Pipe Specification No. PVC 40		**Reference Document**
Pipe Material:	PVC, Schedule 40	CSA B137.3
Fittings or	Same as Pipe	ASTM D2466
	Solvent Weld Type	D2467 CSA B137.3
Flanges:	80 mm and greater: PVC Type 1, Grade 1, Class 150 solvent weld type	ASNI B16.1
Pipe to Equipment Connections:	150# flanges	
Pipe Joints:	Solvent Weld Class 150	ANSI B16.1
Unions:	65 mm and smaller Sch 80 PVC socket ends	
Solvent Cement:	Approved for use in potable water service	ASTM D2564
Service Conditions:	Pressure Range: 0 – 1000 kPa Temperature Range: - 0 - 40?C	

Notes:

1. Sch 40 pipe shall not be threaded. Where a threaded connection is required, a Sch 80 socket by thread adapter coupling shall be used.

2. Reducing bushing shall not be used. Where a pipe size change is indicated, it shall be accomplished by the use of reducer couplings, concentric or eccentric as indicated, and manufactured with at least the same working and burst pressure capability as the pipe.

Pipe Specification No. CL Reference		**Document**
Pipe Material:	Copper Piping. Type L	ASTM B88
Fittings:	Compression fittings – copper	
Pipe to Equipment Connections:	Compression fittings	
Pipe Joints:	Soldered – 95/5 tin/antimony	
Unions:	200 lb – bronze, ground-joint. Crane 521 ½ to be used on one side of a valve.	
Adapters:	Bronze adapters provided where screwed valves specified.	
Service Conditions:	Pressure Range: 0 – 1050 kPa Temperature Range: 60?C	

Pipe Specifications No. VFT		**Reference Document**
Pipe Material:	Vinyl Flexible Tubing – (clear) Typon Type R3603 as supplied by Fabco Min. Wall thickness: ID 6.5 mm or less – 1.6 mm ID 11 mm to 16 mm – 2.3 mm ID 16 mm to 25 mm – 3.1 mm	
Fittings:	Fabco "Fast and Tite" thermoplastic	
Service Conditions:	Pressure Range: 0 – 700 kPa Temperature Range: 10? to 30? C	

END OF SECTION

1.0 GENERAL

1.1 Work Included

.1 Supply, installation and testing of process valves and actuators.

.2 The attached schedule of valves identifies the major valves included in the work. The list is not intended to be comprehensive but rather to act as a general guide for the process valves.

1.2 Related Work

.1	General Process Provisions:	Section 13010
.2	Process Piping:	Section 13100
.3	Detailed Pipe Specification Sheets:	Section 13105
.4	Controls and Instrumentation:	Division 16

1.3 Submissions

.1 Shop Drawings: Shop drawings for valves identified by valve specification number, shall be furnished prior to delivery.

.2 Conform to Section 01300, Shop Drawings and Samples.

1.4 Delivery and Storage

.1 Deliver valves to site using unloading methods which do not damage casings or coatings.

.2 Valves will be clearly tagged, stating size, type, model number, 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.

1.5 Process Valve Schedules

.1 Process valves are identified in the drawings by an alpha-numeric code.

.2 The Valve Schedule in this Section identifies valve tag number, function, type, size, connections, type of actuator, and standard of acceptance.

1.6 Definitions

.1 The following terms are used in this specification and are defined for that purpose as follows:

Low Pressure Service:	Less than 500 kPa
Medium Pressure Service:	500 kPa to 1500 kPa
High Pressure Service:	Greater than 1500 kPa

2.0 PRODUCTS

2.1 General

.1 Provide new, unused valves for the work.

.2 Valve materials shall be free from defects or flaws, with true alignment and bores.

.3 Valve bodies shall be clearly marked in raised lettering to indicate the valve type, rating, and where applicable, the direction of flow.

.4 Valves shall open counter-clockwise.

.5 Process valve schedule: See Drwg 401.

2.2 Drawings

.1 The Process Flow Schedule indicates all valves which are critical to proper process operation.

.2 The detailed process drawings and service piping schematic indicate additional valves for the purpose of draining, flushing, pressure reduction, shut off, etc.

.3 Provide all valves which are necessary to conform to fire and safety codes.

.4 Where a valve may be required for the process to function correctly but it is not included in the Contract Documents, inform the Engineer and provide details and suggestions for remedial action. Do not commence piping in the related pipe run until obtaining the Engineer's direction.

2.3 Valve Ends

.1 Valves in pipe runs 50 mm and less diameter shall be provided with female threaded ends unless indicated otherwise. Threads shall be American National Standard.

.2 Valves in pipe runs greater than 50 mm diameter shall be flanged unless indicated otherwise. Threads shall be American National Standard.

.3 Lug style wafer body valves shall be tapped holes, suitable for the bolts and nuts used to connect pipe flanges on either side.

.4 Wafer body valves shall have positioning holes, suitable for the bolt spacing of the pipe flanges placed on either side.

.5 Grooved joint valve ends shall only be used where indicated or if the Engineer's prior approval is obtained.

2.4 Manual Actuators

.1 Valves shall be provided with manual actuators unless specifically indicated otherwise on the process drawings.

.2 Handwheels shall have the direction for opening clearly shown in raised lettering and symbols.

.3 Handwheel diameters shall conform to MSS Standard Practice.

.4 The maximum rim pull on a handwheel shall not exceed 300 N when one side of the valve is a test pressure and the other side is at atmospheric pressure. Where a shaft mounted handwheel would require greater than this force to operate, a great operated unit shall be provided.

.5 50 mm operating nuts shall be to AWWA standards. Two operating wrenches shall be provided for each plant area in which operating nuts are used.

.6 Deep service valves shall be supplied with stem extensions and valve boxes. Two operating tees shall be provided for the plant.

.7 Quarter turn lever operators shall be perpendicular to the pipe run when the valve is closed.

.8 The maximum pull at the end of the lever arm shall not 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, a gear operated valve operator will be provided.

.9 Gear operators shall be worm gear type, equipped with a handwheel and a visual indicator of the valve position. They shall be grease lubricated. Where gear operators are intended for direct bury, they shall be sealed units with long life lubricant.

.10 For valves mounted more than 1.5 metres above the operating floor, chain wheels shall be provided. The chain pulley shall mesh positively with the chain. The chain will extend from the valve operator to a height 1000 mm above the operating floor. Hooks shall be provided from which to hang the chain. The chain shall be of sufficient weight to hang the chain. The chain shall be of sufficient weight to withstand all operating loads with a safety factor of five. The exact dimensions shall be determined in the field.

2.5 Valve Stem Extensions

.1 Valve stem extensions shall be provided where additional clearance is required for pipe insulation or where valve operation without the extension is difficult. as determined by the Engineer.

2.6 Valve Floor Stands

.1 Floor stands shall be provided where the operating valve is installed below floor level.

.2 Valve stands shall be capable of withstanding all dead loads and operating loads imposed by electric actuator or a manual handwheel, as specified in Contract Documents herein.

2.7 Finishes

.1 Requirements for special interior valve finishes are identified in the valve schedules.

.2 Valves shall be shop primed in accordance with Section 13901.

2.8 Spare Parts

.1 Provide all spare parts which normally would be required for one year's operation.

.2 Provide a list of all spare parts which would expect to be required under normal conditions for a period of five years. At the Engineer's request, provide a price for these parts.

3.0 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 the valves supplied for the work.

.2 Prior to the installation of the valves, field measure and check all equipment locations, pipe alignments, and structural installations. Ensure that the valve location and orientation provides suitable access to actuators.

3.2 Valve Installation

.1 Install valves in conjunction with the piping described in Section 13100.

.2 In horizontal pipe runs other than in locations where space does not permit, all valves except for butterfly valves shall be mounted with a vertical operating shaft with the actuator at the top.

.3 When joining valves to pipe or fittings, do not over torque bolts to correct for misalignment.

.4 Support valves in position using temporary supports until valves are fixed in place.

.5 Where valves are installed in PVC pipework greater than 150 mm dia. the valves shall be supported independently and braced against operating loads and torque to prevent transmission of stresses to the adjacent pipework.

3.3 Valve Extensions

.1 Install valve stem extensions where necessary to provide clearance from insulation.

3.4 Valve Testing

.1 Valves shall be operated under simulated and/or real process conditions to ensure they operate as intended.

.2 Valves shall be pressure tested in conjunction with the pipes in which the valves are installed as specified in Section 13100.

END OF SECTION

PART 1 - GENERAL

1.1 General Requirements

.1 All instrumentation components, items, equipment or programmable logic controller (PLC) systems and ancillary equipment as described in this Section shall refer to the supply, installation and satisfactory operation of the instrumentation and control system and/or component specified herein and/or detailed on the Contract Drawings.

.2 The Contractor shall carefully review the entire Contract Documents with emphasis on the Electrical, Mechanical and Equipment Sections of the Specifications and Contract Drawings. Co-ordination of the instrumentation trades with other trades shall be the responsibility of the Contractor.

.3 All work performed under this Section shall be by skilled instrumentation technicians and in strict accordance with the manufacturer's recommendations, good engineering practices and in accordance to standards established by the Instrument Society of America (ISA).

1.2 Scope of Work

.1 The work specified under this Section includes, but is not limited to the following:

- .1 Supply, assembly, installation, programming, commissioning, testing and start-up of all field equipment, instrumentation, PLC, I/O modules and ancillary equipment as specified herein and by the Instrument Data Sheets attached to this section, Loop Connection Diagrams and the Contract Drawings.
- .2 Adjustments, calibration and satisfactory start-up of all instrumentation and control components associated with all valves and package systems specified under other Sections.
- .3 Calibration of field instruments and start-up assistance as may be necessary to ensure the instrument systems function as specified and to train Owner's personnel on calibration procedures and operating procedures.
- .4 The following specified under this Section is included in this contract:
  - .1 Programming of the PLC and SCADA Operator Interfaces.

1.3 Electrical Requirements

.1 The work shall be carried out in accordance with the latest regulations of the Canadian Electrical Code and all applicable Municipal Codes and Regulations. In no instance, however, shall the standards established by the Drawings and Specifications be reduced by any of the Codes referred to above.

1.4 Shop Drawings

.1 Submit detailed Shop Drawings in accordance with Section 01340.

.2 Catalogues, manuals or price lists are not acceptable as Shop Drawings, but properly marked-up cuts from manufacturers' catalogues may be used to supplement information contained in the Shop Drawings.

.3 Process and Instrument diagrams, points lists, loop wiring diagrams and instrument specification sheets form part of the Shop Drawings. The Engineer will provide a copy of these P&ID's, control loop drawings, points list and data sheets to the Contractor on a CD ROM disk. The Contractor is to maintain a current hard copy during construction and submit a record set on CD ROM at completion of the Contract. Drawings to be done in AutoCAD 2000i format. Points lists and specification sheets to be done in Microsoft Excel format. All components shall be tagged and listed. All logic shall be cross-referenced and documented. All symbols shall follow ISA format with all non-standard symbols identified in a key legend.

.4 Submit Loop Drawings indicating all analog and digital input and output, tag names, terminal numbers, polarity, and controller connection points.

.5 Submit, in Shop Drawing form, documentation to clearly indicate and illustrate the pre-commissioning schedule and work to be performed and the conditions under which the tests will be preformed. Revise procedures if directed by the Engineer.

.6 Shop Drawings required for review include the following equipment from the Instrumentation List in this Division and other equipment from other Divisions:

.1 Pumps
.2 Pump MCCs and Starters
.3 Temperature switch / thermostats
.4 Level switches
.5 Flowmeter
.6 Pump discharge valve
.7 Pressure gauges
.8 PLC I/O modules
.9 Control panel layout and modifications
.10 Control loop drawings.

1.5 Location of Equipment

.1 The Contractor shall alter the location of equipment if directed by the Engineer. Relocation shall be at no extra charge, provided that the distance does not exceed 3 metres and the request for relocation is made before the equipment is installed.

.2 Equipment such as panels, instruments, switches, mounting hardware, etc. are shown in a general location on the Contract Drawings unless otherwise specified. The Contractor shall mount equipment within 500 mm in plan, of the area shown or as directed by the Engineer, to suit actual arrangements and interferences.

.3 Displays, gauges, readouts and indicators unless otherwise specified shall be mounted at eye level and in accordance with good engineering practices and/or as directed by the Engineer.

.4 All hand switches shall be wall-mounted or pedestal-mounted on 75 mm channel 1000 mm above floor level or as shown otherwise.

1.6 Identification

.1 Equipment, instrumentation and panel shall be tagged as per ISA-RP60.6-1984 "Recommended Practice for nameplates, labels and tags for control centres.

.2 Provide identification of all instrumentation components and systems as follows:

- .1 Wiring with heat shrink pre-marked wire markers each end of conductor bearing the same identification tag.
- .2 Terminal blocks using pre-marked snap in markers.
- .3 Relay using lamicoid nameplates with white letters 6 mm high on black background.
- .4 Instruments using 316 SS engraved nameplates permanently secured.
- .5 Switches using lamicoid nameplates with white letters 6 mm high (unless otherwise specified) on black background.

.3 All nameplates and identification shall be installed after painting is completed.

.4 Manufacturers' nameplates shall be clean and legible and shall NOT be painted.

PART 2 - PRODUCTS

2.1 Instrument Data Sheets

.1 All instruments, components and systems as specified on Instrument Data Sheets shall be considered as part of this Contract and unless otherwise specified, shall be supplied, assembled, installed, calibrated and started at no additional cost.

.2 The Tenderer shall, during the tender period, compare the Instrument Data Sheets to the Instrument List for completeness. Should the document being examined be missing Data Sheets, the Tenderer shall obtain said Data Sheets prior to submitting his Tender. No additional payment shall be considered for equipment listed in the Instrument List and not shown on Data Sheets.

.3 In the event of conflict between equipment manufacturer's model number and detailed specifications included on the Data Sheet, detailed specifications shall take precedence.

.4 Equipment supplied shall meet all requirements of the Instrument Data Sheets and shall be a complete component of the instrumentation system. It is the intent of the Data Sheets to define service, performance and optional accessories. Any items required for the proper operation of equipment and not included on the Data Sheets shall be provided at no additional cost.

2.2 Control Panels

.1 See Section 16131 - Splitters, Junction, Pull Boxes and Cabinets.

2.3 Control and Relay Panels

.1 See Section 16900 - Controls.

2.4 Terminal Blocks

.1 See Section 16900 - Controls.

2.5 AC Control Relays

.1 See Section 16900 - Controls.

2.6 DC Control Relays

.1 See Section 16900 - Controls.

2.7 Solid State Timing Relays

.1 See Section 16900 - Controls.

2.8 Sealed Contact Oiltight Limit Switches

.1 See Section 16900 - Controls.

2.9 Pushbuttons

.1 See Section 16900 - Controls.

2.10 Selector switches

.1 See Section 16900 - Controls.

2.11 Indicator lights

.1 See Section 16900 - Controls.

2.12 Control Cable

.1 See Section 16122 - Wires and Cables.

2.13 Instrument Cable

.1 See Section 16122 - Wires and Cables.

.2 Standard of acceptance: Belden Process Control Cabling.

2.14 Additional Conductors

.1 All cables in conduits shall contain 10% spare or a minimum of 2 unused conductors. All multi-conductor cables shall also contain 10% spare or a minimum of 2 unused conductors. Instrument cables ran in cable tray need not contain spare conductors. All spare conductors are to be securely bundled and identified as spares.

PART 3 - EXECUTION

3.1 General Instructions

.1 The Contractor shall be responsible for verifying all measurements and details of the equipment and structures necessary for the proper fitting and connecting of the new work to it, before proceeding with the work. Any discrepancies between the Drawings and work shall be referred to the Engineer. The Contractor is responsible for the proper fitting of the work and shall make such changes as necessary and directed by the Engineer without additional cost to the Contract.

3.2 Co-ordination of the Work

.1 The work of this Section shall be arranged in co-operation with other Divisions of this Contract in such a manner as not to interfere with other work. In areas where the ducts, pipes, wiring and equipment for other sections will be installed in proximity to pipes, wiring and equipment are installed to the best advantage.

.2 Underground conduit installation shall be coordinated with underground work of other trades.

.3 Equipment, conduit, etc., installed but not co-ordinated with the work of other trades shall be relocated as directed by the Engineer without extra cost to the Owners.

.4 Include all costs for overtime (premium time) work, which may be required in the opinion of the Owners to change over, reconnect existing services, (power, signals, branch circuit wiring, etc.) that cannot be done during regular working hours. No additional charges will be accepted by the Owners for work that has to be done on premium time to maintain the necessary continuity of services, within the buildings.

.5 All equipment, material, wiring and devices shall conform to the Canadian Electrical Code for the purpose for which they are to be used and shall bear the approval of the CSA, or have special approval of the Inspection Authority. All equipment shall be designed and manufactured in accordance with applicable CEMA and NEMA Specifications.

.6 Install equipment and apparatus requiring maintenance, adjustment or eventual replacement with due allowance thereof.

.7 Include in the work, requirements of manufacturers shown on the Shop Drawings.

.8 Replace work unsatisfactory to the Engineer without extra cost.

.9 Obtain the approval of the Engineer before doing any cutting. Supporting members of any floor, wall or building structure shall be cut only in such a manner as approved by the Engineer. Arrange to have all patching done by the trades whose work is affected. This work shall be performed in accordance with the requirements of the corresponding Division of these Specifications.

.10 Arrange for regular inspections and a final inspection with the local Electrical Safety Authority.

.11 All programming commissioning and testing shall be done by the Contractor.

.12 Provide training of equipment and instrumentation to the Owner and Operations Staff.

3.3 Cables and Wiring

.1 Unless indicated otherwise, all wiring and cables shall be installed in conduit, in accordance with Division 16.

.2 Branch circuits have been indicated on the Drawings for all lighting, power and other outlets. Identify the circuits in the lighting panels and power panels and at points of termination with cable markers. If the wiring is installed with a different circuit, revise the As-Built Drawings to show the new circuit number which has been given to the respective lighting or other appliance circuit.

.3 Shielded cables shall be terminated so that the shield is no more than 25 mm from the connection point. The shield shall be taped to the cable to prevent inadvertent connections.

.4 The colour scheme for panel wiring shall be:

Black	- 120 VAC Power Wiring
Red	- 120 VAC Control
White	- 120 VAC Neutral (if grounded)
Blue	- DC Control (positive)
Grey	- DC Control (negative)
Yellow	- Power from other source (i.e., not controlled by local disconnect)
Dark Green	- Earth ground
Light Green	- Instrument Ground

.5 The colour scheme for analog wiring shall be:

White	- Positive
Black	- Negative

3.4 Pre-commissioning, Testing and Inspection

.1 The pre-commissioning, testing and inspection work shall be performed in the presence of and to the satisfaction of the Engineer and is to include all devices required to simulate actual site operating conditions.

.2 The pre-commissioning and testing work shall be performed with the computer equipment and software specified connected through programmable controllers, and is to include a demonstration of system operation.

.3 Schedule the pre-commissioning and testing work with the Engineer and advise the Engineer of the proposed test date a minimum of ten working days prior to the test date.

.4 The Contractor shall co-ordinate with suppliers to ensure that both the instrument system technicians and the system integrator programmer are on site at the same time during precommissioning and testing.

.5 Do all system revision and/or correction work required as a result of these tests.

3.5 General Installation of System Components

.1 Unless otherwise specified herein or on the Drawings, including details, install instrumentation and control system components in strict accordance with the component manufacturer's instructions.

.2 If any requirement of this Specification or the Drawings contradict the component manufacturer's installation instruction in a manner which would be detrimental to the component and/or the overall system, notify the Engineer in writing and do not install the component(s) until a written direction has been received from the Engineer.

.3 Confirm all system component locations prior to roughing-in and/or installation.

.4 Supply any materials and/or test facilities required to commission components.

3.6 Controller Installation Requirements

.1 Install controllers in EEMAC panels. Surface wall or floor mount panels must be provided unless otherwise indicated and/or specified.

.2 Locate and install controllers and panels so as to be easily accessible for maintenance and readability of any displays. Provide adequate and permanent light source and 120VAC power to perform all commissioning and maintenance tests.

.3 When drilling conduit entry points in panels, provide proper protection for internally mounted equipment against damage from vibration, shock or metal filings.

3.7 System Wiring Requirements

.1 Provide all required system wiring. Wiring is specified in electrical installation Section.

.2 Where specific wiring types are not specified (except AC power wiring), provide types of wiring as recommended by the system component manufacturers.

.3 Provide conduit for all system wiring, except for power cords with integral plugs, and except where duct, tray or similar raceway materials are provided.

.4 Provide conduit as specified in electrical Section.

.5 Unless otherwise specified, conduit and wiring requirements specified in electrical Section apply to the work of this Section.

.6 Unless otherwise specified, install all analog signal conductors in separate dedicated conduits.

.7 Seal all conduit terminations to prevent moisture penetration into instruments or controllers.

.8 Provide a #6 AWG ground conductor from each instrumentation panel to the ground bus or ground system at the electrical power source.

.9 Analog signal conductor shields must be isolated at one end and grounded at the other end as shown on the Loop Drawings. If Loop is not shown, confirm exact termination and isolation details with the Engineer.

3.8 System Inspection and Testing Prior to Commissioning

.1 After the entire instrumentation and control system is complete and has been initially inspected for proper installation, including site inspections by component manufacturer as required, energize the system and:

- .1 Check and test the operation of each and every system component and the overall system, and adjust or repair as necessary.
- .2 Check the calibration of each instrument, and where necessary, recalibrate in accordance with the manufacturer's instructions.
- .3 For each instrument and system component verify the wiring connection back to the electronic controller terminals, use the I/O card LED's to verify digital I/O operation and polarity, use controller diagnostics to verify analog I/O polarity and calibration.

.2 When the inspection, testing, and calibration work is complete, forward to the Engineer a letter certifying that the instrumentation and control system is complete, operational, and ready for acceptance.

.3 When the Engineer has received the letter certifying that the system is complete, the Engineer and Owner will schedule a site visit or visits to spot check the calibration and operation of a maximum of 30 percent of the system instruments with your supervising personnel in attendance. Supply all devices and labour required to perform verification testing.

.4 If, during the site spot checks of instruments by the Engineer and Owner, more than two instruments are found to be not operating properly or not properly calibrated, the system will be rejected. The testing and calibration must be repeated and a new certifying letter prepared and submitted. A revisit for site spot checks will then be scheduled.

.5 With the Engineer's approval, site spot checks may be performed on completed Sections of the system, upon written certification by you that the Section is complete.

3.9 Site Commissioning Test

.1 When site inspection and testing of the instrumentation and control system has been satisfactorily completed, schedule with the software vendor the installation of controller and computer software.

.2 The contractor and his software vendor will perform loop tests for integrity of signal loop monitoring and equipment control. Provide a minimum of five (5) days assistance on any loop that fails to respond or equipment that must be manually operated during testing. When testing of the instrumentation and control system up to and including the operator display screens have been satisfactorily completed, schedule with the Engineer and Owner a site commissioning test of the entire system.

.3 Include for the presence at the site of qualified instrument technicians and component manufacturer's representatives to supervise the test, which is to demonstrate proper operation of all aspects of the system under all operating conditions to the satisfaction of the Owner and Engineer. Supply all labour, instruments and devices to perform the test.

.4 The site commissioning test must be satisfactorily completed prior to application for a Certificate of Substantial Performance of the Work.

3.10 Training Program for Owner's Operating Personnel

.1 When the site commissioning test has been satisfactorily completed, schedule with the Owner, through the Engineer, a minimum five (5) working day(s) (Monday to Friday) site training program for the Owner's plant operating personnel.

.2 The training program is to be conducted by qualified instrument technicians, component manufacturer's personnel and the system programmer, and is to use system operation and maintenance manual data as the basis for demonstrations and instructions.

.3 The training program is to include functional use of computer and diagnostic equipment and routine maintenance of equipment.

.4 The site training program must be complete prior to application for a Certificate of Substantial Performance of the Work.

.5 Pay all costs associated with the training program, with the exception of all costs (salaries, expenses, etc.) associated with the Owner's operating personnel being trained.

3.11 Post-Commissioning Operators Assistance

.1 After site commissioning Work and Owner's operator training have been completed and day-to-day operation of the instrumentation and control system has been assumed by the Owner, make available to the Owner's operation personnel for a minimum period of ten (10) days, on a 24-hour basis at the Contractor's expense, qualified personnel to assist the Owner's staff in system operation and/or maintenance procedures, including, if necessary, the physical implementation at the site of operator decisions.

3.12 Protection of Equipment

.1 After installation and before operation protect equipment against weather, dust, dirt and dampness in a manner satisfactory to the Owner and in accordance with the manufacturer's instruction, if any.

PART 1 - GENERAL

1.1 General Requirements

.1 All programming and ancillary requirements as described in this Section shall refer to the development and supply, installation testing, documentation and satisfactory operation of the control systems specified herein and/or detailed on the Contract Drawings.

.2 The Contractor shall carefully review the entire Contract Documents with emphasis on the Control and Instrumentation Section of the Specifications. Co-ordination of the programming integrator with other trades will be the responsibility of the Contractor.

.3 All work performed under this Section shall be by skilled PLC and SCADA programmers with at least 4 years' experience in similar projects and certified by the PLC and SCADA supplier. The Contractor will name the programming integrator and provide the Engineer with a referenced project history for each programmer to be used on this project. The named programmers cannot be replaced on this project without the approval of the Engineer.

1.2 Scope of Work

.1 The work specified under this Section includes, but is not limited to, the following:

- .1 Supply of application programming and documentation, software installation, testing, commissioning and start-up of PLCs, local area networks (LANs), SCADA computers and ancillary equipment specified herein.
- .2 Training of Owner's personnel in operating procedures, maintenance and troubleshooting software problems.

1.3 Shop Drawings

.1 Submit detailed Shop Drawings in accordance with Section 01340.

.2 Submit the following templates for approval before developing final versions:

- .1 PLC program showing documentation, program logic, subroutines, tagname, register tables, etc.
- .2 SCADA MMI screens.
- .3 Alarm Data and Historical Logged Data tables.
- .4 Trend display and printout for each type of trend.
- .5 Report.

.3 Submit the following for approval of developed version for review in draft form:

.1 PLC program showing documentation, program logic, subroutines, tagname, register tables, etc.
.2 SCADA MMI screens
.3 Alarm Data and Historical Logged Data tables.
.4 Trend display and printout for each type of trend.
.5 Report.

.4 Submit flow chart diagram of the PLC logic and interaction of the SCADA System

1.4 Control System Documentation

.1 If printed single-sided, all documentation shall be coil bound, printed on 8 1/2" x 11", 24 lb white linen based bond. If printed double-sided, 28 lb paper will be used.

.2 The binder will have a water resistant (acrylic coated) hard cover. Where manuals are more than 2" in thickness, metal hinged fabric covered catalogue style expanding binders shall be used.

.3 Screen reproductions, diagrams and pictorials shall be reproduced in colour where deemed desirable and identified by the Engineer.

.4 The documentation shall include but not necessarily be restricted to the following:
.1 Design Documentation:
.1 Functional specifications.
.2 Detailed design specifications.
.3 Operator/Reference manuals for software development and configuration performed by the Systems Integrator.
.4 System commissioning manuals.
.5 PLC program listing.
.6 PC program listings.
.7 Test results.
.2 Operations Manuals:
.1 Systems Administration Manual
.2 Operator Manuals
.3 Mission critical plan.

.5 The Operator/Reference manuals for software development and configuration performed by the Systems Integrator shall address how to operate the plant and how to perform all functions provided by the control system.

.6 All necessary documentation shall be provided to permit a capable individual to develop and incorporate custom routines and drivers into the system without being required to return to the Systems Integrator for additional information or assistance. In addition, as a minimum the Detail Design Specifications shall include the following:
.1 An overview of the system goals and objectives.