PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Installation, including the supply of anchor bolts, and testing of equipment supplied under other Sections in Division 43.

.2 Commissioning requirements that are over and above the commissioning requirements specified in Section 01 91 13 and the individual process equipment specification sections. With commissioning the Contractor shall demonstrate and provide proof that all installed process equipment and components function as intended, individually and as integrated into the overall process system.

.3 This Section is to be read in conjunction with the provided process and instrumentation drawings and general arrangement drawings.

1.2 MEASUREMENT AND PAYMENT

.1 Payment for provision of all items specified in this Section shall be by Lot Price. No separate payment will be made for work specified in the Contract Documents. All costs incurred by Contractor in meeting with the requirements of this Section shall be included in the bid price for the Work.

1.3 DEFINITIONS AND INTERPRETATIONS

.1 Testing: In this Division, testing is defined as the operation of a specific item of equipment under actual and/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.

.2 Commissioning: In this Division, commissioning is defined as the operation of equipment systems under actual and/or simulated conditions for the purpose of ensuring the system performs its intended functions. Refer also to Section 01 91 13.

1.4 SUBMITTALS

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Provide Operation and Maintenance (O&M) Data for incorporation in the O&M Manual as specified in Sections 01 33 00 and 01 45 00.

.3 Submit system start-up and performance evaluation/commissioning plan at least four weeks prior to commencement of testing and commissioning.

.4 Submit the following prior to the commencement of testing and commissioning Work specified herein:
- .1 Completed Manufacturer's Certificate of Proper Installation.
- .2 Current and up to date certification of calibration for testing equipment, when used to produce test results to demonstrate compliance with the Contract Documents.
- .3 Documentation of pump test results and related instrumentation and control system test results, where such tests are required in terms of the individual Specification Sections.

.5 Submit all startup test results, commissioning records and Facility Performance Evaluation Certification within 3 working days of completing the startup/commissioning.

1.5 COORDINATION

.1 Coordinate with other Divisions to ensure that there is no conflict with the work.

1.6 SHIPMENT, PROTECTION, AND STORAGE

.1 Ship all equipment skid-mounted and pre-assembled, to the degree which is practicable.

PART 2 - PRODUCTS

2.1 EQUIPMENT SCHEDULE

.1 Unless indicated otherwise, supply and install all equipment detailed on the equipment Specification sheets, or shown on the Drawings.

2.1 EQUIPMENT SCHEDULE (Cont'd)

.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 written recommendations, the 2010 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 For rotating equipment, where specified, submit design notes and calculations for anchorage, signed and sealed by a Professional Engineer registered in the Province of Ontario.

PART 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 03.

.3 Coordinate the routing of ancillary piping with Division 23.

.4 Coordinate the routing of electrical and control wiring and conduit with Division 26.

.5 Coordinate all instrumentation equipment with Division 27 and Section 40 90 00.

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 Works.

.2 Refer to the equipment Specifications 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 Bid Documents for equipment bases, piping connections, etc., are approximate and must be corrected by the Contractor 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 Departmental Representative.

.4 Schedule Manufacturer's Representative Site visits. 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

.1 Install all equipment specified in other Sections, detailed on the equipment Specification sheets, or 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 Departmental Representative.

.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.

3.3 INSTALLATION (Cont'd)

.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 Departmental Representative and proceed as directed.

3.4 EQUIPMENT BASES AND ANCHORAGE

.1 Equipment will be mounted on housekeeping pads that are a minimum of 100 mm to 200 mm high.

.2 For rotating equipment of 7.5 kW or above and for equipment requiring structural anchoring, set anchor bolts in advance. Where required, set anchor bolts in sleeves to permit minor adjustment during installation. Use machine base templates where shown.

.3 Prepare grout as specified in Section 40 05 13 and provide full contact with the equipment bases unless otherwise recommended by the equipment Manufacturer and accepted by the Departmental Representative. 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

3.5 ALIGNMENT

.1 (Cont'd)

Under 100 rpm, 50 hp and over	3'00"	0.12 mm
100 to 600 rpm	2'00"	0.12 mm
600 to 1,800 rpm	1'00"	0.10 mm
1,800 to 3,600 rpm	0'35"	0.05 mm

.3 Check for soft foot, maximum permissible 0.002 mm.

.2 Where equipment undergoes a substantial differential temperature rise (30°C between driver and driven unit), provide precision benchmarks in foundation and on equipment and perform alignment at operating temperatures.

.3 Demonstrate to the Departmental Representative and Manufacturer's Representative the final alignment.

3.6 LUBRICANTS

.1 Extend any inaccessible lubrication points and lubricant drains to convenient locations.

.2 Remove storage lubricant and provide the initial fill of new lubricants for the equipment. Lubricant grade to be as recommended by the Manufacturer.

.3 Provide a Lubrication Schedule for all process equipment. Include the following:
.1 Equipment name and number.
.2 Date(s) of lubrication.
.3 Lubricant type installed.
.4 Frequency of lubrication.

3.7 VIBRATION SURVEY

.1 Conduct a vibration survey under normal operating conditions for all equipment with a motor size exceeding 37 kW and for smaller units where specified.

3.7 VIBRATION SURVEY (Cont'd)

.2 Use a calibrated vibration sensor, accepted by the Departmental Representative, 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 (3) 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 Departmental Representative.

.4 Record the vibration velocities for each item of rotating equipment and submit a report to the Departmental Representative detailing the findings. Include a description of the measuring equipment, identification of equipment on which vibration monitoring was completed, description of conditions under which the test was conducted, and a listing of all of the collected data.

.5 Unless specified otherwise, use unfiltered velocities as the vibration criteria. Unfiltered velocities less than 5 mm/s shall be considered acceptable. Undertake corrective action where unfiltered velocities exceed 5 mm/s.

3.8 NOISE SURVEY

.1 Conduct a noise survey for all equipment over 37 kW and for smaller units where specified.

.2 Use a calibrated noise meter, accepted by the Departmental Representative, and capable of measuring noise in the A Scale at a precision of 0.5 dBA and an accuracy of 1 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 Departmental Representative 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.

3.8 NOISE SURVEY (Cont'd)

.5 Equipment is to operate at a noise level of less than 85 dBA, when measured in free field at 1 m. Noise requirements may be more stringent in areas where more than one (1) 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 Where a noise level of 85 dBA is not achievable, post noise level clearly on each entryway to the area.

.8 In any process area, recommend whatever measures necessary to maintain a composite noise level below 85 dBA. Where directed by the Departmental Representative, undertake those corrective actions at no cost to the Departmental Representative.

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 and the required forms in Appendix Q. Complete Form 101, Form 102 and Form 103 that attest to the proper installation and functioning of the equipment.

3.10 TESTING AND COMMISSIONING - GENERAL

.1 Designate and provide one or more of the Contractor's supervisory personnel to coordinate and expedite testing and facility startup and to be present at all times during the testing and the facility startup and the performance evaluation periods.

.2 Develop an equipment commissioning procedure that, as a minimum, accounts for / incorporates the following:

.1 Confirmation that under simulated conditions all operational control switches and instrumentation functions correctly and activate/stop equipment to operate as specified.

.2 Equipment operation under manual control.

.3 Equipment operation under all specified automated control scenarios.

3.10 TESTING AND COMMISSIONING - GENERAL (Cont'd)

.3 Test each system independently and then in unison with integrated systems.

.4 When commissioning is complete and the system accepted by the Departmental Representative as being fully commissioned, remove all temporary measures that were provided for the commissioning process and render the process system operational to perform normal duty operations, as intended.

3.11 TESTING AND COMMISSIONING - FACILITY STARTUP AND EVALUATION

.1 Preparation, Planning and General:

.1 Prior to performing the commissioning work that is called for herein, ensure that:

.1 All factory testing and individual component testing as specified in the individual specification sections are fully completed and all elements of the system fully installed.

.2 Calibrate all testing equipment in accordance with the Manufacturer's written instructions.

.3 Inspect and clean all equipment, devices, connected piping, and structures to ensure they are free of foreign material.

.4 Lubricate all equipment in accordance with the manufacturer's written instructions.

.5 Turn rotating equipment by hand when possible in order to confirm that the equipment is not bound.

.6 Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.

.7 Check the power supply to electric powered equipment for the correct voltage.

.8 Adjust clearances and torque.

.9 Test piping for leaks.

.2 Sequence each unit process to the point that the complete facility is operational for the evaluation of unit process and facility performance.

.3 Demonstrate to the Departmental Representative's operations and maintenance personnel the proper operation of the required interfaces within and between the individual unit processes.

3.11 TESTING AND COMMISSIONING - FACILITY STARTUP AND EVALUATION (Cont'd)

.1 (Cont'd)

.4 Provide the Subcontractor's and the equipment manufacturers' respective staff that must be in attendance with adequate notice in order to prevent delays.

.5 Schedule ongoing Work so as not to interfere with, or delay, the completion of facility startup.

.6 After the facility is operating, complete the performance testing of any items and equipment for which previous testing was not possible.

.2 Evaluation Plan:

.1 Develop a plan in conjunction with the Departmental Representative's operations personnel detailing step by step instructions for the startup of each unit process and the complete facility.

.2 Include a method of evaluation and an overall performance report for each test phase.

.3 The plan shall consist of bound copies of the Startup and Performance Evaluation Forms. Use one form that is acceptable to the Departmental Representative for each unit process.

.4 The Startup and Performance Evaluation Form must include the following, at a minimum:

.1 Description of the unit process being started.

.2 All equipment and devices included in the unit process.

.3 Unit process startup procedures (i.e., valves to be open/closed, order of equipment startup).

.4 Requirements for all water, power, and chemicals needed for startup.

.5 The Contractor's certification that each unit process is capable of performing its intended function(s), including fully automatic operation.

.6 Space for evaluation comments.

.3 Ready-to-test determination: the "ready-to-test" determination will be made by the Departmental Representative based on the following, at a minimum:

.1 Notification by the Contractor of the equipment's readiness for testing.

.2 Acceptable testing plan.

.3 Acceptable Operation and Maintenance Manuals.

.4 Receipt of the Manufacturer's Certificate of Proper Installation, if so specified in the Contract Documents.

3.11 TESTING AND COMMISSIONING - FACILITY STARTUP AND EVALUATION (Cont'd)

.3 (Cont'd)

.5 Adequate completion of the Work adjacent to, or interfacing with, the equipment to be tested.

.6 Availability and acceptability of the manufacturer's representative, when specified in the Contract Documents, to assist in testing the respective equipment.

.7 Satisfactory fulfillment of all other specified manufacturers' responsibilities.

.8 Completion of the equipment and electrical tagging.

.9 Delivery of all spare parts and special tools.

.4 Facility Startup:

.1 Startup sequencing of unit processes shall be as determined by the Contractor.

.2 Make all adjustments, repairs, and corrections necessary to complete the facility start-up.

.3 Startup of the entire facility or any portion thereof shall be considered complete when, in the opinion of the Departmental Representative, the facility or a designated portion of the facility has operated in the manner intended.

.5 Facility Performance Evaluation:

.1 During the facility startup period, the Contractor shall conduct a performance evaluation for the purpose of evaluating the full capabilities of the facility.

.2 Certify, on the Facility Performance Evaluation Form, that each unit process is capable of performing its intended function(s), including fully automatic operation.

END OF SECTION