TESTING, ADJUSTING AND BALANCING OF ELECTRICAL EQUIPMENT AND SYSTEMS

1. GENERAL

1.1 Intent

.1 Except where otherwise specified, arrange and pay for testing, adjusting, balancing and related requirements specified herein.

.2 If test results do not conform with 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 Owner, who shall also sign the test documentation.

.5 Submit procedures proposed in writing for approval two (2) weeks prior to test.

1.2 Related Work

.1 Electrical General Requirements: Section 16010

.2 Starting of Electrical Systems and Equipment: Section 16960

1.3 Manufacturer's Production Test Records

.1 If requested, submit copies of production test records for production tests required by EEMAC and CSA standards for manufactured electrical equipment.

1.4 Site Testing Reports

.1 Log and tabulate test results on appropriate test report forms.

.2 Submit forms to Consultant 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 Consultant before proceeding with test and obtain clarification.

1.6 Manufacturer's Site Services

.1 Arrange and pay for the site services of approximately qualified manufacturer's representatives where site testing, adjusting, or balancing of electrical equipment or systems' performed by Manufacturer's representatives is:

.1 Specified, or

.2 Otherwise required to ensure that electrical equipment and systems are operational in full compliance with the Contract Documents

1.7 Sequencing and Scheduling

.1 Except where otherwise specified, perform all testing, adjusting, balancing and related requirements specified herein prior to Interim Acceptance of the Work.

.2 Perform voltage testing and adjusting after user occupancy or utilization of facility.

2. PRODUCTS

2.1 Test Equipment

.1 Provide all equipment and tools necessary to perform testing, adjusting and balancing specified herein and as otherwise required.

3. EXECUTION

3.1 Fire Alarm System Testing - General

.1 Refer to Section 16010 - Electrical General Requirements.

.2 Consultant will be responsible for directing verification of fire alarm system installation in accordance with:

.1 CAN/ULC-S537, Standard for Verification of Fire Alarm System Installations, and
.2 Requirements of authority having jurisdiction.

.3 Contractor shall be responsible for:

.1 Performing prerequisites to verification procedure; and
.2 Assisting and cooperating with Consultant in verification procedure

3.2 Fire Alarm System Testing - Prerequisites to Verification

.1 Prior to requesting verification by Consultant, do the following:

.1 Inspect system to ensure that the following items are completely installed, connected and fully operational in accordance with requirements of the Contract Documents and Manufacturer's recommendations:

.1 Complete fire alarm system including all components thereof
.2 All fire suppression and detection devices
.3 All smoke control equipment
.4 All other auxiliary equipment connected to fire alarm system

.2 Ensure that any subsequent work remaining to be performed on the above-noted items will not invalidate examinations and tests performed during verification procedures.

.3 Ensure that operation and maintenance data has been submitted.

.4 Ensure that spare parts and maintenance materials have been delivered.

.2 Submit written request to Consultant for verification, certifying that the above prerequisites have been fulfilled and specifying known exceptions in the form of a list of items to be completed, corrected or submitted.

.3 Consultant will, within two (2) weeks after receipt of written request:

.1 Proceed with verification, or
.2 Advise contractor that prerequisites are not adequately fulfilled

3.3 Fire Alarm System Testing - Verification

.1 The contractor and manufacturer shall assist and cooperate with Consultant in verification procedure. The contractor shall provide and pay for the following:

.1 Provide the following equipment:

.1 Voltmeter
.2 Sound pressure level meter
.3 Smoke generator or aerosol test smoke
.4 Four (4) portable communication devices
.5 Scaffolding and ladders

.2 Arrange and ensure that the following parties are present at all times during verification procedures:

.1 Electrical Subcontractor
.2 Fire alarm system manufacturer's representative

.3 Disassemble and reassemble system components

.4 Disconnect and reconnect wiring

.5 Perform required field adjustments

.6 Repair defective work and replace defective components

.7 Perform all work and tests on system required by verification procedure.

.2 Do not proceed with verification unless Consultant's representative responsible for directing verification procedure is present.

3.4 Testing of Wiring and Wiring Devices

.1 All power and control wiring shall be tested for insulation resistance value with a 1000 volt 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.

3.5 Ground Resistance Testing

.1 Measure ground resistance with earth test meter to verify compliance with CSA C22.2 No. 0.4 and Canadian Electrical Code.

3.6 Load Balance Testing

.1 Perform load tests when as many loads as possible, prior to Interim Acceptance of the Work, are operable.

.2 Turn on all possible loads.

.3 Test load balance on all feeders at distribution centres, motor control centre and panelboards.

.4 If load balance exceeds 15%, reconnect circuits to balance loads.

3.7 Power Factor Testing

.1 Record power factor readings at 15 minute intervals for full 24 hour period during normal operation of the facility.

.2 Take reading at following locations on distribution system:

.1 Main Service
.2 Motor Control Centre

3.8 Voltage Testing and Adjusting

.1 Test voltage at all panelboards.

.2 Test voltage at all elevators.

.3 Test voltage at motor control centre.

.4 Adjust transformer tap settings to compensate for under-voltage or over-voltage conditions, if directed to do so by Consultant.

3.9 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%, 50%, 75% and 100% load
.6 Exciting current at rated voltage
.7 Laboratory test of insulating liquid
.8 Impedance
.9 Applied potential test
.10 Induced potential test
.11 95 kV B.I.L. test
.12 Hi-pot test
.13 heat run, temperature rise tests on each transformer.

The above heat run tests and impulse tests to be witnessed by the Owner.

.3 Notify the Owner three (3) weeks in advance, in writing, of the time, date and place of the tests. This test will be attended first by the Owner at the Owner's expense. Any subsequent witness tests due to any reason whatsoever shall be at the expense of the equipment manufacturer but at the direction of the Owner.

.4 Witness tests may be waived by the Owner at his discretion; such waiver shall be in writing and shall not imply any acceptance by the Owner nor limit the liability of the manufacturer. A copy of the test results is to accompany the transformers when shipped.

.5 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.

.6 Site Testing

.1 After the transformers have been set in place, prior to energizing, verify in writing that the transformers have been installed and tested in accordance with recommended practice and are suitable for energizing and use. Without limiting the foregoing, the work shall, as a minimum, include the following:

.2 Prior to connecting, the Electrical Contractor is to inspect visually and conduct the following tests.

.1 Megger insulation and correct reading to 20-1/2 C base. Megger high voltage to ground with the secondary grounded for the duration of the test. Megger low voltage to ground with the primary grounded for the duration of the test.

.2 Perform electrical centres test on high voltage off-load tap changer switch.

.3 Sample transformer insulating liquid laboratory analysis to be carried out as follows:

.1 Dielectric breakdown
.2 Neutralization number
.3 Colour
.4 Interfacial tension
.5 Specific gravity

.4 Leak test piping.

.5 Perform ratio test for all transformer tap positions.

.6 Verify the shipping braces and shipping shims have been removed.

.3 After the connection of line, load, control and alarm wiring, but prior to energizing, the calibration and verification firm is to inspect the installation and confirm the following:

.1 That the transformer has been properly cleaned, is dry and free of foreign materials and contaminants and otherwise is suited for energizing.

.2 That all bus and connector bolts have been installed, tightened, torqued properly, and uninsulated surfaces of connectors and buses have been taped.

.3 That transformer taps have been set to provide the secondary voltage required.

.4 That all insulators are imperfect condition, without cracks, chips or surface contaminants.

.5 That core, coil, terminal boards, tap changers, bushings and all insulated surfaces have not been damaged.

.6 That the forced cooling fans are functioning and that the power supply circuits to the fans have been properly connected and protected.

.7 That all alarm and indicating devices are operating correctly, are properly connected either internally and externally from the terminal of the instrument to the external system, including the following:

.8 Liquid level and pressure

.9 Liquid temperature, with hi and hi-hi contacts connected to the building control computer

.10 Sudden pressure relay is unblocked and wired to trip the primary circuit breaker

.4 Any other tests or inspections deemed necessary or appropriate by the manufacturer.

3.10 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.

.1 Include the following: (NOTE - ADD PRIMARY EQUIPMENT IF APPLICABLE)

.1 Utility overcurrent and fault protection devices

.2 Primary switchgear

.3 Primary and 600v cable thermal damage curves

.4 600v air circuit breaker overcurrent, overload and ground fault devices

.5 347/600 and 120/208v panelboards, MCCs and switchgear, connecting feeder cables and bus duct

.6 15 kV and 600v transformer damage curves, magnetizing currents for all transformers 150 kVA and larger

.7 Locked rotor currents, acceleration times and damage curves for motors 75 kW and larger

.8 Any additional data necessary for successful completion of the coordination and short circuit study.

.2 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 time or otherwise.

.3 Prepare a summation chart showing all ratings and settings with easy reference to the appropriate curve.

.4 Symmetrical and asymmetrical fault current calculations shall be submitted to verify the correct choice of the protective elements of the System.

.5 Prepare a systems single line diagram on which the resultant short circuit valves, device number and ratings are shown.

.2 Relate Work in Other Sections

.1 Pad Mounted Distribution Transformers: Section 16323

.2 Service and Distribution: Section 16400

.3 CDP Panelboards and Molded Case Air Circuit Breakers: Section 16477

.4 Panelboards: Section 16430

.5 Air Circuit Breakers : Section 16476

.3 Qualifications

.1 This study shall be provided by the suppliers of the 600V switchgear.

.2 This study shall be performed by and bear the stamp of the Professional Engineer registered in the Province of Alberta.

.4 Submittals

.1 Submit the complete study for review prior to carrying out calibration and verification.

.5 Tripping Devices

.1 Relay styles, CT ratios and fuse sizes have been selected on a preliminary basis for design purposes.

Final selection shall be based on the results of this study and shall be included at no extra cost.

.6 Execution

.1 Provide the 600V switchgear supplier with all relevant data for equipment no provided by the supplier.

END OF SECTION

ELECTRICAL EQUIPMENT AND SYSTEMS DEMONSTRATION AND INSTRUCTION

1. GENERAL

1.1 Intent

.1 Provide demonstration and instruction sessions to familiarize Owner's operation and maintenance personnel with electrical systems and their operation and maintenance.

.2 Submit system sign off sheets for each system listed prior to substantial completion.

.3 Complete a motor survey sheet for each motor and submit prior to substantial completion. Include a control wiring diagram for each motor neatly drawn in ladder form. Indicate all terminal and wire numbers. Identify all associated control components. Provide typed copies of these lists and diagrams in the operating/maintenance manuals. Include motor overload selection charts for each type and application of overload relay.

.4 All sign off and survey sheets shall be typewritten.

1.2 Manufacturer's Site Services

.1 Arrange and pay for appropriately qualified manufacturers representatives to provide or assist in providing electrical equipment and system demonstration and instruction as specified herein.

1.3 Contractor/Owner Coordination

.1 Owner will chair demonstration and instruction sessions.

.2 Establish agendas for demonstration and instruction sessions in conjunction with Owner. Coordinate scheduling of sessions with Owner.

2. PRODUCTS (NOT APPLICABLE)

3. EXECUTION

3.1 Systems Demonstration

.1 Demonstrate operation of following systems:

.1 Primary Distribution and Transformer

.2 600/347 Volt Electrical System Emergency and Normal

.3 208/120 Volt System Emergency and Normal

.4 Pump Protection Panels

.5 Mechanical Equipment Connections and Controls

.6 Grounding System

.7 Fire Alarm

.8 Telephone

.9 Lighting

.10 Lighting Controls

.11 Future Connection Points and Conduit Stubs

MOTOR SURVEY SHEET

Motor Name & Number _____

Manufacturer _____

H.P. _____ Max. Ambient _____ °C

R.P.M. _____ Service Factor _____

Volts _____/_____/_____ Insulation Class _____

AMPS _____/_____/_____ EEMAC Design _____

PHASE _____ Time Rating _____

Frame _____ Type _____

Serial #

Model # _____

Starter _____ Type _____

OPERATING CONDITIONS

Full Load Operating Amps _____ A _____ B _____ C

Full Load Operating Voltage _____ A-B _____ B-C _____ C-A
at Motor

Overload Relay Installed _____ Adjustable Setting _____ %

M.C.P. AMPS _____ Adjustable Setting _____

Acceleration Time (If over 5 seconds) _____

Reduced Voltage Starter Tap Setting _____

Reduced Voltage Starter Transition Time Setting _____

Special Controls and Remarks (Thermistor and Relay Type, Capacitors and where connected, etc.

_____

_____

ELECTRICAL EQUIPMENT AND SYSTEMS
DEMONSTRATION AND INSTRUCTION

SYSTEM COMPLETION AND COMMISSIONING

SYSTEM: _____

The above system is installed as per the drawings and specifications, is complete and has been commissioned.

Electrical Contractor

Signed by: _____ Dated: _____

General Contractor

Signed by: _____ Dated: _____

Deficiencies Attached ZD?
@DY

This system has been reviewed by:

The Consultant

Signed by: _____ Dated _____

The Owner's personnel have been instructed in the operation and maintenance of the above system:

The Owner

Signed by: _____ Dated _____

The above does not constitute a waiver of any of the requirements of the Contract Documents.

	ELECTRICAL CONTRACTOR	GENERAL CONTRACTOR
	_____	_____
Address:	_____	_____
	_____	_____
	_____	_____
Phone:	_____	_____

END OF SECTION

DIVISION 17
INSTRUMENTATION AND CONTROLS

TABLE OF CONTENTS
DIVISION 17 - INSTRUMENTATION

INSTRUMENTATION AND CONTROLS
GENERAL REQUIREMENTS

1. GENERAL

1.1 Requirements of Work

.1 Supply, install, commission and provide warranty for a complete and fully documented instrumentation and control system as shown on the drawings and as specified herein. The instrumentation and control system contains vendor component subsystems specified in this and other sections of the specification.

.2 Component subsystems of the instrumentation and control system will include, but are not limited to, the following:

.1 Primary elements and transmitters

.2 Final control elements

.3 Instrumentation and control field devices

.4 Instrumentation and control junction boxes and marshalling panels

.5 Instrumentation cabling

.6 Instrumentation power supplies

.7 Conduit and cable trays.

.8 CDACS (Computer Data Acquisition and Control System)

.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 1.1.2.1 to include as a minimum:

.1 Equipment descriptive data.

.2 Equipment installation, service manuals, operation/maintenance manuals and recommended spare parts lists.

.3 Schematics and interconnecting wiring diagrams.

.4 Records of conductor identification, field terminals, changes, etc.

.5 Instrumentation and control panel shop drawings, face layouts, schematics and point-to-point wiring diagrams.

.6 Records of as-built information for the complete instrumentation system.

.6 Documentation provided is formatted as follows:

.1 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 - a sorted 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 Index - a sorted index of the CDACS I/O points shown on the P & IDs, giving the supporting documentation as per the instrument index.

.4 Instrument Specification Sheets - detail the relevant data for the supply of devices.

.5 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 drawing as they become available. A set of 'B' size (11" x 17") ACAD drawings and associated files will be made available to the successful tenderer. Where an ILD is not shown for wiring of simple devices provide a legible sketch for as-built information.

.6 Location Drawings - indicate in plan and/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 System
NEMA ICS 1-88	General Standards for Industrial Control and Systems
NEMA ICS 2-88	Industrial Control Devices, Controllers, and Assemblies
NFPA 70-90	National Electrical Code (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 13

.2 Mechanical: Division 15

.3 Electrical: Division 16

.10 Qualifications

.1 The instrumentation subcontractor to 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 (5) years.

.2 Submit with the bid a list of similar projects recently completed and resumes of the personnel proposed for the project.

.3 The instrumentation subcontractor to be experienced in the process and instrument requirements of this contract.

.4 The instrumentation subcontractor to show that it maintains a fully equipped and qualified organization, capable of performing the present work and of providing warranty service to the system after installation.

.5 Perform all instrument hook-ups, calibrations and checkouts with qualified journeyman instrument mechanics who are familiar with the devices being installed.

.6 Perform all control wiring installation and connections with qualified journeyman electricians.

.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, Canadian Underwriters Laboratories 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 Engineer.

.12 Standards of Workmanship

.1 Execute all work in a manner which will result in the completed installation presenting an acceptable appearance, to a level of quality defined in the general conditions of this specification.

.2 Employ a competent supervisor and all necessary licensed tradesmen to complete the work in the required time.

.3 Arrange and install products to fit properly into designated building spaces.

.13 Unless otherwise specified or shown, install products in accordance with the recommendations and ratings of the product manufacturers.

.1 Supply and execute installation of all instrumentation control tubing in accordance with Division 17.

.14 Contract Drawings and Specifications

.1 Refer to Division 1.

.2 Supply and install all items and accessories specified by the drawings or the specification in the quality and quantity required. Perform all operations as designated by the specification according to the methods prescribed, complete with all necessary labour and incidentals.

.3 Treat any item or subject omitted from this division's specifications or drawings, but which is mentioned or reasonably specified in other divisions' specifications or drawings and pertains to the instrumentation and control system, as being integral to the overall system. Provide such specified items or subjects.

.4 Provide all minor items and work not shown or specified but which are reasonably necessary to complete the work.

.5 If discrepancies or omissions in the drawings or specifications are found, or if intent or meaning is not clear, consult the Engineer 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 Engineer 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 degrees C and the space relative humidity below 50%.

.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

.3 under this section of the specification, comply with the requirements stated in the contract documents.

.4 Itemize all non-conformities noted above and forward them to the Engineer. Any delays in construction resulting from the delivery to site of non-conforming instrumentation and control components to be bourne by the Contractor.

.5 Do not install primary elements or other sensitive equipment until construction is sufficiently completed to provide an "operating condition" environment. Notify the Engineer prior to installing any equipment of this type.

.6 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.

.7 Return all damaged equipment to the factory for total corrective repairs. If deemed necessary by the Engineer, 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

.2 Seismic

.1 Seismic requirements to comply with current Povincial building codes.

1.4 Documentation

.1 Tender Submittals

.1 Submit a schedule within 30 days of award of contract to the Engineer 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 effects 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 job site and sufficiently in advance to allow ample time for checking, submit shop drawings for review.

.3 Contractor to review, modify, and approve the shop drawings prior to submitting shop drawings to the Engineer for review. Contractor approval of a drawing indicates the following:

.1 The drawing has been checked by the person making the approval

.2 The equipment or material complies in all respects with the requirements of the specifications and drawings

.3 The quantities, if indicated on the drawing, are correct

.4 The physical dimensions of the components are such that they can be installed without interference with the building structure or other equipment, and that, after installation, there are sufficient clearances on all sides for maintenance, servicing and operation of the equipment

.5 The points of attachment are clearly indicated, i.e. TOP, BOTTOM, SIDE, etc.

.6 The arrangement and location are properly oriented

.7 The product is suitable for its intended use.

.4 Stamp and sign the shop drawing to show approval, indicating the above has been complied with. If contractor revisions are too extensive, return the submission to the supplier for revision, then repeat the shop drawing approval process before submitting them to the Engineer.

.5 Manufacture of products shall conform to shop drawings marked as reviewed by the Engineer and returned to the Contractor.

.6 Keep one complete, maintained set of shop drawings at the job site during the construction period, record site modifications.

.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

.4 instructions in simple language to guide the Owner in the proper operation and maintenance of his installation.)

.5 A copy of all wiring diagrams complete with wire coding.

.6 Set of final reviewed shop drawings.

.3 Record Drawings

.1 Maintain on-site a complete set of as-built drawings as listed in Division 1 of this specification.

.2 In addition to the requirements as stated in Division 1, record on the drawings the following information:

.1 Mark all change orders, alterations or additions

.2 Show all instrumentation cable and control tubing

.3 Show all changes to the numbers and location of outlets, motors, panels and end devices that may occur during the course of the work.

.3 Before requesting the final completion certificate make any necessary final corrections to the drawings, sign each print as a certification of accuracy and deliver all sets to the Engineer for approval.

2. PRODUCTS

2.1 General

.1 Refer to the requirements of Division 1

.2 Selected Products and Equivalents

.1 Provide products and materials that are new and free from all defects.

.2 Products and materials called for on the drawings or in the specifications by trade names, manufacturer's name and catalogue reference are those which are to be used as the basis for the Tender.

.3 The design has been based on the use of the first named product, where applicable equivalent products are listed.

.4 Provide the products specified unless a proposal for an alternative or substitute product has been accepted by the Engineer.