrument Standard Detail - Ultrasonic Level Element
ISD-18	Instrument Standard Detail - Thermal Mass Flowmeter
ISD-19	Instrument Standard Detail - Level Switch
ISD-20	Instrument Standard Detail - Solenoid Valve Local Control Station

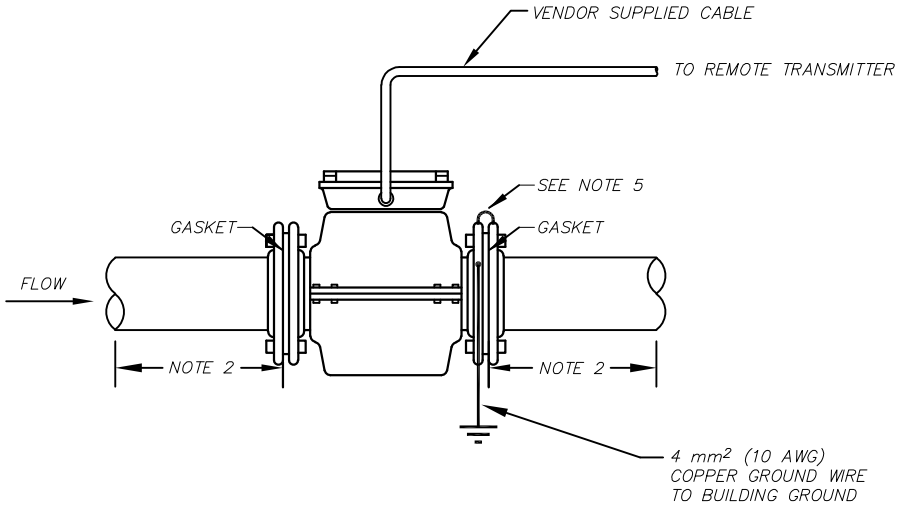
2. PRODUCTS

.1 Not used

3. EXECUTION

.1 Not used

END OF SECTION



FLOW METER INSTALLATION

NOTES:

1. LOCATE THE METER IN A STRAIGHT RUN OF PIPE FREE OF VALVES OR FITTINGS WITH MINIMUM OF FIVE AND FIVE PIPE DIAMETERS UPSTREAM AND DOWNSTREAM LENGTH.
2. IN A VERTICAL PIPE RUN, MOUNT THE METER WITH THE FLOW DIRECTION UPWARD.
3. THE PROCESS PIPE MUST FLOW FULL OF LIQUID.
4. AVOID LOCATING MAGNETIC FLOWMETERS NEAR HEAVY INDUCTION EQUIPMENT (100 hp AND LARGER, NO CLOSER THAN 6 m).
5. INSTALL BONDING CABLES (SUPPLIED WITH MAGNETIC FLOWMETERS) ON METALLIC PIPES ONLY.

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MAGNETIC FLOWMETER
INSTRUMENT STANDARD DETAIL

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A Tyco International Ltd. Company
Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254-3301
Fax: (403) 254-3333

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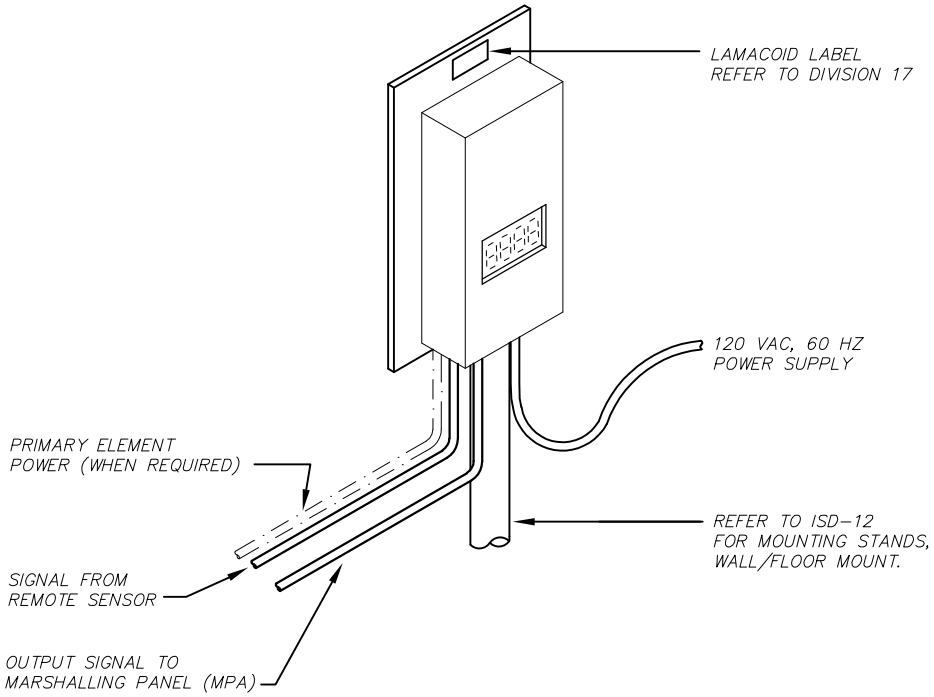

FIG. 1 REMOTE INDICATING TRANSMITTER (SELF POWERED)

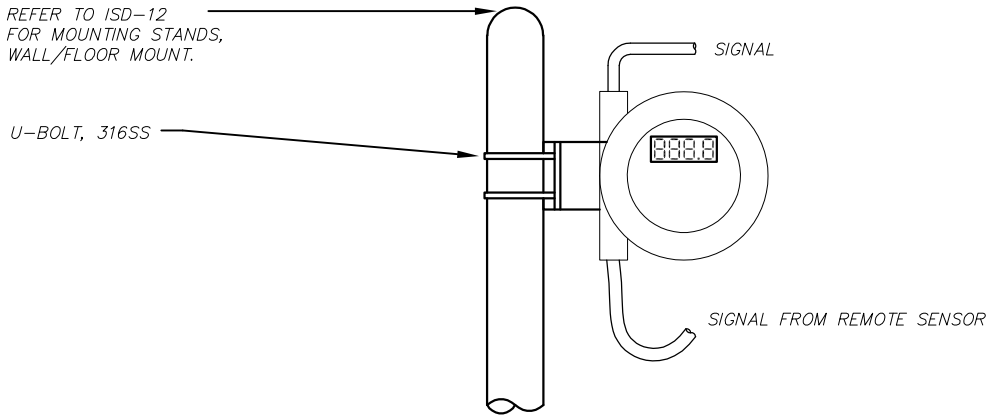

FIG. 2 REMOTE INDICATING TRANSMITTER (LOOP POWERED)

NOTES:

1. REFER TO INSTRUMENT SPECIFICATION SHEET FOR REMOTE TRANSMITTER TYPE.

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REMOTE TRANSMITTER MOUNTING
INSTRUMENT STANDARD DETAIL

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Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254-3301
Fax: (403) 254-3333

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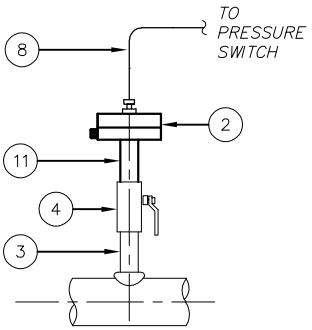

FIG. (a) DIRTY SERVICE
DIAPHRAGM SEAL

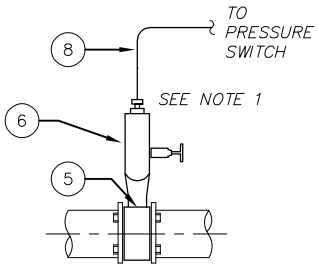

FIG. (b) DIRTY SERVICE
IN–LINE SERVICE

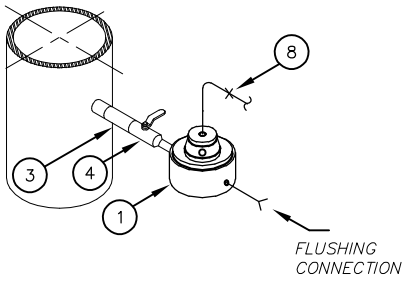

FIG. (c) DIRTY SERVICE – DIAPHRAGM
SERVICE WITH CONTINUOUS FLUSH

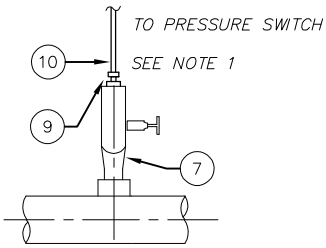

FIG. (d) CLEAN SERVICE

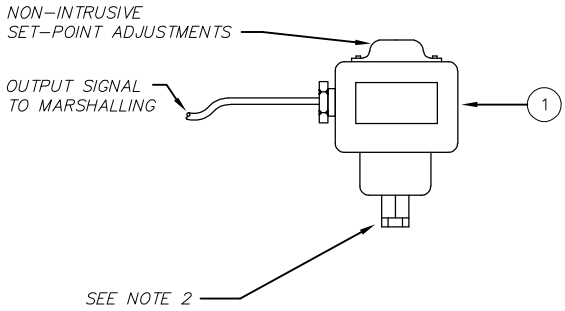

FIG. 1 PRESSURE SWITCH
REMOTE MOUNT

NOTES:

1. WHEN BOTH PRESSURE GAUGE AND PRESSURE SWITCH REQUIRED BY APPLICATION – SEE DWG. ISD–04.
2. PROVIDE REQUIRED CONNECTOR TO ACCOMMODATE PROCESS CONNECTION TO PRESSURE SWITCH.

ITEM	DESCRIPTION
1	PRESSURE SWITCH, 12mm (NPT) PROCESS CONNECTION
2	DIAPHRAGM SEAL
3	LONG NIPPLE, 20mm DIA x 50 mm, SEE NOTE 3
4	BALL VALVE – BV02, 20mm DIA.
5	THRU IN–LINE PRESSURE SENSOR, 12mm (NPT) CONN.
6	MULTI–PORT GAUGE VALVE, STRAIGHT THROUGH TYPE, 12mm x 12mm (NPT)
7	MULTI–PORT GAUGE VALVE, STRAIGHT THROUGH TYPE, 12mm x 20mm (NPT)
8	CAPILLARY TUBING, C/W 316SST ARMOURED SHEATH
9	MALE CONNECTOR, 12mm x 10mm (NPT)
10	TUBING, 10mm DIA, 316SST
11	LONG NIPPLE, 20mm DIA X 50mm LONG

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PRESSURE SWITCH
PROCESS CONNECTION AND ADAPTORS
INSTRUMENT STANDARD DETAIL

Earth Tech
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Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254–3301
Fax: (403) 254–3333

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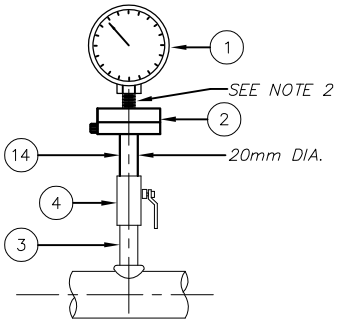

FIG. 1 DIRTY SERVICE DIAPHRAGM SEAL

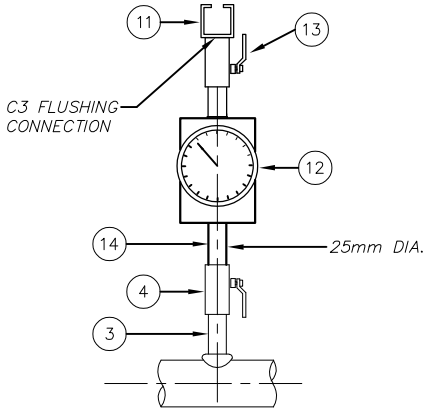

FIG. 2 DIRTY SERVICE IN-LINE SENSOR

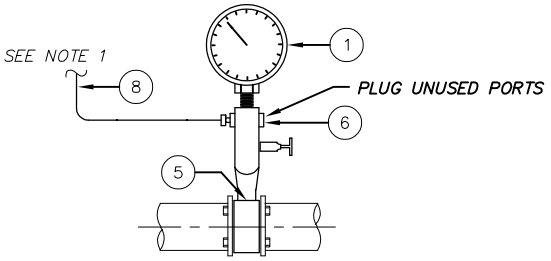

FIG. 3 DIRTY SERVICE IN-LINE SENSOR

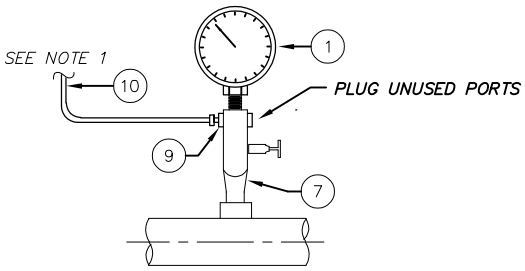

FIG. 4 CLEAN SERVICE

NOTES:

1. TO REMOTE MOUNT PRESSURE SWITCH OR OTHER GAUGE VALVES (FIG. 4 ONLY) WHEN REQUIRED BY APPLICATION. **SEE DWG. ISD-03.**
2. REFER TO INSTRUMENT SPECIFICATION SHEET TO DETERMINE WHETHER A SNUBBER IS REQUIRED.

ITEM	DESCRIPTION
1	PRESSURE GAUGE, 12mm (NPT).
2	DIAPHRAGM SEAL
3	LONG NIPPLE, 50 mm LONG.
4	BALL VALVE – BV02, 20mm DIA.
5	THRU IN-LINE PRESSURE SENSOR, 12mm (NPT) CONN. C/W FLUSHING AND FILL CONN.
6	MULTI-PORT GAUGE VALVE, STRAIGHT THROUGH TYPE, 12mm x 12mm (NPT).
7	MULTI-PORT GAUGE VALVE, STRAIGHT THROUGH TYPE, 12mm x 20mm (NPT).
8	CAPILLARY TUBING, C/W 316SST ARMOURED SHEATH.
9	MALE CONNECTOR, 12mm x 10mm (NPT).
10	TUBING, 10mm DIA, 316SST.
11	QUICK DISCONNECT, 25mm.
12	IN-LINE PRESSURE SENSOR, RED VALVE TYPE 42S, C/W SENSING LIQUID & GAUGE
13	BALL VALVE – BV01, 25mm DIA.
14	LONG NIPPLE, 50mm LONG

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PRESSURE GAUGES
PROCESS CONNECTION AND ADAPTORS
INSTRUMENT STANDARD DETAIL

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Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254-3301
Fax: (403) 254-3333

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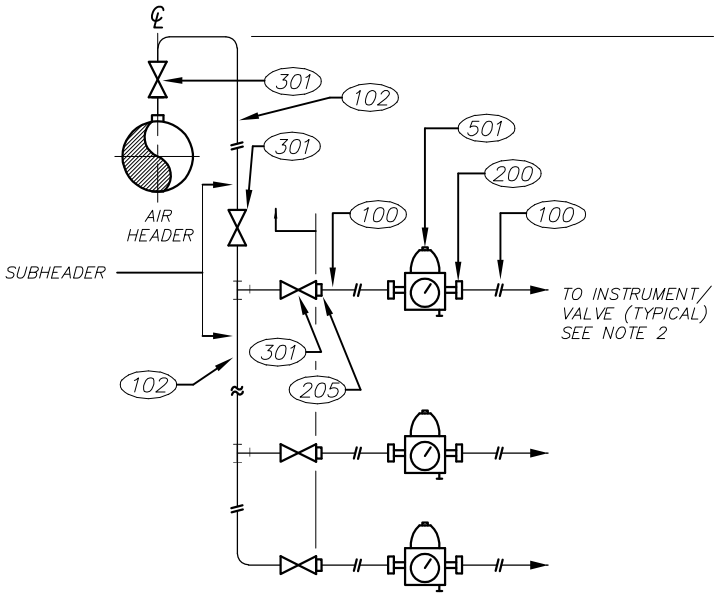

FIG. 1 GROUP INSTRUMENT AIR SUPPLY (SEE NOTE 3)

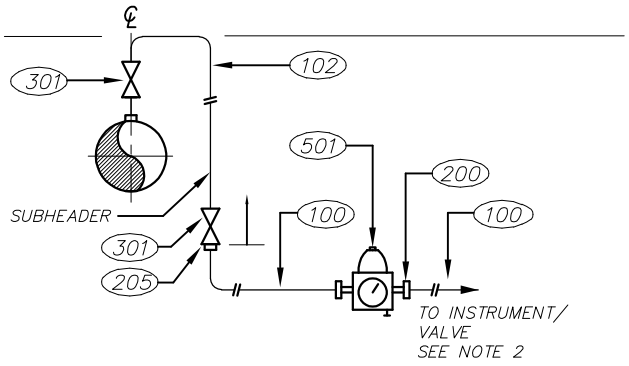

FIG. 2 SINGLE INSTRUMENT AIR SUPPLY

NOTES:

1. MAXIMUM OF 4 TRANSDUCERS OR 3 DIAPHRAGM ACTUATORS OR 2 PISTON ACTUATORS.
2. MAXIMUM LENGTH OF INSTRUMENT SUBHEADER IS 9.0M.
3. ALL TAKE-OFF POINTS FROM SUBHEADER 1.5M MAXIMUM ABOVE FLOOR AND 1.0M MAXIMUM FROM AIRSET OF INSTRUMENT.

ITEM	SIZE	QTY.	DESCRIPTION
100	10 O.D.	A/R	TUBING, 10mm O.D. 316SS
102	12mm	A/R	TUBING
200	10mm	A/R	MALE CONNECTOR, 10mm MNPT, 316SS
205	12mm	A/R	REDUCING BUSHING, 12mm x 10mm 316SST
301	12mm	A/R	BALL VALVE
501	10mm	A/R	FILTER REGULATOR C/W GAUGE

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TYPICAL INSTALLATION
INSTRUMENT AIR SUPPLY
INSTRUMENT STANDARD DETAIL

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Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254-3301
Fax: (403) 254-3333

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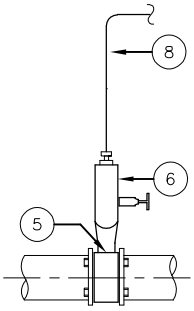

FIG. (a) DIRTY SERVICE IN-LINE SENSOR

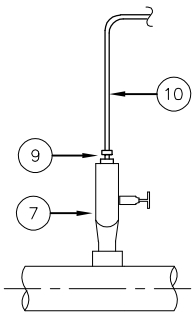

FIG. (b) CLEAN SERVICE

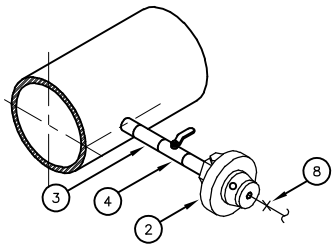

FIG. (c) DIRTY SERVICE DIAPHRAGM SEAL

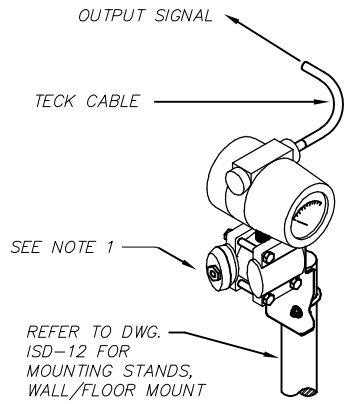

FIG. 1 PRESSURE TRANSMITTER

NOTES:

1. PROVIDE REQUIRED CONNECTOR.
2. REFER TO DWG. ISD-10 FOR ADDITIONAL IN-LINE PRESSURE SENSOR APPLICATIONS.
3. DUPLICATE SENSOR CONNECTION LINES FOR DIFFERENTIAL PRESSURE APPLICATIONS.

ITEM	DESCRIPTION
1	DIAPH. SEAL, ONYX C/W GUAGE TYPE, C/W 12mm PROC. & FLUSHING CONN.
2	DIAPHRAGM SEAL, ASHCROFT TYPE 101, C/W FLUSHING AND FILL CONN.
3	LONG NIPPLE, 20mm DIA x 50 mm
4	BALL VALVE, 20mm DIA.
5	THRU IN-LINE PRESSURE SENSOR, 12mm (NPT) CONN.
6	MULTI-PORT GAUGE VALVE, STRAIGHT THROUGH TYPE, 12mm x 12mmmm (NPT)
7	MULTI-PORT GAUGE VALVE, STRAIGHT THROUGH TYPE, 12mm x 20mm (NPT)
8	CAPILLARY TUBING, C/W 316SST ARMOURED SHEATH
9	MALE CONNECTOR, 12mm x 10mm (NPT)
10	TUBING, 10mm DIA, 316SST

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PRESSURE TRANSMITTER
PROCESS CONNECTION AND ADAPTORS
INSTRUMENT STANDARD DETAIL

Earth Tech
A Tyco International Ltd. Company
Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254-3301
Fax: (403) 254-3333

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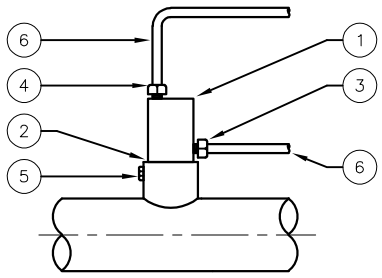

FIG. (a) DIRTY SERVICE IN–LINE SENSOR

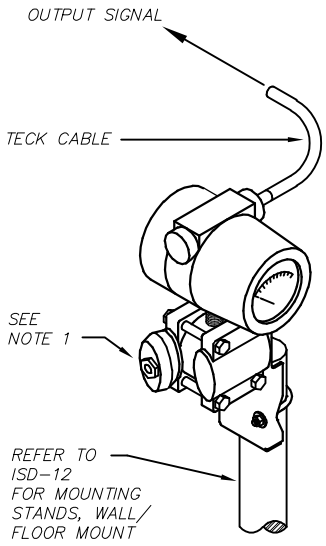

FIG. 1 PRESSURE TRANSMITTER

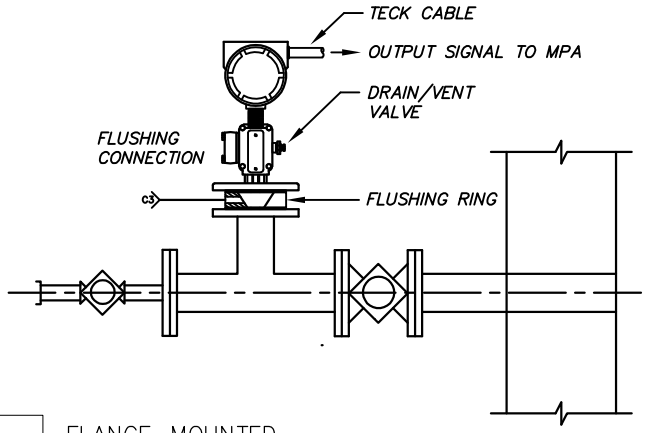

FIG. 2 FLANGE–MOUNTED LIQUID LEVEL TRANSMITTER (CONSTANT FLUSH)

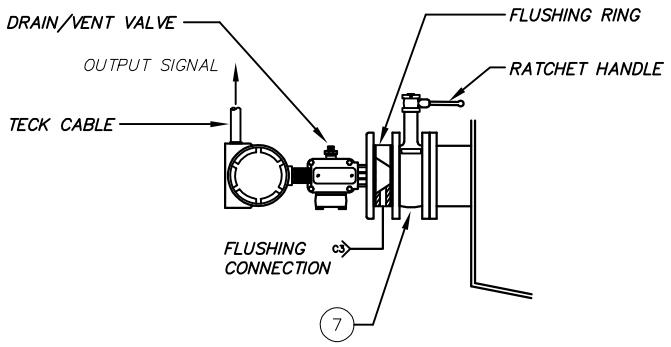

FIG. 3 FLANGE–MOUNTED LIQUID LEVEL TRANSMITTER (MANUAL FLUSH)

NOTES:

1. PROVIDE REQUIRED CONNECTOR.
2. SENSOR SUITABLE FOR PIPE 50mm DIAMETER AND LARGER ONLY.
3. REFER TO ISD–09 FOR ADDITIONAL PROCESS CONNECTIONS & ADAPTORS.

ITEM	DESCRIPTION
1	IN–LINE–PRESSURE SENSOR, PMC TYPE PT
2	WELD–ON NIPPLE, SUPPLIED WITH PRESSURE SENSOR
3	AIR SUPPLY INPUT
4	OUTPUT TO TRANSMITTER
5	SET SCREW AND LOCK WASHER IF APPLICABLE
6	TUBING, 10mm DIAMETER, 316SST
7	LEVEL SENSOR KNIFE GATE VALVE, DE ZURIK – MODEL KLS, 3, L1L, S2, C, CSM, MN–RH–CS

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PRESSURE TRANSMITTER AND IN–LINE PRESSURE SENSOR INSTRUMENT STANDARD DETAIL

Earth Tech
A Tyco International Ltd. Company
Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254–3301
Fax: (403) 254–3333

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DWG. No. ISD–07

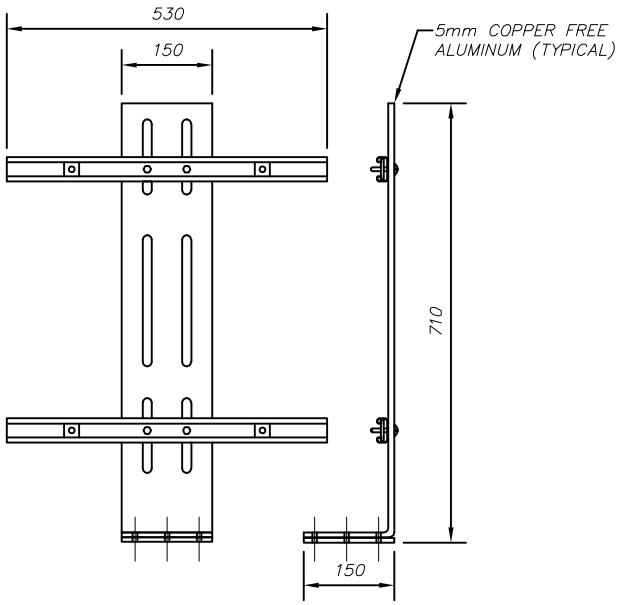

FIG. 1 TYPICAL MOUNTING BRACKET

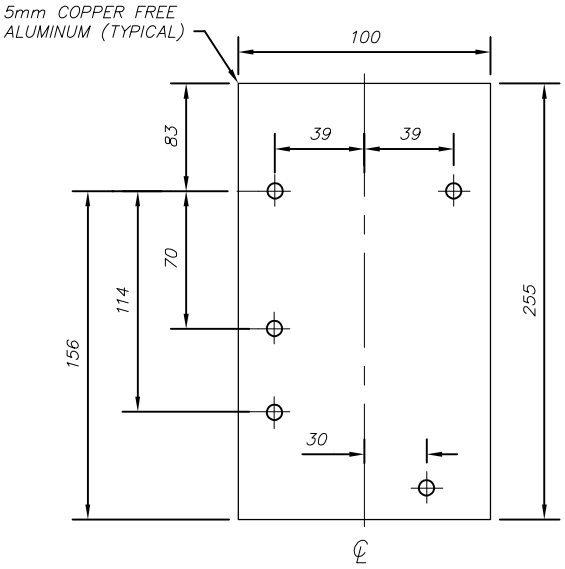

FIG. 2 MOUNTING BRACKET FOR SWITCH BOXES

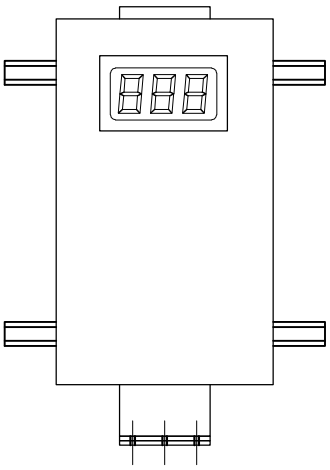

FIG. 3 LARGE CASE INDICATING CONTROLLERS / RECORDER

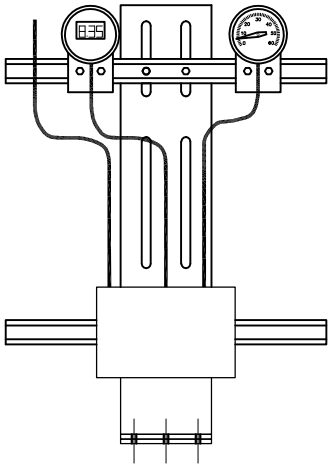

FIG. 4 INDICATING TRANSMITTERS, GAUGES, MANIFOLDS, ETC.

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WEWPCC BIOLOGICAL NUTRIENT REMOVAL UPGRADE

INSTRUMENT VERTICAL
BRACKET MOUNTING
INSTRUMENT STANDARD DETAIL

Earth Tech
A Tyco International Ltd. Company
Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254-3301
Fax: (403) 254-3333

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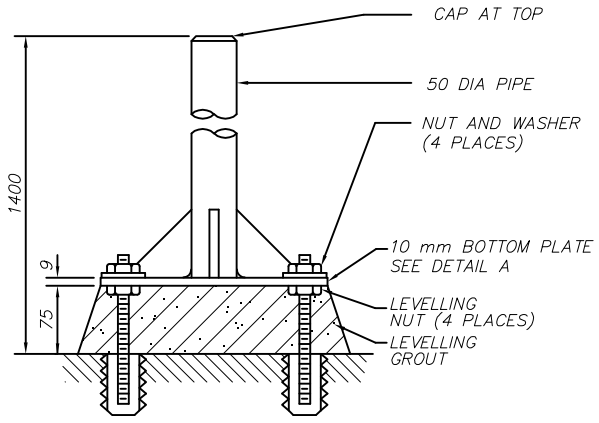

FIG. 1 FLOOR MOUNT

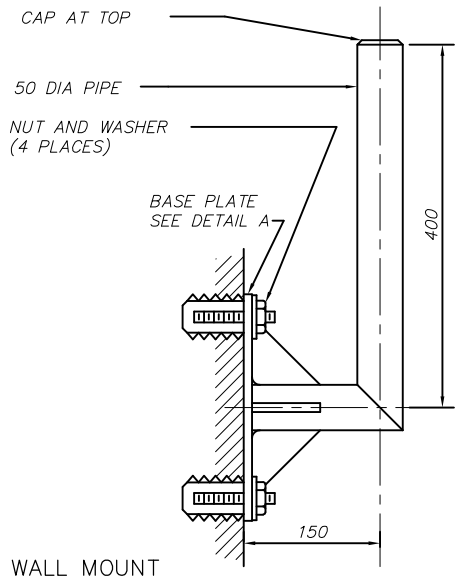

FIG. 2 WALL MOUNT

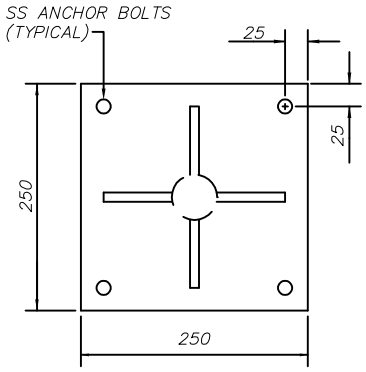

FIG. (a) DETAIL 'A'
MOUNTING PLATE

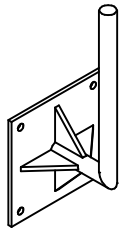

FIG. (b) WALL MOUNT
EXTERNAL VIEW

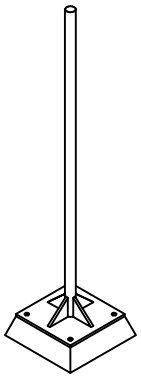

FIG. (c) FLOOR MOUNT
EXTERNAL VIEW

NOTES:

1. PIPE AND MOUNTING PLATE COPPER FREE ALUMINUM.
2. TOP OF PIPE TO BE 1400 (NOMINAL) ABOVE SERVICE FLOOR.
3. GROUTING TO BE POURED ONCE FLOOR MOUNT STAND PLUMBED FASTENED IN PLACE.

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CITY OF WINNIPEG
WEWPCC BIOLOGICAL NUTRIENT REMOVAL UPGRADE

INSTRUMENT MOUNTING STANDS
FOR WALL/FLOOR MOUNTING
INSTRUMENT STANDARD DETAIL

Earth Tech
A Tyco International Ltd. Company
Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254-3301
Fax: (403) 254-3333

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PROJECT. No. 76063

DWG. No.
ISD-09

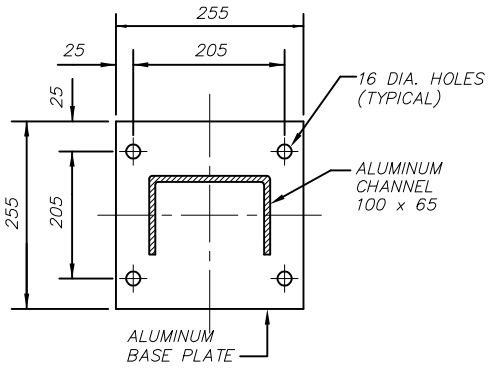

FIG. 1 BASE PLATE

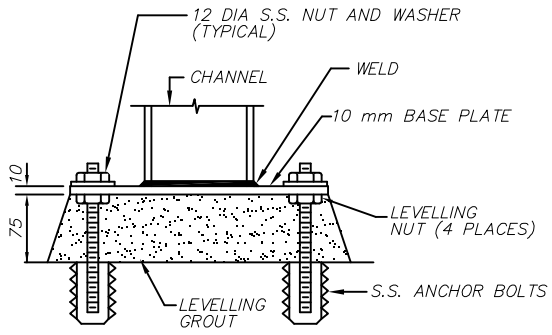

FIG. (a) DETAIL 'A'

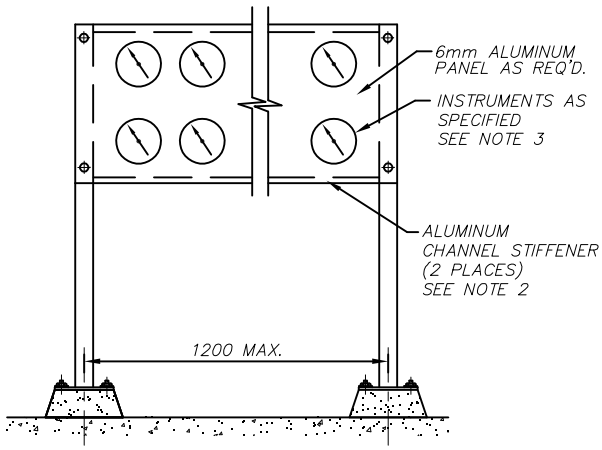

FIG. (b) FRONT VIEW

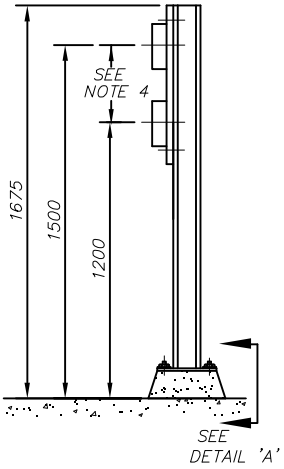

FIG. (c) SIDE VIEW

NOTES:

1. GROUTING TO BE POURED ONCE FLOOR MOUNT STAND PLUMBED FASTENED IN PLACE.
2. PROVIDE ALUMINUM CHANNEL STIFFENERS AS REQUIRED, WELD STIFFENER TO PANEL.
3. SEE INSTALLATION DETAILS FOR MOUNTING OF INSTRUMENTS.
4. MOUNT INSTRUMENTS SUCH THAT INDICATION OR ADJUSTMENTS ARE 1200mm TO 1500mm ABOVE FLOOR.

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CITY OF WINNIPEG
WEWPCC BIOLOGICAL NUTRIENT REMOVAL UPGRADE

TYPICAL
INSTRUMENT LOCAL PANEL MOUNTING STAND
INSTRUMENT STANDARD DETAIL

Earth Tech
A Tyco International Ltd. Company
Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254-3301
Fax: (403) 254-3333

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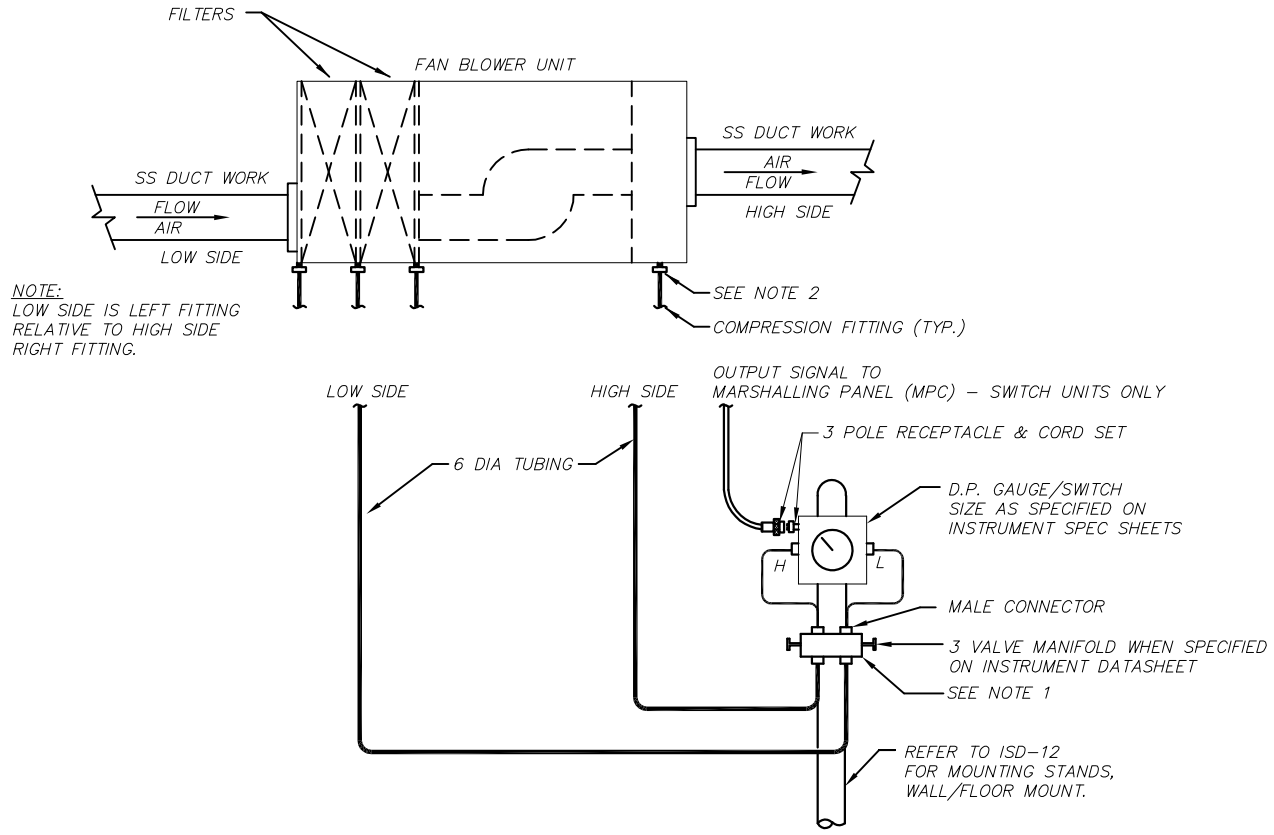
DWG. No.
ISD-10



AIR FLOW INSTALLATION

NOTES:

1. SECURE TO PIPE MOUNT OR MOUNTING PLATE.
2. TAPPINGS BY DIV. 15 AS REQUIRED TO SUIT MATERIAL AND CONSTRUCTION.

DATE	REVISIONS	APP

CITY OF WINNIPEG
WEWPCC BIOLOGICAL NUTRIENT REMOVAL UPGRADE

AIR – LOW RANGE
DIFFERENTIAL PRESSURE GAUGE/SWITCH
INSTRUMENT STANDARD DETAIL

Earth Tech
A Tyco International Ltd. Company
Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254–3301
Fax: (403) 254–3333

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PROJECT. No. 76063

DWG. No.
ISD–11

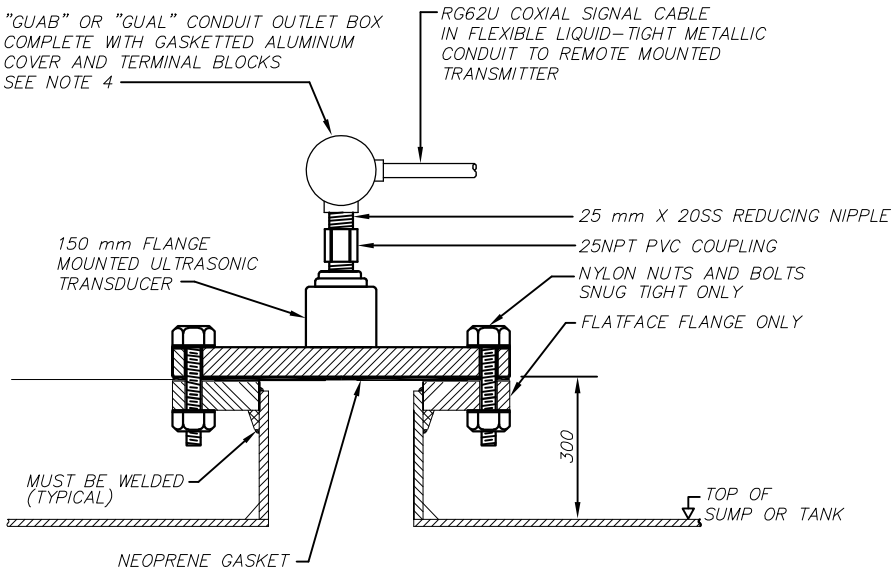

FIG. 1 FLANGE-MOUNTED ULTRASONIC LEVEL TRANSDUCER

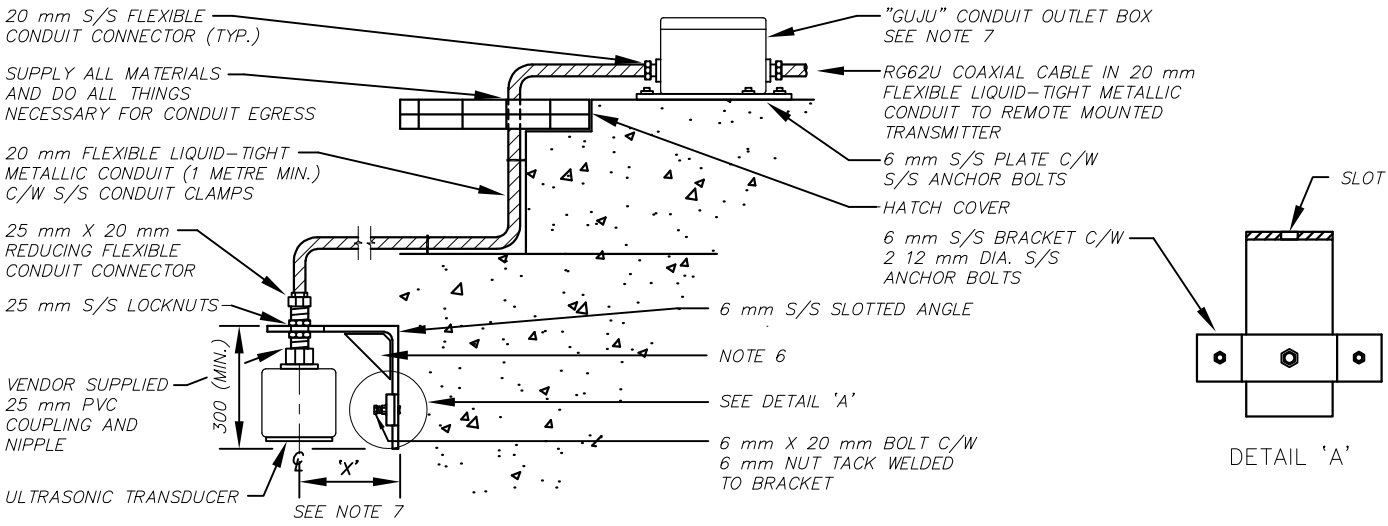

FIG. 2 BRACKET-MOUNTED ULTRASONIC LEVEL TRANSDUCER

NOTES:

1. REFER TO AREA CLASSIFICATIONS.
2. MOUNT TRANSDUCER AT LEAST 300mm AWAY FROM WALL OF SUMP.
3. PROVIDE COPPER-FREE ALUMINIUM CONDUIT OUTLET BOX.
4. FINAL DIMENSION TO BE DETERMINED IN FIELD.
5. WELD GUSSET TO REINFORCE AS REQUIRED.
6. LOCATE TO FACILITATE DISCONNECTION OF TRANSDUCER.
7. 'X' DIMENSION = 300 mm (MIN.) FOR EVERY 3 m OF LEVEL MEASURED.

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CITY OF WINNIPEG
WEWPCC BIOLOGICAL NUTRIENT REMOVAL UPGRADE

TYPICAL FOR ULTRASONIC LEVEL TRANSDUCERS OR RADAR INSTRUMENT STANDARD DETAIL

Earth Tech
A Tyco International Ltd. Company
Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254-3301
Fax: (403) 254-3333

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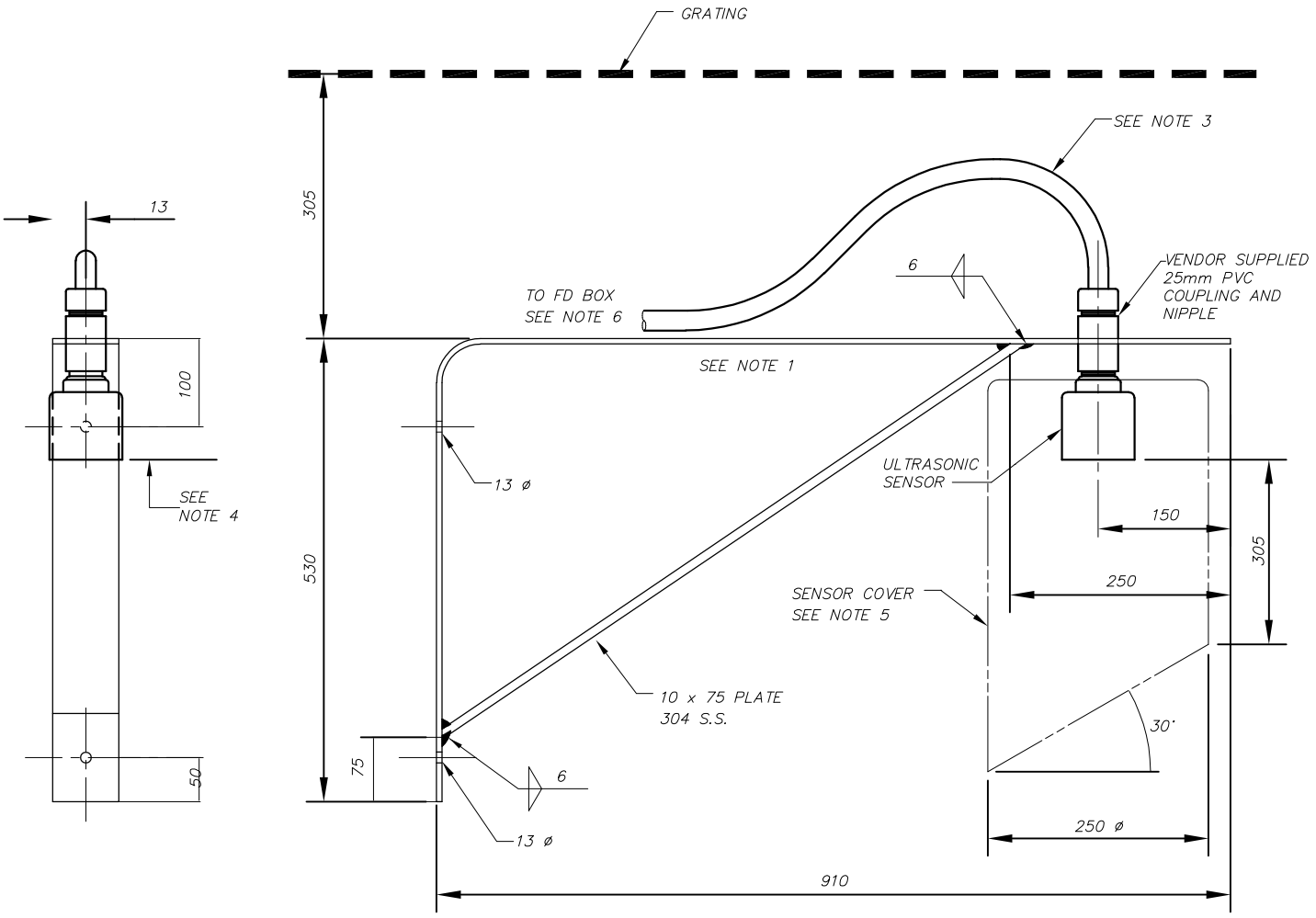
DWG. No. ISD-12



LEVEL SENSOR BRACKET

NOTES:

1) SENSOR MUST BE MOUNTED IN HORIZONTAL PLANE WITH RESPECT TO INFLUENT SEWAGE LEVEL/FLOW.

2) ALL BRACKET COMPONENTS TO BE 304 S.S.. BRACKET TO BE MOUNTED WHERE ONLY ONE SECTION OF GRATING IS REQUIRED TO BE REMOVED FOR SENSOR ACCESS.

3) RG62U COAXIAL SIGNAL CABLE TO BE RUN INSIDE FLEXIBLE LIQUID TIGHT METALLIC CONDUIT AND FASTENED TO BRACKET WITH "P" CLAMPS. CONDUIT CONNECTORS AT JUNCTION BOX ('FD' BOX) TO BE HL RATED (WATER TIGHT). REFER TO CONDUIT INSTALLATION DETAILS FOR CONTINUATION.

4) SENSOR ELEVATION TO BE AS PER INSTRUMENT SPECIFICATION SHEETS.

5) PROVIDE SENSOR COVER WHEN SPECIFIED IN INSTRUMENT INDEX.

6) LOCATE 'FD' BOX TO FACILITATE DISCONNECTION OF SENSOR.

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WEWPCC BIOLOGICAL NUTRIENT REMOVAL UPGRADE

TYPICAL ULTRASONIC LEVEL
TRANSDUCER MOUNTING
INSTRUMENT STANDARD DETAIL

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A Tyco International Ltd. Company
Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254-3301
Fax: (403) 254-3333

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DWG. No.
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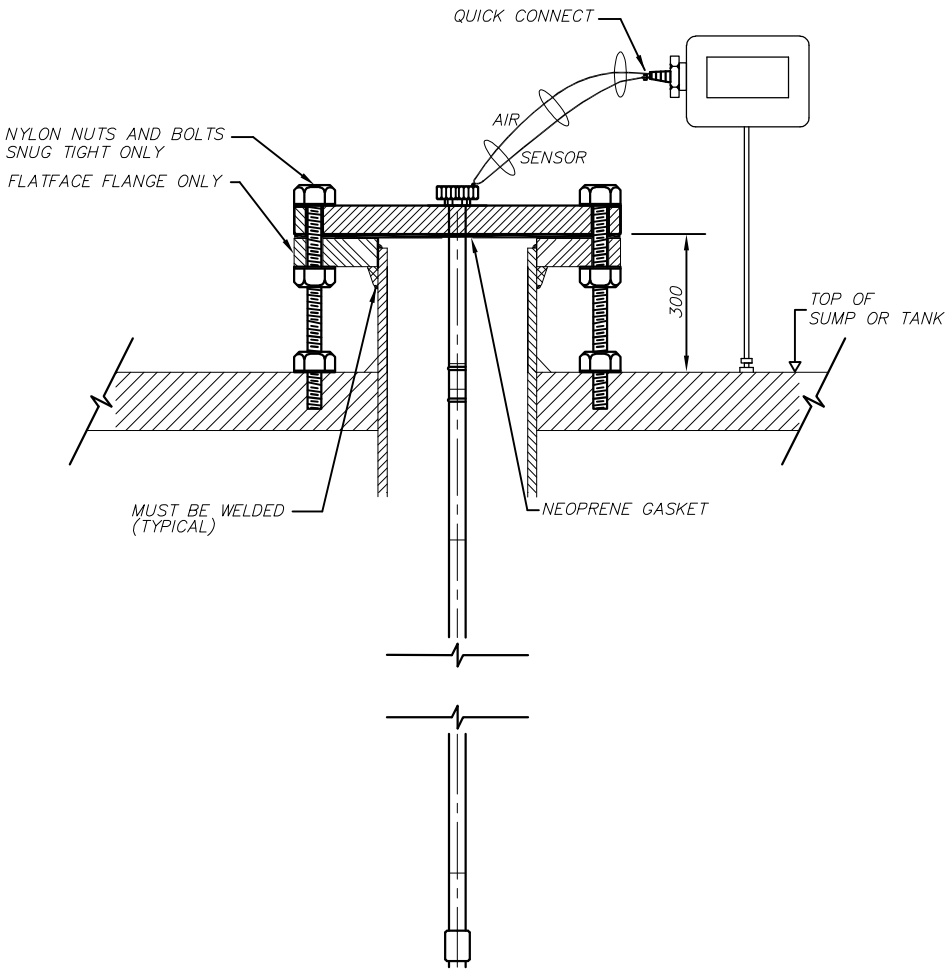

DISSOLVED OXYGEN PROBE

NOTES:

DATE	REVISIONS	APP

CITY OF WINNIPEG
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DISSOLVED OXYGEN PROBE
INSTALLATION DETAILS
INSTRUMENT STANDARD DETAIL

Earth Tech
A Tyco International Ltd. Company
Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254-3301
Fax: (403) 254-3333

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PROJECT. No. 76063

DWG. No.
ISD-14

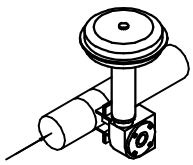
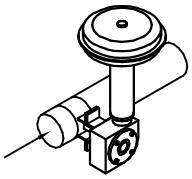
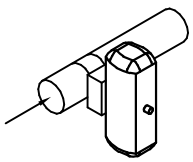
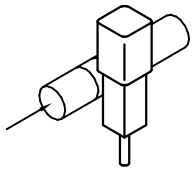
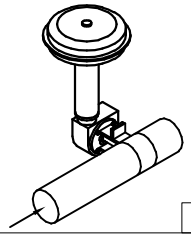
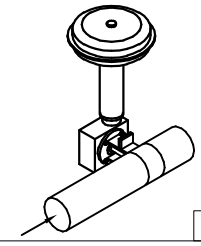
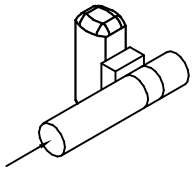
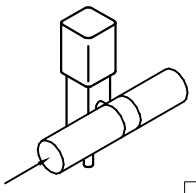
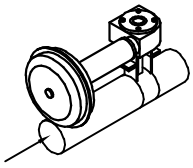
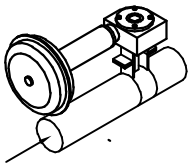
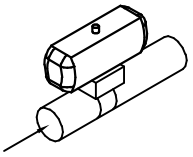
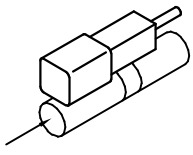
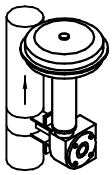
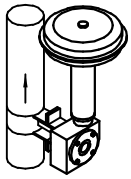
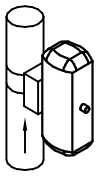
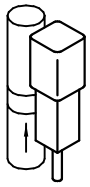
ACTUATOR		ACTUATOR TYPE			
ORIENTATION	LOCATION	DIAPHRAGM – PDTD	DIAPHRAGM – PDTC	RACK AND PINION	SCOTCH YOKE
PERPENDICULAR ACTUATOR	RIGHT HAND MOUNTING (HORIZONTAL SHAFT)	 a	 b	 c	 d
	LEFT HAND MOUNTING (HORIZONTAL SHAFT)	 e	 f	 g	 h
PARALLEL ACTUATOR	ON TOP MOUNTING (VERTICAL SHAFT)	 i	 j	 k	 l
	FLOW DOWN OR UP (HORIZONTAL SHAFT)	 m	 n	 o	 p

FIG. 1 MOUNTING ARRANGEMENTS

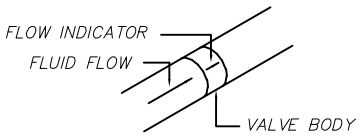


FIG. (a) VALVE INSTALLATION NORMAL FLOW

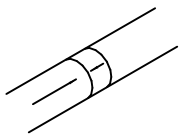


FIG. (b) VALVE INSTALLATION REVERSED FLOW

NOTES:

DATE	REVISIONS	APP

CITY OF WINNIPEG
WEWPCC BIOLOGICAL NUTRIENT REMOVAL UPGRADE

TYPICAL ROTARY VALVE
MOUNTING ARRANGEMENTS
INSTRUMENT STANDARD DETAIL

Earth Tech
A Tyco International Ltd. Company
Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254-3301
Fax: (403) 254-3333

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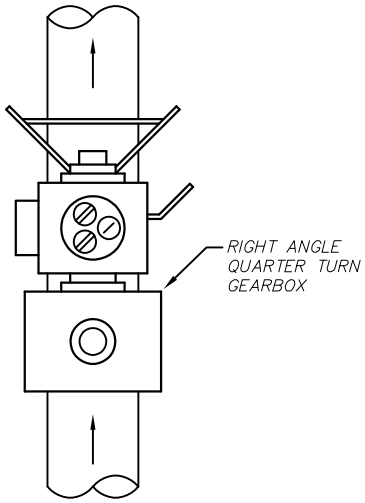

FIG. 1 ROTARY VALVE
VERTICAL TYPE

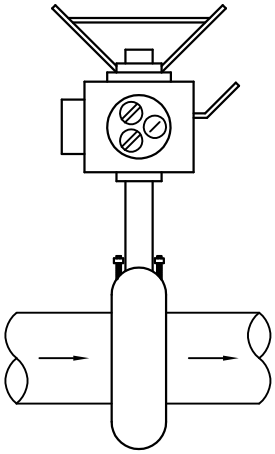

FIG. 2 SLIDE GATE
HORIZONTAL PIPE

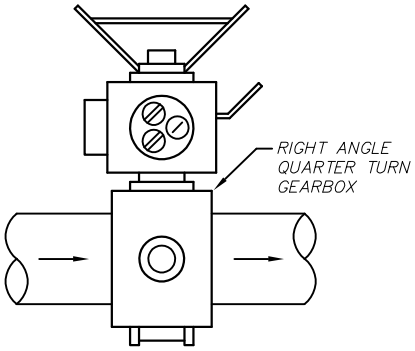

FIG. 3 ROTARY VALVE
HORIZONTAL PIPE

NOTES:

1. FRONT VIEW IS DEPICTED AS 'OPERATIONS' SIDE OF PIPE.
2. INSTALL ACTUATOR WITH OPERATOR CONTROLS ON 'OPERATIONS' SIDE.

DATE	REVISIONS	APP

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WEWPCC BIOLOGICAL NUTRIENT REMOVAL UPGRADE

TYPICAL ELECTRIC ACTUATOR
MOUNTING ARRANGEMENTS
INSTRUMENT STANDARD DETAIL

Earth Tech
A Tyco International Ltd. Company
Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254-3301
Fax: (403) 254-3333

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DWG. No.
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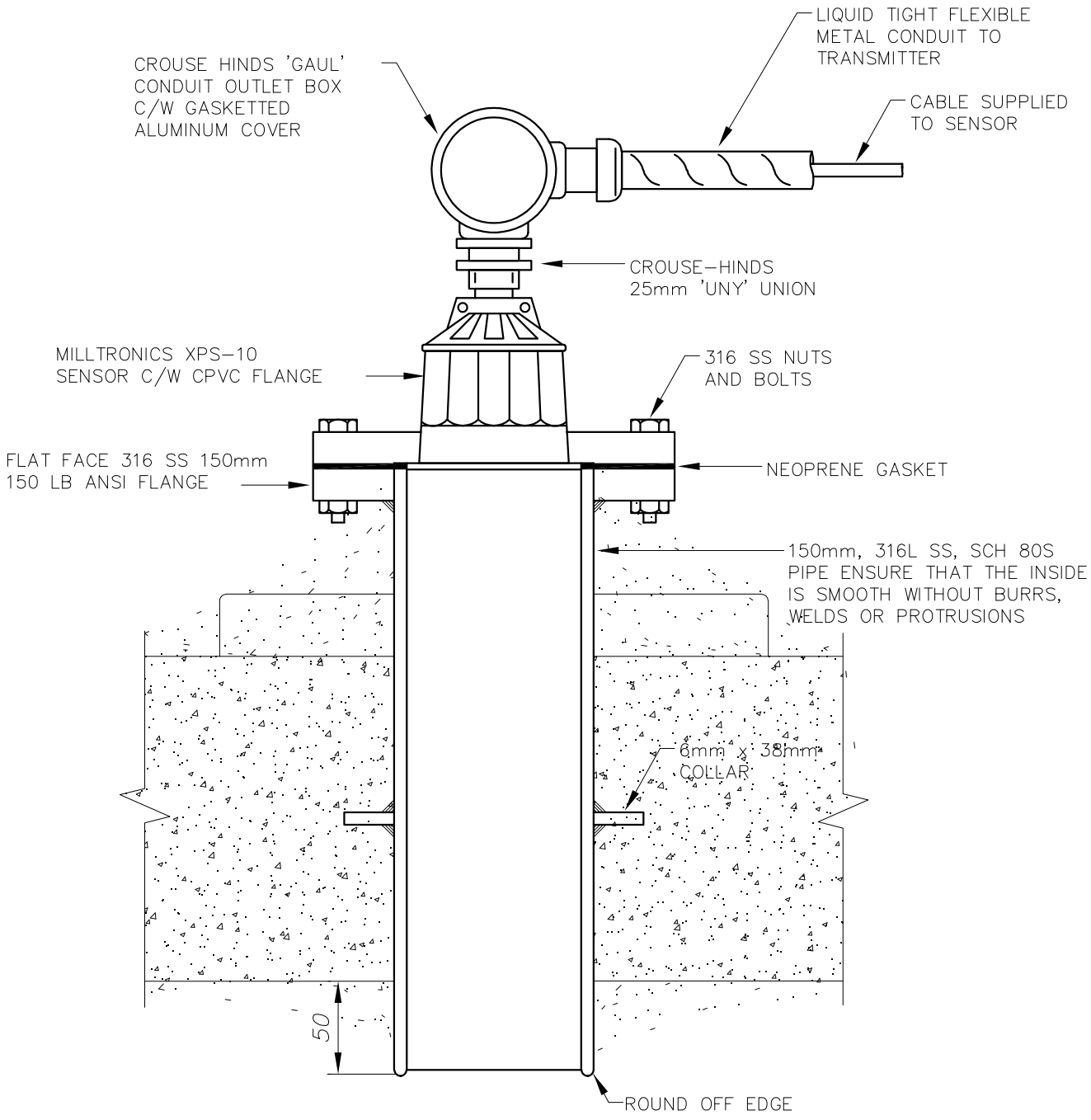

NOTES:

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CITY OF WINNIPEG

WEWPCC BIOLOGICAL NUTRIENT REMOVAL UPGRADE

FLANGED ULTRASONIC LEVEL TRANSMITTER INSTRUMENT STANDARD DETAIL

Earth Tech

A Tyco International Ltd. Company

Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254-3301
Fax: (403) 254-3333

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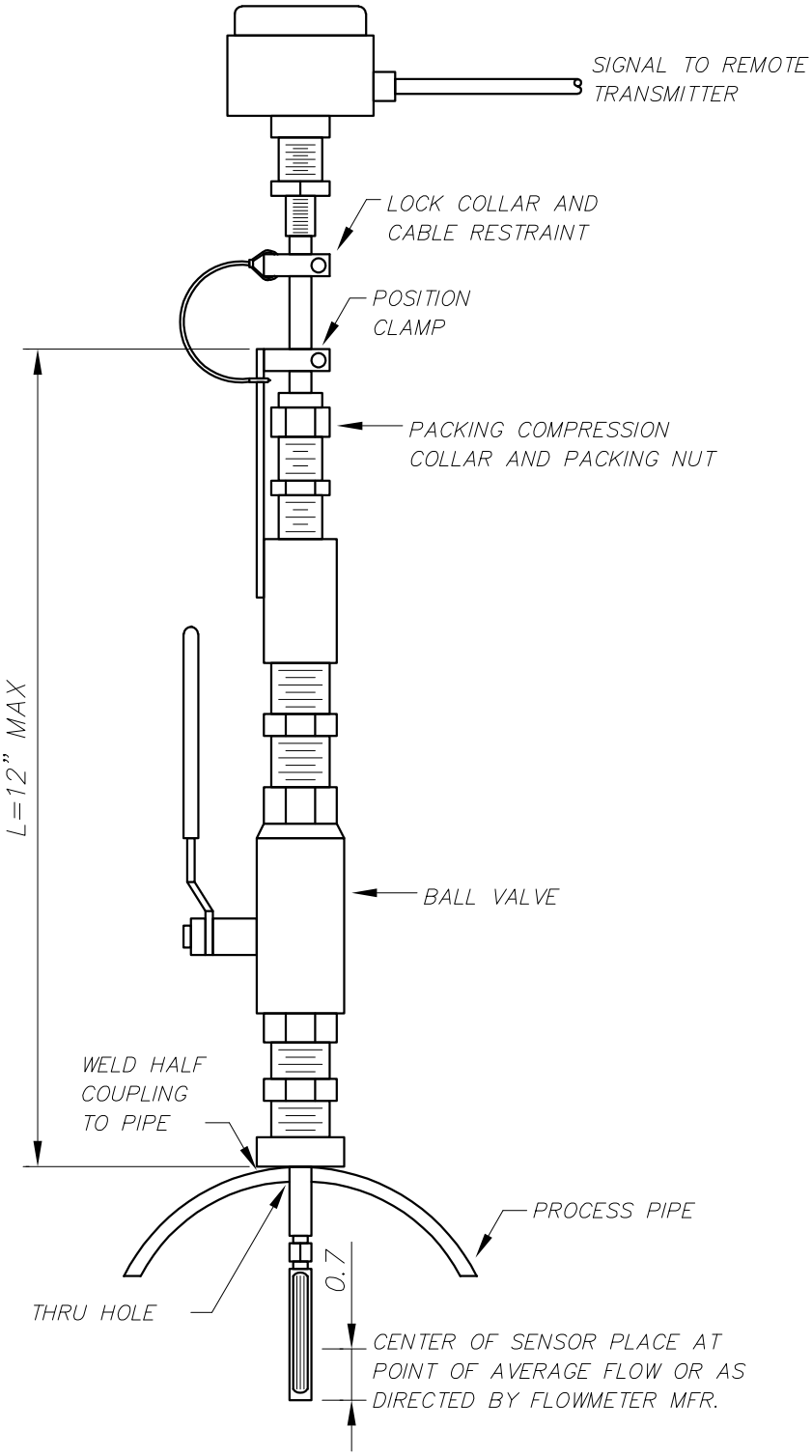
DWG. No.
ISD-17



NOTES:

1. LOCATE THE METER IN A STRAIGHT RUN OF PIPE FREE OF VALVES OR FITTINGS WITH A MIN. OF 20 DIA. UPSTREAM AND 10 PIPE DIA. DOWNSTREAM LENGTH.

2. MOUNT IN EITHER HORIZONTAL OR VERTICAL PROCESS PIPING. USE ON VERTICAL PIPE ONLY IF THE FLOW DIRECTION IS UP.

DATE	REVISIONS	APP

CITY OF WINNIPEG

WEWPCC BIOLOGICAL NUTRIENT REMOVAL UPGRADE

THERMAL MASS FLOWMETER
(IN-LINE REMOVABLE)
INSTRUMENT STANDARD DETAIL

Earth Tech
A Tyco International Ltd. Company

Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254-3301
Fax: (403) 254-3333

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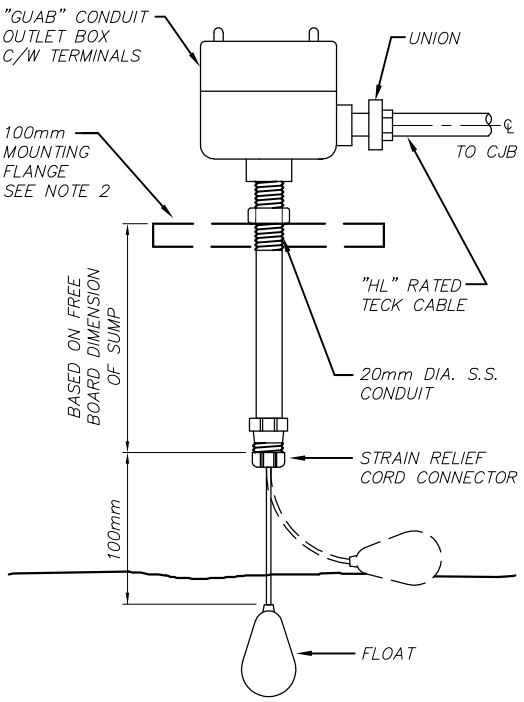


FIG. 1 FLOAT–TYPE LEVEL SWITCH NON–HAZARDOUS AREA

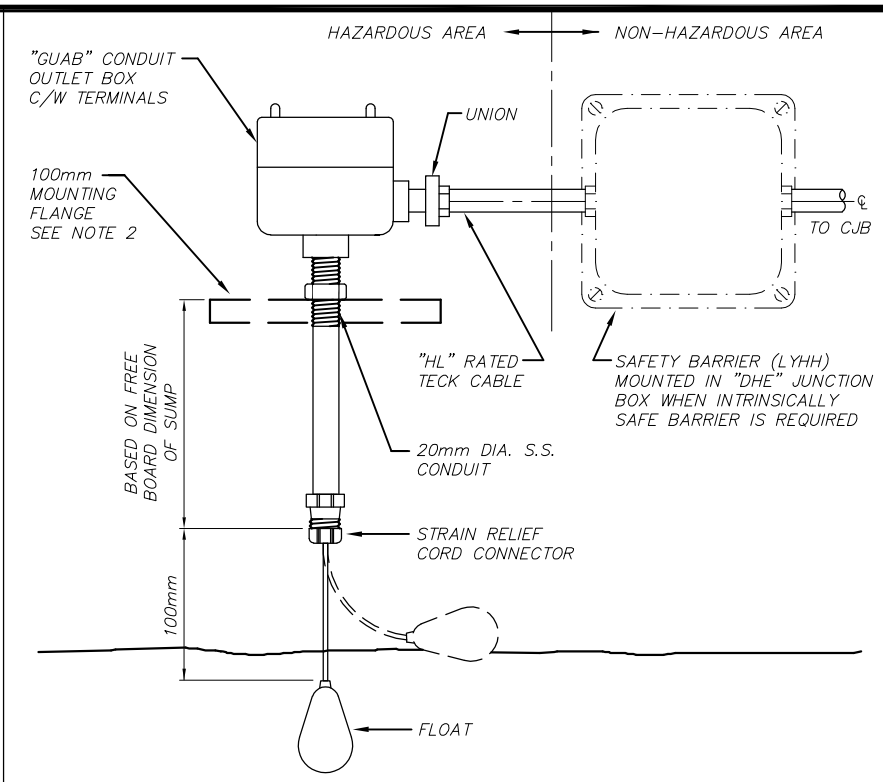


FIG. 2A FLOAT–TYPE LEVEL SWITCH HAZARDOUS AREA

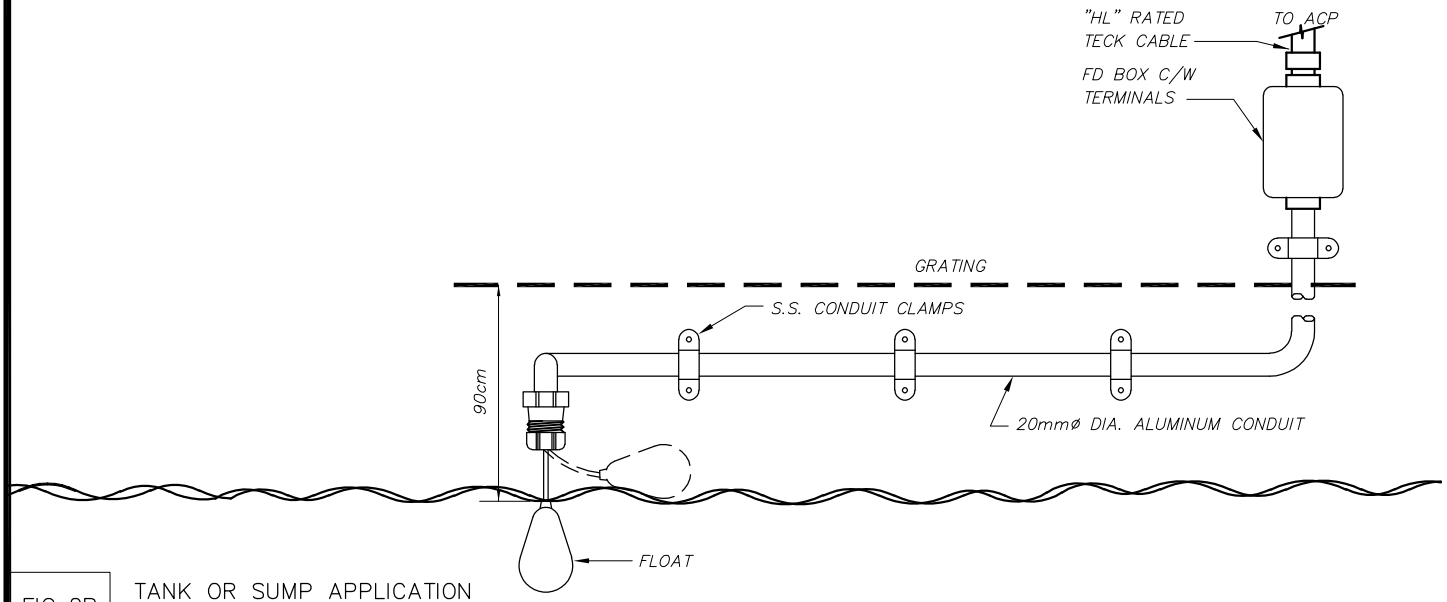


FIG. 2B TANK OR SUMP APPLICATION LEVEL SWITCH–HAZARDOUS AREA

NOTES:

1. REFER TO DWG'S A10 10031 AND A10 10032 FOR HAZARDOUS AREA INSTALLATION.
2. REFER TO DWG. A10 10040 FOR SUMP OR TANK INSTALLATION DETAILS.

DATE	REVISIONS	APP

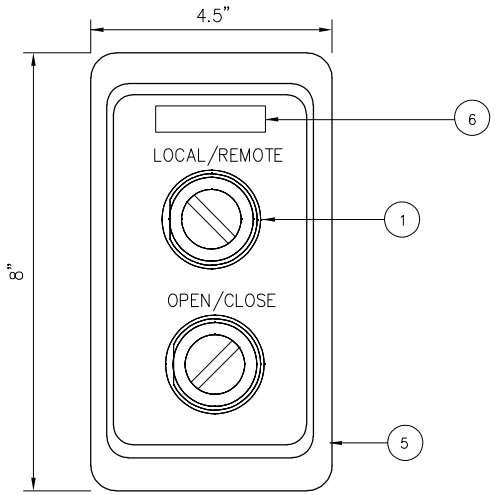
CITY OF WINNIPEG
WEWPCC BIOLOGICAL NUTRIENT REMOVAL UPGRADE

FLOAT LEVEL SWITCHES
INSTRUMENT STANDARD DETAIL

Earth Tech
A Tyco International Ltd. Company
Earth Tech (Canada) Inc.
Calgary, Alberta T2X 1P1
Phone: (403) 254–3301
Fax: (403) 254–3333

SCALE N.T.S
DATE 2006/01/06
DES CD DWN PPL
CKD ES APP SWT
PROJECT. No. 76063

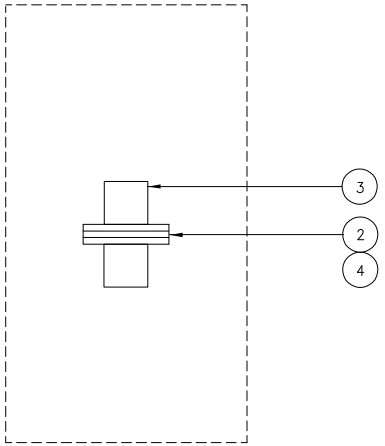
DWG. No.
ISD–19



2-WAY SWITCH CONTACT TABLE (1)

	A	L
1	X	O
2	O	X

X- CLOSED
O- OPEN



BILL OF MATERIALS

ITEM	QUANTITY	MAKE	MODEL	DESCRIPTION
1	2	ALLEN BRADLEY	800H-HR2B	30.5MM TYPE 4X, 2 POSITION SELECTOR SWITCH, MAINTAINED POSITIONS ACCORDING TO CONTACT TABLE THIS DRAWING. C/W LEGEND PLATE.
2	1	WEIDMULLER	WDU 4	FEED THROUGH TERMINAL BLOCK
3	1	WEIDMULLER	TS35	35MM DIN RAIL
4	2	WEIDMULLER		END PLATE
5*	1	ALLEN BRADLEY	800H-2HZ4Y	FIBERGLASS 4X ENCLOSURE, 203.2MM(H)x114.3MM(W)x131.8MM(D) C/W BACK PANEL.
6	1			LAMACOID NAMEPLATE. WHITE LETTERING, BLACK BACKGROUND. TAG PER DEVICE. EX) "F550-SV".

* OR APPROVED EQUAL

NOTE:

EarthTech
Earth Tech (Canada) Inc. Winnipeg, Manitoba 204.477.5381

DATE	REVISION	APP.

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
WEWPCC - BIOLOGICAL NUTRIENT REMOVAL UPGRADE

SOLENOID VALVE LOCATION CONTROL STATION
LOCAL CONTROL STATION / LAYOUT & BILL OF MATERIALS

SCALE AS NOTED
DATE 2006/01/06
DES CD DWN PPL
CKD ES APP SWT

DRAWING NO.
ISD-20